

NEUROMOTRICIDAD Y NEUROEDUCACIÓN

La expresión musical y corporal como herramienta educativa

Editor: FRANCISCO JAVIER ROMERO-NARANJO



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Carta del editor

Estimado lector,

es con una mezcla de profundo respeto y entusiasmo presentar este volumen fruto de años de colaboración e investigación con los compañeros del grupo de investigación del que ya poseemos más de doscientas publicaciones científicas, 60 de ellas catalogadas en Web of Science y más 30 en Scopus. Esta publicación marca no solo un hito en el grupo de investigación, sino, lo que es más crucial, un punto de inflexión en el derrotero conceptual de la disciplina de la Neuromotricidad. Este libro nace de una convicción y de una necesidad urgente: la de dotar a esta disciplina de la arquitectura intelectual y la precisión terminológica que su intrínseca complejidad requiere y merece.

Vivimos en la era de la "neuro-eclosión". El prefijo, otrora reservado a círculos muy especializados de la medicina y la biología, ha permeado la pedagogía, la psicología y, por supuesto, la motricidad. Esta bienvenida apertura ha catalizado, sin embargo, un fenómeno que debemos abordar con discernimiento: la confusión disciplinar. Asistimos a una proliferación de prácticas que, bajo el paraguas de la Neuromotricidad, corren el riesgo de vaciarla de su contenido esencial, diluyéndola en categorías preexistentes o, peor aún, reduciéndola a un mero adendum discursivo. Permítaseme, pues, emplear este espacio para una indispensable labor de clarificación conceptual. El desiderátum de este volumen no es reformular lo ya conocido, sino trazar fronteras epistemológicas claras.

La primera y más persistente falacia conceptual que deseamos dismantelar es la noción de que Neuromotricidad es simplemente hacer movimiento y hablar del cerebro. Esta perspectiva ingenua trivializa dos décadas de investigación en control motor, aprendizaje y plasticidad. La mera mención de la corteza, el cerebelo o los ganglios basales no convierte una clase de educación física o una sesión de rehabilitación en una intervención neuromotriz. Lo que distingue a nuestra disciplina no es el nomenclátor, sino la praxis profundamente fundamentada en la doble tarea con una importancia única en el lenguaje.

La Neuromotricidad exige una comprensión mecanicista de los procesos subyacentes que perfectamente detalló Andreu-Cabrera y Romero-Naranjo en 2021. Requiere que la actividad propuesta sea explícitamente diseñada para modular una función neural específica: la integración sensorial, la anticipación predictiva, la inhibición ejecutiva del movimiento o la optimización de los circuitos de feedforward y feedback. El profesional de la Neuromotricidad no solo observa un movimiento, sino que infiere y busca activar el circuito neural que lo sustenta, modificando las variables ambientales o de la tarea con una precisión quirúrgica basada en la evidencia neurocientífica. Sin esta intencionalidad fundamentada y este rigor analítico, el ejercicio es, sencillamente, movimiento con un comentario neurocientífico tangencial.

La segunda gran confusión, que requiere una delimitación particularmente sensible, concierne a la Psicomotricidad. Afirmamos con vehemencia que Neuromotricidad no es hacer Psicomotricidad y hablar del cerebro. La Psicomotricidad, una disciplina venerable y de vasto alcance histórico-humanístico, se centra tradicionalmente en la globalidad del ser, integrando la dimensión afectiva, relacional, simbólica y motriz. Su foco es la expresión del ser a través del cuerpo y su relación con el mundo, abordando a menudo el esquema corporal y la lateralidad desde una óptica fenomenológica y evolutiva más amplia.

La Neuromotricidad, si bien respeta y reconoce el acervo psicomotriz, opera bajo un marco teórico y metodológico diferente. Su identidad reside en el análisis y la intervención de los sistemas

neuromotrices con la inclusión del lenguaje. Sus actividades están diferenciadas no por el material que se utiliza, sino por el objetivo neural que persiguen. Utiliza el movimiento como vehículo para el cambio en el sistema nervioso, basando sus decisiones en métricas de rendimiento motor y marcadores biológicos o electrofisiológicos indirectos.

Este libro es, por tanto, una invitación a la madurez disciplinar. Es un llamado a todos los investigadores, clínicos y educadores a abandonar las definiciones laxas y a adoptar el rigor conceptual. La Neuromotricidad, como disciplina diferenciada, cuenta con su propia taxonomía de actividades, sus propios instrumentos de evaluación y, fundamentalmente, su propio cuerpo teórico derivado de la neurociencia motora y del desarrollo.

Con la seguridad de que las páginas que siguen servirán para establecer este necesario anclaje, y en la esperanza de que este volumen inspire una nueva generación de profesionales rigurosos y conscientes de la profundidad de su campo, les deseo una lectura enriquecedora y transformadora.

Atentamente,

El Editor.

Francisco Javier Romero-Naranjo

Estrategias de investigación aplicadas en educación musical, danza y artes escénicas. Recomendaciones iniciales, enfoques metodológicos y ejemplos prácticos.

Francisco Javier Romero-Naranjo

Abstract

Research in music, dance and performing arts presents unique methodological challenges, derived from the profound subjectivity and experiential richness that characterize these disciplines. Emphasizing the need for rigorous empirical study design, it provides a comprehensive framework for researchers and students navigating these complex fields. This research provides foundational steps and insights, advocating the consultation of broad educational research methodologies and specialized manuals in music, dance, and the performing arts. It underscores the importance of leveraging key databases such as *Web of Science* for bibliometric analysis and literature reviews, while also guiding researchers toward discipline-specific resources like RILM, RISM, RIPM, and RIDIM for music, and specialized archives for dance and performing arts. The strategic use of Boolean operators and truncation in search queries is detailed to enhance research precision and efficiency. Furthermore, the paper explores various research designs, including descriptive studies, studies of association between variables, and intervention studies (both quasi-experimental and mixed-methods). For each design, the study outlines its purpose, methodology, and application within music, dance, and performing arts contexts, providing concrete examples. It also addresses the role of statistical software and bibliographic management tools in facilitating rigorous data analysis and reference management by synthesizing diverse methodological approaches and resources, this paper offers a valuable contribution to the field, aiming to equip researchers with the tools and knowledge necessary to conduct impactful studies and advance scholarship in music, dance, and the performing arts.

Keywords: Research Methodology; Music, Dance, and Performing Arts; Research Design; Literature Review; Data Analysis.

Resumen

La investigación en música, danza y artes escénicas presenta desafíos metodológicos únicos, derivados de la profunda subjetividad y la riqueza experiencial que caracterizan a estas disciplinas. Haciendo hincapié en la necesidad de un diseño de estudio empírico riguroso, esta proporciona un marco integral para los investigadores y estudiantes que navegan por estos complejos campos. Esta investigación aporta los pasos y los conocimientos fundamentales, abogando por la consulta de amplias metodologías de investigación en educación y manuales especializados en música, danza y artes escénicas. Subraya la importancia de aprovechar bases de datos clave como *Web of Science* para el análisis bibliométrico y las revisiones bibliográficas, al tiempo que orienta a los investigadores hacia recursos específicos de la disciplina como RILM, RISM, RIPM y RIDIM para la música, y archivos especializados para la danza y las artes escénicas. Se detalla el uso estratégico de los operadores booleanos y el truncamiento en las consultas de búsqueda para mejorar la precisión y la eficacia de la investigación. Además, el documento explora diversos diseños de investigación, incluidos los estudios descriptivos, los estudios de asociación entre variables y los estudios de intervención (tanto cuasi experimentales como de métodos mixtos). Para cada diseño, el estudio esboza su propósito, metodología y aplicación en contextos de música, danza y artes escénicas, proporcionando ejemplos concretos. Al sintetizar diversos enfoques metodológicos y recursos, este trabajo ofrece una valiosa contribución al campo, con el objetivo de dotar a los investigadores de las herramientas y conocimientos necesarios para llevar a cabo estudios de impacto y avanzar en el conocimiento de la música, la danza y las artes escénicas.

Palabras clave: Metodología de la investigación; Música, danza y artes escénicas; Diseño de la investigación; Revisión de la literatura; Análisis de datos.

INTRODUCCIÓN

La investigación en música, danza y artes escénicas presenta retos metodológicos específicos, dada la naturaleza subjetiva, experiencial y no tangible de estas disciplinas. Un ejemplo claro de su potencial es la colaboración histórica entre Stravinsky, Diaghilev y Picasso a inicios del siglo XX, la cual estableció un modelo de trabajo interdisciplinar. Stravinsky aportó una música revolucionaria (con ritmos complejos y ruptura tonal, como en *Pulcinella*); Diaghilev actuó como director visionario, uniendo las artes; y Picasso introdujo un diseño visual innovador (cubista/neoclásico en escenografía y vestuario). Esta sinergia *avant-garde* no solo transformó la estética del espectáculo, sino que demostró cómo la unión de música, danza y artes visuales crea una experiencia artística completa (Davis, 2010). En pleno Siglo XXI la unión entre música, danza y artes visuales es cada vez es más palpable y requiere de herramientas para su correcta investigación, principalmente para aquellos estudiantes de final de carrera universitaria o doctorado que necesitan modelos de apoyo. La observación de deficiencias en el diseño de estudios, incluso entre estudiantes avanzados y doctorandos, subraya la necesidad de un marco metodológico introductorio y accesible para saber investigar.

La presente investigación propone articular un conjunto de directrices fundamentales para el diseño de estudios empíricos en música, danza y artes escénicas que le sirvan al alumnado que investiga con el objetivo de conocer los pasos fundamentales para articular correctamente una investigación. Este trabajo se fundamenta en la premisa de que un diseño metodológico sólido es crucial para la generación de conocimiento válido y fiable en estas áreas. Al proporcionar una base sólida para la investigación, se busca fomentar un enfoque de análisis basado en evidencia y datos objetivos, contribuyendo así al avance del conocimiento en estas disciplinas.

Este artículo se estructura en varias secciones principales: primero, se presentan recomendaciones preliminares para el diseño de estudios, abordando consideraciones clave en la investigación en música, danza y artes escénicas. Segundo, se ofrece una aportación a los bibliométricos y tipos de “review” en relación a su importancia en la investigación artística. En tercer lugar, se aportan los modelos de diseño de investigación aplicables, acompañada de ejemplos prácticos para ilustrar su relevancia. En cuarto y último lugar, la importancia de los gestores bibliográficos como apoyo al estudiante para la organización, gestión y citas de las referencias bibliográficas seleccionadas.

Se espera que este trabajo sirva como un recurso valioso para investigadores en formación, así como para aquellos que buscan fortalecer sus habilidades de diseño metodológico en estos campos.

Los objetivos principales de este artículo son:

1. Dotar de herramientas para diseñar estudios de investigación en música, danza y artes escénicas.
2. Mostrar los motores de búsqueda de alto impacto más relevantes y su impacto.
3. Presentar modelos de diseño de investigación aplicados a estas áreas temáticas.

1. LITERATURA BÁSICA.

El presente estudio propone iniciar la exploración metodológica a través de la consulta de autores relevantes en investigación educativa de amplio espectro. Específicamente, se sugiere la revisión exhaustiva de textos como *Research Methods and Methodologies in Education* (Coe et al., 2025), *Research Methods for Education* (Newby, 2014) y, de manera prominente, la obra referencial *Research Methods in Education* (Cohen et al., 2002). Este último, en particular, se erige como un punto de partida fundamental, proporcionando un marco general para la investigación en el ámbito educativo. Dicho marco, previo a la inmersión en la especificidad de la investigación en música, danza y artes escénicas, facilita la comprensión global de los paradigmas y estrategias metodológicas predominantes.

En lo que respecta a la educación musical, como primer paso sugerimos el manual *The Oxford Handbook of Music Education* (McPherson & Welch, 2012) que aporta una visión global sobre dicha temática. En referencia a la danza sugerimos el manual general titulado *Dance education around the world* (Nielsen & Burridge, 2015), a la par que *The Oxford handbook of dance and wellbeing* (MacDonal & Chaiklin, 2017) y *The Oxford handbook of dance and ethnicity* (Shay & Sellers-Young, 2016) dado que todos ellos le aportan al futuro investigador un panorama muy amplio sobre ello. En relación a las artes escénicas, no abunda tanto material en manuales, aunque podemos destacar la obra *Performing arts management: A handbook of professional practices* (Stein, 2022). Con todo ello, es importante mencionar el manual que engloba las artes y sirve de base para la investigación *International handbook of research in arts education* (Bresler, 2007).

1.1 Bases de datos fundamentales.

Al comenzar a investigar se debe fundamentar la investigación en relación a la base de datos Web of Science (WoS), provista por Clarivate Analytics®, como epicentro para la consulta de información bibliográfica relevante en la investigación científica actual. Si bien se reconoce la existencia y utilidad de otras bases de datos como SCOPUS (Elsevier®), ERIC (Institute of Education Sciences®), ARXIV (Cornel University), SPORTDiscus, PsycINFO (American Psychological Association®), EBSCOHost (EBSCO®), PubMed y Medline (National Library of Medicine®), UpToDate (Wolters Kluwer), BHA (The Getty), AATA (Getty), DIALNET (Universidad de La Rioja), Jstor (Ithaka Harbors), se argumenta que WoS posee atributos distintivos que justifican su selección como plataforma principal, especialmente en etapas iniciales de la investigación.

A continuación, procedemos a **justificar el valor tan importante que posee WoS en la investigación** (Pranckutė, 2021):

- **Estándar de referencia:** WoS se consolida como la colección predominante de publicaciones académicas en múltiples disciplinas, siendo ampliamente reconocida y utilizada por la comunidad científica (Shani & Singh Kaurav, 2023).
- **Riqueza de metadatos:** La base de datos WoS proporciona metadatos de investigación exhaustivos, facilitando análisis bibliométricos avanzados y la identificación de patrones en la producción científica (Martin-Martin et al., 2018).

- **Cobertura de citas:** En comparación con otras plataformas como SCOPUS y Google Scholar, WoS ofrece una cobertura más amplia y precisa de la información de citas, permitiendo un seguimiento detallado del impacto de las publicaciones (Chigbu et al., 2023).
- **Sistema de clasificación de revistas:** WoS emplea un sistema de clasificación de revistas con alta precisión, basado en criterios rigurosos y transparentes, lo que garantiza la calidad de las publicaciones indexadas (Pranckutė, 2021).
- **Journal Citation Reports (JCR):** Para focalizar la búsqueda en estudios de alto impacto, se recomienda priorizar las colecciones Social Science Citation Index y Science Citation Index Expanded, que integran las revistas indexadas en el Journal Citation Reports (JCR), reconocido por sus métricas de calidad y relevancia.

En cada ámbito existen revistas específicas que sirven a modo de referencia como es el caso de la música: *Music Education Research*, *British Journal of Music Education* o *Journal of Research in Music Education*. En danza destacan: *Journal of Dance Education*, *Journal of dance medicine Science*, y de manera interdisciplinar *Cuadernos de Música*, *Artes visuales y Artes escénicas*. En artes visuales destacan, *Journal of Visual Arts Practice*, *International Journal of Education the Arts* e *International Journal of Art and Design Education*, entre otros tantos.

¿Cómo buscar en WoS? Al investigar en el campo de la educación musical, a modo de ejemplo, es fundamental utilizar el término “music Education” como punto de partida, complementándolo con palabras clave en inglés. La elección correcta de las palabras clave, (keywords), le ayudará a focalizar correctamente la investigación. Este enfoque te permitirá obtener una visión inicial del extenso panorama de investigaciones existentes. Por ejemplo, podrás identificar las tendencias más actuales, los investigadores más influyentes y los países con mayor producción en este ámbito (Ivanović & Ho, 2019).

En investigación es básico emplear el álgebra booleana cuya función es el proceso de combinar términos de búsqueda mediante las palabras “AND”, “OR” y “NOT” (siempre en mayúsculas), que funcionan para la búsqueda de papers relevantes como «operadores booleanos».

Para refinar tus búsquedas, puedes combinar el operador booleano “AND” con el término “music Education” y otros términos específicos de tu interés. Esto te ayudará a enfocarte en documentos que se alineen con tus objetivos.

Por ejemplo:

- [(“music education”) AND (“dance”)].
- [(“music education”) AND (“body percussion”)].
- [(“music education”) AND (“rhythm”)].

También es posible crear cadenas de búsqueda más complejas, incorporando sinónimos o términos relacionados mediante el operador 'OR'. El uso de «OR» amplía la búsqueda y muestra toda la bibliografía en la que cualquiera de los términos combinados. Por ejemplo:

- [(“music education” OR “music pedagogy” OR “music teaching”) AND “music education”].

Es importante destacar que el uso de «OR» también es útil para conectar sinónimos. Con el objetivo de realizar búsquedas más exhaustivas, puedes utilizar el asterisco (*) para truncar términos, ampliando así la búsqueda a toda su familia léxica. Por ejemplo:

- [(“music pedagogy” OR “musical instruction” OR “music learning” AND (“music education”)].

Otro ejemplo para concretarlo en el campo de la danza, sería con los términos [(“dance instruction*” OR “dance pedagogy*” OR “dance teaching” OR “dance studies” OR “dance skill acquisition”)].

WoS nos permite igualmente realizar cadenas mas complejas como las que proponemos a continuación: [(‘student* teacher*’ OR ‘future teacher*’ OR ‘teacher education’ OR ‘higher education’ OR ‘teacher* training’) AND (‘intervention*’ OR ‘program*’ OR ‘effect*’ OR ‘experimental group’ OR ‘control group’ OR ‘comparison group’) AND ‘music education’)].

En la búsqueda booleana también se puede emplear “NOT” que servirá para restringir la búsqueda, eliminando así todos los resultados que contengan un determinado término de búsqueda. Por ejemplo, “music pedagogy” NOT “alzheimer” reflejará los artículos que contengan el término pedagogía musical, pero omitirá todos los artículos que mencionen Alzheimer. Es importante mencionar que “NOT” debe utilizarse con cautela ya que puede omitir artículos que pueden ser de gran valor para la investigación.

1.2. El Índice h (o Índice de Hirsch) y el Índice i10.

El investigador siempre se encontrará con autores relevantes que tienen las indicaciones de “Índice h”. En el ámbito de la evaluación de la producción científica, el Índice h (o Índice de Hirsch) y el Índice i10 emergen como métricas bibliométricas cruciales que cuantifican la productividad y el impacto aparente de un investigador. El Índice h se define como el número h de publicaciones que tiene un autor que han sido citadas al menos h veces cada una, estableciendo un equilibrio riguroso entre la cantidad de *output* y la relevancia citacional del mismo. Por su parte, el Índice i10, una métrica específica de Google Scholar, representa el número de publicaciones que han recibido al menos diez citas, ofreciendo una medida más directa de la productividad de artículos con un impacto moderado. La importancia de estas métricas radica en su función como indicadores clave de excelencia investigadora, siendo sistemáticamente utilizados por agencias de financiación, comités de promoción y juntas de contratación para realizar una evaluación objetiva y comparativa de la trayectoria académica de un científico, determinando así su visibilidad, su capacidad para atraer recursos y su contribución sostenida al avance del conocimiento en su campo disciplinar.

1.3 Motores específicos de investigación en música, danza y artes escénicas.

En este apartado comentaremos los motores de búsqueda específicos por áreas temáticas que ayudarán al futuro investigador a focalizar de manera muy precisa su investigación.

A. MÚSICA.

En lo que respecta al ámbito musical el investigador debe de consultar bases fundamentales que a continuación describimos.

RILM. El Répertoire International de Littérature Musicale (RILM) es una base de datos bibliográfica exhaustiva que cataloga investigaciones sobre música a nivel global. Funciona como un índice detallado y un repositorio de resúmenes que abarca una amplia gama de publicaciones, desde libros y artículos académicos hasta disertaciones, cubriendo todo tipo de música y temas relacionados. Su objetivo es proporcionar a investigadores y estudiantes un acceso completo y organizado a la literatura musical mundial.

RISM. El Répertoire International des Sources Musicales (RISM) es un proyecto internacional destinado a documentar las fuentes de música manuscrita anteriores a aproximadamente 1800, conservadas en todo el mundo. Su principal objetivo es crear un inventario global de estas fuentes, facilitando así la investigación en musicología y proporcionando información detallada sobre la ubicación, el contenido y la procedencia de los manuscritos musicales históricos.

RIPM. (Retrospective Index to Music Periodicals) es un índice internacional en línea que ofrece acceso a periódicos musicales históricos publicados entre 1760 y 1966. Su objetivo principal es preservar y hacer accesible una valiosa fuente de información sobre la historia de la música, incluyendo críticas, artículos y noticias de la época. RIPM permite a investigadores y estudiantes explorar y analizar la evolución del pensamiento musical y la práctica interpretativa a través de una amplia colección de publicaciones periódicas.

RIDIM. (Répertoire International d'Iconographie Musicale) es un proyecto académico internacional dedicado a la catalogación y estudio sistemático de la iconografía musical. Su objetivo es crear un índice exhaustivo de imágenes que representen temas relacionados con la música a lo largo de diversos períodos históricos y ubicaciones geográficas. Funcionando como un esfuerzo colaborativo, RIDIM facilita la investigación interdisciplinaria al proporcionar un recurso centralizado para académicos en musicología, historia del arte y campos relacionados. A través de sus métodos de catalogación estandarizados, RIDIM permite el análisis de los contextos culturales, sociales e históricos de las prácticas musicales representadas en fuentes visuales, contribuyendo significativamente a nuestra comprensión de la interacción entre la música y las artes visuales.

New Grove & MGG. El "New Grove Dictionary of Music and Musicians" y "Die Musik in Geschichte und Gegenwart" (MGG) son dos enciclopedias musicales de referencia mundial que se pueden consultar tanto en papel como online. El "New Grove", publicado en inglés, es una obra extensísima que abarca todos los aspectos de la música, desde compositores y obras hasta teoría musical e instrumentos, ofreciendo información exhaustiva y actualizada. Por otro lado, el MGG, publicado en alemán, es igualmente completo y detallado, con un enfoque particular en la música en el contexto de la cultura germana, aunque también cubre un amplio espectro de la música global. Ambos diccionarios son recursos indispensables para músicos, investigadores y estudiantes de

música, proporcionando información rigurosa y especializada sobre la historia, la teoría y la práctica musical.

B. DANZA.

Si bien no existe un repertorio internacional de danza que tenga la misma estructura y alcance que RILM o RISM en el campo de la música, existen recursos y proyectos importantes que se dedican a la documentación y catalogación de la danza a nivel mundial. Estos son algunos ejemplos:

- **Dance Heritage Coalition:** Esta organización en los Estados Unidos se dedica a preservar y promover el patrimonio de la danza. Aunque su enfoque principal es estadounidense, contribuye a la documentación de la danza a nivel internacional.
- **Archivos nacionales y bibliotecas:** Muchos archivos nacionales y bibliotecas en todo el mundo conservan colecciones de materiales relacionados con la danza, incluyendo partituras de danza, videos, fotografías y documentos escritos.
- **Proyectos de documentación digital:** Existen varios proyectos que utilizan tecnologías digitales para documentar y preservar la danza, permitiendo el acceso en línea a materiales de danza históricos y contemporáneos.
- **Centros de documentación y archivos de danza:** Existen diferentes centros de documentación a lo largo del mundo que trabajan en el repertorio de la danza. En España por ejemplo se encuentra el Centro de documentación de las artes escénicas y de la música (CDAEM) dependiente del INAEM, que atesora material diverso sobre la danza en este país.

Aunque no existe un "RILM de la danza", estos recursos y proyectos contribuyen a la preservación y el acceso al patrimonio de la danza a nivel mundial. De la misma manera es importante citar el valioso diccionario *The Oxford dictionary of dance* (Craine & Mackrell, 2010).

C. ARTES ESCÉNICAS.

A diferencia de la música, donde existen repertorios internacionales estructurados como RILM o RISM, el campo de la actuación carece de un sistema de catalogación global equivalente. Sin embargo, existen varios recursos y prácticas que cumplen funciones similares:

- **Obras de teatro clásicas y contemporáneas:** Existe un canon de obras teatrales reconocidas internacionalmente, que incluye tragedias griegas, obras de Shakespeare, piezas de Ibsen, Chéjov, y dramaturgos contemporáneos. Estas obras forman un repertorio de referencia para actores y directores en todo el mundo.
- **Textos y manuales de actuación:** Existen numerosos libros y manuales que describen técnicas de actuación, estilos interpretativos y ejercicios prácticos. Estos recursos, como los escritos por Stanislavski, Meisner o Strasberg, sirven como herramientas de formación y referencia para actores.
- **Bases de datos y archivos de artes escénicas:** Existen archivos y bases de datos que catalogan obras de teatro, actuaciones y materiales relacionados. Estos recursos pueden incluir información sobre actores, directores, producciones y críticas.

- **Festivales y eventos teatrales internacionales:** Festivales como el Festival de Edimburgo, el Festival de Aviñón o el Festival Internacional de Teatro Clásico de Almagro, permiten a los actores y compañías teatrales mostrar su trabajo a una audiencia global, fomentando el intercambio y la difusión de repertorio.
- **Recursos digitales:** Como en otros campos de las artes escénicas, los archivos digitales, permiten el estudio y visionado de gran cantidad de material audiovisual, que permite el conocimiento de actores y sus trabajos a nivel internacional.

Sobre esta temática existe un diccionario de gran interés titulado *The Routledge dictionary of performance and contemporary theatre* (Pavis, 2016), así como el *The Methuen drama dictionary of the theatre* (Law, 2013) que ofrecen al investigador los primeros pasos para investigar.

2. BIBLIOMÉTRICOS & REVIEW.

La lectura de estudios bibliométricos y de Review es fundamental para conocer el estado de la cuestión actual sobre la temática elegida.

¿Por qué es importante consultar los bibliométricos sobre el tema elegido?

Un artículo bibliométrico es un estudio que aplica métodos cuantitativos y estadísticos para analizar la literatura científica. Utiliza datos extraídos de bases de datos bibliográficas, como *Web of Science* o *Scopus*, para examinar patrones y tendencias en la publicación y citación de investigaciones. A través de este análisis, se pueden obtener valiosos indicadores sobre la productividad, el impacto y la colaboración en un campo de estudio determinado. Por tanto, el bibliométrico transforma el caos de la información científica en un mapa claro y útil. Es una brújula para los que exploran el conocimiento, ayudándoles a tomar decisiones específicas sobre la temática elegida. Es importante destacar que existe inteligencia artificial específica para la investigación que el investigador puede emplear como SCOPUS AI, SCITE, SCISPACE, ANSWERTHIS, etc.

La utilidad de un artículo bibliométrico se extiende a diversos ámbitos de la investigación:

- **Evaluación del impacto:** Permite medir el impacto de una investigación, un autor, una revista o una institución, a través de indicadores como el número de citas, el índice h o el factor de impacto. Esto resulta crucial para evaluar la relevancia y la influencia de un trabajo científico.
- **Identificación de tendencias:** Facilita la identificación de tendencias emergentes y áreas de investigación en auge, al analizar los patrones de publicación y citación a lo largo del tiempo. Esto ayuda a los investigadores a enfocar sus esfuerzos en temas relevantes y prometedores.
- **Análisis de la colaboración:** Permite estudiar las redes de colaboración entre investigadores, instituciones y países, a través del análisis de las coautorías y las citas. Esto ayuda a identificar a los principales actores y a fomentar la colaboración en un campo de estudio.
- **Últimas tendencias en investigación:** Proporciona información valiosa sobre las últimas tendencias en materia de política científica, financiación de la investigación y gestión de la producción científica. Ayuda a los organismos que financian a identificar proyectos

prometedores, a las instituciones a evaluar su desempeño y a los investigadores a planificar sus carreras.

La función de los bibliométricos es básica a la hora de conocer el estado de la cuestión a nivel estadístico sobre la temática elegida. En relación a la educación musical son varias las publicaciones existentes (Sánchez-Marroquí & Vicente-Nicolás, 2024; Vicente-Nicolás & Sánchez-Marroquí, 2024), así como sobre percusión corporal (Arnau-Mollá & Romero-Naranjo, 2022a, 2022b, 2024) o sobre movimiento y aspectos cognitivos (Mas-Mas, Arnau-Mollá & Romero-Naranjo, 2023).

En lo que respecta a la danza a nivel performativo existen varios bibliométricos (Ho & Ho 2015; Wan & Ho, 2019), así como en las danzas tradicionales (Penalva-Martínez et al., 2024), o el ámbito educativo por países (Alenca et al., 2023). Incluso existen investigaciones específicas sobre Laban (Wu et al., 2024) o Capoeira (Mamede Ferreira da Cruz et al., 2024).

En referencia a las artes escénicas existen bibliométricos fundamentales que aportan una visión amplia y parcelada de la información (Ada & Karagöz, 2022; Agámez-Llanos et al., 2023; Lee, 2024; Oh, 2015).

2.1 ¿Qué aportan los artículos Review en investigación?

Los artículos de revisión se dedican a sintetizar y evaluar la información previamente publicada. Su objetivo principal es proporcionar una visión general y actualizada del estado de la cuestión en un campo de estudio determinado (García-González & Sánchez-Sánchez, 2020). Es importante destacar que existen quince tipos de artículos Review (Grant & Booth, 2009) nos aportan catorce, pero nosotros aportamos uno nuevo con el objetivo de aportar una actualización en investigación. Es menester tener en cuenta que existe inteligencia artificial específica para este tipo de investigaciones como es el caso de RAYYAN AI entre otras tantas.

Para lograrlo, los autores de un artículo de revisión realizan una búsqueda exhaustiva de la literatura científica relevante, seleccionando los estudios más importantes y analizándolos de manera crítica. A partir de este análisis, elaboran una síntesis que destaca los principales hallazgos, las controversias existentes y las áreas de investigación que requieren mayor atención.

En educación musical se han realizado muchos artículos *Review* tanto a nivel general (Droe 2006; Valdebenito & Almonacid-Fierro, 2022), como por metodologías disruptivas (Olvera-Fernández et al., 2023), sobre percusión corporal (Romero-Naranjo, 2013), la improvisación en educación musical (Larson & Gerogii-Hemming, 2019) o incluso por países (Yang & Welch, 2023). No podemos olvidar que existen modas en los tipos de Review en investigación, destacando en la actualidad las revisiones sistemáticas, con claros ejemplos por áreas temáticas. En lo que respecta en la educación musical, es muy abundante la literatura encontrada, como es el caso de los estudios musicales en China (Yang & Welch, 2023), su relación con las habilidades intelectuales (Jaschke et al., 2013), la psicología de la música (Blackwell et al., 2023) o su relación con la conciencia fonológica (Eccles et al., 2021). En danza destaca la revisión sistemática sobre aspectos del “yo” sobre el efecto de la danza en los estudiantes (Schwender et al., 2018).

1.4. Tipos de Review. Una visión general.

En este apartado procedemos a exponer de manera breve 15 tipos de *Review* para que el futuro investigador tenga una visión general sobre los mismos y elija el que mejor se adapte a su tipo de investigación:

I. Revisión crítica.

- **Descripción:** Este tipo de revisión tiene como propósito demostrar que el autor ha investigado la literatura de forma exhaustiva y ha evaluado su calidad de forma crítica. Trasciende la descripción para incorporar análisis e innovación conceptual. El resultado característico es una hipótesis o un modelo, y no una respuesta definitiva.
- **Fortalezas:** Su componente crítico es clave, permitiendo evaluar el valor del trabajo previo y proporcionar una plataforma para nuevo desarrollo conceptual. Puede intentar resolver escuelas de pensamiento en competencia.
- **Debilidades:** Generalmente, estas revisiones no demuestran la sistematicidad inherente a otros enfoques. Los elementos interpretativos son subjetivos, lo que convierte el producto en un punto de partida para una evaluación posterior, no un punto final.

II. Revisión de la literatura.

- **Descripción:** Es un término genérico que abarca materiales publicados que examinan la literatura reciente o actual. Puede cubrir una amplia gama de temas con diversos niveles de exhaustividad y puede incluir hallazgos de investigación. Involucra un proceso de identificación de materiales para su inclusión, síntesis y análisis de su contribución.
- **Fortalezas:** Identifica lo logrado previamente, permitiendo la consolidación, la construcción sobre trabajos anteriores, la suma de conocimientos, la evitación de duplicidades y la identificación de lagunas.
- **Debilidades:** Carece de una intención explícita de maximizar el alcance o de analizar los datos. Las conclusiones están expuestas al sesgo por la posible omisión de secciones significativas o por no cuestionar la validez de las afirmaciones.

III. Revisión de mapeo / Mapa sistemático.

- **Descripción:** Desarrollado para mapear y categorizar la literatura existente sobre un tema, identificando las lagunas en la investigación a partir de las cuales se pueden encargar futuras revisiones o investigación primaria.
- **Fortalezas:** Permite la contextualización de revisiones sistemáticas profundas y la identificación explícita de lagunas en la base de evidencia. Proporciona una base para decidir si emprender una revisión en profundidad o solo un subconjunto de estudios.
- **Debilidades:** Limitadas por el tiempo, carecen de la síntesis y el análisis de enfoques más profundos. Generalmente, no incluyen un proceso de evaluación de la calidad.

IV. Metaanálisis.

- **Descripción:** Técnica que combina estadísticamente los resultados de estudios cuantitativos para proporcionar un efecto más preciso. Para su validez, requiere que los estudios incluidos sean lo suficientemente similares en características clave (población, intervención, comparación y medición de resultados).
- **Fortalezas:** Asimila estudios individuales (que podrían ser insuficientes por sí mismos) en una base de evidencia compuesta. Es eficiente en tiempo para los tomadores de decisiones.
- **Debilidades:** Críticas se centran en la inadecuación de combinar estudios no suficientemente similares. Un principio esencial es que el metaanálisis no puede ser mejor que los estudios que incluye.

V. Revisión de estudios mixtos / Revisión de métodos mixtos.

- **Descripción:** Se refiere a cualquier combinación de métodos donde al menos un componente es una revisión de la literatura (usualmente sistemática). Específicamente, combina una revisión cuantitativa de efectividad y una revisión cualitativa sobre actitudes o implementación. Busca integrar el 'qué funciona' con el 'cómo y por qué funciona'.
- **Fortalezas:** Saca provecho de las debilidades de las revisiones de efectividad. Ofrece una comprensión más holística y potencialmente una imagen más completa del panorama de investigación.
- **Debilidades:** Puede agravar los desafíos metodológicos de la evaluación y síntesis de la investigación cuantitativa y cualitativa con la dificultad adicional de integrar los productos. Existe una falta de consenso sobre el punto óptimo para integrar los componentes.

VI. Panorama general (Overview).

- **Descripción:** Término genérico para cualquier resumen de la literatura que intenta examinarla y describir sus características. Se puede usar para muchos tipos de revisiones con grados variables de sistematicidad.
- **Fortalezas:** Puede proporcionar un resumen amplio y a menudo completo de un área temática, siendo valioso para quienes se acercan al tema por primera vez.
- **Debilidades:** Se utiliza frecuentemente como una palabra no discriminatoria para revisiones de rigor y calidad variables. La Colaboración Cochrane diferencia el 'panorama sistemático' (sinónimo de revisión sistemática) de otros tipos que típicamente carecen de métodos sistemáticos.

VII. Revisión sistemática cualitativa / Síntesis de evidencia cualitativa.

- **Descripción:** Método para integrar o comparar los hallazgos de estudios cualitativos. Busca 'temas' o 'constructos' que se encuentran en o a través de estudios cualitativos individuales. El objetivo no es agregativo, sino **interpretativo**, para ampliar la comprensión de un fenómeno particular. La terminología preferida es 'síntesis de evidencia cualitativa'.
- **Fortalezas:** Se utiliza para explorar barreras y facilitadores, investigar las perspectivas de los usuarios y complementar la evidencia de investigación con consideraciones reportadas por el usuario y el profesional.

- **Debilidades:** Los métodos aún están en su fase inicial. Existe debate sobre la necesidad de estrategias de búsqueda exhaustivas frente a un muestreo selectivo para una interpretación holística.

VIII. Revisión rápida.

- **Descripción:** Evaluación de lo que ya se conoce sobre un tema de política o práctica, que emplea métodos de revisión sistemática para buscar y evaluar críticamente la investigación existente, pero haciendo concesiones a la amplitud o profundidad del proceso debido a las limitaciones de tiempo.
- **Fortalezas:** Buscan ser rigurosas y explícitas en el método, pero realizan concesiones legítimas para acortar el plazo, como enfocar la pregunta o realizar una evaluación de calidad simple.
- **Debilidades:** Acortar la duración del proceso conlleva el riesgo de introducir sesgos. Limitar la búsqueda puede resultar en sesgo de publicación, y limitar la evaluación puede dar un énfasis desproporcionado a la investigación de menor calidad.

IX. Revisión de Alcance (Scoping review).

- **Descripción:** Proporciona una evaluación preliminar del tamaño y alcance potencial de la literatura de investigación disponible. Su objetivo es identificar la naturaleza y la extensión de la evidencia de investigación, a menudo incluyendo investigación en curso.
- **Fortalezas:** Es capaz de informar a los responsables políticos sobre si es necesaria una revisión sistemática completa. Intenta ser sistemática, transparente y replicable.
- **Debilidades:** No pueden considerarse un producto final en sí mismas debido a las limitaciones en su rigor y duración. Típicamente, no incluyen un proceso de evaluación de la calidad.

X. Revisión del estado del arte.

- **Descripción:** Un subtipo de la revisión de la literatura. Se caracterizan por abordar asuntos más actuales. Pueden ofrecer nuevas perspectivas sobre un tema o destacar un área que necesita más investigación.
- **Fortalezas:** Son de considerable valor para aquellos que son nuevos en un área o para quienes buscan identificar oportunidades potenciales para la investigación contemporánea. Permite derivar una idea de la cantidad y las características principales de un tema a partir de un solo artículo.
- **Debilidades:** Son un método transversal limitado en el tiempo, lo que puede distorsionar la imagen general del desarrollo de un campo. Un experto temático puede ofrecer una perspectiva particularmente idiosincrásica.

XI. Revisión sistemática.

- **Descripción:** Busca buscar, evaluar y sintetizar la evidencia de investigación de forma sistemática. A menudo se adhiere a las directrices de organizaciones reconocidas (como la Colaboración Cochrane). Es transparente en el informe de sus métodos para facilitar la replicación.
- **Fortalezas:** Busca reunir todo el conocimiento conocido sobre un área temática. Ha habido un cambio hacia la inclusión de una gama más amplia de diseños de estudio, incorporando estudios cuantitativos, cualitativos y de métodos mixtos.
- **Debilidades:** Restringir los estudios a un único diseño (como los ensayos controlados aleatorios) puede limitar su aplicación a proporcionar únicamente información sobre la efectividad.

XII. Búsqueda y revisión sistemática.

- **Descripción:** Combina las fortalezas de una revisión crítica con un proceso de búsqueda exhaustivo. Típicamente, aborda preguntas amplias y el resultado es una 'síntesis de la mejor evidencia'.
- **Fortalezas:** El amplio alcance a menudo incorpora múltiples tipos de estudio, proporcionando una imagen más completa de la prevalencia de la investigación. El sometimiento de la literatura a una crítica, aunque informal, proporciona un componente evaluativo útil.
- **Debilidades:** La revisión crítica subsiguiente puede ser propensa a las limitaciones de la revisión tradicional. Sin criterios de inclusión y exclusión explícitos y un proceso de síntesis claramente definido, el resultado puede ser una selección subjetiva de investigación.

XIII. Revisión sistematizada.

- **Descripción:** Intenta incluir uno o más elementos del proceso de revisión sistemática, sin llegar a afirmar que el resultado es una revisión sistemática completa. Típicamente, se llevan a cabo como una asignación de estudiante de posgrado, al no poder recurrir a los recursos requeridos para una revisión completa.
- **Fortalezas:** El autor puede demostrar un conocimiento de todo el proceso y competencia técnica en los pasos componentes. Estas revisiones pueden servir de base para un trabajo más extenso.
- **Debilidades:** La evaluación de la calidad y la síntesis pueden ser menos identificables, pudiendo estar ausentes o modeladas con un pequeño conjunto de artículos. Poseen una mayor probabilidad de sesgo.

XIV. Revisión Paragüas (Umbrella Review).

- **Descripción:** Se refiere específicamente a una revisión que compila evidencia de múltiples revisiones en un solo documento accesible y utilizable. Se centra en una condición o problema amplio para el cual existen dos o más posibles intervenciones.

- **Fortalezas:** Permite al lector una visión general rápida y una lista exhaustiva de las revisiones relevantes. Es una respuesta a la disyuntiva de si se debe abordar una necesidad con una revisión amplia o con una sucesión de revisiones enfocadas.
- **Debilidades:** Su utilidad requiere la preexistencia de las revisiones componentes más específicas.

XV. Revisión de alcance con mapa de brechas evidenciales (Scoping review with evidence Gap-Map).

- **Descripción:** Es una investigación exploratoria sistemática que busca mapear la evidencia existente sobre un tema amplio, identificar conceptos clave, teorías, tipos de estudios y vacíos de conocimiento, sin evaluar la calidad metodológica de los estudios incluidos. Se apoya de una representación visual interactiva que sistematiza gráficamente los estudios identificados, mostrando dónde existe evidencia concentrada y dónde hay brechas (pocas o ninguna evidencia) en relación a tipos de intervenciones y resultados evaluados. En esencia, esta combinación produce un mapeo riguroso y visualmente accesible del estado del conocimiento, útil para orientar políticas, prácticas y futuras investigaciones.
- **Fortalezas:** Proporciona una visión de conjunto completa sobre un tema amplio, mostrando la cantidad y distribución de evidencia disponible. Prioriza el enfoque más riguroso y sistemático para localizar vacíos de evidencia, evitando sesgos de percepción de los investigadores. Las brechas se identifican visualmente, no mediante inferencia subjetiva. Determina viabilidad de futuras revisiones sistemáticas o meta-análisis.
- **Debilidades:** La principal ausencia de síntesis y evaluación de calidad se traduce en que el informe no proporciona conclusiones sobre la efectividad de las intervenciones. Al no evaluar el riesgo de sesgo, se corre el peligro de enmascarar la heterogeneidad metodológica entre los estudios, lo que a su vez puede conducir a sobre simplificaciones de los hallazgos. Como resultado, los usuarios no pueden determinar la confianza en la evidencia mapeada.

3. ÍNDICE DE IMPACTO EN EDITORIALES DE LIBROS.

Al igual que existe motores de búsqueda de alto impacto para “Journals” que son WoS y Scopus, en lo que respecta a editoriales de libros, existen diversos tipos de clasificación como es en España **SPI** (Scholarly Publishers Indicators). Sobre ello existe abundante debate sobre los criterios para evaluar su calidad (Engels et al., 2018; Giménez-Toledo et al., 2020).

El sistema SPI, o Indicadores de Editores Académicos, se erige como una herramienta crucial para la evaluación y selección de editoriales en el ámbito académico, especialmente en las ciencias sociales y humanidades en España, dado que existen otros indicadores diferentes en otros países. Desarrollado por el grupo de investigación ILIA del CSIC, este sistema proporciona una visión detallada del prestigio y la calidad de las editoriales, basada en la opinión de expertos, la especialización de las mismas y sus procesos de selección de originales. Al recopilar datos de diversas fuentes, incluyendo encuestas a expertos y análisis de bases de datos, el SPI elabora indicadores que permiten a los investigadores comparar y clasificar las editoriales. Esta información resulta fundamental para académicos que buscan publicar sus trabajos en editoriales de renombre, así como para evaluar el impacto de las publicaciones existentes. El SPI, por tanto, funciona como un mapa detallado que guía a los investigadores a través del complejo panorama de las

publicaciones académicas, facilitando la toma de decisiones informadas y mejorando la calidad de la producción científica.

En la actualidad a nivel internacional, existen tres modelos principales para clasificar la calidad editorial, cada uno con sus propias fortalezas y debilidades.

3.1. Modelos basados en el prestigio percibido.

El modelo de prestigio se basa en la reputación y el reconocimiento de una editorial dentro de la comunidad académica. El ejemplo más conocido en el ámbito iberoamericano fue el sistema español *Scholarly Publishers Indicators* (SPI), desarrollado por el CSIC.

- **Mecanismo:** El SPI generaba un índice de prestigio (ICEE) a partir de encuestas a miles de académicos. La calidad se definía por variables como la trayectoria histórica, la especialización temática de la casa y el aval científico de sus colecciones y directores.
- **Resultados:** Estudios basados en este modelo han demostrado que el prestigio editorial tiende a concentrarse en núcleos pequeños, frecuentemente liderados por la edición universitaria.
- **Contexto Actual:** La discontinuidad en la actualización del SPI ha generado un vacío en la evaluación del libro académico, obligando a buscar alternativas que garanticen la calidad en los procesos de acreditación y financiación.

3.2. Modelos jerárquicos internacionales.

Estos sistemas buscan combinar el concepto de prestigio con la evidencia formal de un control de calidad. Los sistemas nórdicos son el referente más influyente en este enfoque.

- **Mecanismo:** El Registro Noruego de Editoriales y el Foro de Publicaciones Finlandés (JUFO) clasifican a las editoriales en niveles (Tiers), generalmente de 1 a 2 (o 3, el más alto).
- **Criterio de alto impacto:** Para que una editorial alcance el Nivel 2 (prestigio/alto impacto), debe cumplir dos condiciones esenciales: documentar un proceso de revisión por pares externa riguroso y demostrar una fuerte internacionalidad en su base de autores y distribución.
- **Implicaciones:** Este modelo es robusto, pero el énfasis en la internacionalidad puede introducir un sesgo a favor de las grandes editoriales globales y en detrimento de la producción académica excelente en lenguas o contextos regionales específicos.

3.3. Modelos basados exclusivamente en la integridad procesal.

Frente a la subjetividad del prestigio o el sesgo de la internacionalidad, un tercer enfoque pone el foco únicamente en la calidad del *gatekeeping* o control de originales.

- **Mecanismo:** El Sistema Flamenco VABB-SHW (Bélgica) no utiliza niveles de prestigio. Su criterio esencial es demostrar que la editorial aplica un proceso de revisión por pares riguroso para la selección de sus libros.

- **Ventaja:** Este enfoque trata de manera igualitaria a todas las editoriales, desde las prensas universitarias hasta las corporaciones más grandes, siempre y cuando certifiquen la calidad de sus procesos. Este énfasis en la transparencia del proceso es la herramienta más efectiva para combatir a las editoriales depredadoras, que prometen publicación rápida a cambio de altas tarifas sin aplicar una revisión por pares ética. La verificación del *peer review* se convierte así en el umbral mínimo de reconocimiento académico.

3.4. La evaluación complementaria

Ningún ranking de editoriales de libros es universal. Por ello, la evaluación rigurosa del libro académico requiere complementar estos modelos de clasificación con métricas que reflejen su impacto real y su diseminación:

- **Métricas de citación indirectas:** Bases de datos como Scopus han aumentado significativamente la indexación de monografías y capítulos de libros, ofreciendo un recuento de citas que es útil para medir el impacto individual de la obra, especialmente en HSS y para obras en español.
- **Métricas de uso y atención:** El impacto también se mide a través de la *Libcitation* (el número de bibliotecas que adquieren el libro) o las *Altmetrics*, que miden la atención y el uso en redes sociales y plataformas académicas.

Por todo lo expuesto anteriormente, un sistema de evaluación de la calidad editorial robusto debe basarse en una triangulación metodológica: exigir la integridad procesal (revisión por pares transparente) como requisito básico, utilizar la jerarquía de prestigio (como el modelo Nórdico) para reconocer el alcance internacional, y complementar la evaluación con métricas de impacto que reflejen la diseminación real del contenido. Este equilibrio es esencial para la equidad y el rigor científico en la publicación de libros.

4. MODELOS DE DISEÑOS DE INVESTIGACIÓN.

4.1 Estudios descriptivos.

Los estudios descriptivos, en el ámbito de la investigación, se caracterizan por su objetivo de examinar y delinear las propiedades, características y perfiles de un fenómeno, población o situación determinada. A diferencia de los estudios explicativos o experimentales, estos estudios se centran en el "qué" y el "cómo" de un tema, en lugar del "por qué". Utilizan métodos como encuestas, observaciones y análisis de datos para recopilar información detallada, que luego se presenta de manera organizada y sistemática, permitiendo una comprensión clara y precisa del sujeto de estudio. En educación musical existen numerosos ejemplos como el estudio descriptivo de las destrezas musicales (Vera, 1989), o el realizado sobre la actitud del alumnado de música en Educación Secundaria (García, 2013). Desde el punto de vista interdisciplinar donde se mezcla la catástrofe ambiental con lo sonoro es reseñable la publicación *La catástrofe del Mar Menor: catarsis educativa desde lo sonoro y lo visual* (Rubio, 2022).

En lo que respecta a la danza es de destacar el estudio descriptivo sobre la educación valores en la danza (Rodríguez Llorens, 2011) o el estudio sobre danza brasileña (Duarte et al., 2022). A nivel histórico y de investigación destacamos la publicación *Coreografiar la historia europea: cuerpo,*

política, identidad y género en la danza (Martínez del Fresno, 2011) o el recopilatorio sobre *Tesis en Danza* (Martínez del Fresno, 2022).

Las artes escénicas poseen estudios descriptivos relevantes destacando el estudio sobre su vínculo con la etnografía (Peñuelas, 2017), al igual que es estudio sobre danza y salud mental (Calica & Lobo, 2023).

4.2 Estudios de asociación entre variables.

Los estudios de asociación entre variables, dentro del marco de la investigación, se enfocan en examinar la relación estadística existente entre dos o más parámetros, sin necesariamente establecer causalidad. Su propósito central radica en determinar si existe una correlación entre las variables analizadas, su fuerza y dirección (positiva o negativa), y su significancia estadística. Estos estudios emplean métodos estadísticos como la correlación, la regresión y el análisis de contingencia, con el fin de cuantificar la medida en que las variaciones en una variable se relacionan con las variaciones en otra. Los resultados obtenidos son útiles para identificar patrones, predecir posibles resultados y generar hipótesis, sirviendo como base para investigaciones posteriores que busquen establecer relaciones causales. Sobre este respecto existen publicaciones vinculadas a la relación de la educación musical y funciones ejecutivas (Holocho et al., 2017), creatividad (Macdonald & Miell, 2000), inteligencia (Hille et al., 2011), pensamiento crítico (Zellner, 2011). En relación a la conexión entre artes visuales, música y danza existen igualmente publicaciones destacando las realizadas (Ercegovic et al., 2015; Ishiguro et al., 2023; Vanherwegen & Lievens, 2014; Ülger, 2018).

4.3 Estudios de intervención cuasiexperimental.

Los estudios de intervención cuasiexperimentales son diseños de investigación que buscan evaluar el efecto de una intervención en un grupo determinado, sin la asignación aleatoria de los participantes a los grupos de intervención y control. Esta característica la diferencia de los experimentos verdaderos, pero les permite ser aplicados en contextos donde la aleatorización no es factible o ética. Su finalidad principal es determinar si la intervención produce cambios significativos en las variables de interés, aunque la falta de aleatorización introduce limitaciones en la capacidad de establecer relaciones causales definitivas. Estos estudios son útiles en investigaciones educativas, sociales y de salud, donde se busca evaluar el impacto de programas o políticas en poblaciones específicas.

Desde el punto de vista musical destacan los estudios que investigan sobre el empleo de la memoria de trabajo (Roden et al., 2014), sobre el uso de música y matemáticas (An & Tillman, 2015), sobre la composición en la educación musical (Hogenes et al., 2015), sobre la ansiedad en estudiantes de educación musical (Chang et al., 2018).

En lo que atañe a la danza es mucha la producción científica destacando las investigaciones sobre aspectos socio emocionales (Pereira & Marques-Pinto, 2017; Callahan 2023), sobre creatividad (Neville & Makopoulou, 2021) o con flipped learning (Dimarucot, 2022). Desde el punto de vista interdisciplinar donde se trabaja la música con el arte destaca el interesante estudio de Schneider & Rohmann (2021).

4.3.1 Estudio de intervención cualitativa.

Los estudios de intervención cuasiexperimentales cualitativos se emplean para explorar el impacto de una intervención en un contexto natural, donde la asignación aleatoria de participantes a grupos de control y experimental no es factible. A diferencia de los experimentos puros, estos estudios se enfocan en comprender en profundidad las experiencias y percepciones de los participantes a través de métodos cualitativos como entrevistas, observaciones y análisis de documentos. La finalidad es examinar cómo la intervención influye en las dinámicas sociales, las prácticas y los significados construidos por los individuos y grupos involucrados, proporcionando una comprensión rica y contextualizada del fenómeno estudiado.

En educación musical destacan diversos estudios que asientan las bases para poder investigar de manera cualitativa (Bresler, 1996; Bresler, 2021; Bresler & Stake, 2017), también investigación sobre educación temprana (Reynolds, 2020), sobre estudios de caso (Barret, 2014) o una cartografía sobre las posibilidades de la investigación cualitativa en educación musical (Roulston, 2006) o sobre la educación sanitaria para músicos (Matei & Ginsborg, 2022).

Desde el punto de vista de la danza existe una amplia bibliografía que merece un futuro estudio bibliométrico y revisión sistemática que las evalúe. Los estudios más sobresalientes son los siguientes, desde el punto de vista de la expresión corporal (Alves 2016), danza en educación primaria (Neville & Makopoulou, 2021), sobre la salud y bienestar de los estudiantes de danza (Paschali & Araújo, 2023) o danza y bienestar en los entornos educativos (Du et al. 2025).

Las artes visuales poseen muchísimas publicaciones en esta línea, superando de manera muy amplia a los estudios cuantitativos destacando los estudios con niños (Kim et al. 2018). Existen publicaciones donde se realizan investigaciones sobre arte visual y música con resultados muy interesantes en adolescentes (Mogro-Wilson & Tredinnick, 2020), con niños en estado de vulnerabilidad (Coholic & Eys, 2016), o sobre aspectos cognitivos (James et al. 2024). Es altamente interesante, motivo que justifica esta investigación, es la propuesta donde se evalúa de manera conjunta la educación musical, la danza y las artes visuales en alumnado con resultados altamente prometedores (Daykin & Stickley, 2015; Moula & Karkou, 2022), sino también con objetivos terapéuticos (Harris, 2016; Lakes et al. 2019; Lo et al. 2018).

En el desarrollo de este tipo de estudios, es común el uso de software especializado para simplificar los procesos de codificación y examen de las narrativas obtenidas. Entre las herramientas más populares se encuentran AtlasTi®, NVivo® y MAXQDA®, cada uno con capacidades robustas para el análisis detallado del discurso. Adicionalmente, se dispone de Taguette®, una alternativa gratuita que ofrece funcionalidades básicas para quienes buscan una opción sin costo.

4.3.2 Estudio de intervención cuantitativa.

Un estudio de intervención cuantitativa es un diseño de investigación experimental o que busca evaluar los efectos de una intervención específica sobre una variable dependiente, utilizando métodos estadísticos para analizar datos numéricos. Este tipo de estudio se caracteriza por la manipulación deliberada de una variable independiente por parte del investigador, con el objetivo de establecer relaciones causales o medir el impacto de la intervención en una población

determinada. En el ámbito académico, se distinguen dos variantes principales: los estudios sin grupo control y los estudios con grupo control.

Los primeros, conocidos como diseños preexperimentales, carecen de un grupo de comparación, lo que limita la capacidad de atribuir los cambios observados exclusivamente a la intervención, debido a la ausencia de un referente que permita contrastar los resultados.

Por otro lado, los estudios con grupo control incorporan un grupo que no recibe la intervención (o recibe una intervención alternativa), lo que fortalece la validez interna al permitir una comparación directa entre los sujetos expuestos y no expuestos a la variable independiente. Esta distinción es crucial, ya que los diseños con grupo control ofrecen mayor rigor metodológico y una base más sólida para inferencias causales, mientras que los sin grupo control son más susceptibles a sesgos y factores externos que podrían influir en los resultados. Desde el punto de vista interdisciplinar destaca la investigación de Mitchell (2023). En relación a la percusión corporal existen numerosas publicaciones con grupo control y experimental evaluando la atención o las funciones ejecutivas (Arnau-Mollá et al., 2024a, 2024b; Arnau-Mollá, 2025; Romero-Naranjo et al., 2023a, 2023b; Romero-Naranjo & Liendo-Cárdenas, 2025a, 2025b; Romero-Naranjo & Navarro-Camacho, 2025).

En el seno de las investigaciones empíricas, particularmente aquellas de naturaleza cuantitativa, la necesidad de un procesamiento meticuloso de datos es ineludible. Para tales fines, el investigador moderno dispone de un abanico de sofisticadas herramientas de software estadístico, cada una diseñada para desentrañar la complejidad inherente a los conjuntos de datos. Históricamente, SPSS® (Statistical Package for the Social Sciences) ha sido un referente en el ámbito de las Ciencias de la Educación, gracias a su robustez y versatilidad en el manejo de análisis descriptivos e inferenciales. Sin embargo, el paradigma actual favorece la diversidad y la accesibilidad, lo que ha impulsado la popularización de alternativas de código abierto. El entorno R®, con su vasta biblioteca de paquetes y su capacidad para la programación estadística avanzada, se erige como una opción poderosa, especialmente cuando se complementa con interfaces gráficas como R-Commander® que facilitan su uso. Asimismo, Jamovi®, JASP® y Orange® ofrecen entornos intuitivos y amigables para el análisis estadístico, democratizando el acceso a técnicas de vanguardia y permitiendo a los investigadores explorar sus datos con una precisión sin precedentes.

4.3.3 Estudio mixto (cuantitativo y cualitativo).

Los estudios de intervención de naturaleza mixta, que combinan metodologías cuantitativas y cualitativas, se emplean para obtener una comprensión integral del impacto de una intervención en un contexto determinado. Estos estudios integran la medición numérica de variables y la exploración de experiencias y significados subjetivos. La dimensión cuantitativa se enfoca en evaluar los efectos de la intervención a través de datos numéricos y análisis estadísticos, mientras que la dimensión cualitativa busca comprender las experiencias, percepciones y significados de los participantes mediante métodos como entrevistas y observaciones. La finalidad de estos estudios es obtener una visión holística del fenómeno estudiado, combinando la precisión de los datos cuantitativos con la profundidad de la comprensión cualitativa, lo que permite evaluar tanto la eficacia como el proceso y la experiencia de la intervención.

En educación musical se han realizado de este tipo en educación secundaria (Hawkinson, 2015), igualmente sobre las capacidades instrumentales (Clementson, 2014), la educación musical en prisiones (Betts, 2020), sobre la enseñanza de la música polifónica (Onwuegbuzie & Kara, 2024) o la evaluación del profesorado de música (Shouldice, 2009).

4.3.4 Creación de nuevos instrumentos de medida.

La ausencia de instrumentos validados en la literatura para la medición de constructos específicos, como puede ocurrir en el contexto de proyectos de investigación más amplios, justifica el diseño y la construcción de nuevas herramientas de evaluación. Este enfoque metodológico, centrado en la creación de instrumentos, representa un diseño de investigación *per se*. Para la adaptación y validación de cuestionarios, se emplean habitualmente aplicaciones informáticas como IBM-AMOS®, Mplus®, LISREL® o Winsteps®. Asimismo, el método Delphi, basado en paneles de expertos, es una técnica comúnmente utilizada para la elaboración o modificación de los ítems de un cuestionario.

Sobre esta temática existen numerosos estudios destacando las aportaciones sobre el aprendizaje musical (Carrillo et al. 2019), o el autoconcepto musical (Vera et al., 2012). En Artes visuales existe un gran número de publicaciones en esa línea (Begeske, 2022; Morris et al., 2017; Schoch, 2021; Schoch & Ostermann, 2022). En danza son muchas las propuestas, destacando la realizada sobre creatividad (Pürgstaller, 2021) o sobre el rendimiento en danza para niños (Nikolaki et al., 2021).

5. GESTORES BIBLIOGRÁFICOS.

El alumnado puede apoyarse de gestores bibliográficos como *Zotero*, *Mendely*, *EndNote*, *Citavi*, *Paperpile*, *Refworks* o *JabRef* debido a su capacidad intrínseca para optimizar el flujo de trabajo académico y asegurar la integridad metodológica en la producción científica. Estos gestores bibliográficos son herramientas de software diseñadas para ayudar a los investigadores a organizar, almacenar y citar sus referencias bibliográficas. Permiten crear bases de datos personales de referencias, importar datos de diversas fuentes, generar citas y bibliografías en diferentes estilos y colaborar con otros investigadores. Fundamentalmente, permiten la inserción automatizada de citas dentro del manuscrito y la generación instantánea de bibliografías completas, adhiriéndose rigurosamente a una amplia gama de estilos de citación (e.g., APA, MLA, Vancouver). Esta automatización minimiza el riesgo de errores tipográficos y garantiza la consistencia formal en la referenciación, aspectos cruciales para la revisión por pares y la trazabilidad de la evidencia. Por lo tanto, su uso se considera una práctica estándar que promueve la eficiencia, la precisión documental y el cumplimiento normativo en la difusión del conocimiento.

5.1. Chatbots en investigación.

El uso de un *Chatbot* avanzado como *NotebookLM* o herramientas similares se ha vuelto crucial en la investigación moderna debido a su capacidad para optimizar y enriquecer el proceso de manejo y análisis de información. Estas herramientas son asistentes de investigación impulsados por IA que operan sobre la base de los documentos y fuentes que el investigador proporciona, lo que garantiza que sus respuestas y sugerencias estén contextualizadas y libres de alucinaciones externas al corpus de estudio. El principal beneficio reside en la eficiencia y la velocidad: un chatbot puede procesar miles de páginas de artículos, notas de campo o transcripciones en segundos,

identificando rápidamente temas clave, correlaciones, inconsistencias, y lagunas en la literatura que podrían tardar horas o días en ser detectadas por medios manuales. Específicamente, ayudan a sintetizar grandes volúmenes de datos, generando resúmenes concisos, ayudando a estructurar argumentos o secciones del manuscrito, y permitiendo al investigador "conversar" con sus propios datos para formular preguntas complejas y obtener respuestas directamente referenciadas a las fuentes originales. Esto no solo ahorra tiempo valioso, sino que también eleva la calidad de la investigación al asegurar una revisión bibliográfica más exhaustiva y un análisis de datos más profundo y riguroso, permitiendo al investigador centrarse en la interpretación crítica y la generación de conocimiento en lugar de en la mera gestión de la información.

6. LA INTELIGENCIA ARTIFICIAL COMO HERRAMIENTA EN INVESTIGACIÓN.

La integración estratégica de la Inteligencia Artificial (IA) se ha consolidado como un imperativo metodológico para optimizar la eficiencia, exhaustividad y rigor del proceso de investigación académica. Si bien las herramientas de IA no sustituyen la validación final ni el escrutinio profundo inherente a las búsquedas en bases de datos primarias y referenciales como Web of Science (WoS) o Scopus (la cual ya incorpora modelos internos como Scopus AI), estas plataformas aportan una visión sinóptica, potencian el descubrimiento de evidencia y refinan la ejecución de tareas críticas. A continuación, se detalla una taxonomía de herramientas de inteligencia artificial sugeridas para diversas fases del ciclo de investigación, explicitando su función y su potencial académico.

6.1. Estado de la cuestión y marco teórico con inteligencia artificial.

Esta fase se centra en la identificación, cribado y síntesis de la evidencia científica existente para establecer un marco teórico y un estado de la cuestión de alta precisión. No son un sustituto de *WoS* ni *Scopus* pero como primer paso, le ofrece bibliografía importante sobre la temática a investigar.

Herramienta	Dominio Clave	Potencial Académico
I. Descubrimiento y búsqueda semántica		
<i>Semantic Scholar</i>	Motor de búsqueda (IA-Powered)	Análisis semántico de alto nivel. Permite la identificación de citas de alta influencia (proxy de calidad e impacto) y ofrece filtrado avanzado por autoría, fecha y fuente, superando la limitación de la coincidencia de palabras clave tradicional.
<i>Scispace</i>	Búsqueda semántica avanzada	Facilita la exploración del corpus científico mediante lenguaje natural, permitiendo la formulación de consultas complejas y altamente focalizadas para la extracción de información clínica o científica específica.

II. Mapeo, redes y análisis bibliométrico

Connectedpapers	Análisis de Co-citas y acoplamiento	Genera un gráfico de similitud visual que habilita la exploración no lineal del campo. Es fundamental para identificar documentos seminales, trabajos derivados y el corpus principal de una línea de investigación.
ResearchRabbit	Descubrimiento dinámico basado en redes	Fomenta la construcción intuitiva de bibliotecas de investigación, permitiendo al investigador navegar y "saltar" entre artículos, autores y referencias de manera relacional a partir de un punto de partida inicial.
Openknowledgemaps	Visualización de conocimiento	Proporciona una representación visual (mapa conceptual) de la interconexión de las áreas de conocimiento, siendo esencial para obtener una visión panorámica estructurada de campos de estudio nuevos o interdisciplinarios.
Inciteful	Análisis bibliométrico de redes	Ejecuta análisis de redes para identificar autores influyentes, <i>review papers</i> clave y trabajos fundacionales que delinear la trayectoria histórica y conceptual de un tema.

III. Síntesis, Extracción y Revisión Sistemática

Herramienta	Dominio Clave	Potencial Académico
Undermind	Asistencia en diagnóstico teórico	Asistente de investigación avanzado que realiza búsqueda iterativa adaptativa. Genera informes de evidencia detallados y redes de citas, invaluable para el diagnóstico teórico-metodológico y la identificación de lagunas en la literatura.
Rayyan AI	Revisión sistemática colaborativa	Plataforma especializada en revisiones de alcance y sistemáticas. Acelera el proceso de cribado mediante clasificación por IA y automatiza la generación de diagramas de flujo PRISMA, asegurando la reproducibilidad metodológica.
Consensus	Cuantificación de evidencia	Sintetiza automáticamente hallazgos y extrae respuestas basadas en la evidencia. Su "Medidor de consenso" cuantifica la convergencia o divergencia entre estudios, crucial para establecer una posición científica consolidada.
Elicit	Automatización de extracción de datos	Herramienta diseñada para optimizar la fase de extracción de datos. Ayuda a identificar <i>papers</i> relevantes y a extraer métricas o <i>data points</i> específicos de grandes volúmenes de texto de manera eficiente.

6.2. Las co-citas en inteligencia artificial.

Las co-citas (*co-citations*) en investigación son un concepto clave en el campo de la bibliometría y el análisis de redes de conocimiento. Se refieren a la frecuencia con la que dos documentos, artículos o autores diferentes, son citados simultáneamente por un tercer documento o conjunto de documentos.

- Definición y mecanismo: Si el documento A y el documento B aparecen ambos en la lista de referencias del documento C, se dice que A y B están "co-citados" en el documento C. Cuantas más veces A y B sean co-citados a lo largo de la literatura científica, más fuerte es su relación de co-citación.

- **Significado académico:** El análisis de co-citas permite a los investigadores comprender cómo se estructura y evoluciona un campo de estudio. Una alta frecuencia de co-citación entre dos obras sugiere que son percibidas por la comunidad académica como conceptualmente relacionadas o interdependientes. Revela que estos dos documentos son fundamentales para establecer las bases teóricas o metodológicas de una línea de investigación posterior.

Las herramientas de IA, como **Connectedpapers**, utilizan conceptos de co-citas y acoplamiento bibliográfico para generar un gráfico de similitud visual entre artículos, lo que permite la exploración no lineal y la identificación de documentos seminales y derivados en un campo. Por tanto, la co-citación es una forma de medir la similitud temática o conceptual entre dos trabajos a través del lente de la comunidad que los consume y utiliza.

6.3 Validación metodológica y análisis de datos.

Esta sección incluye herramientas diseñadas para auditar la metodología, analizar datos y transcribir información cualitativa.

Herramienta	Dominio clave	Potencial académico estratégico
<i>I. Análisis, procesamiento y automatización de datos</i>		
Julius	Análisis de Datos (IA Generativa)	Herramienta enfocada en la interacción y manipulación de datos (formatos .xlsx, .csv) mediante lenguaje natural democratizando el análisis estadístico y exploratorio sin requerir conocimientos de programación.
Sonix	Procesamiento de Datos Cualitativos	Plataforma de transcripción y análisis impulsada por IA. Proporciona transcripción de alta precisión de audio y video (entrevistas, grupos focales) en múltiples idiomas reduciendo drásticamente el tiempo de preparación de datos cualitativos.
Manus	Automatización y Ejecución de Tareas	Agente autónomo de IA capaz de ejecutar tareas de varios pasos, realizar análisis de datos estructurados, procesar código y automatizar flujos de trabajo basados en documentos. Sirve como asistente avanzado para la detección de errores en procedimientos computacionales.
Powerdrill	Extracción de <i>Insights</i> Analíticos	Funciona como un <i>chatbot</i> analítico que ofrece <i>insight</i> instantáneos y responde preguntas complejas sobre grandes conjuntos de datos de investigación cargados por el usuario siendo compatible con múltiples formatos de archivo (PDF, Excel, Word).
<i>II. Visualización y comunicación de resultados</i>		
Datanwrapper	Creación de gráficos Interactivos	Herramienta en línea que facilita la creación de gráficos, mapas y tablas interactivos y profesionales a partir de datos. Su potencial reside en simplificar el proceso de comunicación visual de información compleja y accesible.

6.3 Estrategias para publicar.

Estas herramientas apoyan la fase de redacción y la selección estratégica del canal de divulgación.

- **Thesify:** Enfocada en la mejora de la escritura académica, particularmente en la redacción de tesis y *papers*. Ofrece recursos y retroalimentación para refinar el estilo y el argumento.
- **Paperpal:** Proporciona sugerencias lingüísticas, gramaticales y de estilo en tiempo real, opciones de traducción académica, y realiza una comprobación de consistencia y detección de plagio contra una base de datos científica, asegurando que el manuscrito cumpla con los estándares editoriales.

6.4 Síntesis visual (Infogramas, Póster).

Herramientas para la creación de material de divulgación y la consolidación de ideas.

- **Napkin:** Convierte automáticamente ideas y documentos de texto en representaciones gráficas y visualizaciones (infogramas, pósteres), facilitando la comunicación de resultados complejos de manera concisa.
- **NotebookLM:** Un entorno de investigación que permite al usuario cargar y centralizar sus propias fuentes de conocimiento (*papers*, notas, videos). La IA procesa estos documentos para generar esquemas, mapas mentales, *podcasts* y síntesis de ideas, funcionando como un asistente único para el investigador.

6.5 Automatización de flujos de trabajo.

Plataformas para la orquestación de tareas y la experimentación con modelos de IA.

- **N8n, Make, y Zapier:** Plataformas de automatización *no-code*. Permiten la interconexión de las diversas herramientas utilizadas en la investigación (desde gestores de referencia hasta bases de datos o *softwares* de análisis), orquestando flujos de trabajo complejos para automatizar tareas repetitivas y optimizar la gestión del proyecto.
- **Google AI Studio:** Entorno de desarrollo para prototipar e interactuar con modelos de IA (como Gemini). Su valor radica en permitir a los investigadores experimentar con *prompts* y construir soluciones de IA personalizadas para tareas específicas de análisis o generación de contenido.

Estas AI expuestas son unas pocas porque se podrían complementar con **Canvas, Khanmigo, Magic School, Padlet Ta y Brisk Teaching** entre otras tantas. Es cierto que todas estas AI son de gran actualidad, pero somos conscientes que en breve pueden cambiar de nombre o desaparecer debido al vertiginoso ritmo cambiante que estas observando día a día.

En las reuniones de grupos de investigación se sugiere emplear **Proactor AI** por su versatilidad y posibilidades que ofrece. Es un asistente inteligente diseñado para hacer que las reuniones de equipo y clases sean mucho más productivas, yendo más allá de una simple grabación. En lugar de solo transcribir lo que se dice, Proactor AI escucha activamente para entender de qué se está

hablando (el contexto), como si fuera un compañero muy atento. Gracias a esto, la herramienta puede anticipar lo que necesitas y te da ayuda en tiempo real, como generar resúmenes instantáneos de lo importante, hacer una lista de las tareas o "deberes" pendientes (los *action items*), y buscar información extra sobre el tema que se está debatiendo. Esto te permite concentrarte completamente en la discusión sin preocuparte por tomar notas, ya que Proactor AI maneja automáticamente la documentación, los seguimientos y los recordatorios. Además, tiene una memoria que conecta todas tus reuniones; por lo tanto, el contexto de un proyecto se mantiene a través del tiempo, permitiendo que tu equipo avance sin problemas y sepa exactamente cuál es el siguiente paso sin tener que escribirlo todo manualmente.

La adopción de estas plataformas, enmarcadas en un código de conducta ético riguroso, representa un salto cualitativo en la capacidad heurística y analítica del investigador. Estas herramientas son un complemento esencial, garantizando una exploración bibliográfica exhaustiva, un cribado riguroso de la evidencia y una validación metodológica optimizada, pilares fundamentales para la construcción de un conocimiento científico de alto impacto y de un *Marco Teórico* verdaderamente sólido.

7. SCIMAGO JOURNAL & COUNTRY RANK (SJR)

Es un portal que ofrece indicadores bibliométricos de revistas científicas y países, basados en la base de datos *Scopus* de Elsevier. Su métrica más conocida, el SJR (SCImago Journal Rank), se utiliza para evaluar el prestigio y la visibilidad de las revistas. Sirve para analizar la producción científica, realizar rankings, y comparar la influencia de distintas revistas y naciones, ayudando a investigadores, instituciones y gobiernos a tomar decisiones informadas sobre publicación y políticas científicas.

8. CONCLUSIONES.

El presente estudio ha articulado un marco metodológico integral y riguroso diseñado específicamente para la investigación en los campos de la música, la danza y las artes escénicas, dada la intrínseca subjetividad y riqueza experiencial que definen a estas disciplinas, enfatizando la necesidad de adoptar un diseño de estudio empírico robusto que sirva de apoyo fundamental para investigadores y estudiantes en formación. El pilar de cualquier investigación de alto impacto reside en una exhaustiva revisión bibliográfica, justificándose la selección de Web of Science (WoS) como la base de datos de referencia principal por su cobertura de citas, su riguroso sistema de clasificación de revistas y su riqueza en metadatos para el análisis bibliométrico avanzado, siendo esta plataforma esencial, junto a otras como Scopus, para la localización de estudios en colecciones de prestigio como el *Journal Citation Reports* (JCR). Para optimizar este proceso, se subraya la importancia del álgebra booleana —mediante el uso estratégico de operadores como "AND", "OR" y "NOT"— y el truncamiento con el asterisco (*) para garantizar precisión y eficiencia en las consultas. Complementando estas bases de datos de amplio espectro, se han mapeado los recursos especializados por disciplina, recomendándose para Música la consulta de repertorios fundamentales como RILM, RISM, RIPM y RIDIM, junto a las enciclopedias *New Grove* y *MGG*; mientras que para Danza y Artes Escénicas, si bien carecen de un repertorio global único al estilo RILM, se destacan centros de documentación, archivos nacionales y diccionarios de referencia como *The Oxford Dictionary of Dance* y *The Routledge Dictionary of Performance and Contemporary Theatre*.

En la fase de síntesis del conocimiento, la lectura de artículos bibliométricos y de revisión (*Review*) se establece como crítica, pues transforman el volumen de información científica en un mapa claro, permitiendo identificar tendencias, analizar la colaboración y determinar las lagunas de conocimiento. En este contexto, de una taxonomía de quince tipos de *Review*, se destacan las Revisiones Sistemáticas y la innovadora Revisión de Alcance con Mapa de Brechas Evidenciales (*Scoping Review with Evidence Gap-Map*) como enfoques de máxima rigurosidad.

En cuanto a los diseños de investigación, se ofrece un repertorio metodológico adaptado a la especificidad artística, abarcando desde los Estudios Descriptivos que proveen una comprensión sistemática del fenómeno, hasta los Estudios de Asociación entre Variables (Correlacionales) que cuantifican la fuerza de las relaciones estadísticas, culminando con los Estudios de Intervención Cuasiexperimental y Mixtos, cruciales para evaluar el efecto de una intervención al combinar la medición de los resultados (cuantitativa) con la comprensión de los procesos y las experiencias (cualitativa), logrando así una visión holística del impacto. Finalmente, la investigación moderna exige la integración de herramientas tecnológicas para la eficiencia y el rigor, siendo los Gestores Bibliográficos como Zotero y Mendeley indispensables para la inserción automatizada de citas y la generación de bibliografías que aseguran la consistencia formal; el Software de Análisis como SPSS, R, Jamovi, y JASP para lo cuantitativo y AtlasTi, NVivo y MAXQDA para lo cualitativo, vitales para el examen de datos; y, como imperativo metodológico, la integración estratégica de la Inteligencia Artificial (IA) con herramientas como Semantic Scholar, Elicit y Rayyan AI para potenciar la búsqueda y el cribado de la literatura, y NotebookLM para la centralización y análisis conversacional de los documentos. Por lo tanto, este trabajo dota a la comunidad investigadora en artes escénicas de una hoja de ruta completa que, al exigir la adopción de un enfoque metodológico sólido y el uso informado de las herramientas tecnológicas disponibles, asegura la construcción de un conocimiento científico de alto impacto, contribuyendo significativamente al avance de la disciplina.

8.1. Líneas futuras

Las futuras líneas de investigación en música, danza y artes escénicas deben concentrarse en la consolidación de la evidencia, aprovechando los vacíos de conocimiento identificados y las capacidades heurísticas de las nuevas herramientas tecnológicas. Específicamente, se requiere una expansión de los estudios de intervención de naturaleza mixta para trascender la mera medición de la eficacia y lograr una comprensión holística del proceso y la experiencia de la intervención (Romero-Naranjo, 2025). Dada la escasez de literatura evaluativa rigurosa en danza y artes escénicas en comparación con la música, es perentorio incrementar las revisiones sistemáticas y los estudios bibliométricos en estas áreas para mapear con precisión el estado del arte y las brechas existentes. Además, la validación y creación de nuevos instrumentos de medida específicos para constructos propios de estas disciplinas, como ya se ha iniciado en áreas de la creatividad y el rendimiento, se configura como un imperativo metodológico para asegurar la validez y fiabilidad de futuras evaluaciones. Finalmente, la adopción ética y rigurosa de la Inteligencia Artificial (IA) no solo en la revisión bibliográfica (ej. cribado y síntesis), sino también en el análisis de datos complejos y la automatización de flujos de trabajo, se establece como un vector clave para optimizar el rigor y la exhaustividad, acelerando el avance del conocimiento en estos campos.

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Justificación teórico práctica del *Clap Change* en el método BAPNE

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Resumen

El clap change es una de las principales actividades en el método BAPNE que no puede faltar en ninguna de sus sesiones, y que se ha mostrado en sus variantes más simples en multitud formaciones y publicaciones científico-académicas sobre la metodología a nivel internacional. Por ello, es conocida por muchos docentes y aplicada en las aulas de todas las etapas educativas. Aún así, existe un gran número de profesorado que ha adquirido un conocimiento sesgado de la actividad a través de las redes sociales, desconociendo en general qué es y para qué sirve. El propósito de este trabajo es realizar una justificación teórico-práctica sobre todo lo relacionado con el *clap change* proporcionando, por una parte, una visión general de las características fundamentales y los aspectos que conviene conocer sobre su funcionamiento, y por otra, un análisis de la actividad basado en los diez pilares de la neuromotricidad. Se espera, que este trabajo sirva como modelo para el análisis de cualquier tipo de actividad del método BAPNE, y que ofrezca al profesorado las claves para su correcto conocimiento y fundamentación de manera seria y académica, así como para conocer las implicaciones cognitivas, psicomotrices y socioemocionales que conlleva para el alumnado su práctica en el aula.

Palabras clave: Clap change, neuromotricidad, funciones ejecutivas, didáctica, BAPNE.

Abstract

The clap change is one of the main activities in the BAPNE method that cannot be missing from any of its sessions, and its simplest variants have been shown in a multitude of scientific and academic publications on the methodology at an international level. For this reason, it is known to many teachers and applied in classrooms at all educational stages. Even so, there are still a large number of teachers who have acquired a biased understanding of the activity through social media, generally unaware of what it is and what it is used for. The purpose of this work is to provide a theoretical and practical justification for everything related to the clap change, offering, on the one hand, an overview of its fundamental characteristics and the aspects that should be known about how it works and, on the other, an analysis of the activity based on the ten pillars of neuromotor skills. It is hoped that this work will serve as a model for the analysis of any type of activity in the BAPNE method and that it will offer teachers the keys to a proper understanding and foundation in a serious and academic manner, as well as to understanding the cognitive, psychomotor and socio-emotional implications for students of its practice in the classroom.

Keywords: Clap change, neuromotricity, executive functions, teaching, BAPNE.

INTRODUCCIÓN

El clap change es una de las principales actividades dentro del glosario del método BAPNE que se realiza, en alguna de sus tipologías, en todas sus clases, formaciones, cursos o talleres sobre la metodología. Por ello, se trata de una actividad ampliamente conocida y utilizada por el profesorado de todas las etapas educativas. Aun así, existe una gran cantidad de incógnitas en los docentes a nivel general, tanto respecto a su finalidad, tipologías, metodología, o dificultades a tener en cuenta, como relacionadas con para qué sirve desde diferentes puntos de vista y sus implicaciones en el alumnado. Este desconocimiento se debe, en gran medida a la búsqueda de actividades en las redes sociales de algunos docentes para cubrir sus necesidades didácticas con respecto a la música y el movimiento.

Por lo tanto, es de vital importancia resolver estas incógnitas, permitiendo así a los docentes, no solo aplicar de forma correcta, sistemática y rigurosa las actividades de clap change, sino también saber fundamentarlas y tomar consciencia de las grandes implicaciones de estimulación cognitiva, psicomotriz y socioemocional que conlleva en el alumnado.

El método BAPNE se gestó en 1998 cuando el PhD. Francisco Javier Romero Naranjo pretendió crear una serie de actividades, entre ellas el clap change, que se diferenciaron de los grandes postulados pedagógico-musicales del siglo XX imperantes en aquella época. Desde entonces, se han ido ampliando y desarrollando hasta la actualidad a través de las siete etapas de evolución de la metodología, pasando progresivamente por diferentes teorías de fundamentación y justificación que avanzó desde las Inteligencias Múltiples hasta las funciones ejecutivas y la neuromotricidad (Arnau-Mollá & Romero-Naranjo, 2022c).

Al tratarse de un tipo de actividades de gran importancia dentro de la metodología, y que no pueden faltar en ninguna de las sesiones, el clap change se ha mostrado en multitud de publicaciones científico-académicas, normalmente en sus variantes más simples. Encontramos diversas alusiones y explicaciones, más o menos amplias a modo de ejemplos en documentos de justificación teórica, empírica, teórico-práctica, como parte de propuestas didácticas, o mostrando y/o resaltando alguna de sus implicaciones a nivel cognitivo, psicomotriz o socioemocional.

A nivel empírico, Alonso-Marco y Romero-Naranjo (2022) realizaron un estudio cinemático de los movimientos básicos de la percusión corporal en el método BAPNE, que incluía entre otros, los utilizados en el clap change, es decir, las palmadas y las figuras geométricas del triángulo y el cuadrado. A través de la metodología de fotogrametría y vídeo, analizaron variables como el rango de movimientos, el movimiento de determinadas articulaciones, la velocidad y la trayectoria. Determinaron que los movimientos básicos de percusión corporal utilizados en el método BAPNE pueden ser físicamente beneficiosas para personas de cualquier edad, ya que no se trata de movimientos nocivos ni agresivos.

Por otra parte, Romero-Naranjo y Llorca-Garnero (2023) realizaron un estudio de ergoespirometría o prueba de esfuerzo cardiopulmonar para analizar el intercambio de gases durante la realización de cinco tipos de actividades de BAPNE FIT entre las que se encontraba el clap change simple y doble. Este tipo de actividades, dentro de programa BAPNE FIT, aunque mantienen la esencia de la actividad, están enfocadas a la educación física y el deporte, por lo que se realizan con elementos adicionales como “(...) Step, bandas elásticas en muslos tobillos, pesos en muñequeras y tobilleras y por último actividades de percusión corporal con calzado Kangoo Boots” (p.674). Las actividades se realizaron durante dos minutos cada una a un sujeto de 43 años de edad y determinaron que el programa de actividades BAPNE FIT “(...) ayudan y aumentan el consumo máximo de oxígeno, así como la frecuencia cardíaca” (p.674).

A nivel experimental, el método BAPNE cuenta con más 20 investigaciones cuantitativas de intervención con grupo experimental y control, pretest y posttest, evaluación con test y cuestionarios validados en los respectivos países, donde se midió el impacto de sus actividades músico-motoras de neuromotricidad basadas en la doble tarea sobre aspectos cognitivos, psicomotrices y socioemocionales en diferentes poblaciones (niños, adolescentes, adultos y personas mayores) y etapas educativas (Infantil, Primaria, Secundaria, Universidad, Conservatorios). Por supuesto, el clap change estuvo siempre presente en alguna de sus variantes en todas estas investigaciones (Arnau-Mollá & Romero-Naranjo, 2020, 2022a, 2022b, 2024a, 2024b, 2025a, 2025b; Arnau-Mollá, Romero-Naranjo & Andreu-Cabrera, 2024; Castelló-Juan et al., 2019; Latre-Nava et al., 2019; Moral et al., 2020; Romero-Naranjo & Liendo, 2025a, 2025b;

Romero-Naranjo & Navarro, 2025; Romero-Naranjo, Pujalte et al., 2023; Romero-Naranjo, Sayago-Martínez et al., 2023; Ros-Silla et al., 2019; Torró-Biosca et al., 2019).

El método BAPNE reúne todos sus tipos de actividades en un glosario que está en continuo desarrollo. Está formado por 35 bloques de actividades pensadas para la estimulación de las funciones cognitivas y las funciones ejecutivas principalmente, en las que la doble tarea siempre está presente. Dentro de cada bloque de actividades existen muchas tipologías y variantes, con diferentes grados de dificultad, que en función de como se utilicen y se combinen aportarán un mayor o menor grado de estimulación cognitiva, psicomotriz o socioemocional al alumnado. El clap change se ubica concretamente en el primer bloque de actividades de este glosario (Arnau-Mollá & Romero-Naranjo, 2023a).

Antes de aplicarlas al aula, se realiza una selección de actividades del glosario para cada sesión, puesto que las sesiones en el método BAPNE poseen una estructura clara y sistematizada en tres partes (rito de inicio, estimulación cognitiva, rito de cierre), con una temporalización, finalidades y objetivos bien diferenciados.

El clap change, como muchos otros bloques de actividades, se ubica dentro de la parte central de la sesión denominada de estimulación cognitiva. Esta es la parte más extensa de la sesión y ocupando el 80% de la misma (Arnau-Mollá & Romero-Naranjo, 2023a, 2023b; Asurmendi & Romero-Naranjo, 2022; Romero-Naranjo, Arnau-Mollá et al., 2023).

Arnau-Mollá y Romero-Naranjo (2023a) clasificaron los bloques de actividades del glosario que debían incluirse dentro de la parte de la sesión de estimulación cognitiva, y presentaron, además de una explicación de cada bloque, una propuesta didáctica a modo de ejemplo con cinco actividades y su secuenciación, donde se encontraba entre ellas el clap change simple.

Por otra parte, Arnau-Mollá y Romero-Naranjo (2025c) mostraron de forma amplia y detallada el uso de la voz en el método BAPNE (hablada, pensada, recitada y cantada). Aportaron gran cantidad de ejemplos prácticos sobre cada aspecto articulados sobre la figura del cuadrado. Respecto al clap change, presentaron una explicación general de la actividad; sus variantes simple y doble mediante la voz recitada; y desglosaron la variante melódica a una y dos voces sobre canciones, escalas, arpeggios y notas concretas.

A nivel de evaluación, Arnau-Mollá, Romero-Naranjo y Navarro-Maciá (2024) abordaron la justificación y aplicación de las rúbricas como herramienta de evaluación en el contexto educativo del método BAPNE. Presentaron a modo de ejemplo una serie de rúbricas para evaluar actividades de clap change en sus variantes simple y doble, articuladas mediante tres figuras geométricas, el cuadrado, el triángulo y la denominada “U” de cinco pulsaciones. Para ello, realizaron una explicación de los elementos que posteriormente evaluarían en diferentes niveles de complejidad, como los conteos en la voz, las palmadas alternantes, y el movimiento de las figuras geométricas en los pies.

Otro tipo de alusión menos extensa la encontramos en la publicación de Romero-Naranjo y Andreu-Cabrera (2023b), donde presentaron una serie de actividades, entre las que se encontraba el clap change, para aplicar de manera interdisciplinar en materias como la música, la educación física o en el aprendizaje de otras lenguas. En este caso, presentaron una explicación de la variante simple, una breve cita a la variante Bapne for math, y una breve explicación de una variante

melódica mucho más sencilla para alumnado de infantil, donde el alumnado camina a pulso sobre un cuadrado gigante con números mientras canta una melodía y debe dar la palmada en los números que indique el profesor. Posteriormente, mostraron una definición de las funciones ejecutivas y relacionaron el clap change con la toma de decisiones y la velocidad de procesamiento.

Esta variante más sencilla para trabajar el pulso en infantil, entre otras actividades pertenecientes al solfeo cognitivo, la abordaron con más detalle Romero-Naranjo (2020), y la relacionaron neuropsicológicamente con “(...) la atención sostenida y dividida, el control de impulsos, la flexibilidad cognitiva, la memoria de trabajo entre otras” (p.110).

Del mismo modo, Romero-Naranjo y Andreu-Cabrera (2023c) en el artículo de los diez pilares de la neuromotricidad, hicieron alusión al clap change a modo de ejemplo en el apartado de aspectos cinestésicos, mostrando una pequeña explicación de la variantes simple, Bapne for math y melódica, relacionando posteriormente el clap change con la velocidad de procesamiento y la toma de decisiones.

Por último, encontramos en formato libro dos publicaciones interesantes con alusiones al clap change. Por una parte, *Bapne for teachers*, que se trata de un libro didáctico destinado a futuros formadores del método BAPNE (Romero-Naranjo, 2015). Contiene 25 apartados diferentes sobre el clap change con secuencias de entrenamiento, desde muy simples hasta extremadamente complejas, que abordan todas las variantes, combinadas con todas las formas geométricas. Por otra parte, *Body Percussion Basic* (Romero-Naranjo, 2018), que recoge una selección de actividades en sus secuencias más simples para que pueda ser aplicada en el aula por cualquier docente. Encontramos una explicación general del clap change, una secuencia de la variante simple y una de la melódica sobre una canción. Cabe destacar que en esta publicación se presentó un pequeño esquema que mostraba los objetivos generales que se pretendían estimular, divididos en objetivos físicos, psíquicos, sensoriales, perceptivos, socio-afectivos y musicales.

Como hemos visto, el clap change como bloque de actividades de gran importancia dentro del método BAPNE, se ha mostrado y explicado a modo de ejemplo en diferentes tipos de publicaciones, aunque en ninguna de ellas se ha realizado un análisis en profundidad que recoja toda su esencia. Por lo tanto, el propósito de este trabajo es realizar una justificación teórico-práctica sobre el clap change en el método BAPNE, que ofrezca al profesorado las claves para su conocimiento, correcta aplicación y fundamentación, así como las implicaciones que puede conllevar para el alumnado su práctica en el aula.

Para ello, nos proponemos los siguientes objetivos:

- Detallar los aspectos importantes que se necesitan saber para tener un amplio conocimiento sobre el clap change.
- Presentar un análisis profundo del clap change basado en los diez pilares de la neuromotricidad que sirva como modelo para analizar y justificar de forma seria y académica cualquier tipo de actividad neuromotriz del método BAPNE.

¿Qué debo saber sobre el clap change?

En este apartado se presenta una visión general de las características fundamentales y los aspectos que conviene conocer sobre el funcionamiento del clap change dentro del método BAPNE. Se describirá en qué consiste, cuál es la función de sus elementos, a qué tipo de aprendizaje y movimiento se vincula y cuáles son sus principales tipologías. Encontraremos también, su relación con las figuras geométricas, el error o con los paradigmas de dual-task, para por último, abordar cómo se organiza, secuencia y gestiona su aplicación, junto con las consideraciones previas y las posibles dificultades que el docente debe tener en cuenta antes de aplicarlas en el aula.

¿Qué es el *Clap Change*?

El clap change es la denominación de una actividad específica, con registro de propiedad intelectual, que te indica como mover las extremidades superiores (preferiblemente mediante palmas) mientras mueves las extremidades inferiores con movimientos concretos en el Método BAPNE (Arnau-Mollá & Romero-Naranjo, 2023a). Por otra parte, Romero-Naranjo, Andreu-Cabrera, González et al. (2024) la describen como la capacidad de usar las extremidades superiores de forma variable mediante códigos numéricos o palabras que deben ejecutarse principalmente con palmadas, mientras se usa la extremidad inferior mediante figuras geométricas.

¿Qué función desempeñan la voz y las extremidades inferiores y superiores?

En el clap change se utilizan la voz, las extremidades inferiores y las superiores de forma conjunta, aunque cada una de ellas funciona de forma independiente:

La voz. Realiza conteos, canciones, escalas, arpegios, notas concretas, palabras o ritmos y no se interrumpe en ningún momento.

Las extremidades inferiores. Se mueven en base a las figuras geométricas que representan los compases simples o compuestos con diferente número de pulsaciones, y tampoco se detienen nunca.

Las extremidades superiores. Realizan la palmada alternante solo en determinados momentos que anuncia el profesor. Generalmente, aunque no siempre, la palmada alternante se ejecuta en función a la voz. Es decir, cuando se está articulando en la voz el número, palabra o nota concreta, que ha anunciado el profesor.

En este tipo de actividades el profesor realiza cambios continuamente, indicando en qué figuras geométricas deben moverse, qué deben articular en la voz, y en qué momento o momentos de la voz o de los pies deben realizar la o las palmadas.

¿A qué forma de aprendizaje pertenece?

En el método BAPNE todas las actividades se aprenden por medio de alguna de sus cuatro formas de aprendizaje: imitación, reacción inversa, coordinación circular variable y señalización a tiempo real (Arnau-Mollá & Romero-Naranjo, 2024c, 2024d). Concretamente, el clap change se ubica dentro de la coordinación circular variable, donde la coordinación cambia continuamente.

¿A qué categoría de movimiento pertenece?

En todas las actividades del método BAPNE el movimiento espacio-temporal que se realice con las extremidades inferiores se clasifica de tres formas: a) pasivo, cuando las actividades no requieren nunca el desplazamiento o movimiento; b) intermedio, al ubicar el desplazamiento o movimiento solo en momentos puntuales de la actividad; y c) activo, cuando la actividad conlleva un movimiento o desplazamiento constante sin interrupción (Arnau-Mollá, Romero-Naranjo, & Navarro-Maciá, 2024). Por lo tanto, el clap change se ubica dentro de la categoría activa de movimiento, puesto que las extremidades inferiores se mueven de ininterrumpidamente hasta el final de la actividad.

¿A qué categoría y variantes pertenece el uso de la voz?

Para Arnau-Mollá y Romero-Naranjo (2025c) en el método BAPNE “La voz y el canto se trabajan, prácticamente, en todos los bloques de actividades de su glosario, a través de tres categorías (pasiva, intermedia, y activa), y cuatro variantes (hablada, cantada, recitada, y pensada)” (p.19). El clap change, en todas sus tipologías hace uso de la categoría de voz activa, ya que se utiliza sin interrupción durante toda la actividad. Por otra parte, se utilizan las variantes recitada (conteos y palabras), y cantada (canciones, escalas, arpeggios, notas concretas) según la tipología que se trabaje.

¿Cuáles son sus principales tipologías?

Las principales tipologías de clap change son: simple, doble, triple, polimétrico, polirrítmico, Bapne for solfeo, Bapne for math, melódico y grupal. Todas ellas pueden trabajarse con todas las figuras geométricas siendo el gestor el que gradúa la dificultad intercalando varias figuras con la alternancia de palmadas en función del nivel del grupo. Combinando estas tipologías se pueden extraer más de 20 variantes diferentes (Arnau-Mollá & Romero-Naranjo, 2023a; Romero-Naranjo & Andreu-Cabrera, 2023c). A continuación se describen cada una de las principales tipologías a modo de ejemplo articulada sobre la figura geométrica del cuadrado.

Simple. Contar del 1 al 4 mientras te mueves en cuadrado con palmadas alternantes en relación a la voz.

Doble. Contar del 1 al 8 mientras te mueves en cuadrado con palmadas alternantes en relación a la voz.

Triple. Contar del 1 al 5 mientras te mueves en cuadrado con palmada alternante tanto en relación a la voz como a los pies. Es decir, si se pide que la palmada sea en el 1 se ejecuta cada vez que empiece el cuadrado y cada vez que recitemos el 1 con la voz.

Polimétrico. Contar del 1 al 5 mientras te mueves en cuadrado con palmada alternante en relación a la voz. De esta forma el 1 recaerá cada vez en una pulsación de la figura.

Bapne for solfeo. Actividad para trabajar diferentes figuras musicales por medio de palabras percutiendo de forma alternada sobre las sílabas de las palabras. Recitar las palabras rítmicas que indique el profesor mientras te mueves en cuadrado y realizas palmada alternante en la sílaba o sílabas determinadas. En la Figura 1 se muestran palabras rítmicas asociadas a cada figura musical.

Figura 1

Palabras asociadas a las figuras musicales



Bapne for math. Contar del 1 al 4 mientras te mueves en cuadrado y percutir en la pulsación resultante de la operación matemática que indique el profesor (palmada en el 2+1; en el 1+1; en el 2x2, etc.). El gestor puede realizar una operación matemática cada vez, o también puede realizarlas directamente sobre el resultado. Es decir, se puede anunciar “palmada en el 2+2” y el alumnado realiza la palmada en el 4, seguidamente el gestor puede decir “menos 1” a lo que el alumnado debería realizar la palmada en el 3.

Melódico. Moverse en cuadrado mientras se canta una melodía, escalas, arpeggios o notas concretas, y añadir palmada alternante, en el número de pulsación que indique el profesor si se está utilizando una melodía, o en el nombre de la nota o notas que se anuncien si se están utilizando escalas, arpeggios o notas concretas. Sobre esta tipología melódica encontramos multitud de variantes con ejemplos prácticos en la publicación *Percusión corporal y voz. Recursos prácticos desde el método BAPNE* (Arnau-Mollá & Romero-Naranjo, 2025c).

Polirrítmico. Cantar un ritmo (clave cubana) mientras te mueves en cuadrado con palmadas alternantes en relación a la pulsación de los pies según la indicación del gestor.

Grupal. Se trata de una tipología mediante la que se pueden trabajar todas las anteriores, ya que en esta las palmadas alternantes se realizan chocando las manos con los compañeros de delante o los de los lados en función de la posición de aprendizaje que se esté utilizando.

¿Qué vinculación posee con las figuras geométricas?

El clap change posee un vínculo vital con las figuras geométricas puesto que son sobre las que se articula el movimiento constante de las extremidades inferiores (activo) y sirven como base para la doble tarea, a la que se le añade la voz y la palmada alternante. Estas figuras están siempre presentes y cambian continuamente.

Musicalmente, cada figura se asocia a un compás concreto que coincide con su número de pulsaciones. Estos compases pueden ser simples ($2/4$, $3/4$, $4/4$, $5/4$, $6/4$, $7/4$, $9/4$) o compuestos ($6/8$, $9/8$, $12/8$). Las figuras que representan los compases compuestos se representan con un círculo en cada vértice de la figura. En la Figura 2 se presentan las figuras asociadas a cada compás.

Figura 2

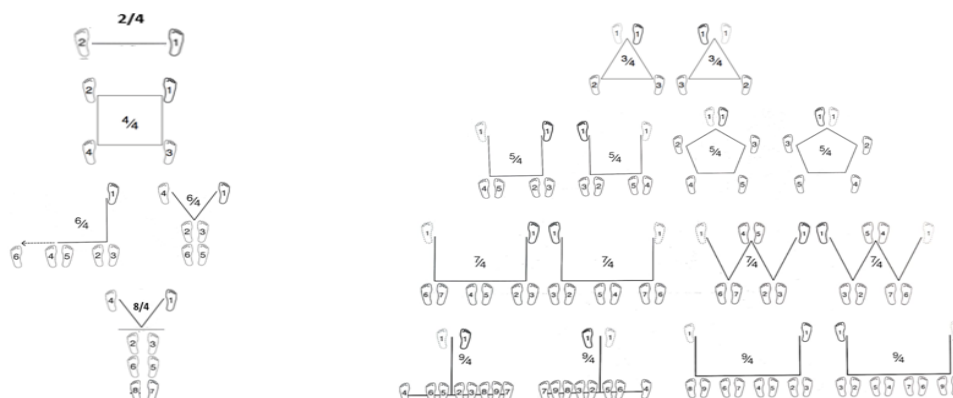
Figuras geométricas asociadas a cada compás



En la realización de las figuras geométricas, la primera pulsación es siempre hacia delante, siendo el peso del cuerpo la referencia del inicio del compás, excepto en el $2/4$ en el que se realiza la pulsación sin desplazamientos. Estos dos aspectos son de gran ayuda para el alumnado, ya que en todo momento pueden guiarse y ubicar la primera pulsación, tanto observando al grupo, como a través de su propia percepción del peso de su cuerpo hacia delante. Existe una norma de ejecución para todas las figuras en la que nunca se repite el movimiento de un mismo pie, debiendo estos moverse siempre de forma alternada. Es decir, nunca realizaremos dos pulsaciones seguidas con un mismo pie. Al realizar una misma figura repetidamente y con la alternancia de los pies correcta, las figuras asociadas a los compases pares ($2/4$, $4/4$, $6/4$, $8/4$) empezarán siempre en el mismo pie, mientras que las impares ($3/4$, $5/4$, $7/4$, $9/4$) lo harán una vez en cada pie. Por último, cabe destacar que en el método BAPNE un mismo compás puede realizarse a través de varias figuras diferentes, como es el caso de los compases $5/4$, $6/4$, $7/4$ y $9/4$, siendo el profesor el que determine cuáles de ellas elegir en función del nivel del grupo. En la Figura 3 se presenta las figuras geométricas asociadas a cada compás y la alternancia correcta de los pies.

Figura 3

Figuras geométricas asociadas a cada compás y alternancia de los pies



¿Cómo se relaciona con el error?

En el método BAPNE consideramos el error como parte del aprendizaje. Es normal errar en las actividades y todos lo hacen en algún momento. Cuando esto pasa, el alumno queda en evidencia y puede sentirse observado. En estos casos, el grupo en lugar de penalizar, sirve de guía y ayuda para retomar la actividad. La metodología no jerárquica y flexible se adapta al alumnado aumentando y disminuyendo la dificultad intentando evitar siempre la generación de indefensión aprendida y frustración.

¿Qué paradigmas de dual-task se utilizan?

A lo largo de la historia la doble-tarea ha sido investigada y clasificada en diferentes paradigmas por multitud de autores según el tipo de actividades o tareas realizadas de forma simultánea (Andreu-Cabrera et al., 2024; Arnau-Mollá, 2025; Mas-Mas et al., 2023; Romero-Naranjo, Andreu-Cabrera, & Arnau-Mollá, 2023, 2024). En la actualidad encontramos estos cinco paradigmas de doble-tarea:

- Motor-motor: dos tareas motoras de forma simultánea.
- Cognitivo-motor: una tarea cognitiva y una tarea motora.
- Cognitivo-cognitivo: dos tareas cognitivas.
- Rítmico-motor: una tarea rítmica y otra motora.
- Rítmico-Motor-cognitivo: una tarea rítmica, una motora y otra cognitiva.

En todas las tipologías de clap change la voz y el movimiento se articulan de forma simultánea, aunque de forma independiente, por lo que siempre están en funcionamiento una o varias tareas motoras (movimiento de los pies en figuras geométricas y palmadas alternantes), y una cognitiva (contar, cantar, recitar palabras, realizar operaciones matemáticas o responder a preguntas concretas). Por lo tanto se hacen uso al menos de estos tres paradigmas:

Cognitivo-motor. Moverse en cuadrado mientras se cuenta del uno al cuatro y se realiza palmada alternante según la indicación del gestor (clap change simple).

Rítmico-motor. Recitar las palabras rítmicas (taki, música, tomatina...) mientras nos movemos en cuadrado y percutir mediante palmas la sílaba indicada por el gestor (Bapne for solfeo).

Rítmico-motor-cognitivo. Realizar un ritmo con la voz, por ejemplo la clave cubana, mientras nos movemos en cuadrado y ejecutamos la palmada alternante en base al número de pulsación que indique el profesor (Polirrítmico).

¿Cómo se secuencian?

En todas las actividades del método BAPNE la secuenciación posee una importancia vital. De ello dependerá el éxito o el fracaso de la actividad. Debe gestionarse la dificultad de forma muy progresiva para que sea un reto para el alumnado, pero sin llegar a generar indefensión aprendida. A modo de ejemplo se presenta la secuenciación del clap change simple desde cero.

1. Realizar el cuadrado y el conteo del 1 al 4 (solo voz).
2. Decir solo el uno y omitir los demás números (varias veces).

3. Pasar por los demás números (2, 3, 4) diciendo solo un número cada vez (varias veces).
4. Seleccionar combinaciones de dos números (solo voz) e ir pasando por todas las posibilidades.
5. Seleccionar combinaciones de tres números (solo voz)
6. Recitar todos los números (varias veces).
7. Sin parar de contar, introducir la palmada alternante seleccionando primero solo un número, después dos, y finalmente tres.
8. Mezclar todo tipo de combinaciones con cambios cada vez más rápidos.

Esta sería la secuenciación correcta si es la primera vez que se presenta la actividad. Por el contrario, cuando ya se conoce, se empieza directamente con la palmada alternante. Es importante que cada vez que se retome la actividad en diferentes sesiones se realicen combinaciones un poco más fáciles a modo de recordatorio de la sesión anterior, para después añadir nuevas secuencias graduando la dificultad en función del nivel del grupo.

¿Cómo se gestiona?

Gestionar esta actividad es muy diferente de solo realizarla, puesto que implica una mayor carga cognitiva. Cuando se gestiona la actividad, el profesor o alumno que actúa como tal, también realiza la actividad y da las indicaciones pertinentes al mismo tiempo. En este caso, el grupo es el que realiza el conteo en voz alta y no el gestor. De este modo las indicaciones serán más precisas y claras y serán percibidas correctamente por el grupo.

Es importante empezar a gestionar la actividad en grupos pequeños. En BAPNE denominamos a esta actividad “*You are the teacher*”. En ella es el alumnado el que actúa como gestor. Se empieza con grupos pequeños de cuatro personas donde cada alumno gestiona la actividad durante unos minutos, para progresivamente ir aumentando el número de componentes del grupo. Al principio debe realizarse el clap change simple a través de una sola figura. Es decir, el gestor cambiará solo la palmada alternante y no la figura geométrica. Posteriormente, según el grado de dominio puede introducirse cambios de figuras, así como conteos simples y dobles en una misma gestión.

En “*you are the teacher*”, el gestor experimenta por primera vez la mayor carga cognitiva que se precisa para gestionar la actividad, pues debe dar las indicaciones al mismo tiempo que la realiza. Es entonces cuando se disparan de forma exponencial la estimulación de su atención dividida, dual-task, planificación, toma de decisiones, inhibición, memoria de trabajo y velocidad de procesamiento, entre otras.

¿Durante cuánto tiempo debo aplicarla?

Una de las reglas del método BAPNE es la regla de los tres minutos, aplicable a todas sus actividades sin excepción. Esta duración aproximada es la clave para mantener altos niveles de atención y concentración en el alumnado en el aula (Crespo et al., 2015). Si se sobrepasa el tiempo aconsejado, pronto notaremos cómo decrece el interés en la actividad, ya que el alumnado empieza a cometer más errores de lo normal al estar hablando entre ellos y riéndose de sus propios errores. Como se ha dicho anteriormente, lo ideal es empezar recordando de forma rápida lo trabajado en

las anteriores sesiones para seguidamente incorporar nuevas secuencias de mayor complejidad a la actividad.

Por el contrario, esta regla es más flexible cuando se trabaja en cursos de formación para el profesorado, donde lo que se pretende es mostrar la máxima información sobre los aspectos didácticos. En estos casos, las actividades pueden mostrarse durante más tiempo, intercalando entre ellas práctica, justificación y didáctica.

¿Qué debo tener en cuenta antes de aplicarla?

Lo primero es controlar al 100% cualquier actividad que pretendamos aplicar en el aula. Obviamente todos nos equivocamos, y no pasa nada. Al alumnado le gusta ver los docentes también somos humanos y nos equivocamos como ellos, pero si nuestros errores son muy recurrentes, perderán la confianza en nosotros y pensarán que “si tú no puedes, yo no puedo”.

Teniendo esto en mente, lo mejor es gestionarse a sí mismo dando las indicaciones en voz alta a un grupo imaginario, y poco a poco ir adquiriendo el control de todas las figuras geométricas y todas las variantes de clap change. Por supuesto, debido a la gran cantidad de variantes y combinaciones posibles, esta no es tarea que se adquiera en poco tiempo, sino que necesita de muchísima preparación. Por lo tanto, no es necesario aprender a gestionar todas las variantes, sino solo aquellas que realmente nos interese aplicar en el aula con total seguridad. Obviamente, al controlar variantes más complejas, aunque no las apliquemos al aula, más fácil nos será gestionar las variantes más simples.

¿Qué dificultades debe saber gestionar el docente?

Para una correcta aplicación de las actividades en el aula es necesario que el docente tenga en mente una serie de aspectos que pueden dificultar la ejecución de la actividad al alumnado. Por ello el docente debe tener muy en cuenta y asegurarse de que los siguientes parámetros los realiza a la perfección:

- Dar la indicación con suficiente antelación.
- Que el tono de la voz y la dicción sean muy clara y precisa.
- Que la posición de las manos y espalda sea la correcta.
- Que el movimiento de los pies sea muy claro y sirva de referente al grupo.

A continuación se presenta en la Figura 4 un esquema a modo de resumen y que puede servirles como estudio de todos los aspectos importantes a saber en relación a las actividades de clap change que se han mostrado en este apartado.

En este esquema las respuestas se han realizado de forma muy resumida, puesto que la finalidad es mostrar una visión general sobre dichos aspectos a saber.

¿Qué debo saber sobre el clap change?



¿PARA QUÉ SIRVE DESDE LOS 10 PILARES DE LA NEUROMOTRICIDAD?

Los diez pilares de la neuromotricidad son una guía propuesta por Romero-Naranjo y Andreu-Cabrera (2023c) donde se sientan las bases sobre los principales aspectos sobre los que debe justificarse de forma seria y académica las actividades del método BAPNE. En este apartado se presenta un análisis detallado sobre las implicaciones del clap change basado en los diez pilares de la neuromotricidad: funciones cognitivas, funciones ejecutivas, red atencional, aspectos hormonales, aspectos socioemocionales, modelos teóricos de aprendizaje, habilidades múltiples, aspectos cinestésicos, formas visuales de aprendizaje, y aspectos musicales.

Funciones cognitivas

Entendemos las funciones cognitivas como las responsables de recibir, seleccionar, almacenar y procesar la información del entorno que nos rodea (Romero-Naranjo & Andreu-Cabrera, 2023a) y que nos permiten realizar tareas como leer, escribir, mantener conversaciones o escuchar música con atención. En el clap change están implicadas, en mayor o menor grado, todas las funciones cognitivas propuestas por el método BAPNE (memoria, lenguaje, red atencional, praxias, gnosias, funciones ejecutivas, orientación espacial, habilidades visuoespaciales y cognición social).

Memoria. Este tipo de actividad, en alguna de sus variantes, requiere en nuestra memoria la codificación, almacenamiento y recuperación de conteos (simples, dobles), canciones, notas concretas, escalas, arpeggios, palabras, operaciones matemáticas, posiciones de aprendizaje o figuras geométricas entre otras. Por lo tanto, toda esta información debe ser almacenada y procesada a través de la memoria sensorial (visual y auditiva), la memoria a corto plazo (unos segundos), y la memoria a largo plazo (Atkinson & Shiffrin, 1968). Dentro de la memoria a largo plazo, se hace uso de la memoria semántica (Tulving, 1985), y la memoria procedimental (Squire, 2004).

Lenguaje. El lenguaje está siempre presente en este tipo de actividades. A través de él se articulan todos los elementos de dual-task vinculados a la voz cantada y recitada (conteos, canto, ritmos y palabras).

Red atencional. Para la realización del clap change se necesita un alto grado de atención y concentración, por lo todos los aspectos relacionados con la atención están siempre presentes en este tipo de actividades. Puesto que la red atencional es el tercero de los pilares básicos de la neuromotricidad, se especificará de forma detallada más adelante.

Praxias. Las praxias son un proceso neurológico mediante el cual la cognición dirige las acciones motoras. Están íntimamente relacionadas con la cinestesia y las podemos encontrar de varios tipos: ideomotoras, ideacionales, visoconstructivas y orofaciales (Romero-Naranjo & Andreu-Cabrera, 2023c). En el clap change utilizamos principalmente las praxias ideomotoras. Estas implican movimientos simples con las manos. En este caso las utilizamos al realizar la palmada alternante.

Gnosias. Se entiende por gnosias a las “(...) habilidades que permiten percibir el entorno mediante el procesamiento de las diferentes señales sensoriales” (Valencia-Echeverry et al, 2020, p.116). Los principales tipos de gnosias pueden clasificarse en función del sentido a través del cual

se procesa la información sensorial (visual, auditiva, táctil, olfativa o gustativa). En el clap change entran en funcionamiento las gnosias táctiles, visuales y las auditivas.

- Las táctiles a través del contacto de las manos con los compañeros (Tipología grupal).
- Las visuales también al realizar las palmadas con los compañeros ya que tienen que controlar las distancias (tipología grupal), o al estar pendiente del movimiento del grupo y de los compañeros de alrededor (cualquier tipología).
- Las auditivas al atender a las indicaciones verbales del profesor e interpretar dónde dar la palmada alternante o a qué figura cambiar.

Funciones ejecutivas. Las funciones ejecutivas son un tipo de función cognitiva de alto nivel. Existen diferentes modelos de funciones ejecutivas. El método BAPNE se basa en los modelos de Miyake (2000) y en el de Tirapu-Ustarroz y Luna-Lario (2008). En el clap change se estimulan todas las funciones ejecutivas propuestas en estos dos modelos que justificaremos en el segundo pilar de la neuromotricidad.

Orientación espacial. En el clap change la orientación espacial entra en funcionamiento cuando se explican las diferentes direcciones que conllevan los desplazamientos asociados a cada figura geométrica.

Habilidades visuoespaciales. Las habilidades visuoespaciales se estimulan en el momento en el que el alumnado aplica el movimiento de cada figura geométrica, puesto que debe recordar la representación espacial de cada figura y aplicarla al movimiento de las extremidades inferiores. Se estimula a través de recordar, por una parte, la representación espacial de cada figura geométrica y aplicarla al movimiento, y por otra, al recordar las diferentes posiciones de aprendizaje.

Cognición social. El clap change es un tipo de actividad que se realiza siempre de forma grupal, donde todo el alumnado la realiza al mismo tiempo. Por lo tanto, la cognición social está siempre presente al tener que interpretar continuamente juicios sobre nosotros mismos, sobre los demás, y sobre las relaciones que se establecen entre el grupo.

Funciones ejecutivas

El término funciones ejecutivas fue acuñado por primera vez en 1982 por Lezak quien las definió como las capacidades mentales esenciales para formular y llevar a cabo un plan de manera eficiente, independiente, creativa y socialmente aceptada (Romero-Naranjo, Andreu-Cabrera, Di Russo et al., 2023). A partir de aquí aparecen multitud autores que estudian este campo de trabajo aportando sus propios modelos. A raíz de esto, encontramos en la actualidad más de 30 definiciones y funciones ejecutivas diferentes.

Como se ha dicho anteriormente, el método BAPNE se basa en los modelos del investigador Akira Miyake (Miyake et al., 2000; Miyake & Friedman, 2012) que proponen un modelo factorial que presenta tres funciones ejecutivas que denomina nucleares de las que surgen todas las demás, y que están presentes en la mayoría de los modelos de otros autores. Estas son la memoria de trabajo, la inhibición y la flexibilidad cognitiva.

Por otra parte, BAPNE se basa también en el modelo de Tirapu-Ustarroz y Luna-Lario (2008) que recogen las tres funciones ejecutivas nucleares propuestas por Miyake y añade las siguientes: velocidad de procesamiento, planificación, dual-task, toma de decisiones, fluencia verbal y branching.

En las actividades de clap change, al igual que ocurre con las funciones cognitivas, se estimulan en mayor o menor medida todas las funciones ejecutivas mencionadas en estos dos modelos. Todas estas funciones ejecutivas han sido expuestas y definidas en varios artículos sobre el método BAPNE, puesto que su estimulación es el eje central de la metodología (Andreu-Cabrera & Romero-Naranjo, 2021; Arnau-Mollá, 2025; Romero-Naranjo & Andreu-Cabrera, 2023b; Romero-Naranjo, Andreu-Cabrera, & Arnau-Mollá, 2023; Romero-Naranjo & Romero-Naranjo, 2022; Romero-Naranjo, Sayago-Martínez et al., 2023). A continuación, se presenta un breve recordatorio de cada una y un pequeño ejemplo de cómo se estimula a través de alguna de las variables de clap change.

Memoria de trabajo. “(...) Es la capacidad de registrar, codificar, mantener y manipular la información durante un intervalo muy concreto de tiempo para mantener el sentido de unidad de la actividad cognitiva” (Andreu-Cabrera & Romero-Naranjo, 2021, p.935). Se estimula a través de todas las variantes de clap change principalmente al retener momentáneamente dónde debe darse la palmada alternante, en qué figura geométrica se está moviendo o qué tipo de ritmo se realizando.

Flexibilidad cognitiva. “(...) es la habilidad que permite realizar cambios en aquello que estaba previamente planeado y adaptarnos así a las circunstancias de nuestro entorno” (Andreu-Cabrera & Romero-Naranjo, 2021, p.936). En el clap change, tanto la voz, como los movimientos de los pies y las palmadas alternantes están en continuo cambio, por lo que se produce en el alumnado un alto grado de estimulación de esta función ejecutiva.

Inhibición o control inhibitorio. “(...) es la capacidad de inhibir o controlar las respuestas impulsivas, interferencias o distractores mientras se realiza una tarea” (Andreu-Cabrera & Romero-Naranjo, 2021, p.936). Se estimula al inhibir de las palmadas las pulsaciones que no han sido anunciadas por el gestor.

Velocidad de procesamiento. “(...) tiempo que le lleva a una persona poder realizar una tarea mental. Es la cantidad de unidades de información que maneja el cerebro en una unidad de tiempo determinado” (Romero-Naranjo, 2020, p.116). Se estimula muchísimo al realizar operaciones matemáticas, y también al dar cada vez menor tiempo de reacción al alumnado para ejecutar la palmada, el cambio de conteo o de figura geométrica. Por ejemplo, decir palmada en el cuatro cuando ya te encuentras en la tercera pulsación. De este modo se ha reducido al mínimo el tiempo de reacción del alumnado.

Planificación. “(...) es la capacidad de generar objetivos, desarrollar planes de acción para conseguirlos y elegir el más adecuado con base a la anticipación de consecuencias” (Romero-Naranjo, 2020, p.116). Al realizar el clap change, el alumnado debe planificar a gran velocidad el movimiento concreto que debe ejecutar y donde debe dar la palmada para tener éxito.

Doble tarea. “(...) es la capacidad de realizar dos tareas completamente diferentes simultáneamente y prestando igual atención a ambas de manera constante” (Andreu-Cabrera &

Romero-Naranjo, 2021, p.935). Está presente en todas las actividades de clap change, puesto que la voz, la palmada y el movimiento de los pies van totalmente independientes.

Toma de decisiones. “(...) es el proceso de realizar una elección entre varias alternativas en función de nuestras necesidades, sopesando los resultados y las consecuencias de todas las opciones” (Romero-Naranjo, 2020, p.117). En todo momento, el alumnado está tomando decisiones rápidamente, pues tiene muy poco tiempo para elegir dónde debe dar la palmada para que sea correcta.

Fluencia verbal. “(...) es la capacidad de proceso de información y emisión de respuestas de forma eficaz empleando el menor tiempo posible” (Romero-Naranjo, 2020, p.117). Se estimula mucho cuando se exige una gran carga cognitiva, por ejemplo, cuando te mueves en cuadrado contando en doble (1-8) percutiendo el 1-2-4 y respondiendo a preguntas (capitales, contrarios, traducciones de palabras, etc.).

Branching. “(...) es la capacidad de organizar y realizar tres tareas óptimamente de manera simultánea, intercalándolas y sabiendo en qué punto está cada una de ellas en cada momento” (Andreu-Cabrera & Romero-Naranjo, 2021, p.936). Está continuamente presente en el clap change, pues los conteos y las figuras cambian continuamente. Me muevo en cuadrado mientras cuento simple (1-4), para después moverme en triángulo contando doble (1-6) y más tarde volver de nuevo al cuadrado simple. Todo esto alternando las palmadas donde indique el profesor.

Es importante saber que cuando se realiza el clap change en cualquiera de sus tipologías o variantes, no solo se estimula una función ejecutiva en concreto, sino muchas a la vez. El gestor es el encargado de graduar la dificultad de la actividad en función del nivel del grupo y del grado de estimulación cognitiva que desee aplicar. Debe asegurarse de que el grupo le sigue y que no está generando indefensión aprendida al alumnado por exceso de dificultad.

Red atencional

La atención es un componente clave y fundamental en la cognición humana, ya que posibilita y contribuye a la ejecución de las demás funciones psicológicas. La mayoría de los educadores concuerdan en que la falta de atención y de niveles bajos de concentración es una realidad evidente en el contexto del aula (Arnau-Mollá & Romero-Naranjo, 2020).

En cuanto a su naturaleza, la atención se considera una función cognitiva compleja que ha sido objeto de estudio exhaustivo a lo largo de la historia, desde los pensadores clásicos hasta el presente. Con el tiempo, su definición ha evolucionado y variado. De hecho, desde mediados del siglo XX han surgido más de 25 modelos atencionales. Estos modelos a menudo se influyen mutuamente o se reinterpretan con nuevos datos obtenidos, por ejemplo, mediante técnicas de neuroimagen (Arnau-Mollá, Romero-Naranjo, & Andreu-Cabrera, 2024).

El método BAPNE se basa en el modelo atencional propuesto por Sohlberg y Mateer (1987, 1989). Según Piqueres et al. (2018), la mayoría de test validados en España están en concordancia con este modelo jerárquico de la atención. Propone seis tipos de atención: arousal, focal, sostenida, selectiva, alternante y dividida en el cada uno precisa del buen funcionamiento del anterior al precisar mayor carga cognitiva.

Al igual que los aspectos incluidos en cada pilar de la neuromotricidad, este modelo de atención ha sido explicado en varias publicaciones del método BAPNE (Arnau-Mollá, 2025; Arnau-Mollá & Romero-Naranjo, 2020; Arnau-Mollá, Romero-Naranjo, & Andreu-Cabrera, 2024; Romero-Naranjo, Pujalte et al., 2023). A continuación, se presenta una breve descripción de cada una y un pequeño ejemplo de cómo se estimula cada tipo a través de las actividades de clap change.

Arousal. “(...) capacidad de estar despierto y mantener la alerta. Activación general del organismo” (Arnau-Mollá, 2025, p.36). Representa la activación general de todo el sistema para poder recibir y procesar información. En todas las variantes de clap change el alumnado necesita estar alerta para poder realizar la actividad. Sobre todo cuando se realiza la actividad “*You are the teacher*” el alumnado siente de forma más acusada sus propias sensaciones internas.

Focal. “(...) habilidad para concentrar la atención en un estímulo, ya sea visual, auditivo o táctil. Supone resistir distracciones y/o cambiar la atención hacia otro estímulo (si fuera necesario)” (Arnau-Mollá, 2025, p.36). En todas las actividades del clap change se presiona de poder focalizar la atención, sobre todo de forma auditiva, aunque también visual para poder realizar la actividad.

Sostenida. “(...) capacidad de mantener un estímulo concreto durante un tiempo prolongado” (Arnau-Mollá, 2025, p.36). Su trabajo continuado es esencial para evitar que el nivel de vigilancia decaiga con el paso del tiempo. En todos los tipos de clap change el alumnado debe mantener la atención en la actividad para poder realizarla con éxito, por lo que la atención sostenida se estimula de forma continua.

Selectiva. “(...) habilidad para elegir aquellos aspectos relevantes del proceso atencional eliminando los efectos distractores de una tarea concreta” (Arnau-Mollá, 2025, p.36). En todos los tipos de clap change el alumnado debe ejecutar la palmada concretamente en el lugar indicado por el profesor, por lo que la atención selectiva es continuamente estimulada.

Alternante. “(...) posibilidad de variar el foco de atención entre tareas que implican un requerimiento cognitivo diferente y hacerlo con eficacia” (Arnau-Mollá, 2025, p.36). Esta función requiere de flexibilidad mental para manejar la alternancia de las tareas. En todos los tipos de clap change se realizan cambios constantes en la voz, la palmada y el movimiento de los pies, por lo tanto, también la atención alternante se estimula de forma constante.

Dividida. “(...) capacidad que permite atender a más de un estímulo sin que ello implique una pérdida en la eficacia o eludiendo errores en la ejecución de dichos estímulos” (Arnau-Mollá, 2025, p.36). En todos los tipos de clap change se estimula continuamente la atención dividida, puesto que la voz, el movimiento de los pies y de las manos se van siempre de forma independiente.

Aspectos hormonales

Las hormonas y los neurotransmisores son esenciales porque actúan como los mensajeros químicos del organismo, transmitiendo información vital entre las células y los órganos (García-Arnés & García-Casares, 2022).

Algunas de estas sustancias poseen una doble función, comportándose como hormonas cuando son producidas por las glándulas suprarrenales y vertidas al torrente sanguíneo; y actuando como

neurotransmisores cuando se liberan en paralelo en las terminaciones nerviosas (Romero-Naranjo & Andreu-Cabrera, 2023c).

Existen una serie de hormonas y neurotransmisores íntimamente vinculadas al movimiento. Todas las que se muestran a continuación, se benefician o facilitan no solo la acción motora, sino también el vínculo social, la estabilidad emocional, la mitigación del estrés o la búsqueda del placer y el bienestar. Por supuesto, en algunas de ellas no mostramos sus funciones principales, sino aquellas que tienen una relación directa con el movimiento. Las hormonas o neurotransmisores que entran en funcionamiento al realizar las actividades del clap change son las siguientes:

Glutamato. Potencia la comunicación entre grupos neuronales.

Dopamina. Vinculada a la recompensa y el placer.

Acetilcolina. Implicada en los procesos de aprendizaje y memoria.

Serotonina. Vinculada a nuestro estado de ánimo y a los procesos del sueño.

Endorfinas. Tienen la capacidad de inhibir las neuronas implicadas en el dolor y regular la liberación del estrés.

Noradrenalina. Implicada en mantenernos despiertos, activos y enfocados.

Cortisol. Implicada en la regulación del estrés y la ansiedad.

Oxitocina. Implicada en los vínculos sociales, afectivos y emocionales.

Vasopresina. También implicada en el reconocimiento social, la cognición y la regulación emocional.

Prolactina. Sus niveles altos influyen negativamente en la dopamina y con ello al estado de ánimo, a la motivación y al movimiento.

En resumen, la relación con el movimiento es bidireccional: el movimiento estimula la liberación y acción de estos compuestos, y estos, a su vez, son necesarios para ejecutar el movimiento de forma eficaz, concentrada, y para asegurar que la experiencia de aprendizaje motriz sea emocionalmente estable y placentera.

Aspectos socioemocionales

Respecto al fundamento socioafectivo o socioemocional, el método BAPNE se centra, en el modelo de los universos emocionales propuestos por el psicólogo Roberto Aguado, que clasifica las emociones en agradables (CASA), desagradables (TRAM), y mixtas. En las agradables incluye la curiosidad, la alegría, la seguridad y la admiración, mientras que en las desagradables, la tristeza, la rabia, el asco y el miedo, dejando como emoción mixta la sorpresa (Aguado, 2014). Por otra parte, BAPNE también se basa en las tres formas de arraigamiento grupal (Lowen, 2014) para cohesionar al grupo a través de la interacción de la mirada, el contacto con las manos y los desplazamientos. Se comentan a continuación los aspectos que se potencian en el alumnado a través de la práctica del clap change.

Generación de emociones agradables (CASA). La curiosidad, al no saber el tipo de actividad o secuencia que se va a encontrar en cada sesión. La admiración, cuando el profesor te mira y valora tu trabajo, lo admiras, lo idealizas, lo tienes como referente, y por ello intentas imitarlo. La seguridad, puesto que sabe que el error no es penalizado, sino normalizado como parte del aprendizaje. Y la alegría, al ser capaz de conseguir realizarla con éxito gracias a la graduación progresiva de la dificultad.

Tres formas de arraigamiento. Al mantener la mirada y el con el grupo, así como los desplazamientos para la interacción.

Autoestima. Gracias a la secuenciación y la graduación de la dificultad, el alumnado se siente capaz de realizar la actividad satisfactoriamente.

Sensación de pertenencia. Se trata de actividades grupales y colaborativas donde el objetivo es siempre común.

Aceptación del error. No se penaliza el error, sino que se considera necesario, como parte del aprendizaje.

Motivación. Tanto extrínseca como intrínseca e incluso trascendente, al no solo querer obtener una recompensa o incentivo (extrínseca), sino al realizar la actividad por placer o satisfacción personal (intrínseca), o sobre todo en futuros docentes o profesionales de otros ámbitos, cuando tienen en mente el impacto que pueden ejercer en otras personas la aplicación de estas actividades (trascendente).

Aprendizaje en valores. Se potencian el trabajo en equipo, la empatía, el respeto a la cultura y a los compañeros, la tolerancia, y la transmisión emocional a través del movimiento.

Modelos teóricos de aprendizaje

Este módulo se centra en cómo se imparte y se propaga el conocimiento, enfatizando que la óptica o el enfoque de la información puede variar considerablemente. El proceso de aprendizaje del ritmo no es igual en todas las culturas, ya que en unas se entiende el movimiento según un sentimiento, percepción o expresión, y en otras más relacionado al pensamiento y el entendimiento (Crespo et al., 2015).

Para Romero-Naranjo y Andreu-Cabrera (2023c), en el método BAPNE se tiene en cuenta la forma de enseñar y de presentar la información, basándose en diferentes teorías de aprendizaje según se muestre la información secuenciada o aleatoria (Gregorc), según los estilos de aprendizaje (Kolb), en base a la personalidad o el perfil psicológico del estudiante (Myer Briggs), o en función de la preferencia de aprendizaje de los estudiantes (Dunn & Dun).

En todas las actividades del método BAPNE, y concretamente en todas las tipologías y variables de clap change sin excepción, el modelo de Gregorc está siempre presente, pues es de vital importancia la secuenciación del aprendizaje. Por lo tanto, nunca se presenta la información de forma aleatoria, sino a través de una secuenciación precisa y minuciosa.

Habilidades múltiples

La variedad de alumnado en el aula es un hecho. Por ello, encontramos estudiantes que se sienten más cómodos aprendiendo dentro de ciertos parámetros (cinestésico, lingüístico, lógico-matemático, musical o visuoespacial), o incluso mediante la combinación de varios de estos.

A través de las actividades neuromotrices se pueden desarrollar múltiples habilidades o destrezas de las expuestas anteriormente. Estas habilidades, interconectadas entre sí, tienen una relación directa con las funciones cognitivas. De forma más concreta, al realizar las actividades de clap change el alumnado estará potenciando las siguientes habilidades o destrezas:

Cinestésica. El movimiento de extremidades inferiores y superiores está siempre presente y articulado de forma independiente.

Lingüística. El lenguaje hablado, recitado o cantado también se utiliza de forma ininterrumpida a través de conteos, melodías, palabras, o respuestas a preguntas o traducciones.

Matemática. El conteo numérico simple o doble, así como las operaciones matemáticas (sumas, restas, multiplicaciones, divisiones o series numéricas) se pueden aplicar prácticamente todas las variantes.

Visuoespacial. El movimiento de las extremidades inferiores a través de las figuras geométricas es continuo e ininterrumpido. Además, los desplazamientos del cuerpo hacia delante, detrás, derecha o izquierda son diferentes en cada figura.

Musical. A través del uso continuado de conteos o palabras realizados siempre de forma rítmica, así como el canto de melodías, y la realización de ritmos con las palmas o con la voz.

Intrapersonal. El alumno se siente a sí mismo mientras realiza las actividades, se concentra, se evalúa, y descubre cuáles son sus potencialidades y sus debilidades.

Interpersonal. Las actividades son siempre grupales. En la tipología grupal existe interacción con los demás estudiantes, pues las palmadas se realizan con los compañeros de enfrente o de la derecha y de la izquierda simultáneamente.

Aspectos cinestésicos

Debido al gran componente psicomotor que poseen las actividades de clap change, encontramos relación con diferentes aspectos como la biomecánica, coordinación, disociación, lateralidad, esquema corporal, condición física y habilidades motrices básicas.

Biomecánica. Entendemos la biomecánica como la ciencia que estudia los movimientos que puede realizar el cuerpo humano en función a su estructura ósea y muscular. La biomecánica posee un papel destacado en diferentes campos de estudio como la medicina, las ciencias de la actividad física y el deporte o la danza. Para justificar cómo son los movimientos del cuerpo humano la biomecánica hace referencia a los planos y los ejes. Los planos biomecánicos son el horizontal, sagital y longitudinal. En las actividades de clap change solo se utilizan los planos biomecánicos, concretamente, el plano horizontal, que divide el cuerpo en dos mitades arriba/abajo (extremidades inferiores y superiores); y el plano sagital, que divide el cuerpo en dos mitades derecha/izquierda.

Coordinación. Se define como la facultad de poner en marcha varios músculos o grupos de ellos para realizar una acción determinada. Puede estar vinculada a la psicomotricidad fina y gruesa, y ser óculo-audio-manual, óculo-audio-pedal, y óculo-audio-disociativa. En el clap change se utiliza principalmente la psicomotricidad gruesa a través del movimiento de los pies y la palmada alternante, y principalmente el tipo de coordinación óculo-audio-manual, pues el alumnado debe coordinar la palmada alternante con sus compañeros en la variante grupal.

Disociación. Entendemos la disociación como la capacidad de movilizar de modo independiente las distintas partes del cuerpo que entran en juego cuando se ejecuta una acción. Esta capacidad es fundamental porque la independencia de cada segmento corporal con respecto a los otros contribuye a afinar la psicomotricidad en su conjunto. Encontramos la disociación entre las extremidades inferiores, las superiores y la voz en todas las variantes de clap change.

Lateralidad. La lateralidad es un tema interesantísimo que posee un bloque específico dentro del glosario de actividades BAPNE. Podríamos definirla como la consecuencia de la distribución de funciones establecida entre los dos hemisferios cerebrales, de la cual depende la utilización preferente de un lado del cuerpo para realizar acciones o respuestas. La lateralidad puede ser visual, auditiva, manual y pedal (Morales et al., 2024; Romero-Naranjo, 2012). En las actividades de clap change la lateralidad se estimula principalmente en los desplazamientos de las figuras geométricas y al trabajar la variante grupal, cuando el alumnado realiza la palmada alternante con los compañeros de la derecha y de la izquierda simultáneamente.

Esquema corporal. Sobre el esquema corporal encontramos un documento clave elaborado por Romero-Naranjo, Andreu-Cabrera, y Arnau-Mollá (2023). Según estos autores, el esquema corporal es una estructura fundamental y una noción central del desarrollo motor humano, siendo indispensable para la corporalidad y las amplias posibilidades de movimiento. Depende de la interrelación de las partes del cuerpo entre sí y, sobre todo, de su relación con el espacio y los objetos que nos rodean. El esquema corporal se conforma diferentes variables perceptivo-motrices como la actitud, el control postural, la estructuración espacial y temporal, el equilibrio y la coordinación (Romero-Naranjo, Andreu-Cabrera, & Arnau-Mollá, 2023). El trabajo de las actividades de clap change llevan implícitas prácticamente todas estas variables que pasamos a comentar:

- *Control postural.* Su objetivo principal es conseguir y mantener una posición habitual, cómoda y estable con una fatiga mínima que no cause desequilibrios. El tono muscular es clave en esta adquisición, siendo el cerebelo quien regula el control postural. En las actividades de clap change se precisa de una postura flexible, cómoda y sin tensiones que se potencia a través del movimiento ininterrumpido de las extremidades inferiores.
- *Estructuración espacial.* El espacio no solo es un objeto de representación mental, sino una percepción que tenemos en función a la acción motora que realizamos. Para ello es clave cómo apreciamos las direcciones, las distancias, la localización de los objetos cuando están en movimiento y la orientación en el espacio. En el clap change, la estructuración espacial viene determinada por el desplazamiento realizado a través de las figuras geométricas con las extremidades inferiores, y por la palmada alternante realizada en la variante grupal, donde se chocan las palmas con los compañeros.

- *Estructuración temporal.* En la estructuración temporal entran en funcionamiento la percepción de organización, orden e intervalos de duración. El ritmo, con todos sus componentes, es esencial para la mejora de la ejecución motora y la coordinación de movimientos. En el clap change, el ritmo está siempre presente, bien sea en la voz, en las extremidades superiores, en las inferiores, o en dos o tres de estos componentes simultáneamente.
- *Equilibrio.* Podemos entender por equilibrio la capacidad que poseemos de controlar nuestro cuerpo y de mantener una posición vertical en el espacio. Puede ser estático, si no nos movemos, y dinámico si estamos en movimiento. En las actividades de clap change, se potencia el equilibrio a través de la desestabilización que provoca, bien sea el equivocarnos con la coordinación de las extremidades inferiores e intentar retomar la actividad, o al chocarnos con algún compañero que se ha equivocado, ambos aspectos bastante normales en la realización de estas actividades.
- *Coordinación.* Este aspecto forma parte de la adquisición del esquema corporal, pero ya ha sido tratado y justificado con anterioridad dentro de los aspectos cinestésicos.

Condición física. Existen diferentes definiciones de condición física, así como varias clasificaciones de las cualidades físicas básicas que se incluyen dentro de ella. Romero-Naranjo y Andreu-Cabrera (2023a) realizan un estudio en el que relacionan la neuromotricidad método BAPNE con la adquisición de la condición física y determinan, en base al consenso de la literatura existente, que las cualidades físicas básicas más comunes son la fuerza, la resistencia, la agilidad y la velocidad. En las actividades de clap change se trabajan únicamente la agilidad y la velocidad al aumentar de forma progresiva el número de figuras geométricas y de palmadas alternantes cada vez más complejas y a mayor velocidad.

Habilidades motrices básicas. Según Andreu-Cabrera et al. (2024) las habilidades motrices básicas se pueden clasificar según su movimiento implique locomoción, manipulación o estabilidad. En su trabajo, proponen actividades de neuromotricidad método BAPNE que pueden contribuir a la mejora de los desplazamientos, los saltos, los giros, los lanzamientos y las recepciones. Concretamente, en las actividades de clap change estaríamos trabajando únicamente la habilidad motriz básica del desplazamiento por medio del movimiento de las extremidades inferiores sobre las diferentes figuras geométricas.

Formas visuales de aprendizaje

En el método BAPNE se analiza la geometría del aula para asegurar que la ubicación de los estudiantes optimice la interacción social durante la ejecución de los movimientos. Utiliza diferentes posiciones de aprendizaje siempre de forma no jerárquica. La manera en que el individuo interactúa, se relaciona y logra conectarse con sus compañeros mediante estas estructuras espaciales es crucial. Esta disposición es fundamental para crear buenas relaciones interpersonales a través del movimiento. El trabajo de las actividades de clap change es principalmente en círculos, aunque también se puede realizar en casi todas sus otras posiciones como círculos concéntricos, filas enfrentadas, parejas, cuartetos, sextetos u octetos.

Aspectos musicales

El método BAPNE no es un método musical. No pretende enseñar música, sino a través de ella, y especialmente a través del ritmo. Sus objetivos no son puramente musicales, sino de estimulación cognitiva, psicomotriz y socioemocional. Por otra parte, tampoco utiliza instrumentos musicales ni música pregrabada, sino el propio cuerpo única y exclusivamente. Podemos decir que posee grandes diferencias con los principales métodos pedagógico-musicales del siglo XX (Arnau-Mollá & Romero-Naranjo, 2024d). Aun así, son muchísimos los aspectos musicales que se pueden trabajar desde el enfoque de la neuromotricidad. Concretamente, las actividades de clap change llevan implícitas el uso de aspectos tan variados como:

Pulso. Siempre está presente en todas las variantes. En las extremidades inferiores se marca el pulso siempre, mientras que en la voz se realiza cuando se utilizan los conteos simples.

Tempo. Se trabaja a varias velocidades en función del nivel del grupo y el dominio de la variante utilizada. Es realmente satisfactorio para el alumnado cuando se les lleva al límite realizando a gran velocidad una actividad controlan al 100%.

Metro. Se utilizan compases simples (2/4, 3/4, 4/4, 5/4, 6/4, 7/4, 9/4) y compuestos (6/8, 9/8, 12/8). Sus pulsaciones pueden coincidir en la voz y las extremidades inferiores (simple), o por el contrario utilizar un metro diferente para cada una (triple y polimétrica).

Ritmo. Se realizan ritmos básicos de negra en las extremidades inferiores. En las extremidades superiores ritmos de negra, negras y corcheas, corcheas y semicorcheas, tresillos de negra, la combinación de todas ellas, así como ritmos con contratiempos. En la voz ritmos de negras, corcheas, tresillos, semicorcheas, combinación de todas ellas y ritmos concretos como la clave cubana o el reggaetón.

Canto. Tiene gran importancia en estas actividades. Se utiliza a través de canciones (generalmente africanas), escalas mayores, menores y pentatónicas, arpeggios mayores o menores y en notas concretas. A cada tipo de metro o figura se le asocia un tipo de canción, escala, arpeggio o notas concretas, aunque también pueden ir de forma independiente al metro.

Subdivisión. Generalmente a través de los conteos dobles con la voz, pero también se puede utilizar en las palmadas mientras la voz varía de simple a doble. En el clap change nunca se asocia la subdivisión a las extremidades inferiores.

Tiempos y contratiempos. Se trabajan mediante la palmada alternante según se indiquen los tiempos fuertes o los débiles. También a través de la voz, con el uso de ritmos que conlleven contratiempos.

Para concluir este apartado sobre para qué sirve el clap change desde los diez pilares de la neuromotricidad, podemos decir que permitirá al profesorado no solo conocer de forma amplia y fundamentada las implicaciones de estimulación que implica en el alumnado, a varios niveles la práctica de estas actividades en el aula, sino también a fundamentarla de manera seria y académica en sus programaciones didácticas en beneficio de un proceso de enseñanza-aprendizaje de calidad. Además, podrá servirle como modelo para justificar cualquier tipo de actividad neuromotriz del método BAPNE. A continuación, se muestra a modo de resumen en la Tabla 1, todos los aspectos de estimulación implicados en la práctica del clap change.

Tabla 1

¿Para qué sirve el clap change desde los diez pilares de la neuromotricidad?

Funciones cognitivas	Funciones ejecutivas	Red atencional	Aspectos hormonales	Aspectos socioemocionales
Memoria	Memoria de trabajo	Arousal	Glutamato	Emociones agradables (CASA)
Lenguaje	Flexibilidad cognitiva	Focal	Dopamina	- Curiosidad
Red atencional	Control inhibitorio	Sostenida	Acetilcolina	- Admiración
Praxias (ideomotoras)	Velocidad de procesamiento	Selectiva	Serotonina	- Seguridad
Gnosias	Planificación	Alternante	Endorfina	- Alegría
Funciones ejecutivas	Dual-task	Dividida	Noradrenalina	Autoestima
Orientación espacial	Toma de decisiones		Cortisol	Aceptación del error
Habilidades visuoespaciales	Fluencia verbal		Oxitocina	Motivación
Cognición social	Branching			- Intrínseca
				- Extrínseca
				- Trascendente
				Aprendizaje en valores
				Arraigamiento (Lowen)
Formas teóricas de aprendizaje	Habilidades múltiples	Aspectos cinestésicos	Formas visuoespaciales de aprendizaje	Aspectos musicales
Gregorc	Lingüística	Planos biomecánicos	Círculo	Pulso
	Matemática	- Horizontal	Círculos concéntricos	Tempo
	Cinestésica	- Sagital	Filas	Canto
	Interpersonal	Coordinación	Parekas	Ritmo
	Intrapersonal	- óculo-manual	Cuartetos	Subdivisión
	Musical	Disociación	Sextetos	Tiempo y contratiempo
		- Extremidades superiores	Octetos	
		- Extremidades inferiores		
		- Voz		
		Lateralidad		
		Esquema corporal		
		- Control postural		
		- Estructuración espacial		
		- Estructuración temporal		
		- Equilibrio		
		Condición física		
		- Agilidad		
		- Velocidad		
		Habilidades motrices básicas		
		- Desplazamientos		

CONCLUSIÓN

El clap change, como actividad principal dentro del método BAPNE ha sido difundida a través de formaciones y publicaciones sobre la metodología, por lo que es muy conocida y aplicada por docentes de todas las etapas educativas, aunque todavía existe un gran desconocimiento sobre qué es realmente y para qué sirve.

En este trabajo nos propusimos realizar una justificación teórico-práctica sobre el clap change que despejara estas incógnitas, detallando los aspectos importantes y fundamentales a saber, así como realizando un análisis exhaustivo de sus implicaciones desde los diez pilares de la neuromotricidad que sirviera como modelo para analizar cualquier tipo de actividad neuromotriz del método BAPNE.

Para ello, partimos de una revisión de los antecedentes a modo de estado de la cuestión para saber qué tipo de alusiones, explicaciones y justificaciones sobre el clap change existían en las publicaciones científico-académicas, encontrando referencias cinemáticas, ergoespiométricas, didácticas, metodológicas, experimentales y de evaluación.

A partir de aquí mostramos todo lo que consideramos fundamental que se debe saber sobre el clap change. Por una parte, a nivel metodológico: qué es; cómo actúan cada uno de sus componentes; en qué formas de aprendizaje, categorías de movimiento y voz se ubican; cuáles son sus tipologías; y su relación con el error, las figuras geométricas y los paradigmas de dual-task. Por otra parte, a nivel didáctico: cómo se secuencian; cómo se gestiona; cuál es su duración; qué aspectos tener en cuenta antes de aplicarla; y qué dificultades debe saber gestionar el docente. La resolución de estas incógnitas didácticas y metodológicas permitirá al profesorado una aplicación correcta, seria, académica, sistemática y rigurosa de las actividades, con total conocimiento de causa en beneficio de un proceso de enseñanza-aprendizaje de calidad.

Seguidamente, se realizó un análisis sobre las implicaciones de la práctica del clap change en el alumnado basado en los diez pilares de la neuromotricidad, donde se muestra la implicación concreta del clap change en cada uno de ellos: 1) Funciones cognitivas; 2) Funciones ejecutivas; 3) Red atencional; 4) Aspectos hormonales; 5) Aspectos socioemocionales; 6) Modelos teóricos de aprendizaje; 7) Habilidades múltiples; 8) Aspectos cinestésicos; 9) Formas visuoespaciales de aprendizaje; 10) Aspectos musicales.

Este tipo de análisis aportará al profesorado un conocimiento de gran valor, que le permitirá fundamentar y justificar a diferentes niveles en sus programaciones didácticas los beneficios de estimulación que el uso del clap change en el aula puede aportar a su alumnado. Además, tomar este análisis como modelo permitirá realizar de forma autónoma un análisis muy detallado de cualquier tipo de actividad neuromotriz del método BAPNE, obviamente, adaptando la justificación en base a la estimulación concreta que aporte la actividad analizada.

Este trabajo era necesario, ya que el clap change, como actividad fundamental en el método BAPNE, y muy conocida y aplicada por el profesorado, no contaba con una publicación específica que recogiera de forma global toda su esencia metodológica, didáctica y justificativa, y que contribuyera a su aplicación en el aula con un amplio conocimiento de causa por parte del profesorado.

Como limitaciones a este estudio podemos mencionar que no presenta representaciones gráficas de las tipologías de clap change que podrían ayudar a la comprensión de cada una de ellas mediante un ejemplo gráfico. Por otra parte, que solo se han mostrado las principales tipologías de clap change, dejando fuera las más de 20 variantes posibles resultantes de un gran número de combinaciones.

Como posibles líneas de futuro, podrían realizarse justificaciones teórico-prácticas sobre los diferentes bloques de actividades del glosario BAPNE (Romero-Naranjo, 2025a, 2025b). Este tipo de publicaciones sería de gran interés para su correcta aplicación y justificación, no solo en el ámbito educativo, sino también en el de la salud, terapia, pedagogía, psicología, gerontología o envejecimiento activo o el tiempo libre entre otros.

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Body Percussion as a tool for acting training

Francisco Javier Romero-Naranjo

Abstract

Contemporary acting training demands innovative approaches that integrate body, rhythm and emotion as central axes of interpretative development. This article introduces body percussion -understood as the production of rhythmic sounds through the body as an instrument- as a novel pedagogical tool in actor training, addressing a significant gap in the academic literature on performing arts. Through an interdisciplinary theoretical-practical analysis, crossing anthropology, neuroscience, psychology and the main acting methods (Stanislavski, Strasberg, Meisner, Lecoq, Brecht, Grotowski), a state of the art is presented to justify its relevance. A structured model based on ten fundamental pillars is proposed: body awareness, rhythm and temporality, coordination and precision, active listening and group connection, improvisation and creativity, stage presence, memory and repetition, attention and concentration, spatial and dynamic awareness, and non-verbal emotional expressiveness. These pillars, supported by frameworks such as embodiment, Merleau-Ponty's phenomenology and neuroscientific studies on rhythmic synchronization, show how body percussion enhances kinesthetic, cognitive and socioemotional skills essential for stage performance. This work not only establishes a theoretical basis for its application, but also proposes practical exercises and opens lines of future research, including empirical studies, cross-cultural adaptations and the integration of emerging technologies. Thus, body percussion is positioned as a transformative resource that enriches theatrical pedagogy, preparing the actor for the multifaceted demands of modern performance art.

Keywords: Body percussion, actor training, rhythm, body awareness, Bapne.

Resumen

La formación actoral contemporánea exige enfoques innovadores que integren el cuerpo, el ritmo y la emoción como ejes centrales del desarrollo interpretativo. Este artículo presenta la percusión corporal —entendida como la producción de sonidos rítmicos a través del cuerpo como instrumento— como una herramienta pedagógica novedosa en la formación de actores, abordando una laguna significativa en la literatura académica sobre las artes escénicas. A través de un análisis teórico-práctico interdisciplinario, que abarca la antropología, la neurociencia, la psicología y los principales métodos de actuación (Stanislavski, Strasberg, Meisner, Lecoq, Brecht, Grotowski), se presenta un estado del arte para justificar su relevancia. Se propone un modelo estructurado basado en diez pilares fundamentales: conciencia corporal, ritmo y temporalidad, coordinación y precisión, escucha activa y conexión grupal, improvisación y creatividad, presencia escénica, memoria y repetición, atención y concentración, conciencia espacial y dinámica, y expresividad emocional no verbal. Estos pilares, respaldados por marcos teóricos como la encarnación, la fenomenología de Merleau-Ponty y los estudios neurocientíficos sobre la sincronización rítmica, muestran cómo la percusión corporal mejora las habilidades cinestésicas, cognitivas y socioemocionales esenciales para la interpretación escénica. Este trabajo no solo establece una base teórica para su aplicación, sino que también propone ejercicios prácticos y abre líneas de investigación futura, incluyendo estudios empíricos, adaptaciones interculturales y la integración de tecnologías emergentes. Así, la percusión corporal se posiciona como un recurso transformador que enriquece la pedagogía teatral, preparando al actor para las múltiples exigencias del arte escénico moderno.

Palabras clave: Percusión corporal, formación de actores, ritmo, conciencia corporal, Bapne.

INTRODUCTION

Body percussion, understood as the production of rhythmic sounds using one's own body as an instrument, has been a form of expression present in various cultures throughout history. Cultures in Africa, Asia and America have used clapping, beating on the thorax, thighs or other parts of the body in rituals, dances and celebrations, demonstrating its universality as a form of communication and artistic expression (Romero-Naranjo, 2013). This discipline has gained ground

in the last decade as a pedagogical resource in music education and in the sciences of physical activity and sport due to its relation to the contents of body expression; more recently, its potential has begun to be explored in the training of actors as a tool with extensive resources. This paper aims to analyze the theoretical and practical bases that support the application of body percussion in the development of acting skills, arguing its effectiveness and use in active pauses, as well as in the improvement of coordination, rhythm, concentration, body expression and emotional connection.

Body Percussion in context.

While the term “body percussion” may evoke the technique of physical exploration, in the context of the performing arts it refers to the creation of contrasts, music and rhythms through percussion with different parts of the body that brings diverse possibilities in the performative realm. This includes actions such as clapping, finger snaps, chest, thigh and foot beats, among others. The variety of sounds that can be generated is wide, and the combination of these allows the construction of complex rhythmic patterns and very interesting musical structures, as is the case of the work *Corporel?* by Vinko Globokar and *Clapping* by Steve Reich among many others (Di Russo et al., 2024). The most accepted definition, which also takes into account the performing arts, is that of Romero-Naranjo (2013) who defines it as follows:

“Body percussion is the art of striking the body to produce various types of sounds for didactic, therapeutic, anthropological and social purposes. In both the world of musical traditions and the world of the performance, body percussion has had various roles, which can be classified into its uses, meanings and functions which are specific to each individual culture. It is important to point out that nowadays the media and social networks play an important role in promoting body percussion due to their high levels of visual and aesthetic content”.

From the point of view of movement there is a wide debate on whether body percussion is considered a dance, a dance or a performance, an aspect that has been recently addressed providing data from various sources (Di Russo & Romero-Naranjo, 2024). Body percussion is a discipline that can be analyzed and investigated in a polyhedral way due to its wide versatility. For this reason, it is attributed twelve areas of action, which are the following (Romero-Naranjo, 2013, 2020, 2022):

Didactic. 2. Ethnographic - Ethno Musicological. Neuropsychological. 4. Kinaesthetic. 5. Socio-Emotional. Space and Architecture. 7. Team Building. 8. Historical. 9. Rationale - Justification. 10. Cross Learning. 11. Performance / Entertainment. 12. Technology.

Regarding the relationship between body percussion and acting training, after a bibliographic screening in Scopus, WOS, Eric, SPORTDiscus, PsycINFO, EBSCOHost and the bibliometrics and Review published so far on Body percussion (Arnau-Mollá & Romero-Naranjo, 2022a, 2022b, 202; Romero-Naranjo, 2013), there is no paper published on this subject.

In view of the above, this would be the first academic contribution on its relationship with acting training, serving as a basis for future studies. For this reason, being a first paper on this subject, it will focus on the following objectives:

1. State of the art on body percussion and performing arts.

2. The ten basic pillars of body percussion in acting training.
3. Practical applications with body percussion for actor training.

State of the art in Body percussion and its relation to acting training.

Body percussion manifests itself in different ways in cultural, educational, performance or academic contexts. For example, Verbunk dances in Hungary, Flamenco in Spain, Haka in Oceania, Gumboots in South Africa or a performance company, bring each of them with a completely different function and application (González de Benatuil et al., 2024a, 2024b). As far as body language is concerned, the use of clicks or clapping can have a very anthropological connotation as Fornés-Pellicer (2008) has shown. The state of the bibliographic question on this subject is recently published in two bibliometric articles whose publications are included in Web of Science, where it is stated that there is no publication on the performing arts (Alonso-Marco & Romero-Naranjo, 2022; Arnau-Mollá & Romero-Naranjo, 2022; Romero-Naranjo, 2025b).

With regard to acting training, it has evolved towards approaches that transcend mere memorization of text or superficial imitation, incorporating methods that integrate the body as a central instrument of artistic expression. In this context, body percussion emerges as an innovative tool that combines rhythm, movement and body awareness.

Body percussion responds to the need for methods that develop a kinesthetic awareness in the actor, an aspect underlined by theorists such as Stanislavski (1989), who emphasized the importance of the body as a vehicle of emotion, and Grotowski (2012), who advocated a physical theater based on organicity, that is, an authentic and natural performance, where physical and emotional expressions emerge spontaneously and deeply connected to the essence of the actor, avoiding artifice or mechanical performances. These perspectives resonate with the principles of body percussion, which requires full attention to movement and rhythm, strengthening the connection between the internal impulse and its external manifestation.

From psychology, somatic learning theory (Hanna, 1988) suggests that the body is a privileged medium for processing and expressing experiences. This connects us to Embodiment because it has gained relevance in disciplines such as cognitive psychology, neuroscience and the performing arts, proposing that the body is not a mere container of the mind, but an active participant in cognitive and emotional processes (Gallagher, 2005). All this reconnects us with the original ideas of Stanislavski who linked the importance of emotional memory and physical action as ways to access the scenic truth (Stanislavski, 1989).

From a phenomenological approach, Merleau-Ponty (1945), argues that perception and movement are inseparable from lived experience. Applied to body percussion, this suggests that the rhythmic patterns generated by the body not only reflect internal states, but actively shape them. For example, a fast-paced rhythm can induce tension and urgency, while a slow one can evoke calm or introspection, valuable tools for acting in character building. From an ethnographic point of view, we can observe this in the way the Maories beat their bodies when performing a Haka.

On the other hand, neuroscience research (Leman, 2007) shows that rhythmic activities stimulate neural synchronization, enhancing body memory and empathy, crucial skills in stage performance.

Rhythm in relation to the main techniques in acting training.

Acting training is nourished by very famous techniques that give actors tools to be able to interpret their roles in the best possible way, highlighting Stanislavski, Chekhov, Adler, Mnouchkine or Grotowski among many others. In this section we will focus on six fundamental models in acting interpretation and their perception of rhythm in brief:

A. Stanislavski's System.

Stanislavski proposes the idea that the actor must create a believable character through the understanding of his psychology, the creation of a realistic context and the emotional connection with the character. In Stanislavski's System, rhythm is intrinsically linked to “tempo-rhythm,” a concept he developed to describe the speed and emotional pulse of a scene or character. Stanislavski argued that each action has an internal rhythm that reflects the psychological state of the character and must align with the external rhythm of the staging.

B. Lee Strasberg's Method.

In Strasberg's Method, rhythm is deeply connected to the actor's affective memory and emotional state. The psychological intensity that the actor relives directly influences how the rhythm manifests itself in his body and voice. Using techniques such as sensory training or substitution, the actor can experience rhythmic fluctuations that reflect his own experiences transferred to the character.

C. Meisner Technique.

The Meisner Technique has a direct and dynamic relationship with rhythm, since it is based on real-time interaction between actors. The repetition exercise, for example, establishes a shared rhythm that evolves organically. Meisner emphasizes “living in the moment,” which means that the rhythm is not preconceived, but arises from the immediate response to the stimulus of its partner. The actor learns to “dance” rhythmically with his partner, adjusting to his pauses and accelerations.

D. Physical Theater (Jacques Lecoq).

In Lecoq's physical theater, rhythm is a central component, as the actor's body becomes the main generator of tempo and stage dynamics. Lecoq explored rhythm through movement, drawing inspiration from natural patterns (waves, wind, animals) and structures such as the Commedia dell'Arte, where characters have distinctive physical rhythms (e.g., Harlequin's staccato).

E. Bertolt Brecht's technique.

In Brecht's approach, rhythm is used in a conscious and structured way to break the theatrical illusion and keep the audience in a state of critical reflection. Brecht manipulated rhythm through deliberate interruptions, such as songs, direct monologues to the audience or abrupt changes in the action, which generated a syncopated and anti-naturalistic rhythm.

F. Grotowski Method.

For Grotowski, rhythm is an energy rooted in human nature, which connects the actor with his physical and spiritual essence, transcending conventional theatricality. Rhythm is autonomous and pre-existent to the text or story. In his “poor theater,” rhythm emerges from the actor's body

and voice in a state of total surrender, often through repetitive and strenuous exercises that mimic rituals. This rhythm can be cyclical, pulsating or even chaotic, depending on the intention of the performance.

The ten pillars of body percussion as an acting tool.

Body percussion as a training tool for actors is based on a series of interdisciplinary pillars that integrate physical, emotional, cognitive and social aspects. The ten essential pillars of this practice in relation to theatrical training are proposed and justified below, supported by pedagogical theories, acting principles and studies on movement and rhythm:

1. Body awareness.

Body percussion requires the actor to develop an accurate perception of his own body as an instrument. This pillar is based on the need for actors to understand their anatomy and their possibilities of movement and sound. According to Jacques Lecoq's approach, theatrical training must start from the “body in space”, and body percussion amplifies this idea by turning the body into an active source of rhythmic expression. By practicing it, the actor improves his proprioception and his ability to inhabit the stage with intentionality.

Justification: An actor who masters his or her body can project emotions and physical narratives with greater precision, which is essential for characters who rely on gesture and physical presence.

2. Rhythm and temporality.

Rhythm is an essential skill in theater, both in the delivery of dialogue and the construction of scenes. Body percussion trains the actor to internalize tempo and synchronicity, concepts that align with Konstantin Stanislavski's theories of “tempo-rhythm” as a tool for connecting the internal and external action of the character.

Justification: The ability to maintain a constant tempo or vary it intentionally allows the actor to synchronize with other performers and respond to the dynamics of the scene, enriching the theatrical narrative.

3. Coordination and precision.

The execution of complex rhythmic patterns in body percussion requires a high level of coordination between hands, feet and voice. This pillar is linked to the BAPNE method research on body percussion and neuromotor skills that has more than 60 publications in Web of Science, more than 4000 academic citations, as well as several international research awards (Romero-Naranjo et al., 2023a, 2023b, 2023c, 2023d, 2024). Sayago-Martinez et al. 2021. Regular practice improves motor dexterity and muscle memory; these skills are transferable to stage choreography or the handling of objects on stage.

Rhythm is intrinsic to theater, from diction to stage movement (Stanislavski linked it to emotional “tempo-rhythm”). Body percussion trains the actor to synchronize with dramatic timing, whether in dialogue, choreography or meaningful pauses.

Justification: Precision in movements and sounds reinforces the actor's credibility and ability to execute complex physical actions without losing interpretive focus.

4. Active listening and group connection.

Body percussion, especially in group dynamics, fosters the ability to listen and respond to the sounds of others. This pillar aligns with the concept of “ensemble” in theater, where collaboration and empathy among actors are essential for cohesive staging. In group body percussion exercises, actors learn to work as a collective organism, adjusting their rhythms and movements in unison or in contrast. This pillar is based on Bertolt Brecht's theater, where collectivity and interaction between performers reinforce the scenic message.

Justification: An actor trained in body percussion develops an auditory sensitivity that improves his timing and his capacity for improvisation, key aspects in stage interaction.

5. Improvisation and creativity.

Spontaneity is a central component of body percussion, as actors can experiment with new patterns and sounds in real time. This pillar finds echoes in the techniques of Viola Spolin, who used improvisational games to unlock acting creativity.

Justification: The creative freedom offered by body percussion prepares the actor to adapt to unforeseen events on stage, a crucial skill in live theater.

6. Stage presence.

Body percussion increases the actor's confidence and energy on stage by making him aware of his ability to fill the space with sound and movement. This pillar is inspired by Michael Chekhov's concept of “radiation”, where the actor projects his energy towards the audience.

Rationale: A strong stage presence is essential to capture and hold the audience's attention, and body percussion offers a direct way to achieve this through the integration of rhythm, body and emotion.

7. Memory and repetition.

The practice of rhythmic sequences in body percussion strengthens the actor's kinesthetic and auditory memory. This pillar is related to the repetition techniques of Sanford Meisner, who used repetition to deepen emotional authenticity.

Justification: Memorization of rhythmic patterns improves the actor's discipline and ability to internalize complex texts or choreography, a practical aspect in rehearsals and performances.

8. Attention and Concentration.

Concentration is the basis of “being present” on stage (Chekhov). A rhythmic error requires immediate recovery, analogous to managing unforeseen events during a performance.

Justification: Body percussion through the BAPNE method brings numerous publications demonstrating an improvement of attention through its activities where the voice has a special role as opposed to the use of the upper and lower limbs. These activities can even be used as active pauses during the acting work.

9. Spatial and Dynamic Awareness.

The use of the body to create sounds that interact with the space is fundamental. Mastery of stage space is central to directors like Peter Brook. Body percussion teaches how to modulate energy according to proxemics.

Justification: Body percussion activities in circle, concentric circles, facing rows, quartets, sextets and free movement help us to work on space and our relationship with each other through very specific activities through song.

10. Non-verbal emotional expressiveness.

The body can be used as an instrument to transmit emotions through rhythmic dynamics (intensity, speed, silences). Brecht and Artaud valued the body as a primary means of expression. A soft thump (tenderness) versus a boom (anger) can replace or complement the text.

Justification: Emotions, following Roberto Aguado's model, can be worked through body percussion providing tools for the work of pleasant (CASA) and unpleasant (TRAM) emotions. In the same way that the state of Flow can be investigated as well as the happiness of the group that performs it (Rizzatto et al., 2024).

Practical applications with body percussion for actor training.

Here are some practical exercises for the application of body percussion in actor training following the BAPNE method (Andreu-Cabrera & Romero-Naranjo, 2021):

- Body exploration: invite actors to explore the different sounds they can produce with their body, from clapping and clicking to chest, thigh and foot beats. You can guide the exploration through specific prompts, such as “explore low body sounds” or “explore high body sounds.”

- Rhythmic imitation: The teacher or a student creates a simple rhythm with body percussion, and the others imitate it. The complexity of the rhythms can be progressively increased by introducing variations, tempo changes and polyrhythms. The BAPNE method provides different ways of working imitation, such as progressive imitation, which requires a high level of attention (Arnau-Molla & Romero-Naranjo, 2024).

- Creation of characters: Assign each actor a rhythm or rhythmic pattern that represents a specific character, with each character having a “leitmotif” that identifies him/her. The actors should move and interact in the space using only their body percussion to express the characteristics of the character. The exercise can be complemented with the incorporation of everyday objects such as percussion elements or specific gestures.

- Sound improvisation: Divide the actors into groups and assign them a scene or situation. The actors should improvise the scene using only body percussion to create the sound effects and atmosphere. A specific theme can be proposed for the improvisation, such as “a day in the city” or “a suspenseful scene.”

- Creation of situations: Specific situations are proposed in which body percussion is the center of the action, such as hunting a fly or mosquito, a person with obsessive compulsive

disorder, etc. A. “The fly swatter” where the actor imagines that he has a room with flies and must swat them. B. Person with OCD.

Other applications as a tool for actor training.

A. Body percussion as an active pause in acting training.

During the preparation and practice of a character or a specific scene, the body and mind need to pause. Their preparation involves a high level of concentration, so an active pause through body percussion is a healthy resource because it can help to rest from the role they are preparing, but without losing the attentional network (González de Benatuil & Romero-Naranjo, 2024).

B. Body percussion in augmented reality, virtual reality and artificial intelligence in relation to acting training.

Relevant publications on this subject are beginning to appear (Boillos-García & Romero-Naranjo, 2024a, 2024b). They detail how to apply the most updated digital competence in the field of training.

Virtual Reality allows the creation of simulated environments where actors can practice body percussion in diverse scenic contexts, from a classical theater to abstract spaces that challenge their creativity. In this case, an actor could synchronize body rhythmic patterns with visual and sound stimuli generated in virtual reality, developing greater precision and connection between body and narrative.

Unlike virtual reality, which replaces the physical environment, augmented reality superimposes digital elements on the real world, which is ideal for integrating body percussion into face-to-face rehearsals. For example, using devices such as HoloLens or mobile apps, performers could visualize projections of rhythmic patterns on their bodies, adjusting their performance in real time.

Artificial intelligence plays a key role in providing personalized analysis and feedback. Machine learning algorithms, trained on motion data captured through sensors (such as Kinect or wearables), can assess the accuracy, tempo and expressiveness of an actor's body percussion, offering specific suggestions for improvement. In addition, generative AI could create rhythmic sequences tailored to a student's skill level, encouraging progressive learning.

The integration of these technologies not only modernizes acting training, but also responds to current demands in the theatrical field, where the hybridization between the physical and the digital is increasingly relevant.

CONCLUSION

This paper has explored in a pioneering way the integration of body percussion as an innovative tool in acting training, filling a significant gap in the academic literature on the performing arts. Through an interdisciplinary analysis that combines theoretical perspectives from anthropology, neuroscience, somatic psychology and the main theatrical pedagogical currents, a state of the art has been established that validates the potential of body percussion as a holistic approach to the development of acting skills. The ten proposed pillars -body awareness, rhythm

and temporality, coordination and precision, active listening and group connection, improvisation and creativity, stage presence, memory and repetition, attention and concentration, spatial and dynamic awareness, and nonverbal emotional expressiveness - not only offer a structured framework for practical application, but also dialogue with the conceptions of rhythm and the body present in established methods such as those of Stanislavski, Strasberg, Meisner, Lecoq, Brecht and Grotowski. This triangulation between theory, practice and scenic tradition, supports the relevance of body percussion as a pedagogical resource in the contemporary theatrical field.

From an academic perspective, this study makes a significant contribution by proposing a model that transcends traditional approaches to actor training, usually focused on diction, textual memorization or psychological introspection. By integrating the body as an active instrument of rhythmic production, body percussion responds to the demands of a modern theatre that values physicality, spontaneity and collective interaction, aligning itself with paradigms such as Mnouchkine's "total actor" or Lecoq's "physical action". Moreover, its grounding in theories of embodiment (Gallagher, 2005) and the phenomenology of Merleau-Ponty (1945) reinforces its intellectual rigor, demonstrating how rhythmic patterns not only reflect internal states, but actively shape them, offering the actor tools to construct characters from a kinesthetic and emotional base (Vicente Nicolás & Alonso-Sanz 2013). Furthermore, connections with neuroscience (Leman, 2007) and somatic learning (Hanna 1988) provide an empirical dimension that validates the cognitive and expressive benefits of this practice, such as improved attention, memory and empathy.

However, this work also opens up space for academic discussion and debate. While the ten pillars provide a solid framework, their practical implementation poses challenges that require further exploration. For example, the effectiveness of body percussion might vary according to the cultural context or the specific demands of each theatre style (realism, physical theatre, experimental), suggesting the need for comparative studies to assess its adaptability. Furthermore, although a theoretical connection has been established with methods such as Grotowski's - where rhythm is a primal force that reveals the essence of the actor - it remains to be investigated how the rhythmic structure of body percussion, often more playful or musical, can dialogue with the ritualistic intensity of his "poor theatre". This contrast invites reflection on whether body percussion might tend towards a superficial aestheticization rather than the ontological depth Grotowski sought, a point that deserves to be addressed in future analyses.

In terms of future lines of work, this study lays the foundations for more ambitious research. A first direction could be the development of empirical studies that quantitatively and qualitatively measure the effects of body percussion on variables such as concentration, coordination or emotional expressiveness of actors, using tools such as kinematic analysis (Alonso-Marco & Romero-Naranjo, 2022) or neuropsychological assessments (Romero-Naranjo & Liendo-Cárdenas, 2025a; 2025b; Romero-Naranjo & Navarro-Camacho, 2025; Romero-Naranjo, 2025). Another promising avenue would be to explore their application in specific contexts, such as actor training for musical theatre, film or interdisciplinary performance, where rhythm and movement are central. Furthermore, the integration of emerging technologies, such as augmented reality or artificial intelligence (Boillos-García & Romero-Naranjo, 2024a, 2024b), could expand the pedagogical possibilities of body percussion, allowing for immersive simulations or real-time analysis of the rhythmic patterns generated by actors. Finally, a cross-cultural approach that examines how body

percussion traditions (e.g., flamenco, haka, gumboots) can enrich global actor training would be a valuable contribution to diversify and contextualize this practice. It is important to note that within the performing arts, it would be advisable to create a specific type of notation in line with the performing arts world and its specific movements (Sánchez-González et al., 2018).

In summary, this article not only justifies the relevance of body percussion as a transformative tool in theatre pedagogy, but also establishes a starting point for a broader academic dialogue. By positioning it as a bridge between body, rhythm and emotion, it proposes an evolution of acting training that responds to the demands of an ever-changing performing art (Romero-Naranjo, 2025a, 2025b). Future research should consolidate these ideas through praxis and rigorous analysis, ensuring that body percussion is not seen as a mere add-on, but as a fundamental pillar in the training of 21st century actors.

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The elements of Body Percussion

Francisco Javier Romero Naranjo

Abstract

This academic paper addresses the historical conceptual fragmentation and reductionism that have limited the study of body percussion (BP) by proposing a new, exhaustive taxonomy of ten fundamental, intrinsically interconnected constructs: Body, Sound, Rhythm, Time, Movement, Action, Intentionality, Space, Energy, and Social Bond. Traditionally confined to folkloric expression and pedagogy, BP is recontextualized as a powerful and empirically relevant vehicle for sophisticated cognitive stimulation and neuromotor development, primarily through the lens of the emerging paradigm of Neuromotricity. This framework is justified by the discipline's intrinsic reliance on the Dual Task (DT) methodology, which prevents simple motor automaticity and continually engages the prefrontal cortical networks responsible for executive functions (EFs).

The theoretical structure rigorously integrates definitions and principles drawn from three distinct epistemological axes. First, the Biokinetic Axis (Biomechanics) analyzes the body as both an acoustic generator and receptor, necessitating a focus on kinematics, Dynamic Alignment, and the conscious use of the Weight of the Body for efficient energy transfer, injury prevention, and control of acoustic Intensity. Second, the Neurocognitive Axis (Cognitive Neuroscience) establishes the core academic value by differentiating between Rhythm (the organizational pattern stimulating working memory) and Time (the dimension of temporal precision). The control of Time is a neural calibration mechanism that directly trains prospective motor planning via the management of Negative Asynchronies, involving the activation of the Dorsolateral Prefrontal Cortex (DLPFC). Third, the Phenomenological and Semiotic Axis (Embodied Cognition) incorporates the view that musical meaning (semiosis) is produced through corporeality and gestuality. Movement and Action are functionally understood as expressive gestures, and the Laban/Bartenieff movement analysis system provides the rigorous, quantifiable vocabulary for describing these qualities. The resultant ten-element taxonomy provides the essential operational variables for designing rigorous interdisciplinary studies. The Social Bond is legitimized as a neurobiological phenomenon of inter-subject synchronization, profoundly potentiating the discipline's therapeutic and social utility. The paper concludes that BP is an exercise in embodied cognition where the stimulation of EFs is inseparable from meaningful gestuality, projecting the methodology as central for cutting-edge research, particularly when integrated with advanced technologies like AI, Virtual Reality (VR), and Brain-Computer Interface (BCI) systems for precise neurovalidation and personalized protocols.

Keywords: Body percussion, Embodied Cognition, Neuromotricity, Executive Functions, Dual Task.

Resumen

Este artículo académico aborda la fragmentación conceptual histórica y el reduccionismo que han limitado el estudio de la percusión corporal (PC) proponiendo una nueva taxonomía exhaustiva de diez constructos fundamentales e intrínsecamente interconectados: cuerpo, sonido, ritmo, tiempo, movimiento, acción, intencionalidad, espacio, energía y vínculo social. Tradicionalmente confinada a la expresión folclórica y la pedagogía, la BP se recontextualiza como un vehículo poderoso y empíricamente relevante para la estimulación cognitiva sofisticada y el desarrollo neuromotor, principalmente a través de la lente del paradigma emergente de la neuromotricidad. Este marco se justifica por la dependencia intrínseca de la disciplina en la metodología de la tarea dual (DT), que evita la simple automaticidad motora y compromete continuamente las redes corticales prefrontales responsables de las funciones ejecutivas (EF). La estructura teórica integra rigurosamente definiciones y principios extraídos de tres ejes epistemológicos distintos. En primer lugar, el eje bioquinético (biomecánica) analiza el cuerpo como generador y receptor acústico, lo que requiere centrarse en la cinemática, la alineación dinámica y el uso consciente del peso corporal para una transferencia de energía eficiente, la prevención de lesiones y el control de la intensidad acústica. En segundo lugar, el eje neurocognitivo (neurociencia cognitiva) establece el valor académico fundamental al diferenciar entre el ritmo (el patrón organizativo que estimula la memoria de trabajo) y el tiempo (la dimensión de la precisión temporal). El control del tiempo es un mecanismo de calibración neural que entrena directamente la planificación motora prospectiva mediante la gestión de las asincronías negativas, lo que implica la activación de la corteza prefrontal dorsolateral (DLPFC). En tercer lugar, el

eje fenomenológico y semiótico (cognición incorporada) incorpora la visión de que el significado musical (semiosis) se produce a través de la corporeidad y la gestualidad. El movimiento y la acción se entienden funcionalmente como gestos expresivos, y el sistema de análisis del movimiento de Laban/Bartenieff proporciona el vocabulario riguroso y cuantificable para describir estas cualidades. La taxonomía resultante de diez elementos proporciona las variables operativas esenciales para diseñar estudios interdisciplinarios rigurosos. El vínculo social se legitima como un fenómeno neurobiológico de sincronización intersubjetiva, lo que potencia profundamente la utilidad terapéutica y social de la disciplina. El artículo concluye que la BP es un ejercicio de cognición incorporada en el que la estimulación de las FE es inseparable de la gestualidad significativa, proyectando la metodología como fundamental para la investigación de vanguardia, especialmente cuando se integra con tecnologías avanzadas como la IA, la realidad virtual (RV) y los sistemas de interfaz cerebro-ordenador (BCI) para una neurovalidación precisa y protocolos personalizados.

Palabras clave: Percusión corporal, cognición incorporada, neuromotricidad, funciones ejecutivas, doble tarea.

INTRODUCCION

The study of body percussion (BP) has undergone a significant and necessary recontextualization within academic literature. Traditionally confined to the limited scope of folkloric expression, pedagogy and performing arts, BP has successfully transcended these boundaries to establish itself as a powerful and empirically relevant vehicle for sophisticated cognitive stimulation and neuromotor development. It is important to note that there are several bibliometric studies that summarise and explain in detail and academically which authors are the most prominent and which are the most cited, how many experimental studies have been conducted, what type of tests have been used to evaluate them, in which language they have been published, and what academic impact they have had (Arnau-Mollá & Romero-Naranjo, 2022a, 2022b). The seriousness of research is generated through publications in Scopus and Web of Science, which lend credibility to the research. Using bibliographies outside these channels generates grey literature, without evidence, which does not transcend and does not help the scientific community. Academically, body percussion is defined as the art of percussing one's own body to generate diverse acoustic output with clear didactic, therapeutic, anthropological, and socio-educational objectives (Romero-Naranjo, 2013). This critical shift in paradigm is fundamentally catalyzed by rigorous, integrative methodologies, most notably the BAPNE method (Biomechanics, Anatomy, Psychology, Neuroscience, and Ethnomusicology). Within this robust conceptual framework, the human body is no longer viewed merely as an acoustic resonator but is reconceptualized as the principal and indispensable instrument for the modulation and systematic stimulation of superior executive functions (EFs), including sustained attention, working memory, and concentration (Romero-Naranjo & Andreu-Cabrera, 2023). The essential justification for this neurocognitive focus resides in the empirical fact that complex, multi-layered rhythmic practice inherently demands high-demand sensorimotor coordination. This demanding practice is known to promote the bilateral activation and precise synchronization of both cerebral hemispheres, facilitating cross-functional neural communication. Given this superior level of required biopsychosocial and psychomotor integration, a comprehensive theoretical framework is required—one that is robust enough to permit the rigorous empirical quantification of effects while retaining the necessary depth for phenomenological understanding.

The didactic and pedagogical application

The didactic utility of body percussion represents a core pillar of its academic value, extending its application significantly within pedagogical and socio-educational domains. The discipline's

capacity to achieve specific socio-educational objectives necessitates its formal inclusion in learning curricula. Body percussion, particularly when integrated through structured frameworks like the BAPNE method, facilitates experiential learning, where complex musical and rhythmic concepts are internalized directly through physical movement and gestural execution. Extensive scholarly publications confirm the discipline's didactic foundation, detailing its pedagogical utility as a resource for future educators, providing strategies for structuring effective classroom sessions, and establishing its measurable impact on selective attention, concentration, and anxiety reduction across various educational levels. This validated application highlights body percussion's proven capacity to serve as an interdisciplinary resource that actively develops kinesthetic ability and systematically reinforces executive functions in learners.

Objective and research questions

The primary objective of this academic paper is to overcome the historical conceptual fragmentation and reductionism surrounding the study of body percussion and human movement. To achieve this, the paper constructs and substantiates a novel, exhaustive taxonomy comprising ten fundamental and intrinsically interconnected constructs, which are hereby presented as the 10 Elements of Neuromotricity via Body Percussion. This new model rigorously integrates definitions and principles drawn from three essential, distinct epistemological axes: Biomechanics, Cognitive Neuroscience, and Music Phenomenology (embodied cognition). The ultimate goal is to legitimize body percussion as a precise, measurable methodology within cutting-edge interdisciplinary research, enabling its application in fields such as neurorehabilitation and optimized cognitive training.

This objective is articulated and addressed through three principal research questions that structure the subsequent theoretical development and discussion:

1. How can the core elements of body percussion be structurally organized and defined within a rigorous, multi-axis taxonomy that integrates Biomechanics, Cognitive Neuroscience, and Music Phenomenology?
2. What is the theoretical justification for framing body percussion within the emerging paradigm of Neuromotricity, and how does the intrinsic requirement of the Dual Task (DT) methodology enhance superior executive functions?
3. In what specific way does the novel taxonomy of the ten fundamental elements—the first of its kind to be explicitly applied to the framework of Neuromotricity—provide the essential operational variables for rigorous interdisciplinary and neuroscientific validation?

The Conceptual transition. From body percussion to neuromotricity as the new paradigm.

The analysis of motor action in the 21st century necessitates overcoming the traditional constructs of *motricity* and *psychomotricity*, evolving toward an independent theoretical structure: Neuromotricity (Andreu-Cabrera & Romero-Naranjo, 2021). This emerging paradigm postulates a conception of movement that is intrinsically linked to cerebral functions, thus conceptually differentiating itself from previous models.

The rationale for framing body percussion within neuromotricity is found in the discipline's constitutive elements. Neuromotricity is fundamentally based on the essential inclusion of

cognitive functions and in the constant presence of the Dual Task (DT) methodology in activity design. By requiring simultaneous double processing, the Dual Task prevents simple motor automaticity and continually engages the prefrontal cortical networks responsible for cognitive control and attentional demands. In this context, body percussion becomes a neuromotor instrument *par excellence*, as the success of motor learning for a new percussive sequence depends directly on cognitive functions. These functions are responsible for accurate *observation* (linked to the attentional channel) and *active listening* (necessary for subsequent response planning).

The functional definition of neuromotricity relies on specific principles and their application in practical methodology, as summarized in the table below. The causal relationship between DT and cognitive gain underscores why body percussion is posited to optimize cerebral performance, forcing simultaneous processing that actively enhances attention and working memory.

Table 1. Principles of neuromotricity and application in Body Percussion.

Neuromotricity Principle	Principal Thesis	Application in Body Percussion
Essential Cognitive Functions	Executive Functions guide the success of motor learning	Correct observation and active listening plan the percussive response
Dual Task (DT)	Methodology with constant demand for double processing	Synchronization of a rhythmic pattern (motor) with an attentional cognitive task
Optimization of Cerebral Performance	Stimulation protocols of increasing complexity promote neural networks	The BAPNE method is proposed to optimize brain performance in motor skills

Body Percussion

Historically, the study of rhythm and movement has been fragmentary. Dance and pedagogy has typically concentrated on acoustic and temporal structure, while the performing arts have developed detailed taxonomies for Movement and Energy, such as the widely recognized Laban/Bartenieff system.^b The theoretical framework of the current study is significantly enriched by incorporating the phenomenological view, drawing on the reflections of Pelinski (2005) concerning corporeality and musical experience. Pelinski suggests that overcoming reductionist concepts is essential to grasp musical semiosis—the process through which meaning is generated via music. Within body percussion, this semiosis unfolds through gesturality and corporeality, establishing experientiality as a determinant dimension: meaning is fundamentally produced *in and through the body*. This perspective is further supported by López Cano (2005), who conceptualized the "bodies of music," reinforcing the notion that music is not merely an abstract or auditory phenomenon but is inherently *embodied*. Therefore, musical cognition is understood as embodied cognition, wherein the physical act of percussing, feeling, and synchronizing is inseparable from the cognitive processing involved.

To address the existing conceptual dispersion and reductionism, this approach establishes a taxonomy of ten fundamental, interconnected constructs, henceforth referred to as the 10 Elements of Body Percussion: 1. *Body*, 2. *Sound*, 3. *Rhythm*, 4. *Time*, 5. *Movement*, 6. *Action*, 7. *Intentionality*, 8. *Space*, 9. *Energy*, 10. *Social bond*.

II. INTERDISCIPLINARY EPISTEMOLOGICAL FOUNDATIONS

The Biokinetic axis. Biomechanics and the kinematics of sound production.

The human body functions simultaneously as both the generator and the receptor of the acoustic signal in body percussion, a critical dualism that imposes unique biomechanical requirements. A rigorous bio-physical analysis of human movement is, consequently, indispensable for a percussive practice (*praxi*) that is both sustainable and efficient. Biomechanics and Anatomy constitute the central axes of training within the BAPNE method, serving the dual purpose of maximizing sound production efficiency and preventing injuries, particularly those resulting from muscle overload, which are common in wrists and forearms of active percussive practitioners.

Kinematics of percussive action and ergonomics

Sound production in BP is achieved through bodily impact or friction. From a kinetic perspective, the technique of the strike must be analyzed to ensure energy is transferred efficiently and safely.

The integration of biomechanical principles dictates the expressive dynamics of the performance. For instance, Dynamic Alignment—the precise and coordinated motor control of posture—is directly correlated with the efficiency of energy transfer, which, in turn, influences the optimal acoustic output. Furthermore, the conscious use of the Weight of the Body and gravity enables controlled force transfer, which is essential for modulating the acoustic *Intensity* of the sound. Therefore, biomechanical analysis serves not only for injury mitigation but also as a direct input for controlling musical and acoustic quality.

Table 2. Biomechanical principles, biokinetic description, and neuro-ergonomic/neurological finality.

Biomechanical Principle	Biokinetic Description	Neurological/Ergonomic Finality
Anatomical Understanding	Awareness of joints and muscle planes	Optimization of sound production and injury prevention
Dynamic Alignment	Precise and coordinated motor control of posture	Efficiency in Energy transfer
Weight of the Body	Use of bipedal posture and gravity in movement	Flow and transfer of force to modulate acoustic Intensity

The neurocognitive axis

The core academic and applied value of body percussion is fundamentally established in the field of neuroscience. Evidence indicates that complex rhythmic practice is a potent catalyst for cerebral plasticity, which is defined as the nervous system's capacity to modify its connections and functions, thereby facilitating learning and behavioral change (Coull et al., 2008).

Motor Control, timing, and temporal synchronization

Rhythmic execution necessitates the coordinated activation of specific subcortical and cortical structures. Training in body percussion stimulates the motor cortex, the cerebellum, and the basal ganglia, all of which are essential for smoothing muscular movements and coordinating postural changes. Direct training in rhythm and time is reflected in the enhancement of Executive Functions (EFs), which are complex cognitive processes encompassing reasoning, planning, and the regulation of affect.

A crucial distinction in the neurocognitive model is drawn between *Rhythm* and *Time*. While Rhythm establishes the abstract pattern structure (stimulating working memory), Time is the focus on temporal precision and synchronization capacity. Neurobiology requires this precise distinction because temporal perception involves the activation of distinct cerebral areas vital for anticipation and sequencing.

The study of Time is particularly significant as the dimension where Negative Asynchronies manifest. This mechanism, a common occurrence in motor planning where a movement slightly anticipates the beat, involves the activation of the Dorsolateral Prefrontal Cortex (DLPFC) during the encoding of temporal interval durations. Consequently, controlling Time through body percussion exercises serves as a neural calibration mechanism that directly trains prospective motor planning, providing an objective measure for assessing improvements in executive motor control.

Table 3. Temporal Constructs, neuronal correlates, executive functions, and Body Percussion implications.

Temporal construct	Principal neuronal correlate	Primary executive function	Implication in body percussion
Rhythm (Pattern)	Bilateral stimulation, Mapping of cerebral lobes	Working Memory and Sustained Attention	Execution of sequences and polyrhythms
Time (Precision)	Basal Ganglia, Cerebellum, Dorsolateral Prefrontal Cortex (DLPFC)	Temporal Anticipation and Motor Planning	Motor synchronization (Negative Asynchronies)
Off-beat (Syncopation)	Coordination of nervous influx in specific areas	Broad Psychomotor Control	Dissociation and laterality shift

The Phenomenological and semiotic axis. Corporeality, gesturality, and experientiality.

This epistemological axis integrates the study of body percussion with humanistic frameworks, specifically embodied cognition and phenomenology. The seminal work of Pelinski (2005) emphasizes that musical meaning is produced through corporeality and gesturality. Within BP, Movement and Action are functionally understood as *gestures* that carry specific meaning, thereby organizing the performer's comprehension of the music. Musical semiosis, therefore, resides in the interpretation and execution of these percussive gestures, which function as a form of language.

Experientiality (Pelinski, 2005) is established as the regulating principle that unifies the ten elements. It mandates that the performer must experience the rhythm *in* their body, a fundamental condition that modulates the expenditure of Energy and the dynamic expressive quality of the performance. The integration of the Laban/Bartenieff movement analysis system provides the rigorous, quantifiable vocabulary necessary to accurately describe this gesturality, classifying specific Actions (e.g., Striking, Chopping) and the kinetic principles (e.g., Spatial Intention, Dynamic Alignment) that underlie the percussive act (Lewis & Miall, 2003).

III. TAXONOMICAL DEVELOPMENT OF THE TEN FUNDAMENTAL ELEMENTS

To ensure methodological sophistication and definitively overcome conceptual fragmentation, this paper introduces and develops a detailed, novel taxonomy of ten fundamental constructs. This taxonomy represents the inaugural, comprehensive theoretical framework for the study of Neuromotricity via Body Percussion, rigorously integrating definitions from biomechanics, cognitive neuroscience, and phenomenology. This development provides the essential conceptual structure previously absent in the literature.

1. Body. The ontological and biomechanical substrate

The Body is recognized as the primary, irreplaceable instrument of body percussion. Its study carries an ontological dimension, as it is the very seat of *experientiality*. Executing coordinated movements requires precise motor control and sustained body awareness, demanding constant proprioceptive feedback and tactile discrimination.

The BAPNE method structures its exercises based on traditional biomechanical planes (sagittal, frontal, transversal) to optimize learning and total integration, linking directly to the development of kinesthetic motor and sensorimotor coordination. Crucially, BAPNE specifically classifies laterality work to address distinct improvements in body schema and motor skills. This approach separates generalized motor training into highly specialized challenges, enabling targeted intervention for specific neuropsychomotor deficits, such as difficulty processing sensory feedback in the non-dominant hemi-body (Somesthetic Laterality) versus difficulty executing rhythms involving crossed patterns (Percussive Laterality).

Table 4. BAPNE Laterality classification.

Type of Laterality (BAPNE)	Principal Related Element	Neuropsychomotor Challenge
Somesthetic	Body / Action	Awareness and sensory response in the opposite hemi-body
Percussive	Rhythm / Sound	Dissociated rhythmic execution with crossed patterns
Rotational	Movement / Space	Supination and pronation movements
Spatial	Space / Time	Orientation and body awareness in the environment during rhythm

2. Sound. Acoustic phenomenology and semiotic extension.

Sound is defined as the acoustic consequence of the Body's interaction with itself or with the surrounding air. Academic analysis of corporeal sound utilizes its fundamental constitutive elements: Timbre, Intensity, and Pitch. The active production of this sound activates both the cerebral areas responsible for audition and, critically, those related to proprioception. The diverse range of sounds generated by various parts of the body (e.g., chest strikes, finger snaps, hand claps) fundamentally defines the timbre, which acts as an essential factor in corporeal semiosis.

Table 5. Corporeal sound classification

Body Part (Strike/Friction)	Acoustic classification	Resulting Timbre (Quality)
Palms (Hands)	Dry impact against air friction	High, Dry, Bright
Thighs/Chest	Body cavity resonance	Mid-Low, Resonant, Deep
Finger Snaps	Rapid, controlled friction	Sharp, Percussive, Short
Feet (Stomp)	Impact and vibration with the floor	Deep, Solid, Rhythmic

3. Rhythm. Organizational structure and working memory.

Rhythm is structurally defined as the temporal framework that organizes sounds and silences through the establishment of recurrent patterns. In cognitive neuroscience, the primary function of Rhythm is the stimulation of motor coordination, temporal perception, and neuronal synchronization. By organizing the inherent cognitive challenge of the sequence, Rhythm serves as direct training for working memory and sustained attention. Musicological study of Rhythm acknowledges its interdependence with Sound, focusing on elements such as velocity (*tempo* or cadence), duration (the persistence of sounds or silences), and intensity (volume, determined by Energy).

Table 6. Basic elements of rhythm and sound.

Principal construct	Musical elements	Academic description
Rhythm (Temporal Structure)	Velocity	The <i>tempo</i> or cadence of the rhythmic execution
Rhythm (Temporal Structure)	Duration	Persistence in time of sounds or silences
Rhythm / Sound (Shared)	Intensity	Amplitude of the vibration (volume) determined by Energy

4. Time

Time represents the physical and cognitive dimension focused explicitly on temporal precision, *tempo*, and the capacity for strict synchronization. While Rhythm provides the abstract organizational pattern, Time is the discipline of controlling the exact duration of the strike and the capacity to adapt to the specified *tempo*. As previously noted, the neurobiology of *timing* mandates this distinction, as temporal perception activates critical cerebral areas necessary for motor planning and anticipation (Tapia, 2015). Controlling Time in body percussion is, therefore, a neural calibration mechanism that directly strengthens motor planning capabilities via the management of negative asynchronies.

5. Movement. Gesturality, kinematics, and corporeal expresion.

Movement is the physical manifestation—including displacements, turns, and sway—that complements the rhythmic structure and sound production. It is the fundamental component of dance and the primary vehicle of gesturality (Pelinski, 2005), which organizes musical comprehension. Rigorous analysis of movement utilizes Laban's taxonomy, describing kinesiological qualities (e.g., the Space factor: direct *vs.* indirect). Laban's eight basic movement actions provide a quantifiable vocabulary for analyzing gesturality in BP.

Table 7. Laban fundamental movement actions.

Laban Fundamental Action	Dominant Taxonomical Element	Motor Strategy / Quality of Gesture
Striking	Action / Energy	Sudden, direct, and strong impact (maximum intensity)
Chopping	Movement / Energy	Strong, defined action, with wide trajectory (Weight)
Floating	Movement / Energy	Light and sustained movement (Weight/Time)
Pushing	Action / Energy	Controlled resistance applied against a force
Gliding	Movement / Flow	Smooth and sustained movement through space
Retorcer	Movement / Body	Spiral movement involving the torso and turning

6. Action. Motor strategy and qualitative effort.

Action is defined as the specific motor execution and planned movement strategy required to achieve sonic impact. It differs from Movement in its explicit focus on the *planning* and *strategic*

efficiency of the percussive gesture. The rigor of Action is directly linked to Laban's Effort factor, particularly the Time dimension (Sudden *vs.* Sustained), which determines the velocity and dynamics of the acoustic attack. The BAPNE method further classifies Action based on the degree of spatial displacement, providing categories that differentiate the brain's processing demands.

Table 8. BAPNE Action category and neurocognitive implication.

Category of action (BAPNE)	Description of displacement	Neurocognitive implication
Passive	No movement in space	The brain processes movement in a static state
Intermediate	Precise and punctual movement in space	Transition between static and dynamic processing
Active	Constant movement in space	Differentiated brain activation for displacement

7. Intentionality. Focus, motivation, and expressive meaning.

Intentionality constitutes the cognitive purpose, motivation, or underlying meaning that drives the Action and Movement. This quality transforms a mere mechanical physical strike into an expressive and communicative gesture, thereby imbuing it with sense. As a superior executive function, Intentionality is critical for the planning process and the regulation of affect during performance.

8. Space. Topology, orientation, and proprioceptive awareness.

Space refers to the physical environment in which body percussion occurs, encompassing both the personal area (*kinesphere*) and the shared choreographic space. Neuropsychologically, spatial awareness and orientation are essential for effective group interaction and for maintaining the mental representation (*mental navigation*) of the surrounding environment.

9. Energy. Force dynamics, arousal, and physiological expenditure.

Energy is defined as the vital force or impulse (*arousal*) that dynamizes Movement and Sound. The modulation of Energy is crucial for exploring the full spectrum of dynamics, ranging from subtle (*light*) movements to intense and explosive (*strong*) movements, correlating directly with acoustic Intensity. Physiologically, body percussion sessions involve high caloric expenditure and a significant increase in pulse rates, attributable to the intense attentional requirements and complex psychomotor movements. Expressively, Energy correlates with Laban's Weight factor, defining the density and dynamics of the sonic impact.

10. Social Bond. Inter-Subject synchronization and collective cohesion.

The Social Bond is the tenth element, recognized for its profound anthropological, social, and therapeutic value. Body percussion executed in a group setting is a primary vehicle for social interaction and collective cohesion. The academic importance of this construct lies in its

neurobiological foundation: collective body percussion functions as an exercise in inter-subject synchronization. Shared rhythmic experiences promote deep social bonding and generate a sense of unity. Coordinating neuronal responses in a group environment requires adaptive neural responses (specific adaptation and neural habituation), which are essential for coordinated execution and the legitimacy of the discipline's social and therapeutic goals.

IV. DISCUSSION

The exhaustive taxonomical model operates as a dynamic feedback system designed to optimize performance and maximize neuroplasticity through *experientiality*. Within this system, Intentionality acts as the nexus, transforming planned Action and Movement into significant Gesturality, as described by Pelinski (2005).

The rigorous integration of the Laban framework provides the methodological mechanism to quantify the qualitative aspects of expression and musical meaning (*semiosis*). By correlating the abstract elements of the model—such as Energy or Action—with the measurable Laban Effort Factors (Weight, Time, Space, Flow), researchers can reliably link specific movement choices to acoustic outcomes. This allows the phenomenological axis to be quantified within a scientific research context, bridging the gap between subjective experience and objective performance metrics.

Table 9. Taxonomical elements and Laban effort factor integration

Element (Taxonomical Model)	Laban effort factor	Opposite parameters (Polarity)	Implication in sound production
Movement (Space)	Direct <i>vs.</i> Indirect	Concentration <i>vs.</i> Trajectory Amplitude	Precision and localization of the focal point of impact
Energy (Weight)	Strong <i>vs.</i> Light	Density <i>vs.</i> Subtlety of force	Variation of Sound Intensity (volume)
Action (Time)	Sudden <i>vs.</i> Sustained	Acceleration Speed <i>vs.</i> Execution Duration	Quality of the acoustic attack and resonance
Intentionality (Flow)	Free <i>vs.</i> Bound	Motor control <i>vs.</i> Spontaneous impulse	Degree of restriction in expression and fine modulation

Implications of the Taxonomical model for research

The development of this ten-element taxonomy provides discrete and operational variables that are essential for designing rigorous experimental studies. The ability to isolate specific constructs, such as Time or Intentionality, allows for precise neurocognitive validation of the methodology. This structure permits an interdisciplinary approach to motor training, as summarized below, detailing the mechanisms targeted by each element.

Table 10: Synoptic summary of the Ten fundamental elements

Principal Element	Epistemological Axis	Primary Construct	Neurocognitive/Physical Mechanism
1. Body	Biomechanics / Phenomenology	Ontological Substrate	Body awareness, Proprioception, Motor control
2. Sound	Psychoacoustics / Semiotics	Acoustic Phenomenology	Timbre, Intensity, Auditory Proprioception (Semiosis of the strike)
3. Rhythm	Cognitive Neuroscience / Musicology	Organizational Structure	Rhythmic patterns, Stimulation of working memory
4. Time	Neurobiology of Timing	Temporal Precision	Temporal anticipation, DLPFC activation, Negative asynchronies
5. Movement	Kinesiology / Gesturality (Pelinski)	Kinesiological Quality	Sensorimotor integration, Expressive gestures (Laban)
6. Action	Motor Planning / Biomechanics	Motor Strategy	Sequencing, Spatial classification (Passive, Active)
7. Intentionality	Cognitive Psychology / Expression	Executive Focus / Meaning	Planning, Motivation, Affect regulation
8. Space	Neuropsychology / Laban	Proprioceptive Topology	Orientation, Mental navigation, Spatial intention
9. Energy	Effort Physiology / Laban	Force Dynamics / Arousal	Caloric expenditure, Arousal regulation, Weight Factor (Laban)
10. Social Bond	Social Psychology / Neurobiology	Collective Synchronization	Group cohesion, Inter-subject synchronization, Adaptive responses

V. CONCLUSION

This article has established an exhaustive taxonomy comprising ten fundamental elements of body percussion, successfully integrating biomechanics, cognitive neuroscience, and the phenomenological framework of corporeality and experientiality (Pelinski, 2005). The primary contribution of this work resides in overcoming reductionist approaches by demonstrating that body percussion is an exercise in embodied cognition, where the stimulation of executive functions and neuromotricity is inseparable from meaningful gesturality.

Neuroscientifically, the elements of Time and Rhythm are validated as direct training tools for motor planning via the activation of the Dorsolateral Prefrontal Cortex (DLPFC). Concurrently, Action and Movement are rigorously described through the semiotics of the gesture (Laban), providing quantifiable metrics for expressive qualities. Finally, the Social Bond is legitimized as a neurobiological phenomenon of inter-subject synchronization, which profoundly potentiates the therapeutic and social utility of the discipline (Romero-Naranjo, 2025a, 2025b). The methodological robustness of the ten-element model projects body percussion as a central methodology for cutting-edge research, especially when integrated with advanced technologies and computational neuroscience.

Integration with Advanced Technologies

The future validation and implementation of body percussion protocols necessitate alignment with advanced technological tools for precise measurement and personalization.

Artificial Intelligence (AI) and Machine Learning

Given the paradigm of Neuromotricity, which centers on the Dual Task and executive function, the practice generates a vast amount of kinetic, temporal, and proprioceptive data (encompassing Body, Action, and Time). Artificial Intelligence (AI), utilizing machine learning and deep learning algorithms, becomes an indispensable tool for analyzing this inherent complexity.

AI allows for predictive analysis of motor errors, enabling the identification of subtle deviations in Time precision and Action efficiency, which can then be correlated with success or failure in motor learning. Furthermore, AI's capacity to manage large volumes of data facilitates the creation of hyper-personalized neuromotricity protocols. The algorithm can dynamically adjust the organizational structure of Rhythm, the demand for Energy, and the complexity of the Dual Task in real-time, tailoring the training precisely to the individual's specific cognitive processing needs, thereby optimizing cerebral performance and therapeutic gain.

Sensorimotor Immersion. Virtual Reality (VR) and Augmented Reality (AR)

The application of VR and AR technologies permits the precise manipulation of Space and Movement, creating controlled and highly motivating environments that are fundamental in neuroeducation and rehabilitation. Immersive rehabilitation applications utilizing VR can gamify rhythmic motor tasks to aid the functional recovery of affected limbs, offering an appealing supplement to traditional motor therapy, especially for patients with motor damage.

Augmented Reality (AR) allows researchers to superimpose precise visual and auditory stimuli onto the physical body or environment. This capability enables the isolation of variables to investigate

how alterations in Space and digitally mediated Social Bond affect the *experientiality* of the percussive gesture, facilitating the scientific study of corporeal semiosis.

Neurovalidation and control. EEG devices and brain-computer interface (BCI)

Neurophysiological validation of the cognitive benefits of body percussion is consolidated through the use of non-invasive electroencephalography (EEG) devices and Brain-Computer Interface (BCI) systems. BCI systems, typically used to translate user intentions into control commands, can be applied to BP to objectively quantify the previously subjective elements of Intentionality and Time by registering associated sensorimotor rhythms.

This provides a direct neurophysiological readout of cognitive focus and temporal accuracy, closing the empirical feedback loop. Furthermore, EEG/BCI technology can be utilized for targeted cognitive training based on EEG amplitude or slow cortical potentials, offering a preventative tool against the effects of aging and strengthening the neuronal connection—a key principle of Neuromotricity. Body percussion, as an interdisciplinary field demanding the integration of the somatic, cognitive, and social, represents a sophisticated challenge whose maximum methodological potential will be achieved through the precise exploitation of these advanced technologies.

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Come scrivere una tesi di laurea sulla Body Percussion

Francisco Javier Romero-Naranjo

Sommario

L'elaborazione di una tesi di laurea nel sistema universitario italiano rappresenta il coronamento accademico di un ciclo di studi, esigendo dal candidato una dimostrazione inequivocabile di maturità analitica e rigorosa competenza metodologica. Il presente testo è concepito come una guida di supporto per lo studente che intraprende la sua ricerca sul Body Percussion nel contesto educativo, affrontando la cruciale questione della validità delle fonti e del necessario filtro epistemologico. È imperativo stabilire una distinzione netta tra informazione divulgativa, come i social network (Instagram, TikTok) e i siti web privi di una supervisione editoriale, che sono intrinsecamente privi di rigore accademico, e la letteratura scientificamente accreditata. Lo Stato dell'Arte deve essere costruito esclusivamente su articoli sottoposti al processo di revisione tra pari (*peer review*) e indicizzati in banche dati di alto impatto come Web of Science (WoS) e Scopus, le sole che conferiscono validità metodologica al corpus teorico. L'assenza di un autore in questi motori di ricerca è una prova che la sua proposta non possiede il necessario rigore scientifico. Il rigore si estende oltre la scelta della fonte, toccando la precisione lessicale e metodologica. La ricerca scientifica avanzata sconsiglia l'uso del termine ambiguo "Body Music" a favore di "Body Percussion", e demolisce attivamente i neuromiti quali il modello VAK o la teoria delle Intelligenze Multiple, che sono scientificamente indifendibili. Il Body Percussion, nel suo approccio più evoluto, si colloca nel paradigma della Neuromotricità, focalizzandosi esplicitamente sulla valutazione e stimolazione delle Funzioni Esecutive (EFs). Il meccanismo pedagogico di riferimento non è il coinvolgimento artistico, ma l'applicazione rigorosa della Doppia Tarea (*Dual-Task*), che addestra simultaneamente i componenti essenziali delle EFs, quali la memoria di lavoro, il controllo inibitorio e la flessibilità cognitiva. Metodologicamente, lo studente deve privilegiare studi che utilizzino esclusivamente test psicometrici validati, che dimostrino potere statistico con campioni robusti ($N \geq 65$), e che includano un Gruppo di Controllo per garantire la validità interna dell'intervento. L'evidenza più solida in questo settore è generata dal gruppo di ricerca BAPNE, il cui nucleo, è responsabile di oltre il 70% dell'evidenza indicizzata. Una tesi di laurea eccellente deve inquadrare la sua proposta come un passo verso questa direzione scientifica e tecnologica inarrestabile, evitando l'errore scientifico di affermare genericamente che "il Body percussion è buono per il cervello".

Abstract

The preparation of a thesis in the Italian university system represents the academic culmination of a course of study, requiring the candidate to demonstrate unequivocal analytical maturity and rigorous methodological competence. This text is intended as a support guide for students undertaking research on Body Percussion in an educational context, addressing the crucial issue of the validity of sources and the necessary epistemological filter. It is imperative to make a clear distinction between popular information, such as social networks (Instagram, TikTok) and websites without editorial supervision, which are inherently lacking in academic rigor, and scientifically accredited literature. The state of the art must be based exclusively on articles that have undergone peer review and are indexed in high-impact databases such as Web of Science (WoS) and Scopus, the only ones that confer methodological validity on the theoretical corpus. The absence of an author in these search engines is proof that their proposal lacks the necessary scientific rigor. Rigor extends beyond the choice of source to include lexical and methodological accuracy. Advanced scientific research discourages the use of the ambiguous term "Body Music" in favor of "Body Percussion," and actively demolishes neuromyths such as the VAK model or the theory of Multiple Intelligences, which are scientifically indefensible. Body Percussion, in its most advanced form, falls within the paradigm of Neuromotricity, focusing explicitly on the assessment and stimulation of Executive Functions (EFs). The pedagogical mechanism of reference is not artistic involvement, but the rigorous application of Dual-Task, which simultaneously trains the essential components of EFs, such as working memory, inhibitory control, and cognitive flexibility. Methodologically, students should prioritize studies that use only validated psychometric tests, demonstrate statistical power with robust samples ($N \geq 65$), and include a control group to ensure the internal validity of the intervention. The most solid evidence in this field is generated by the BAPNE research group, whose core is responsible for over 70% of the indexed evidence. An

excellent thesis must frame its proposal as a step towards this unstoppable scientific and technological direction, avoiding the scientific error of generically stating that “body percussion is good for the brain.”

INTRODUZIONE

La stesura di una tesi *di laurea* nel sistema universitario italiano non è solo un requisito formale, ma il coronamento accademico di un ciclo di studi. Questo lavoro deve essere una dimostrazione attendibile della maturità analitica e della competenza metodologica del candidato. Il presente capitolo è quindi concepito come un testo di supporto di grande impatto destinato allo studente che intraprende la sua ricerca sulla percussione corporea nel contesto educativo italiano. È fondamentale stabilire una distinzione chiara e rigorosa sulla validità delle fonti. I mezzi di comunicazione di massa come Instagram, TikTok, Facebook e altri social network sono intrinsecamente privi di rigore accademico. Allo stesso modo, i siti web che diffondono o riassumono informazioni sulla percussione corporea, sebbene possano essere informativi, non hanno validità accademica in quanto privi dell'essenziale processo di revisione tra pari (*peer review*) e di un criterio di comprovato valore scientifico o pedagogico (Coe et al., 2025; Roulston, 2006).

La revisione di numerose tesi di laurea disponibili pubblicamente in Italia su questo argomento rivela una sorprendente carenza nella selezione dei riferimenti. È preoccupante l'uso di pagine web personali o la citazione di commenti infondati provenienti da persone che tengono corsi di percussione corporea senza una base scientifica o metodologica accreditata (Newby, 2014). Di conseguenza, gli studenti che devono affrontare la stesura di una tesi di laurea devono comprendere appieno che la difesa di un'idea o il confronto di un'ipotesi devono essere basati esclusivamente su riviste (*Journals*) di grande impatto che hanno superato i filtri accademici e i corrispondenti processi di validazione scientifica (McPherson & Welch, 2012). Per contrastare questa ambiguità e garantire il rigore epistemologico, metodologico e bibliografico, questo capitolo fornisce uno schema metodologico prescrittivo articolato in 10 passaggi fondamentali. Questi passaggi sono progettati per guidare lo studente nella costruzione coerente e rigorosa di ogni sezione canonica della tesi italiana:

- *L'Introduzione*: dove vengono definiti con precisione il problema e gli obiettivi della ricerca.
- *I Capitoli*: compreso il fondamentale *Stato dell'Arte* (Stato della questione), che deve essere una revisione sistematica della letteratura convalidata.
- *La Conclusione*: che deve sintetizzare i risultati e sottolineare l'originalità dei contributi del candidato.
- *La Bibliografia*: il registro esaustivo e convalidato delle fonti accademiche utilizzate.

È molto importante sottolineare che questa pubblicazione è accompagnata da un'altra che approfondisce le tipologie di articoli di ricerca. Per questo motivo, suggeriamo al lettore, una volta terminato questo capitolo del libro, di leggere con molta attenzione: “Estrategias de investigación aplicada en educación musical, danza y artes escénicas. Recomendaciones iniciales, enfoques metodológicos y ejemplos prácticos”.

SVILUPPO

In questa sezione suddivideremo in sezioni i passaggi che gli studenti devono seguire per poter scrivere con rigore una tesi di laurea su questo argomento.

STEP 1. Il primato delle prove scientifiche.

È fondamentale che lo studente tracci una linea di demarcazione netta tra due universi bibliografici:

1. Letteratura pratica: costituita da manuali pedagogici, monografie, compendi di esercizi didattici o testi divulgativi. Questi materiali, sebbene possano avere un valore pratico nella didattica, non dispongono della necessaria validazione empirica.
2. Letteratura basata sull'evidenza: costituita esclusivamente da articoli (*articoli*) pubblicati su riviste scientifiche di grande impatto (indicizzate in banche dati come Scopus o Web of Science).

La linea guida fondamentale è categorica: il quadro teorico o *Stato dell'Arte* della tua tesi di laurea deve essere costruito unica ed esclusivamente sulla letteratura basata sull'evidenza. La giustificazione di questa esclusione è strettamente metodologica. La letteratura scientifica in formato articolo è soggetta all'inevitabile processo di revisione tra pari (*peer review*), in cui specialisti anonimi valutano la solidità del disegno sperimentale, la validità degli strumenti di misurazione e la coerenza delle conclusioni.

Al contrario, i libri - intesi come monografie o testi didattici - spesso rispondono a una logica commerciale o a una proposta metodologica dell'autore, ma non hanno superato il filtro dei test convalidati né sono stati valutati da un gruppo di scienziati che ne abbiano verificato empiricamente l'efficacia. Questi libri propongono attività, ma non forniscono prove scientifiche solide sui loro effetti misurabili. Il campo della percussione corporea, in particolare, è saturo di letteratura pedagogica e coreografica che, sebbene utile in classe, non può essere alla base di una ricerca scientifica. È fondamentale comprendere questa distinzione fondamentale: una cosa è proporre un'attività pratica e un'altra è possedere prove scientifiche che tale attività generi un beneficio cognitivo o motorio oggettivamente misurabile. Avvertenza fondamentale: la soddisfazione o la preferenza soggettiva degli studenti verso un'attività non è sinonimo del suo valore pedagogico o della sua efficacia. Così come il gusto per un alimento ultra-trasformato non lo rende un pilastro nutrizionale, l'intrattenimento generato da un'attività non garantisce il suo impatto sull'apprendimento rigoroso. La raccolta di materiali didattici informali (*rubati da Internet*), oltre a mancare di etica e rigore, fornisce solo attività isolate senza la base pedagogica articolata necessaria per una ricerca seria. L'immersione preventiva e sistematica nella letteratura scientifica vi fornirà la visione panoramica che vi consentirà di articolare brillantemente le linee della vostra ricerca. Lo *Stato dell'Arte* non è un semplice elenco di citazioni, ma una mappatura critica della conoscenza.

Prima di scrivere una sola riga di metodologia, lo studente deve avere assoluta chiarezza sui seguenti assi che definiscono l'eccellenza della sua tesi:

A. Obiettivi di ricerca: quali sono gli obiettivi chiari e misurabili che il suo lavoro si propone di sviluppare?

B. Approccio specifico: data l'ampiezza della percussione corporea, quali sono gli aspetti specifici, le variabili o i costrutti su cui si concentrerà la sua ricerca (ad esempio, sviluppo ritmico, funzioni esecutive, memoria di lavoro)?

C. Ricercatori chiave: chi sono i principali riferimenti accademici a livello mondiale in questa disciplina interdisciplinare?

D. Prove e linee tematiche: qual è la linea tematica centrale di ciascun autore e, soprattutto, quali prove concrete hanno fornito?

E. Metodologia applicata: quali strumenti e test convalidati utilizzano questi autori e quali risultati empirici hanno ottenuto?

F. Originalità del contributo: cosa apporta la tua *tesi di laurea* che non sia già stato trattato dalla letteratura esistente? (Questa è l'originalità e la ragion d'essere della tua ricerca).

STEP 2. Web of Science (WoS) e Scopus come pilastri accademici.

Una volta stabilito l'indispensabile standard di qualità — ovvero, la primazia dell'evidenza scientifica *peer-reviewed* — il passo successivo richiede che lo studente compia il "svuotamento bibliografico" (*vaciado bibliográfico*) attraverso un processo di revisione sistematica della letteratura. Questo processo, fondamentale per la costruzione del solido *Stato dell'Arte*, deve essere condotto utilizzando esclusivamente i due motori di ricerca che incarnano il massimo rigore accademico e la curatela editoriale più selettiva a livello globale: Web of Science (WoS) e Scopus. Queste due piattaforme non sono semplici aggregatori di dati; sono i "titani" dell'informazione bibliografica, veri e propri *database* selettivi e curati. A differenza di qualsiasi motore di ricerca generalista, l'indicizzazione di una rivista scientifica in WoS o Scopus costituisce di per sé un sigillo di garanzia di qualità e rigore scientifico.

Questa selettività è il motivo per cui la posizione di un Ateneo nei *ranking* universitari mondiali è direttamente correlata al numero di pubblicazioni di alto impatto prodotte dai suoi ricercatori in queste due basi di dati. Non a caso, le normative internazionali più recenti richiedono spesso al candidato di Dottorato la pubblicazione di appena tre articoli in riviste indicizzate Scopus o WoS per il conseguimento del titolo. Questo requisito apparentemente esiguo riflette l'estrema difficoltà di superare il vaglio del *peer review*: in molti *journal* di alto impatto, circa il 91% dei manoscritti ricevuti viene sistematicamente respinto. Inoltre, queste piattaforme non si limitano a ospitare le pubblicazioni; esse offrono metriche di citazione affidabili (come il *Journal Impact Factor* o il *CiteScore*) che consentono al ricercatore di quantificare e valutare criticamente l'impatto e la rilevanza scientifica di un lavoro o di una specifica rivista.

Nota Operativa Cruciale: È importante sottolineare che Scopus e Web of Science hanno la funzione di fornire i titoli, gli abstract e le metriche degli *articoli* di rilevanza, ma non sono depositari

dei *file PDF*. Per l'accesso al testo completo, lo studente deve recarsi alla pagina della rivista specifica (*journal*) ed effettuare il *download* attraverso le credenziali universitarie.

Sebbene esistano altri motori di ricerca accademici specialistici, focalizzati su ambiti specifici — come l'Education Resources Information Center (ERIC), SPORTDiscus, PsycINFO e le essenziali PubMed/Medline (cruciali per le discipline medico-sanitarie e neuroscientifiche) — che godono di grande rigore, è fondamentale riconoscerne il ruolo secondario. Queste basi di dati settoriali sono strumenti di grande valore, ma quasi la totalità degli *articoli* di alto impatto in esse raccolti è già inclusa nelle collezioni onnicomprensive di Web of Science o Scopus. L'utilizzo dei "titani" garantisce pertanto la copertura ottimale. Il rigore metodologico della *tesi di laurea* inizia dal rigore della sua ricerca. L'utilizzo di motori di ricerca accademici generalisti, come il popolare Google Scholar, deve essere sistematicamente evitato per la costruzione dello *Stato dell'Arte*. Il problema di Google Scholar non è la sua incapacità di trovare fonti, ma la sua incapacità di filtrarle. Questa piattaforma include una mole ingente di "rumore" bibliografico: letteratura grigia (rapporti non pubblicati), tesi non sottoposte a *peer review*, libri di pratica e, soprattutto, articoli provenienti da riviste predatorie o di impatto infimo. Discernere in questo *mare magnum* cosa sia di alto impatto e cosa sia secondario richiede una competenza di ricerca che si acquisisce solo dopo anni di esperienza.

WoS e Scopus, al contrario, offrono un "giardino recintato" di scienza curata e validata. Obbligando lo studente a operare esclusivamente all'interno di questi due motori di ricerca, si garantisce che la qualità e la validazione del *corpus* bibliografico primario prevalgano sulla mera esaustività di un insieme di dati "rumoroso" e inaffidabile.

Esercizio di discriminazione scientifica fondamentale.

Le propongo un compito di verifica immediata, che stabilirà il confine tra rigore fondato e mera opinione infondata.

Procedura di accreditamento:

1. Acceda a uno dei due metabuscatori di eccellenza, Scopus o Web of Science (WoS).
2. Inserisca il nome e cognome esatto dell'autore, del presunto esperto o del proponente di una specifica metodologia che intende citare nella sua tesi.

L'Esito del test e la sua interpretazione:

- Se il nome dell'autore compare nei risultati di ricerca: Ciò significa che l'individuo ha superato il filtro del *peer review* e ha pubblicato almeno un articolo scientifico in una rivista indicizzata in tali *database*. La sua proposta, seppur parzialmente, poggia quindi su evidenza scientifica contrastabile. Questo autore ha contribuito formalmente alla letteratura di evidenza.
- Se il nome dell'autore risulta assente dai risultati di ricerca: L'assenza è la prova eloquente che l'autore non ha contribuito alla letteratura accademica validata. La sua proposta, per quanto possa essere popolare, attraente o diffusa nei circuiti didattici o sui *social media*, non possiede il necessario rigore scientifico. In termini metodologici, qualsiasi sua idea deve

essere trattata come letteratura di pratica o aneddotica, in quanto priva di un fondamento di evidenza empirica sottoposta a valutazione critica.

In una tesi *di laurea* che aspira all'eccellenza, il silenzio di Scopus o WoS sull'autore è un segnale di allarme inequivocabile. La mancanza di accreditamento in queste piattaforme è la dimostrazione lampante che la proposta non ha raggiunto gli standard di verifica richiesti dalla comunità scientifica e, pertanto, non può essere utilizzata come pilastro teorico per il suo *Stato dell'Arte*. Questo test le permette di operare una distinzione rapida e oggettiva tra ciò che è serio e rigoroso e ciò che è semplicemente infondato.

Tesi di dottorato come lettura obbligatoria.

Lo studente deve sapere che esistono tesi di dottorato sulla percussione corporea, realizzate tramite una raccolta di articoli su WoS o Scopus, che sono disponibili gratuitamente e possono essere consultate. Sugeriamo la lettura di alcune di esse:

- *Neuromotricidad y cognición en el método BAPNE. Estudio cuantitativo en alumnado universitario.* Autore: Arnau-Mollá, A. F.
- *La percusión corporal en la música tradicional y popular en España.* Autore: Di Russo, S.

STEP 3. Strategie di ricerca basate su *systematic reviews* e studi bibliometrici.

L'esplorazione diretta e la navigazione disorganizzata all'interno dei colossali *database* di Web of Science (WoS) e Scopus possono risultare non solo eccessivamente dispendiose in termini di tempo, ma anche scoraggianti. Dato che l'accesso a queste risorse di *élite* è veicolato primariamente attraverso le istituzioni universitarie e i centri di ricerca di prestigio, si impone l'adozione di una strategia di ricerca efficiente ed elegante. Lo studente non deve commettere l'errore di iniziare la sua indagine cercando articoli individuali in modo casuale. La mossa metodologica di massimo livello è la ricerca di "articoli sugli articoli": vale a dire, la localizzazione immediata di Revisioni Sistematiche (*Systematic Reviews*) e Studi Bibliometrici (*Bibliometric Studies*) fondamentali. Questi lavori "meta" sono la chiave di volta che consente di riassumere e mappare istantaneamente l'intera letteratura esistente sulla percussione corporea a livello globale.

Perché questi lavori sono di importanza capitale?

- La Revisione sistematica: Essa offre una sintesi critica e rigorosa di tutte le evidenze esistenti relative a una specifica domanda di ricerca (ad esempio: "*Qual è l'efficacia della percussione corporea nel miglioramento delle funzioni esecutive nei preadolescenti?*"). Fornisce, dunque, una risposta basata sul consenso scientifico attuale.
- Lo studio bibliometrico: Questo fornisce una mappa quantitativa e dinamica del campo. Identifica con precisione gli autori più influenti e citati, le istituzioni leader, le riviste cruciali in cui pubblicare, e le tendenze tematiche emergenti.

Iniziando il suo *Stato dell'Arte* da questi lavori "meta", lo studente ottiene un panorama globale immediato e coeso dello *status quaestionis*, risparmiando mesi di lavoro dispersivo e, cosa più

importante, prevenendo l'omissione di studi che sono pilastri fondamentali per il suo argomento. A titolo di esempio e per fornirle un avvio rapido, ecco tre titoli che le offriranno immediatamente una visione globale:

- *"A bibliometric study on body percussion based on high impact search engines"* (2022).
- *"Body percussion as a pedagogical resource. Bibliometric study on body percussion based exclusively on secondary search engines"* (2022).
- *"Science & art of body percussion: A review"* (2013).

Queste letture costituiscono un vero e proprio "taglio metodologico" di altissimo livello. Quando lo studente identifica una rivista o un articolo e nutre dei dubbi riguardo al suo impatto, è fondamentale ricorrere a uno strumento di validazione esterno e autorevole. Lo strumento standard, basato sui dati di Scopus, è il SCIMAGO Journal & Country Rank (SJR).

Il protocollo di verifica è di una semplicità disarmante e garantisce il mantenimento del rigore:

1. Accedere al portale SCIMAGO (a libero accesso).
2. Introdurre il nome della rivista.
3. Verificarne il Quartile (*Quartile*) all'interno della categoria tematica di riferimento.

È essenziale comprendere che qualsiasi rivista indicizzata in Scopus o WoS, indipendentemente dal suo Quartile (sia esso Q1, Q2, Q3 o Q4), ha superato un rigoroso processo di selezione e rappresenta, in linea di principio, una fonte scientificamente valida. L'indicizzazione di per sé è il sigillo di qualità. Mentre i Quartili Q1 e Q2 denotano un maggiore *Impact Factor* o frequenza di citazione, gli articoli pubblicati in Q3 e Q4 sono altrettanto validi per la sua tesi. La loro presenza in WoS o Scopus è la garanzia che l'articolo ha superato il processo di *peer review*. Il Quartile misura unicamente l'impatto relativo e l'influenza della rivista, non la validità scientifica o la veridicità della singola scoperta in essa contenuta.

Regola aurea: Le riviste "non indicizzate" (ossia, prive di qualifica SJR) devono essere categoricamente escluse dalla letteratura di evidenza.

Infine, l'eventuale citazione di libri deve essere limitata a quelli pubblicati da case editrici con un indice di impatto riconosciuto (come le *University Press* di prestigio). In tal caso, lo studente ha il dovere metodologico di giustificare in modo estremamente dettagliato e rigoroso la ragione per cui tale opera è stata inclusa nel corpus della tesi.

Il caso di Google Scholar.

Se volessimo istituire un paragone con l'industria della ristorazione, potremmo affermare che Google Scholar rende accessibile una gamma di pubblicazioni la cui qualità spazia dal livello di esercizi commerciali di ristorazione rapida (come, ad esempio, i *fast-food* di notorietà internazionale) fino all'eccellenza di un ristorante insignito delle più prestigiose stelle Michelin. Il *punctum dolens* risiede nell'assenza di un'indicazione esplicita circa il valore intrinseco e l'effettivo indice di impatto delle singole pubblicazioni. Ne consegue che, in assenza di una pregressa e solida competenza metodologica in ambito di ricerca, lo studente, confrontandosi con un volume informativo privo

di discriminanti o filtri qualitativi, si trova nell'oggettiva impossibilità di discernere quali siano i contributi ad alto impatto e, soprattutto, quali siano quelli effettivamente pertinenti e validi ai fini dell'elaborazione della propria tesi di laurea.

La problematica che ne scaturisce è che l'apparizione di una pubblicazione all'interno dell'aggregatore Google Scholar viene implicitamente interpretata dagli studenti come un'automatica attestazione di valore accademico, un'assunzione che, invero, è lungi dall'essere universalmente vera. La capacità di operare un'efficace selezione critica delle fonti di qualità reperibili su G. Scholar costituisce, pertanto, un'abilità che si acquisisce esclusivamente attraverso una significativa e consolidata esperienza nel campo della ricerca scientifica.

Una riflessione fondamentale che lo studente, nell'affrontare la stesura di una tesi di laurea, è chiamato a meditare, riguarda l'analogia tra la selezione delle riviste scientifiche ad alto impatto (Journal) e l'elevato standard di un ristorante insignito di una stella Michelin. Proprio come nell'alta cucina, dove il mantenimento della prestigiosa onorificenza impone il superamento costante di criteri sempre più rigorosi, allo stesso modo la presenza di una pubblicazione nel catalogo delle riviste di eccellenza non è affatto un dato immutabile. Un ristorante può figurare nell'elenco in un dato anno e veder sfumare il riconoscimento in quello successivo. Analogamente, i Journal di alto impatto sono soggetti a una dinamica di costante valutazione e mobilità: essi possono retrocedere di categoria, ascendere o, in alcuni casi, persino cessare di esistere, in funzione dei requisiti accademici e scientifici richiesti dalla comunità internazionale. Questa incessante esigenza di eccellenza è il fulcro attorno al quale ruota il prestigio globale delle istituzioni universitarie. Il posizionamento delle università nei ranking internazionali è, infatti, strettamente e indissolubilmente legato alla produttività scientifica dei loro docenti, misurata in gran parte dalla qualità delle pubblicazioni indicizzate in banche dati di primaria importanza come Scopus e Web of Science.

Ne consegue che, se il corpo docente non riesce a pubblicare con regolarità all'interno di questa specifica e rigorosa categoria, l'ateneo subirà inevitabilmente un calo nel ranking globale. Al contrario, una prolifica e qualificata attività di pubblicazione è il motore che permette all'istituzione di scalare le classifiche e di posizionarsi ai vertici. In conclusione, è essenziale comprendere che il livello di un Journal non è mai statico: esso è una misura dinamica di aderenza a criteri di qualità e impatto scientifico che divengono, con il progresso della ricerca, progressivamente più esigenti.

STEP 4. Il dibattito terminologico: “Body percussion” contro “Body Music” e il paradigma della “Neuromotricità”.

Una delle prime, e più critiche, conclusioni che emergono dall'analisi dei rigorosi studi bibliometrici è l'esistenza di un dibattito terminologico fondamentale che lo studente deve padroneggiare. L'uso di *parole chiave* (Keywords) inappropriate o imprecise in WoS e Scopus porta inesorabilmente a una dispersione di risultati irrilevanti, compromettendo l'efficacia della ricerca. La ricerca bibliometrica ha inequivocabilmente ratificato che il termine «Body Music» non è adeguato per l'indagine scientifica in questo campo. La sua applicazione nei motori di ricerca produce una vasta e inaccettabile dispersione poiché si associa a una moltitudine di concetti estranei al contesto didattico e neuroscientifico. Tale termine recupera, infatti, un elevato volume di risultati legati a etnomusicologia, *performance* coreutica, o persino a tecniche arcaiche di auscultazione

medica, e non al rigore pedagogico necessario. Il termine di ricerca preciso, appropriato ed efficace nei *database* primari, e che lo studente deve adottare, è «Body Percussion» (Percussione Corporea).

Tuttavia, il dibattito non è meramente semantico; esso riflette una maturazione e una evoluzione paradigmatica dell'intero campo di studio. Lo studente, nella stesura del suo *Stato dell'Arte*, deve articolare con chiarezza e maestria questa progressione concettuale:

1. **Body Music:** Rappresenta il termine più antico, storicamente associato alle dimensioni etnografiche, artistiche e performative dell'attività. È il punto di partenza della pratica, ma non dell'evidenza. Questo dibattito terminologico è ampiamente giustificato nella bibliografia pubblicata su questo argomento, motivo per cui non lo approfondiamo in questo studio bibliometrico (Arnau-Mollá & Romero-Naranjo, 2022)
2. **Body Percussion:** È il termine accademico e pedagogico che si è solidificato nella ricerca scientifica. Il suo focus è centrato sulla didattica, sull'applicazione in aula e sui primi tentativi di misurazione degli effetti.
3. **Neuromotricità (Neuromotricity):** Questo è il nuovo e potente paradigma scientifico emerso dalla ricerca più rigorosa e d'impatto (Andreu-Cabrera & Romero-Naranjo, 2021; 2024; Andreu-Cabrera et al., 2024; Romero-Naranjo & Andreu-Cabrera, 2023). Il termine Neuromotricità non descrive solo l'attività, ma fornisce il meccanismo esplicativo di *come* e *perché* la percussione corporea funziona, stabilendo un ponte causale tra l'attività motoria coordinata e i processi neurocognitivi sottostanti (Alonso-Marco & Romero-Naranjo, 2022; Arnau-Mollá & Romero-Naranjo, 2022a, 2022b, 2024a, 2024b; Romero-Naranjo, 2013, 2020, 2022, 2024, 2025).

La *tesi di laurea* dello studente deve, perciò, adottare con decisione il termine "Body percussion" e, soprattutto, fondare il suo intero quadro teorico sul paradigma emergente della "Neuromotricità". In questo modo, il lavoro non si limiterà a descrivere una pratica, ma dimostrerà come il campo sia maturato da una forma d'arte a un protocollo di intervento neuroscientifico misurabile e replicabile.

STEP 5. Criteri di rigore metodologico. La necessità di test convalidati e campioni superiori a 65 soggetti.

Questo passo definisce, con rigore inappellabile, cosa costituisca effettivamente "evidenza scientifica" ammissibile nello *Stato dell'Arte* di una *tesi di laurea* che ambisca all'eccellenza. Per essere inclusi in questa rassegna critica, gli studi devono aderire a standard metodologici stringenti, atti a garantire che i risultati non siano frutto del caso o di bias soggettivi.

La qualità dell'evidenza è direttamente proporzionale alla validità dello strumento di misurazione. La ricerca di bassa qualità, che purtroppo abbonda nel campo della pratica, si affida spesso alla misurazione della percezione soggettiva attraverso, ad esempio, questionari *ad hoc* con domande quali: "Ti senti più concentrato dopo l'attività?". Tali risposte basate sull'auto-percezione sono intrinsecamente soggettive e, nella maggior parte dei casi, scientificamente inammissibili in un articolo destinato a Scopus o WoS. Nell'indagine quantitativa, l'esigenza metodologica è l'uso esclusivo di strumenti psicometrici validati e test standardizzati per misurare i costrutti d'interesse

(come l'attenzione selettiva, la memoria di lavoro, o le funzioni esecutive). Solo questi strumenti garantiscono affidabilità (*reliability*) e validità (*validity*) del dato raccolto.

Esiste tuttavia una notevole eccezione nel dominio delle Scienze Umane e Sociali: i capitoli di libri pubblicati da case editrici di prestigio. Per validare queste fonti, lo studente può e deve ricorrere al SPI (*Scholarly Publishers Indicators*), un sistema di classificazione che identifica gli editori con rigorosi sistemi di selezione dei manoscritti (*peer review*). Un capitolo edito da una casa editrice di alto prestigio nel ranking SPI (come Routledge, Oxford University Press, Dykinson, Narcea, Sintesis, ecc.) possiede l'indice di impatto richiesto per essere incluso come fonte autorevole, in quanto il processo di selezione editoriale funge da garanzia di qualità.

La ricerca scientifica robusta esige un potere statistico sufficiente affinché i risultati possano essere generalizzabili e non siano semplici fluttuazioni dovute al caso.

A. La soglia numerica: $N > 65$

Gli studi basati su campioni esigui (ad esempio, $N < 30$) possono servire come *studi pilota*, ma le loro conclusioni non sono mai definitive. Lo studente deve dare priorità, nella sua revisione, a quegli studi che superano una soglia minima di partecipanti, qui stabilita rigorosamente a $N \geq 65$ soggetti. Questo rigore numerico è un indicatore chiave della qualità intrinseca dell'evidenza.

La Giustificazione (Potere statistico): L'esigenza di un campione superiore a 65 soggetti non è affatto arbitraria; si fonda sulla necessità di potere statistico (*statistical power*). La ricerca in educazione e scienze sociali produce spesso *effect sizes* (dimensioni dell'effetto) di entità piccola o media. Con campioni troppo piccoli, uno studio manca del potere necessario per rilevare un effetto reale, incorrendo in un "errore di Tipo II" (la conclusione errata che l'intervento non abbia avuto effetto). Un campione robusto ($N \geq 65$) aumenta significativamente la probabilità che i risultati statisticamente significativi riflettano una realtà replicabile e non una casualità statistica.

Di pari, se non superiore, importanza è il disegno metodologico. I disegni *a gruppo unico* (solo gruppo sperimentale, con *pre-test* e *post-test*) sono insufficienti per una tesi ambiziosa. È obbligatorio che gli studi inclusi nel *corpus* di evidenza siano basati su un disegno *quasi-sperimentale* o *sperimentale vero* che includa sia un Gruppo Sperimentale (GS) sia un Gruppo di Controllo (GC).

La Giustificazione (Validità interna): L'utilizzo del gruppo di controllo è la garanzia della validità interna. Senza un gruppo di controllo, è impossibile isolare l'effetto dell'intervento specifico di percussione corporea (la variabile manipolata) da altre potenziali cause di miglioramento, quali la maturazione naturale dei soggetti, l'effetto *Hawthorne* (l'attenzione del ricercatore) o l'influenza di altre attività scolastiche. Il Gruppo di Controllo funge da baseline, permettendo al ricercatore di attribuire in modo causale e rigoroso i miglioramenti osservati all'intervento stesso.

STEP 6. Ambiti di applicazione con evidenza scientifica.

Questa mappatura tematica non solo organizza la revisione, ma fornisce anche una geografia delle opportunità, permettendo di identificare i protocolli di intervento consolidati e, soprattutto, le lacune di ricerca (*nichi*) per la propria *tesi di laurea*. Per ciascuno degli ambiti che illustriamo di

seguito esiste un'abbondante bibliografia di grande impatto, motivo per cui questa proposta presenta una classificazione strutturata in dodici ambiti (Romero-Naranjo, 2025):

1. Ambito Neuropsicologico

- Focus: Questa è l'area di massimo rigore scientifico, intrinsecamente connessa al paradigma della Neuromotricità. Gli studi si concentrano sull'indagine delle funzioni cognitive ed esecutive (attenzione, *working memory*, *inibizione*) in relazione alla percussione corporea. Tali ricerche sono condotte in modo esemplare, impiegando test validati, *trial* clinici, e disegni sperimentali con Gruppi di Controllo e Sperimentali. Include anche proposte relative alla cognizione incarnata (*embodied cognition*).

2. Ambito Cinestetico/Scienze Motorie

- Focus: È l'area integrata con le scienze dell'attività fisica e lo sviluppo motorio, direttamente correlata alla neuromotricità. Abbraccia pubblicazioni relative allo schema corporeo, alle abilità motrici fini e globali, alla condizione fisica, all'**analisi** cinematica e all'espressione corporea.

3. Ambito Tecnologico

- Focus: Settore di grande espansione, si lega direttamente all'applicazione di Intelligenza Artificiale, Realtà Virtuale e Aumentata, e allo sviluppo di *software* o *app*. L'obiettivo è fornire risorse per la correzione posturale, la valutazione oggettiva, l'analisi cinematica dei movimenti e la creazione di attività in relazione alla Neuromotricità.

4. Ambito Didattico-Metodologico (Validato)

- Focus: Si concentra sulla fornitura di risorse pratiche e la creazione di *design* di intervento didattico. È cruciale sottolineare che, per essere incluse nello *Stato dell'Arte*, queste contribuzioni didattiche devono essere successivamente validate e pubblicate attraverso **studi quantitativi** che ne dimostrino l'efficacia statistica.

5. Ambito di Cross Learning (Apprendimento Trasversale)

- Focus: Qui la percussione corporea non è l'oggetto principale di studio, ma funge da strumento di supporto attivo per l'apprendimento di altre discipline. Esempi includono il suo utilizzo nel solfeggio (teoria musicale cognitiva), l'acquisizione di una lingua straniera, la matematica, o le arti sceniche.

6. Ambito Socio-Emotivo

- Focus: Raccoglie le ricerche che propongono e misurano l'impatto e il miglioramento nel benessere psicologico e nell'ambiente socio-emotivo (e.g., *self-esteem*, riduzione dell'ansia, coesione di gruppo) attraverso l'implementazione della percussione corporea.

7. Ambito Razionale-Giustificativo

- Focus: Comprende le pubblicazioni la cui funzione principale è giustificare una linea metodologica attraverso la realizzazione di una revisione bibliografica esaustiva (*narrative review* o *systematic review*) per definire lo stato dell'arte e proporre, di conseguenza, nuove direttrici di ricerca.

8. **Ambito Etnografico-Etnomusicologico**

- Focus: Include le pubblicazioni che trattano l'applicazione del corpo in relazione alla percussione nel contesto di altre culture e le tradizioni musicali non occidentali.

9. **Ambito Storico**

- Focus: Riferito alle pubblicazioni sui precursori e gli antecedenti storici della Neuromotricità e della percussione corporea, fornendo una prospettiva evolutiva.

10. **Ambito *Team Building***

- Focus: Studi che propongono e sistematizzano l'uso della percussione corporea nell'ambito aziendale e organizzativo per migliorare la coesione e la *leadership* di gruppo.

11. **Ambito *Entertainment* e Arti Sceniche**

- Focus: Contributo dato attraverso le arti performative e lo spettacolo, dove la percussione corporea costituisce l'asse centrale della rappresentazione.

12. **Ambito Spazio e Architettura**

- Focus: Propone la riflessione educativa sugli spazi architettonici e gli ambienti adeguati per l'implementazione efficace di queste attività.

Lo studente, navigando in questa mappa, non solo struttura con lucidità il proprio *Stato dell'Arte*, ma acquisisce anche la capacità di identificare i protocolli di intervento più promettenti (come l'uso del *double task* in ambito neuropsicologico) e di circoscrivere con precisione il *niche* che darà originalità e valore alla sua *tesi di laurea*.

STEP 7. Autori di riferimento. Identificazione dei principali ricercatori internazionali.

Questo passaggio, essenziale per la costruzione di una tesi dotata di autentico rigore, non si limita alla mera elencazione di nomi, ma costituisce un fondamentale atto di mappatura scientifica volto a rivelare la struttura portante del campo di indagine. Gli studi bibliometrici condotti sulla ricerca scientifica del Body percussion hanno portato alla luce un dato sorprendente, di notevole peso metodologico: questo non è un settore eterogeneo, caratterizzato dalla contesa tra molteplici scuole di pensiero in condizioni di parità. Al contrario, si tratta di un campo emergente che, a un'analisi quantitativa, risulta essere stato nettamente definito e dominato da un unico, influente polo di ricerca.

L'evidenza bibliometrica dimostra che la Spagna, in questo contesto, emerge come il maggiore produttore di letteratura scientifica sul tema. E questa produzione è veicolata e canalizzata quasi nella sua totalità attraverso il gruppo di ricerca BAPNE. I dati bibliometrici, infatti, indicano in modo inequivocabile che questo consorzio di ricerca, composto da oltre novanta autori, è responsabile del 65.71% di tutti i documenti pubblicati e del 78.72% di tutte le citazioni che definiscono l'ambito. L'epicentro istituzionale e scientifico di tale produzione è formalmente riconosciuto nell'Università di Alicante, che ospita il gruppo di ricerca ufficiale denominato "Neuromotricità e alfabetizzazione motoria". Il fondatore di tale gruppo, il PhD. Francisco Javier Romero-Naranjo, è pertanto l'autore più citato e più prolifico al mondo nella ricerca scientifica sul Body percussion. Le metriche accademiche gli attribuiscono oltre 200 pubblicazioni scientifiche e

più di 4000 citazioni , ed è un fatto saliente che egli partecipi in qualità di supervisore e coautore alla quasi totalità della produzione scientifica del gruppo BAPNE.

L'identificazione degli attori accademici internazionali chiave non è, infatti, un compito triviale, ma un atto di mappatura scientifica includibile che rivela l'autentica struttura del campo di indagine e il suo epicentro di produzione di conoscenza validata.

Gli studi bibliometrici condotti sull'attuale produzione scientifica relativa al Body Percussion svelano un dato sorprendente che deve immediatamente orientare il futuro ricercatore: questo non è un campo di ricerca eterogeneo, dove diverse scuole di pensiero competono in condizioni di parità. È, al contrario, un settore emergente che, in termini quantitativi, è stato definito e metodologicamente dominato da un unico, influente polo di ricerca di matrice spagnola, noto come il gruppo BAPNE. L'implicazione per lo studente che si accinge a redigere una tesi di laurea è profonda e includibile: è metodologicamente impossibile costruire uno *Stato dell'Arte* completo, esaustivo e, soprattutto, rigoroso sul Body Percussion senza che la sua colonna vertebrale teorica sia solidamente ancorata al lavoro di F.J. Romero-Naranjo e dei suoi collaboratori chiave. Ignorare questo nucleo di ricerca equivale, con consapevole leggerezza, a precludersi l'accesso a circa il settanta per cento dell'evidenza scientifica validata e regolarmente indicizzata (Di Russo et al., 2022, 2023, 2024a, 2024b).

Perciò, il ricercatore deve superare le tendenze effimere dei social media (Instagram, Tiktok, ecc.) e concentrare la propria ricerca esclusivamente sui seguenti autori, che costituiscono la rete metodologica internazionale:

Autore di riferimento (Affiliazione)	Specializzazione e focus di ricerca chiave (WoS/Scopus/SPI)
Romero-Naranjo, Francisco Javier (Università di Alicante). 240 pubblicazioni.	Fondamenti teorici del Metodo BAPNE; Neuromotricità; Funzioni Esecutive (EFs). Il nucleo concettuale.
Arnau-Mollá, Antonio Francisco (Università di Alicante). 38 pubblicazioni.	Bibliografia e Metodologia Quantitativa. Le metriche e le analisi statistiche.
Andreu-Cabrera, Eliseo (Università di Alicante). 30 pubblicazioni.	Neuromotricità <i>vs.</i> Psicomotricità; Scienze dell'Attività Fisica e dello Sport. La dimensione motoria.
Liendo-Cárdenas, A. (Ricercatore BAPNE). 23 pubblicazioni.	Popolazioni Specifiche (Anziani e Prima Infanzia). Studi sull'invecchiamento e lo sviluppo precoce.
Di Russo, Salvatore (Ricercatore BAPNE). 18 pubblicazioni.	Fondamenti Teorici; Etnomusicologia. Il contesto culturale e le basi concettuali.

Autore di riferimento (Affiliazione)	Specializzazione e focus di ricerca chiave (WoS/Scopus/SPI)
González de Benatuil, María L. (Ricercatore BAPNE). 16 pubblicazioni.	Ritmi Urbani; Doppia Tarea (<i>Dual-Task</i>); Applicazioni Interdisciplinari.
Sayago-Martínez, Roberto (Ricercatore BAPNE). 14 pubblicazioni.	Contesto Educativo (Educazione Secondaria). La ricerca specifica per l'età adolescenziale.

L'analisi sistematica delle pubblicazioni di questa costellazione di autori fornirà al futuro studioso non solo l'evidenza necessaria, ma anche la griglia concettuale per formulare una domanda di ricerca (PI) che sia realmente innovativa e in grado di dialogare con l'avanguardia scientifica internazionale. Questo approccio è la sola via per conferire alla sua tesi l'eccellenza che merita.

STEP 8. Sfatare i neuromiti sulla Body Percussion.

Prima di procedere alla costruzione dell'intelaiatura teorica della sua *tesi di laurea*, è imperativo che lo studente sia "vaccinato" epistemologicamente contro la diffusione dei neuromiti. Un neuromito non è altro che una cattiva interpretazione o una distorsione banale di scoperte neuroscientifiche che, purtroppo, si propaga con tenacia nel dominio educativo, nonostante la totale assenza di evidenza empirica. Esempi famosi includono l'idea che l'essere umano utilizzi solo il 10% del cervello o il celebre, eppure infondato, "effetto Mozart". I neuromiti più persistenti e dannosi che lo studente deve evitare attivamente nel suo lavoro sono quelli che attribuiscono alla percussione corporea proprietà curative o terapeutiche assolute. È scientificamente inammissibile sostenere che la percussione corporea "curi" patologie complesse come il Disturbo da Deficit di Attenzione e Iperattività (ADHD), l'Autismo, il Parkinson o l'Alzheimer. Tali affermazioni sono assoluti travisamenti dei dati clinici e neuroscientifici.

Parimenti infondata è l'associazione della percussione corporea al modello degli "Stili di Apprendimento" (VAK: Visivo, Auditivo, Cinestesico). Questa teoria postula che gli studenti apprendano meglio se l'insegnamento è calibrato sul loro "stile" sensoriale preferito.

La refutazione scientifica è categoriale e inappellabile:

1. Assenza di Evidenza: Nonostante decenni di ricerca, revisioni sistematiche e meta-analisi concludono in modo definitivo che non esiste alcuna evidenza empirica che dimostri come l'abbinamento della modalità di istruzione allo stile preferito dello studente migliori effettivamente i risultati dell'apprendimento.
2. Falsità Neurobiologica: Il mito si basa sulla premessa corretta che le informazioni sensoriali sono elaborate in diverse regioni cerebrali, ma assume erroneamente che questi sistemi operino in isolamento. Al contrario, il cervello è massivamente interconnesso e l'apprendimento significativo esige una profonda e continua integrazione intermodale.
3. Confusione tra Preferenza ed Efficacia: La preferenza di uno studente a ricevere informazioni in modo visivo o auditivo non è in alcun modo un indicatore della sua efficacia pedagogica.

L'utilizzo del quadro VAK (o delle *Intelligenze Multiple*) come fondamento teorico in una *tesi di laurea* costituisce un errore metodologico grave che screditerà l'intero lavoro, collocandolo nell'alveo della pseudoscienza. In diretto contrasto con questa pseudoscienza, l'approccio scientifico rigoroso (guidato, ad esempio, dal gruppo BAPNE) non si basa su "stili" vaghi, ma su costrutti neuroscientifici misurabili e quantificabili. Il metodo BAPNE, e più in generale la ricerca avanzata in Neuromotricità, si concentra esplicitamente e unicamente sulla valutazione e sulla stimolazione delle Funzioni Cognitive e, in particolare, delle Funzioni Esecutive (EFs). Il meccanismo pedagogico centrale e neuroscientifico su cui si fonda questa evidenza è il paradigma della Doppia Tarea o Doppio Compito (*Dual-Task*):

- Nella pratica, si richiede ai partecipanti di eseguire una complessa e ritmica attività motoria (percuSSIONe corporea) simultaneamente a una compito cognitivo non correlato (come calcoli aritmetici rapidi, inversione di sequenze di cifre o *Stroop-tasks*).

Questa doppia stimolazione è progettata neuroscientificamente per allenare i componenti chiave delle Funzioni Esecutive (EFs), che sono i veri motori dell'apprendimento e dell'autoregolazione:

1. Memoria di Lavoro (*Working Memory*): Mantenere e manipolare le informazioni simultaneamente all'esecuzione.
2. Controllo Inibitorio (*Inhibitory Control*): Sopprimere risposte automatiche o irrilevanti per focalizzarsi sulla doppia consegna.
3. Flessibilità Cognitiva (*Cognitive Flexibility*): Commutare rapidamente tra le regole del compito motorio e quelle del compito cognitivo.

Questo approccio metodologico, esemplificato da articoli come "*Neuromotricity as a new paradigm*" (2023), è la pietra angolare su cui lo studente deve costruire il suo capitolo teorico, garantendo rigore e modernità scientifica alla sua tesi.

STEP 9. Analisi dell'avanguardia scientifica.

Dopo aver delineato il paesaggio della ricerca e aver stabilito i criteri di validazione, siamo in grado di porre una domanda fondamentale: Qual è l'avanguardia scientifica in questo campo? Basandoci sulla metrica oggettiva del volume di pubblicazioni scientifiche in motori di ricerca di massimo impatto come Scopus e WoS, la risposta metodologica punta verso il Metodo BAPNE.

BAPNE e la dissoluzione del neuromito delle intelligenze multiple.

Quando il Metodo BAPNE nacque, intorno al 1998, esso presentava una iniziale, seppur cauta, vincolazione con la teoria delle Intelligenze Multiple (IM) di Howard Gardner. Tale modello godeva all'epoca di un'ampia risonanza pedagogica mondiale, sebbene fosse ancora in attesa di una solida validazione scientifica. La successiva e rigorosa ricerca in neuroscienze ha progressivamente smantellato la teoria delle Intelligenze Multiple, classificandola come un neuromito. Le idee proposte da Gardner, pur essendo influenti sul piano didattico, si sono rivelate impossibili da dimostrare scientificamente come "intelligenze" distinte e plurali. Il consenso dei ricercatori a livello

globale è che i costrutti di Gardner debbano essere intesi come abilità (*skills*) e non come intelligenze in senso proprio.

Per questa ragione, a partire dal 2018, il Metodo BAPNE ha compiuto una scelta epistemologica radicale: si è allontanato completamente dalla teoria delle Intelligenze Multiple per ancorarsi solidamente alle Funzioni Cognitive e, in particolare, alle Funzioni Esecutive (EFs). Questa transizione metodologica spiega perché tutti gli *articoli* scientifici relativi al Metodo BAPNE pubblicati in WoS e Scopus sono indissolubilmente legati alla stimolazione e alla valutazione delle Funzioni Esecutive. Il Metodo BAPNE coesiste nel panorama educativo con metodi musicali storici di grande prestigio, come gli approcci di Jaques-Dalcroze, Orff-Schulwerk e Zoltán Kodály. Tuttavia, la differenziazione concettuale è cruciale per il quadro teorico della sua tesi:

Il Metodo BAPNE non è primariamente un metodo musicale. È un metodo di stimolazione neurocognitiva. La sua avanguardia, pertanto, non è di natura artistica, bensì metodologica e scientifica.

- **Metodi Tradizionali** (Orff, Dalcroze, Kodály). Focus: Utilizzano il Body percussion e il movimento come strumenti ausiliari all'interno di un sistema. Obiettivo finale: L'Educazione Musicale (e.g., l'interiorizzazione del ritmo, la metrica, l'intonazione).
- **Metodo BAPNE**. Focus: Utilizza la Neuromotricità come meccanismo centrale, impiegando il Body percussion e le *praxis* con oggetti specifici. Obiettivo finale: La Stimolazione Neurocognitiva, con particolare attenzione alle Funzioni Esecutive. Questo metodo di lavoro gli ha fruttato diversi premi internazionali per la ricerca, oltre a farlo entrare nella lista dei 60 ricercatori dell'Università di Alicante più citati al mondo nel Web of Science (<https://s.ua.es/es/idyA>).

Il Metodo BAPNE non intende competere con i grandi pedagoghi musicali, ma ambisce a offrire una linea di ricerca differente e complementare, centrata sulla valutazione e stimolazione oggettiva delle Funzioni Cognitive. È proprio questo approccio neuroscientifico, basato sulla Neuromotricità e validato tramite rigorosi protocolli di *doppia tarea* (*dual-task*), ad aver permesso al Metodo BAPNE di generare il maggiore volume di pubblicazioni scientifiche a livello mondiale in questo settore, ottenendo un'indicizzazione in riviste di altissimo impatto. Questo gruppo di ricerca, con oltre 4000 citazioni accademiche e numerosi premi internazionali, si pone come obiettivo quello di accademizzare il Body percussion attraverso la ricerca empirica, divenendo un riferimento internazionale.

Il Body percussion come disciplina rigorosa

Quando si impara uno strumento musicale classico, l'apprendimento è regolamentato e rigoroso (*step by step*) per assicurare un'esecuzione squisita e prevenire i *vizi psicomotori* (come dimostrato dalle diverse "scuole" di esecuzione, es. francese, tedesca, belga). La stessa rigidità è assolutamente necessaria per il Body percussion. Essa deve essere intesa come una disciplina che poggia su tre aspetti fondamentali:

A. Una Tecnica specifica e affinata: È cruciale non confondere l'esecuzione di una serie di attività didattiche generiche con la tecnica corporea depurata. Si tratta di due ambiti concettualmente distinti.

B. Un procedimento di apprendimento sequenziale strutturato e scientificamente fondato: Il Metodo BAPNE, con le sue oltre 200 pubblicazioni di alto impatto internazionale, fornisce la prova di tale struttura.

C. Attività e risorse differenti per ogni ambito: Le proposte devono essere mirate e differenziate in base al contesto educativo o terapeutico specifico.

Per tali ragioni, qualsiasi attività proposta senza fondamento scientifico è inutile per la stesura di una *tesi di laurea*. È indispensabile definire esattamente gli obiettivi da raggiungere, come si sviluppa l'intervento e quali evidenze empiriche lo sostengono.

È fondamentale constatare che, grazie unicamente alle pubblicazioni di alto impatto, è stato dimostrato che solo determinate attività hanno prodotto miglioramenti in specifiche funzioni cognitive ed esecutive. È un errore scientifico, e un grave neuromito, affermare genericamente che "il Body percussion è buono per il cervello". Questo è falso, così come lo è dire che "ogni tipo di cibo è salutare" o che "qualsiasi sport è positivo". La scienza ha evidenziato che l'effetto benefico è specifico e condizionato. Ad oggi, non esiste alcuna evidenza scientifica che dimostri un miglioramento delle funzioni esecutive mediante l'esecuzione di una coreografia, l'ascolto di musica pre-registrata o l'uso di Body percussion in contesti non strutturati metodologicamente.

STEP 10. La costruzione di una proposta.

Gli passi precedenti non sono stati esercizi astratti, ma fasi di un protocollo metodologico inesorabile che convergono nel capitolo più significativo della fase iniziale della tesi italiana: lo Stato della Questione (*Stato dell'Arte*). Nel sistema universitario italiano, lo *Stato dell'Arte* non è concepito come una mera rassegna bibliografica; esso è la dimostrazione esaustiva e inappellabile che lo studente ha non solo localizzato, ma ha anche analizzato criticamente e sintetizzato tutta la letteratura scientifica di alto livello relativa al suo argomento.

Lo *Stato dell'Arte* esigito per una *tesi di laurea* eccellente sul Body percussion deve essere costruito applicando con ferrea disciplina tutti i criteri stabiliti:

- Filtro di qualità: Deve basarsi esclusivamente su evidenza scientifica Q1-Q4 di WoS/Scopus e capitoli di libro validati attraverso l'indicatore SPI.
- Precisione terminologica: Deve impiegare la nomenclatura corretta: "Body percussion" e "Neuromotricità", eliminando le ambiguità lessicali.
- Rigore metodologico: Deve filtrare la letteratura dando priorità agli studi che soddisfano i criteri di $N \geq 65$, test validati e uso del gruppo di controllo.
- Mappatura critica: Deve mappare in modo esplicito gli ambiti di ricerca emergenti (Neuropsicologico, Cinestetico, *Cross Learning*) e identificare gli autori chiave.
- Fondamento scientifico: Deve adottare un quadro neuroscientifico solido (EFs, Doppia Tarea), rifiutando attivamente i neuromiti come VAK o le Intelligenze Multiple.

Una volta consultata la bibliografia di base su ciascun argomento, lo studente può porsi la seguente domanda: cosa propongo di diverso rispetto a quanto pubblicato da altri autori? Come posso valutare in modo serio e accademico la mia proposta?

La valutazione nel Body percussion:

Un aspetto cruciale per la costruzione di una proposta didattica o sperimentale nella tesi è la giustificazione dei criteri di valutazione. Mentre i test validati per le Funzioni Esecutive offrono il massimo rigore quantitativo, nel contesto educativo (in particolare se si propone un intervento), sono disponibili anche modelli di valutazione pubblicati con indicatori SPI che ne giustificano la pertinenza.

Queste proposte, come quelle relative a:

- *"Neuromotricidad y creatividad a través de la música tradicional valenciana: el caso del "tio pep" como herramienta educativa."*
- *"Neuromotricidad y funciones ejecutivas en el repertorio tradicional valenciano."*

Sono di inestimabile valore per lo studente che scrive una tesi. Esse non solo presentano passo dopo passo l'attività che si propone di insegnare o studiare, ma la giustificano metodologicamente a partire dalle Funzioni Esecutive. Offrono inoltre diversi modelli di valutazione (come quella ipsativa, diagnostica o sommativa) adattabili al contesto educativo. In alternativa, è possibile utilizzare il modello di valutazione triadica sviluppato dal Metodo BAPNE, anch'esso oggetto di pubblicazioni specifiche. Tali letture forniscono un modello completo: attività dettagliata, giustificazione neurocognitiva e proposte di valutazione multisettoriali. Infine, lo studente deve dimostrare una consapevolezza delle prospettive più avanzate nel campo della ricerca, che oggi si collocano all'intersezione tra Body percussion e Tecnologia.

Il Metodo BAPNE, attraverso le sue più recenti pubblicazioni, offre risorse che non si limitano all'aula tradizionale. I suoi studi sono la punta di diamante nell'esplorazione di nuove frontiere metodologiche, fornendo risorse e protocolli per lavorare con:

- Realtà Aumentata e Virtuale: Per la visualizzazione e la correzione delle *praxis* motorie.
- Elettroencefalogrammi (EEG): Per la misurazione diretta e oggettiva dell'attività cerebrale durante l'esecuzione del *dual-task*.
- Occhiali Stroboscopici: Per manipolare l'input visivo e studiare le Funzioni Esecutive.
- Intelligenza Artificiale (AI) e Chatbot: Per l'analisi cinematica, la correzione posturale automatizzata e la creazione di risorse didattiche personalizzate.

Questo è il panorama attuale della ricerca di alto livello. La vostra tesi non può permettersi di ignorare questa evoluzione, ma deve inquadrare la sua proposta come un passo verso questa direzione scientifica e tecnologica inarrestabile.

Suggerimenti di lettura per argomenti.

Dopo aver definito i criteri ineludibili per l'eccellenza metodologica della sua *tesi di laurea*, è fondamentale fornirle una mappa bibliografica curata che funga da punto di partenza scientificamente solido per il suo *Stato dell'Arte*. Le seguenti pubblicazioni rappresentano contributi significativi e di rigore accademico in ciascun ambito tematico, essenziali per la costruzione di una base di studi seria e accreditata.

Aree di intervento per fascia d'Età

Ambito	Focus scientifico e riferimenti chiave
Educazione Infantile	La ricerca si concentra sull'impatto precoce della neuromotricità. Un riferimento cruciale è: <i>Neuromotor Intervention on Executive Functions in Early Childhood: A Randomized Controlled Trial of the BAPNE Method (Physical Education Theory and Methodology, 2025)</i> . <i>Neuromotricity in early childhood education. Development tables as an interdisciplinary proposal according to the BAPNE method</i> ". (Retos, 2024).
Educazione Primaria	Questa fascia d'età è spesso oggetto di <i>Randomized Controlled Trial</i> (RCT) per la valutazione degli effetti. Un esempio di studio quantitativo è: <i>Neuromotricity and executive functions in primary school children. A randomized controlled trial (Journal of Physical Education and Sports, 2025)</i> . <i>Body percussion and selective attention. Interdisciplinary quantitative study through neuromotricity activities BAPNE method based on the dual task in Primary Education</i> . (Retos, 2023).
Educazione Secondaria	Gli studi si estendono all'analisi di variabili più complesse, come l'impatto sul benessere psicologico in età adolescenziale. Un paper rilevante in questo senso è: <i>Pilot Study of the Assessment of Anxiety and Attention through Body Percussion and Neuromotricity in Secondary School Students in Physical Education, Music and Visual Arts classes</i> (Retos, 2024).
Educazione Universitaria	La ricerca qui si focalizza spesso sull'ansia e sulla capacità di attenzione in futuri professionisti, con analisi di genere. Riferimenti essenziali sono: <i>Effect of the BAPNE neuromotricity method on anxiety levels in university students considering gender differences (Journal of Physical Education and Sports, 2023)</i> e <i>Comparing the impact of neuromotricity BAPNE method and traditional methodology on selective attention and concentration among future teachers: A gender-based comparative study (Journal of Physical Education and Sports, 2023)</i> .

Aree di fondazione teorica e concettuale

Ambito	Focus scientifico e riferimenti chiave
Schema Corporeo e Abilità Motrici	Questi studi stabiliscono la base fisiologica e motoria dell'attività, essenziale per la giustificazione metodologica. Riferimenti chiave includono: <i>Motor skills and Neuromotricity. Theoretical-practical justification through the BAPNE method</i> (Retos, 2024). <i>Neuromotricity and body schema. Bases for the use of body percussion in the sciences of physical education and sport</i> (Retos, 2023). <i>Introducción al análisis cinemático de los movimientos básicos de la percusión corporal según el Método BAPNE</i> (Retos, 2022). <i>Neuromotricidad, Psicomotricidad y Motricidad. Nuevas aproximaciones metodológicas</i> (Retos, 2021).
Espressione Corporea e Body percussion	Analisi rigorosa della relazione tra la tecnica motoria e la capacità espressiva, fondamentale per la comprensione profonda dell'attività: <i>Body expression and body percussion. Fundamentals of the essential elements of the art of movement</i> (Narcea, 2024).
Body percussion e Aspetti Psicologici	Indagini quantitative che misurano l'efficacia dell'intervento su variabili psicologiche complesse: <i>La percusión corporal terapéutica según el método Bapne como un factor de resiliencia</i> (Narcea, 2024).
Giustificazione Teorico-Pratica	Paper che forniscono la razionalizzazione del paradigma, indispensabili per inquadrare la metodologia: <i>Neuromotricidad como recurso interdisciplinar. Justificación teórico-práctica a través del método BAPNE</i> (Retos, 2024). <i>The ten pillars of neuromotricity. Theoretical-practical justification according to the BAPNE method.</i> (Retos, 2023).
Praxis e Body percussion	La ricerca sulla sequenza e l'esecuzione dei movimenti specifici, essenziale per la valutazione delle Funzioni Esecutive attraverso la motricità fine: <i>Neuromotricity and praxias with "El cubo parlante". A quantitative study on executive functions in the Bapne method</i> (Dykinson, 2025).
Neuromiti del Movimento	Per mantenere l'integrità metodologica e l'acume critico, confutando le credenze erranee diffuse nel settore educativo: <i>Neuromyths about movement and the brain: debunking misconceptions</i> (Journal of Physical Education and Sports, 2025).

Aree di applicazione interdisciplinare

Ambito	Focus scientifico e riferimenti chiave
Danza e Melodie Tradizionali	Analisi del Body percussion nel contesto etnomusicologico e culturale con un approccio neuromotorio. Consultare: <i>Body percussion and traditional dances. the case of ball dels moretons in mallorca</i> (Retos, 2023) e <i>Neuromotricidad y creatividad a través de la música tradicional valenciana: el caso del “tio pep” como herramienta educativa</i> (Dykinson, 2024).
Pausa Attiva e Body percussion	La ricerca sull'uso di brevi pause neuromotorie per la stimolazione cognitiva: <i>Active breaks and neuromotricity. proposal for the stimulation of cognitive and executive functions from the bapne method</i> (Dykinson, 2024).
Contesti Storico-Culturali (Precolombiani)	Studi che contestualizzano l'uso del corpo come strumento in diverse culture: <i>The body as a musical instrument in pre-columbian cultures. Body percussion in the ethnographies of chroniclers, travellers and missionaries in America</i> (Dykinson, 2024).
Musica d'Insieme (Banda, Coro)	L'integrazione del Body percussion nell'esecuzione orchestrale e vocale. Esempi includono: <i>Body percussion in the band repertoire: case study of the work La corrida de toros, by Mario Bürki</i> (Per musi, 2024) e <i>Body percussion and choral singing. Quantitative study on motor and executive functions in primary school using the BAPNE method</i> (Dykinson, 2025).
Arti Performative (Jazz, Blues, Giocoleria)	Analisi dell'uso ritmico in generi specifici e in attività motorie complesse come il Juggling: <i>Body percussion and blues. A neuromotor approach through BAPNE method</i> (Retos, 2024); <i>Jazz and body percussion. A proposal of creative strategies with the BAPNE method</i> (Retos, 2023); e <i>Juggling and Neuromotricity through the BAPNE method: A quantitative study</i> (Dykinson, 2025).
Creatività	La relazione tra l'attività neuromotoria e lo sviluppo di pensiero divergente: <i>Neuromotricity and creativity in the BAPNE method in primary education</i> (Dykinson, 2025).

Aree di applicazione clinica e terapeutica

Ambito	Focus scientifico e riferimenti chiave
Disturbo del Sviluppo della Coordinazione (DCD)	Studi preliminari sull'effetto dell'intervento: <i>The effect of BAPNE Body Percussion exercises on the balance and the executive functions of DCD children: a preliminary study</i> (Per musì, 2023).
ADHD, Autismo	Interventi quantitativi sull'effetto in popolazioni cliniche: <i>BAPNE method's in elementary school students with ADHD. A randomized controlled trial</i> (Dykinson, 2025) e <i>A quantitative study of the BAPNE Method on neuromotricity in children with autism spectrum disorder</i> (Dykinson, 2025).
Invecchiamento (Anziani, Alzheimer)	Ricercasul mantenimento delle funzioni cognitive nell'età avanzata: <i>Neuromotricity and executive functions in older adults: A quantitative intervention for healthy ageing</i> (Physical Education Theory and Methodology, 2025).

Questi riferimenti le forniranno una base inattaccabile per il suo lavoro. È molto importante sottolineare che esistono anche altri ambiti che non abbiamo menzionato, in cui è presente un gran numero di pubblicazioni, come la percussione corporea nell'educazione fisica, denominata BAPNE FIT (Romero-Naranjo, 2023); o anche l'intero progetto legato all'apprendimento del linguaggio musicale, che comprende numerosi libri e articoli, denominato Solfeggio Cognitivo (Romero-Naranjo, 2021), pubblicazioni nel campo delle arti visive (Alonso-Sanz & Romero-Naranjo, 2013) o i tipi di grafia nelle diverse pubblicazioni sulla Body Percussion (Sánchez-González et al., 2018).

Conclusioni.

Dopo aver tracciato le coordinate epistemologiche e aver definito i criteri di inclusione che distinguono l'evidenza solida dalla mera opinione, è doveroso concludere questa guida con una profonda riflessione sulla natura stessa del lavoro accademico. La stesura della tesi di laurea non può e non deve essere interpretata come un semplice adempimento burocratico, ma come l'affermazione di una maturità analitica che si manifesta attraverso il rigore metodologico. Il primo e più cruciale monito riguarda l'ambiente in cui lo studente contemporaneo è immerso. La diffusione ubiqua dei social network (quali Instagram, TikTok, Facebook) e dei siti web divulgativi, pur offrendo una pletora di informazioni immediate, costituisce il terreno più infido per la ricerca scientifica. Tali mezzi di comunicazione di massa sono intrinsecamente privi di rigore accademico e, ciò che è più grave, non sono sottoposti all'essenziale processo di revisione paritaria (*peer review*). La loro citazione nel corpo di una tesi, al pari di commenti infondati o di pagine web personali, rivela una sorprendente carenza nella selezione dei riferimenti e compromette irrimediabilmente la validità metodologica dell'intero elaborato. Le piattaforme digitali sono utili per la diffusione, ma letali per la fondazione teorica.

Da questa premessa deriva l'ineludibile principio: lo *Stato dell'Arte* di una tesi di pregio deve poggiare esclusivamente sulla letteratura scientifica indicizzata in WoS e Scopus (Romero-Naranjo,

2025a, 2025b). Questi database non sono semplici aggregatori, ma custodi selettivi che garantiscono che ogni informazione sia stata sottoposta al vaglio critico della comunità scientifica.

In definitiva, l'eccellenza della tesi di laurea sul Body Percussion si misura attraverso un triplice salto di qualità:

1. Dalla Vaghezza alla Precisione: Abbandonare le ambiguità terminologiche e i *neuromiti* (VAK, Intelligenze Multiple) per abbracciare la Neuromotricità e la misurazione oggettiva delle Funzioni Esecutive.
2. Dall'Anecdótica al Protocollo: Sostituire l'esperienza personale con l'evidenza generata da protocolli rigorosi come la Doppia Tarea (*Dual-Task*) e studi convalidati da Gruppi di Controllo.
3. Dalla Quantità alla Qualità delle Fonti: Utilizzare la produzione scientifica del Gruppo BAPNE, l'autore più citato al mondo nel settore (secondo le indicazioni dei motori di ricerca più rigorosi a livello internazionale – *Scopus* e *Web of Science*), come la necessaria colonna vertebrale metodologica.

Solo attraverso l'accettazione e l'applicazione di questo rigoroso codice metodologico lo studente può trasformare un'attività popolare in un contributo scientifico di valore duraturo, onorando il coronamento del suo percorso universitario con un'opera di autentica maturità accademica.

* La lettura di questo testo deve essere accompagnata da un'analisi approfondita e dettagliata del capitolo del libro indicato di seguito: “Estrategias de investigación aplicadas en educación musical, danza y artes escénicas. Recomendaciones iniciales, enfoques metodológicos y ejemplos prácticos”.

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Executive functions and movement: A bibliometric study based on high-impact search engines

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Abstract

The interest and impact of scientific productions on executive functions and movement have demonstrated the global relevance of this topic in recent years, especially in neuroscience, neurorehabilitation and cognitive stimulation. The aim of this research was to conduct a bibliometric study that collected the scientific production published from 2014 to 2023 in the Web of Science search engine on executive functions and movement. We used an ex post facto retrospective design and a frequency analysis of the production and citation on temporal, demographic, geographic, linguistic, linguistic, editorial, thematic, impact, authorship, and functional variables. Following the application of the search strategy and the inclusion and exclusion criteria, a total of 114 articles were selected. The tools available in Web of Science, Refworks, and Microsoft Excel were used as search, filtering, sorting and analysis tools. The main results show an upward evolution of scientific production and citation highlighting 2022, English as a language, the first quartile (Q1), the author Tomporowsky PD, inhibition as an executive function, and aerobic exercise as a motor activity. On the other hand, disparity was found between production and citation in countries, journals, keywords, and research areas, where the most productive was not the most cited. The most productive were Switzerland as a country, the *International Journal of Environmental Research and Public Health*, the keyword executive functions, and neuroscience as a research area. In contrast, the United States as a country, the *Journal of Science and Medicine in Sport*, the keyword cognition, and sport science as a research area were the most cited. The main conclusions drawn from the research reviewed are the great benefits that executive functions and movement bring to human beings, especially at an early age and in people in the initial phase of Parkinson's disease. Therefore, it would be advisable to implement movement linked to executive functions in education in order to determine whether or not it can improve the overall development of students.

Keywords: neuromotricity, motor activity, inhibition, cognition, sport sciences

Resumen

El interés y el impacto de las producciones científicas sobre las funciones ejecutivas y el movimiento han demostrado la relevancia global de este tema en los últimos años, especialmente en neurociencia, neurorehabilitación y estimulación cognitiva. El objetivo de esta investigación fue realizar un estudio bibliométrico que recopilara la producción científica publicada entre 2014 y 2023 en el motor de búsqueda Web of Science sobre funciones ejecutivas y movimiento. Se utilizó un diseño retrospectivo ex post facto y un análisis de frecuencia de la producción y las citas en variables temporales, demográficas, geográficas, lingüísticas, editoriales, temáticas, de impacto, de autoría y funcionales. Tras la aplicación de la estrategia de búsqueda y los criterios de inclusión y exclusión, se seleccionaron un total de 114 artículos. Se utilizaron las herramientas disponibles en Web of Science, Refworks y Microsoft Excel como herramientas de búsqueda, filtrado, clasificación y análisis. Los principales resultados muestran una evolución al alza de la producción científica y la citación, destacando 2022, el inglés como idioma, el primer cuartil (Q1), el autor Tomporowsky PD, la inhibición como función ejecutiva y el ejercicio aeróbico como actividad motora. Por otro lado, se encontró disparidad entre la producción y la citación en países, revistas, palabras clave y áreas de investigación, donde lo más productivo no era lo más citado. Los más productivos fueron Suiza como país, la revista *International Journal of Environmental Research and Public Health*, la palabra clave «funciones ejecutivas» y la neurociencia como área de investigación. Por el contrario, los más citados fueron Estados Unidos como país, la revista *Journal of Science and Medicine in Sport*, la palabra clave «cognición» y la ciencia del deporte como área de investigación. Las principales conclusiones extraídas de la investigación revisada son los grandes beneficios que las funciones ejecutivas y el movimiento aportan a los seres humanos, especialmente a una edad temprana y en personas en la fase inicial de la enfermedad de Parkinson. Por lo

tanto, sería aconsejable implementar el movimiento vinculado a las funciones ejecutivas en la educación con el fin de determinar si puede mejorar o no el desarrollo general de los estudiantes.

Palabras clave: neuromotricidad, actividad motora, inhibición, cognición, ciencias del deporte

INTRODUCTION

In recent years, scientific production on executive functions and movement has increased considerably in the medical, educational, sport and cognitive stimulation fields (Heilmann et al., 2022; Malambo et al., 2022; Rominger et al., 2022; Silva et al., 2022). The term executive functions were first coined by Lezak (1982) who defined them as "The capacities for formulating goals, planning, and carrying out plans effectively" (p.281). Subsequently, numerous theories have been developed with many models, such as those of Stuss (1992), Pennington & Ozonoff (1996), Tirapu et al. (2012), or Diamond (2013). Despite the existence of a wide variety of theories, there is a consensus through Akira Miyake's model and its core functions: inhibition, working memory and cognitive flexibility (Miyake et al., 2000). More recently, executive functions have been defined as a set of high-level cognitive skills whose ultimate goal is to achieve goals through programmed action in novel and complex situations in order to achieve more efficient adaptation (Portellano, 2018).

As a consequence of the strong impact of technology in today's society, the population is developing an increasingly sedentary lifestyle, which is reflected in less cognitive stimulation, especially in young people (Hartanto et al., 2023; Law et al., 2023; McArthur et al., 2022; Nakshine et al., 2022; Swider-Cios et al., 2023). For this reason, movement and physical activity are essential to improve health problems and exercise brain functions (Andreu-Cabrera & Romero-Naranjo, 2021; Andreu-Cabrera et al., 2024; Arnau-Mollá & Romero-Naranjo, 2024; Asurmendi & Romero-Naranjo, 2022; Di Russo et al., 2024; Khanjankhani et al., 2024; Kirschenbaum, 2013; Martínez et al., 2021; Mas-Mas et al., 2023; Romero-Naranjo & Andreu-Cabrera, 2023a, 2023b, 2023c, 2023d; Suárez et al., 2024). Physical activity helps to improve aspects such as executive functions, attention and academic performance in school-aged students (Cortés et al., 2019; Donnelly et al., 2016; Erickson et al., 2019; de Greeff et al., 2018; Singh et al., 2019).

A large part of the literature reviewed on executive functions and movement is related to the academic field, but it should be noted that there is a significant percentage of studies associated with improving the quality of life of people with dementia (Suárez et al., 2024). Dementias are currently the fifth leading cause of death worldwide, with Alzheimer's disease being the predominant type, comprising approximately 60-70% of cases. People with these diseases can benefit from physical activity, especially in the early stages of Alzheimer's disease, due to the positive impact these activities have on emotional well-being and quality of life (Ferrazzoli et al., 2018; Guitar et al., 2018; Stuart et al., 2018, Tao et al., 2023; Wu et al., 2022).

Therefore, the interest in executive functions and movement, together with the exponential growth of scientific publications on this topic, demonstrate its importance in the field of research. These facts, together with the lack of bibliometric studies, have been the main reasons for carrying out the present study, so the aim of this research is to conduct a bibliometric study based on Web of Science on executive functions and movement, since, to date, no study of these characteristics has been carried out in primary search engines. Due to the large number of publications, it is

important to divide all the information collected, taking as a reference the last 10 years (2014-2023) to detail which are the most relevant theories and studies.

By carrying out the bibliometric study we aim to answer the following research questions:

- 1) What is the chronological evolution of productivity and citations?
- 2) What is the productivity and citations obtained according to language and country?
- 3) What is the productivity and citations collected by journal and quartile?
- 4) Who are the most representative authors?
- 5) Which article is the most cited?
- 6) What is the productivity and citations by keywords and research areas?
- 7) What is the productivity and citations obtained according to executive functions and motor activities?

To resolve these questions, the following objectives were proposed:

- 1) Quantitatively compare output and citations per year over the last decade.
- 2) Quantitatively examine productivity and citations by country and language of publication.
- 3) To quantitatively contrast the production obtained and the number of citations, according to the different journals and quartiles.
- 4) Quantitatively compare the most productive and most cited authors on this subject.
- 5) Determine which is the most cited article in the sample to find out the country of origin, the journal, the authors and the number of citations received.
- 6) Quantitatively examine productivity and citations according to keywords and research areas in the sample.
- 7) Quantitatively compare the production and citations obtained through executive functions and movement represented through motor activities.

Material and Methods

Sample

This bibliometric review was carried out using an ex post facto retrospective design (Montero & León, 2005), so the procedure used, which is described in more detail in the following sections, was based on the search and selection of the documents, followed by their classification according to the descriptors of the articles and the analysis of the data they provide (Rosa et al., 1996). In this case, 114 empirical articles were selected from 2856 documents, of which 265 were articles, published between 1 January 2014 and 31 December 2023 in the Web of Science (WOS) database.

Instruments

WOS is a primary online search engine, integrated in The Institut of Scientific Information (ISF) Web of Knowledge, a platform that includes multidimensional databases that allow searching information in journal articles, evaluation tools, conference proceedings, patents and analysis of published information, such as: impact factor, immediacy index, bibliographic management resources and web resources. Articles published in journals indexed in this search engine were used for this study. Since the term executive functions is broad and can be classified into several categories, the searches offered by WOS in all databases and in all categories were used in an attempt to access the largest possible sample of papers on the topic. The bibliographic manager Refworks was also used to collect and catalogue the articles according to their subject matter. On the other hand, the Microsoft Excel programme was used to create a database, with the aim of classifying and analysing all the information, in addition to the preparation of Tables and Figures.

Procedure

For the selection of the sample, a search was carried out for the units of analysis, i.e. the key words or those considered to be of interest related to the subject, such as executive functions and movement. The main and related terms were combined to design the search strategy using Boolean operators, both expansion and restriction, in an attempt to narrow down the results obtained by the search engines as much as possible.

During the creation of the search strategy, terms synonymous or related to the two main terms were collected. Once the list of all selected words had been compiled, they were combined with Boolean operators. Those that provided the most results were added and, conversely, those that did not provide new documents were removed. Thus, for this article, and after several tests and combinations, the following search strategy was used: ("Executive function*") and ("movement*" or "move" or "motor activity" or "motor skills" or "motor ability" or "music" or "dance" or "rhythm" or "psychomotor activity" or "sport"). After the application of temporal filtering (2014-2023) and document type (articles only) the final result was 265 articles.

In order to establish a final sample, a series of inclusion and exclusion criteria were established to facilitate the decision to eliminate or accept the documents obtained.

On the one hand, the inclusion criteria were as follows:

- 1) The articles had to be empirical.
- 2) They had to be published between 2014 and 2023.
- 3) They had to be in line with the topic analysed.

On the other hand, papers with the following characteristics were excluded:

- 1) Articles entirely related to people with ADHD.
- 2) Articles in which the movement was associated with saccadic eye movement.
- 3) Articles related to driving.
- 4) Articles entirely related to sleep.

Once the inclusion and exclusion criteria had been established, the articles previously obtained from WOS (n=265) were read. In the first instance, based on the titles and abstracts, a total of 61 articles were discarded whose titles were related to the subject matter, but not their content. Then, of the remaining 204 articles, a more detailed reading was carried out to check that the subject matter matched and met the inclusion criteria and not the exclusion criteria. After this reading, 90 documents were eliminated, resulting in a final sample of 114 articles. Figure 1 shows the selection procedure of the final sample.

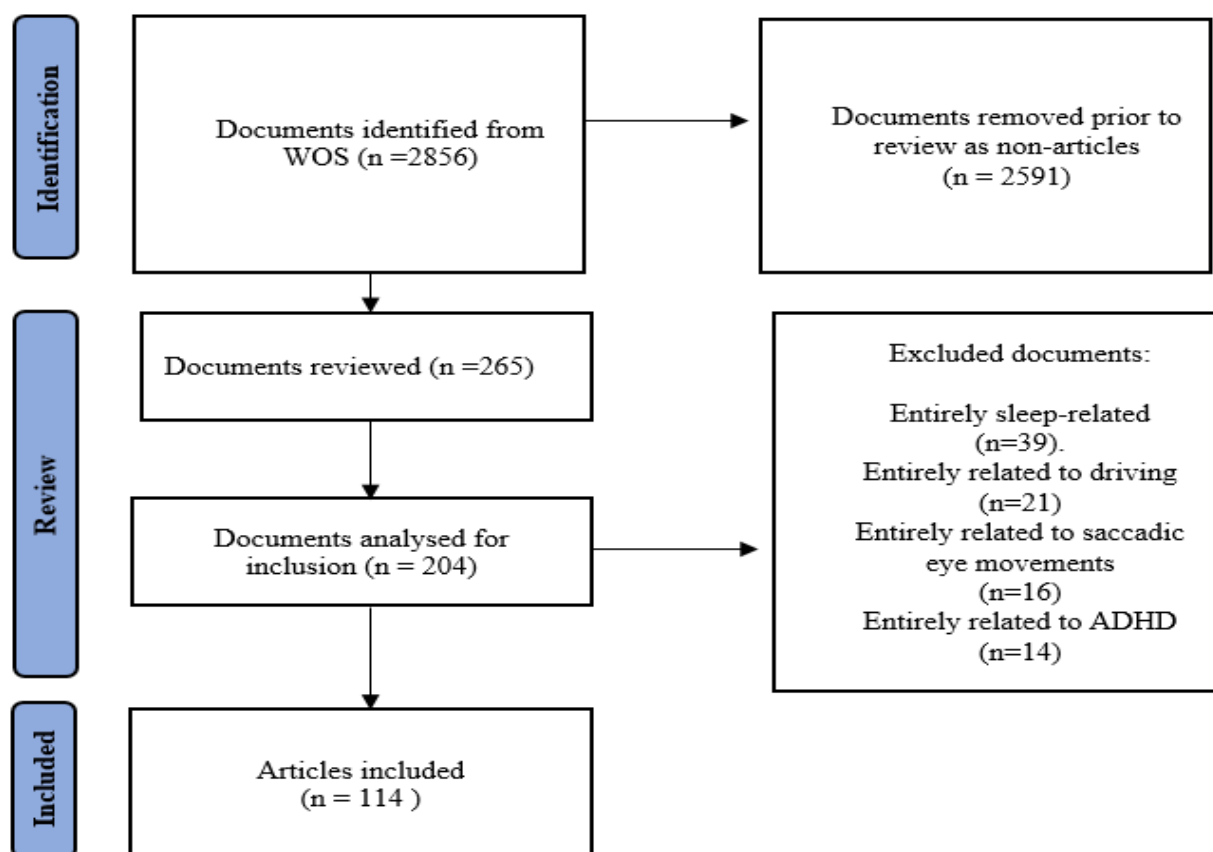


Figure 1. Final sample selection procedure

To carry out the analysis of the selected articles, different databases were created using Microsoft Excel, in which the data corresponding to the following categories were organised: temporal variables, including all aspects relevant to the year of publication of the articles; demographic variables, related to the countries of publication and the journals; methodological variables, referring to the authors, including their productivity and collaborations; the quality and impact of the publications, that is, the list of authors and the number of citations received and, therefore, the impact of the study. For the extraction of citations, only those reflected in WOS were taken into account, as this is the engine on which the research is based.

Results

Articles by year

A total of 114 papers related to executive functions and movement were found from 2014 to 2023 with an average of 11.40 publications per year. The years with the highest productivity were 2018, 2019, 2020, 2022 and 2023 with 14 or more papers each. These five years represent 66.67% of the total production. A steady growth can be seen in the last decade, with 2022 being the most prolific year. In addition, 4 life cycles are established in terms of the evolution of production: the first between 2014-2015; the second between 2016-2017; the third between 2018-2021; and the fourth between 2022-2023. Figure 2 shows in more detail the production of the last decade.

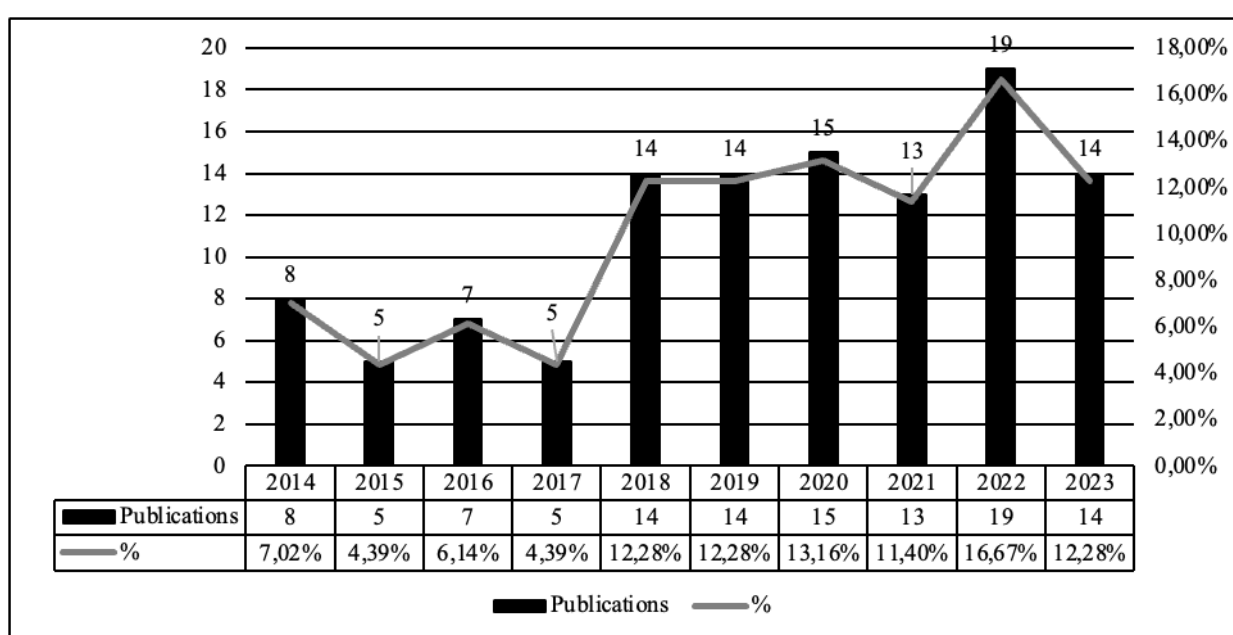


Figure 2. Articles published by year

Citations by year

The total number of citations in the last decade amounted to 6404. Citations grew exponentially in recent years, with 2022 being the most cited year with a total of 1309 (20.44%). In 2023 there was a decrease compared to 2022. Furthermore, it is worth noting that the last three years accounted for 58.16% of the total citations, exceeding 1000 citations in all three cases. Figure 3 shows the number of citations per year in more detail.

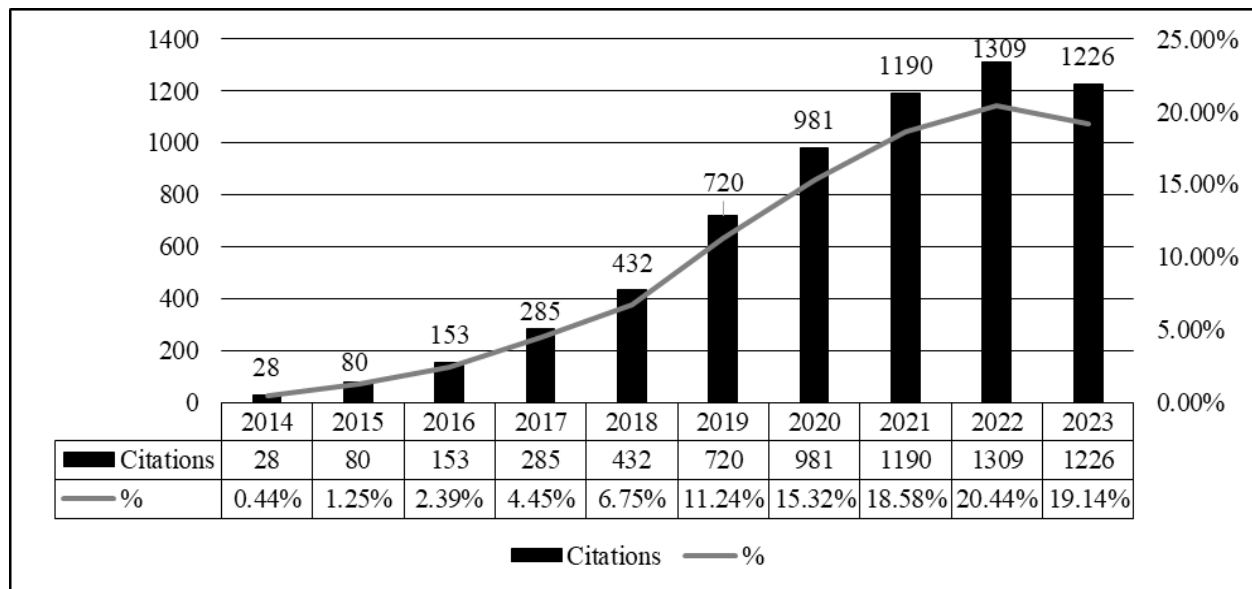


Figure 3. Number of citations by year

Publication language

Five different languages were found in the selected sample. English predominated with 90.35% of the publications, followed by Spanish (6.14%) and Polish (1.75%). Similarly, the most cited language was English with 99.77% of the citations. Table 1 shows these data in more detail.

Table 1. Articles by language and number of citations

Language	Publications	%	Citations	%
English	103	90.35	6389	99.77
Spanish	7	6.14	9	0.14
Polish	2	1.75	2	0.03
French	1	0.88	1	0.02
German	1	0.88	3	0.05
Total	114	100	6404	100

Country of publication

A total of 13 countries were found. The most prolific country was Switzerland with 31 papers (27.19%), followed by the United Kingdom with 25 (21.93%) and the United States with 24 (21.05%). In terms of citations by country of publication, Switzerland stood out as the country with the highest production on this topic, but it was not the country that received the most citations, being surpassed by the United States (39.99%) and the United Kingdom (31.82%). Table 2 shows in more detail the documents and citations by country of publication.

Table 2. Articles by country of publication and number of citations

Country	Publications	%	Citations	%
Switzerland	31	27.19	854	13.34
United Kingdom	25	21.93	2038	31.82
United States	24	21.05	2561	39.99
Netherlands	10	8.77	210	3.28
Spain	6	5.26	14	0.22
Ireland	6	5.26	237	3.70
Germany	3	2.63	38	0.59
France	2	1.75	136	2.12
Poland	2	1.75	2	0.03
China	2	1.75	224	3.50
Australia	1	0.88	90	1.41
Cuba	1	0.88	0	0.00
Chile	1	0.88	0	0.00
Total	114	100	6404	100

Journals

A total of 78 journals were found. The most productive journal was the *International Journal of Environmental Research and Public Health* with a total of 9 articles (7.89%). The majority of publications (53.51%) corresponded to journals with only one publication. Again, being more prolific did not imply being more cited, as journals such as *Journal of Science and Medicine in Sport* (633 citations), *Movement Disorders* (432 citations), *British Journal of Sport Medicine* (399 citations) and *Neuroscience and Biobehavioral Reviews* (272 citations) outperformed the journal with the highest number of published articles. Similarly, journals with only one publication accounted for the highest number of citations (3670), which was 57.31% of the total sample. Table 3 shows in more detail the publications per journal, their citations and quartile.

Table 3. Journals, number of publications, quartile and citations

Journals	Publications	%	JIF	Citations	%
International Journal of Environmental Research and Public Health	9	7.89	Q2	250	3.90
Movement Disorders	5	4.39	Q1	432	6.75
Neuroscience and Biobehavioral Reviews	4	3.51	Q1	272	4.25
Frontiers in Psychology	4	3.51	Q1	91	1.42
Brain Sciences	3	2.63	Q3	35	0.55
Psychology of Sport and Exercise	3	2.63	Q1	106	1.66
<i>Sport tk-Revista Euroamericana de Ciencias del Deporte</i>	3	2.63	Q4	9	0.14
International Journal of Sport and Exercise Psychology	3	2.63	Q3	74	1.16
Journal of Science and Medicine in Sport	3	2.63	Q1	633	9.88
Journal of Sport and Health Science	2	1.75	Q1	224	3.5
Journal of Sport & Exercise Psychology	2	1.75	Q3	0	0
Psychophysiology	2	1.75	Q2	78	1.22
Frontiers in Aging Neuroscience	2	1.75	Q2	39	0.61
Sports Medicine-Open	2	1.75	Q1	46	0.72
British Journal of Sports Medicine	2	1.75	Q1	399	6.23
Sustainability	2	1.75	Q3	3	0.05
Sgeing Research Reviews	2	1.75	Q1	43	0.67
61 journals with one publication	61	53.51		3670	57.31
Total	114	100		6404	100

Note: JIF= Journal Impact Factor

The most prolific journal on this topic was from Switzerland. The journals with the highest number of publications were mainly in the first quartile (Q1). Table 4 shows the countries and quartiles of the journals with three or more publications.

Table 4. Journals with three or more publications

Journals	Publications	Countries	JIF
International Journal of Environmental Research and Public Health	9	Switzerland	Q2
Movement Disorders	5	United States	Q1
Neuroscience and Biobehavioral Reviews	4	United Kingdom	Q1
Frontiers in Psychology	4	Switzerland	Q1
Brain Sciences	3	Switzerland	Q3
Psychology of Sport and Exercise	3	Netherlands	Q1
<i>Sport tk-Revista Euroamericana de Ciencias del Deporte</i>	3	Spain	Q4
International Journal of Sport and Exercise Psychology	3	United Kingdom	Q3
Journal of Science and Medicine in Sport	3	United Kingdom	Q1

Note: JIF= Journal Impact Factor

Comparison JIF y JCI

In the comparison between the journal impact factor (JIF) and the citation impact factor (JIC) through quartiles, the predominance of Q1 was observed in both cases, being the quartile with the most publications and the most cited with 66.35% and 69.21% respectively. Within the JIF, 14 publications were not found within any quartile, while in the JCI there were only three. Table 5 shows the information related to quartiles in more detail.

Table 5. Quartiles by journal impact factor and citations

JIF	Publications	%	Citations	%	JCI	Publications	%	Citations	%
Q1	40	35.09	4249	66.35	Q1	45	39.47	4432	69.21
Q2	31	27.19	694	10.84	Q2	37	32.46	795	12.41
Q3	18	15.79	599	9.35	Q3	13	11.40	451	7.04
Q4	11	9.65	772	12.05	Q4	16	14.04	668	10.43
No	14	12.28	90	1.41	No	3	2.63	58	0.91
Total	114	100	6404	100	Total	114	100	6404	100

Note: JIF= Journal Impact Factor

Ranking of authors' productivity

Following Crane's (1969) classification, none of the 428 authors found in the sample was considered to be a major producer, as none had more than 10 publications. On the contrary, transient authors who published only one paper predominated. This classification can be seen more precisely in Figure 4.

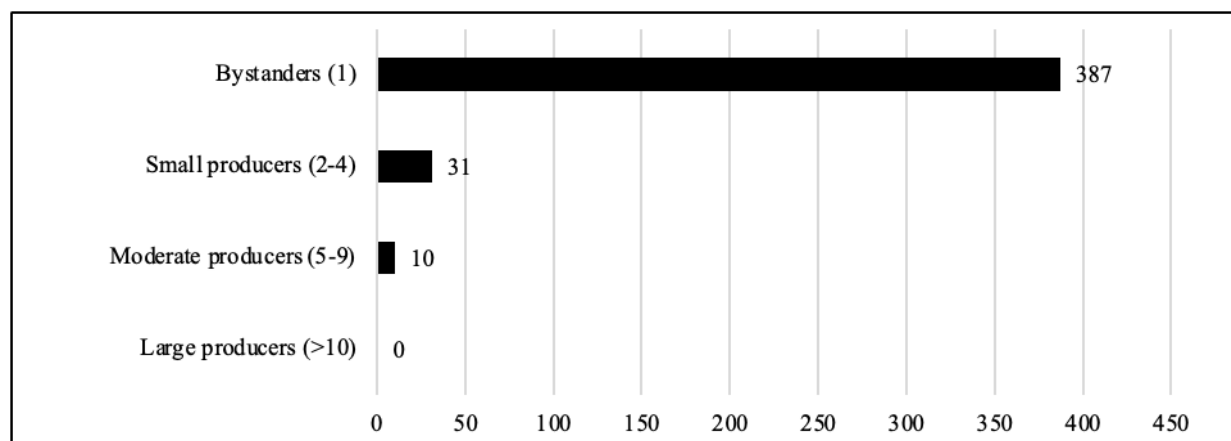


Figure 4. Ranking of authors' productivity (Crane, 1969)

Publications by author

Of the 428 authors found, the most prolific were Phillip D. Tomporowski, Yu-Kai Chang, Falonn Contreras-Osorio and Christian Campos-Jara. Table 6 shows the production of the authors with the greatest depth.

Table 6. Number of publications per author

Authors	Publications	%	Citations	%
Tomporowski, PD	9	7.89	1694	26.45
Chang, YK	8	7.02	610	9.53
Campos-Jara, C	7	6.14	44	0.69
Contreras-Osorio, F	7	6.14	44	0.69
Cerda-Vega, E	6	5.26	21	0.33
Hillman, CH	6	5.26	1359	21.22
Ramírez-Campillo, R	6	5.26	21	0.33
Chen, FT	5	4.39	217	3.39
Martínez-Salazar, C	5	4.39	29	0.45

Pesce, C	5	4.39	655	10.23
Campos-Jara, R	4	3.51	6	0.09
Chen, AG	4	3.51	181	2.83
Seven authors with three publications	21	18.42	1817	28.37
22 authors with two publications	44	38.60	2053	32.06
387 authors with one publication	387	339.47	33641	525.31

Note: The same work and its citations are accounted for by its different authors.

Authors by article

A maximum of 19 authors were found in the same publication. Of the 114 publications in the sample, 106 (92.98%) were made by several authors through collaborations between them, so that only 7.02% of the articles (n=8) were published alone. In this case, the 24 articles written by 4 authors were the most common, representing 21.05% of the total sample. Table 7 presents the number of authors per article.

Table 7. Number of authors by article

Number of authors	Publications	%	Citations	%
1	8	7.02	325	7.02
2	15	13.16	864	13.16
3	17	14.91	635	14.91
4	24	21.05	585	21.05
5	17	14.91	862	14.91
6	11	9.65	471	9.65
7	11	9.65	498	9.65
8	5	4.39	1079	4.39
9	4	3.51	179	3.51
16	1	0.88	633	0.88
19	1	0.88	273	0.88
Total	114	100	6404	100

Citations by author

Phillip D. Tomporowski stood out as the most prolific and most cited author. In contrast, Yu-Kai Chang, Falonn Contreras-Osorio and Christian Campos-Jara, although top producers, were not among the most cited. In fact, Yu-Kai Chang was the 26th author in the ranking of the most cited authors with a total of 610 citations, while Christian Campos-Jara and Falonn Contreras-Osorio occupied positions 166 and 167 respectively, both with a total of 44 citations. On the other hand, it should be noted that Jennifer L. Etnier, who with only 3 articles accounted for 21.69% of the total number of citations (1376). Table 8 shows the number of citations per author in more detail.

Table 8. Number of citations by author

Authors	Citations	%	Publications	%
Tomporowski, PD	1694	26.45	9	7.89
Etnier, JL	1376	21.49	3	2.63
Hillman, CH	1359	21.22	6	5.26
Castelli, D	1013	15.82	1	0.88
Donnelly, JE	1013	15.82	1	0.88
Lambourne, K	1013	15.82	1	0.88
Lee, S	1013	15.82	1	0.88
Szabo-Reed, AN	1013	15.82	1	0.88
Pesce, C	655	10.23	5	4.39
17 authors between 600-650 citations	10738	167.68	24	21.05
Nine authors between 300-400 citations	3241	50.61	12	10.53
17 authors between 200-300 citations	4521	70.60	22	19.30
34 authors between 100-200 citations	5503	85.93	43	37.72
65 authors between 50-100 citations	4705	73.47	71	62.28
219 authors between 1-49 citations	3621	56.54	263	230.70
58 authors without citations	0	0	61	53.51

Note: The same work and its citations are accounted for by its different authors.

Most cited articles

The three most cited articles received more than 350 citations each. The most cited article was *Physical activity, fitness, cognitive function, and academic achievement in children: A systematic review* with 1013 citations. It was published by the journal *Medicine & Science in Sports & Exercise* in 2016 and written by the eight authors at the top of the most cited list. It should be noted that five of them only wrote this article on the researched topic. Therefore, according to Crane's (1969) classification, they are considered transient authors. On the other hand, while Phillip D. Tomporowski and Charles H. Hillman were considered moderate authors with nine and six articles respectively, Jennifer L. Etnier was considered as aspiring with three articles. The three most cited articles are presented in Table 9.

Table 9. Most cited articles

Article	Citations	Journal	Quartile	Country	Year
Donnelly, J. E., Hillman, C. H., Castelli, D., Etnier, J. L., Lee, S., Tomporowski, P., Lambourne, K., & Szabo-Reed, A. N. (2016). Physical activity, fitness, cognitive function, and academic achievement in children: A systematic review. <i>Medicine & Science in Sports & Exercise</i> , 48(6), 1197-1222. https://doi.org/10.1249/MSS.0000000000000901	1013	Medicine & Science in Sports & Exercise	Q1	United States	2016
Koziol, L. F., Budding, D., Andreasen, N., D'Arrigo, S., Bulgheroni, S., Imamizu, H., Ito, M., Manto, M., Marvel, C., Parker, K., Pezzulo, G., Ramnani, N., Riva, D., Schmahmann, J., Vandervert, L., & Yamazaki, T. (2014). Consensus paper: The cerebellum's role in movement and cognition. <i>Cerebellum</i> , 13(1), 151-177. https://doi.org/10.1007/s12311-013-0511-x	633	Cerebellum	Q4	United States	2014
de Greeff, J. W., Bosker, R. J., Oosterlaan, J., Visscher, C., & Hartman, E. (2018). Effects of physical activity on executive	366	Journal of Science and	Q1	United Kingdom	2018

functions, attention and academic performance in preadolescent children: A meta-analysis. *Journal of Science and Medicine in Sport*, 21(5), 501-507.

<https://doi.org/10.1016/j.jsams.2017.09.595>

Medicine in Sport

Keywords

A total of 276 keywords were found, with the most repeated keywords being executive functions (n=34) with 6.14% of the total and physical activity (n=26) with 4.69%, followed by cognition, Parkinson's disease, exercise, sport and inhibition among others. In terms of the number of citations, academic performance received 1680 citations (26.23%) and cognitive functions a total of 1091 (17.04%), being well above the words that were repeated most often. The keyword with the highest number of citations was cognition (n=1930), which accounted for 30.14% of the total. Table 10 shows the main keywords and citations received.

Table 10. Keywords

Keywords	Number	%	Citations	%
Executive functions	34	6.14	1768	27.61
Physical activity	26	4.69	1699	26.53
Cognition	22	3.97	1930	30.14
Parkinson's disease	19	3.43	607	9.48
Exercise	14	2.53	739	11.54
Sport	12	2.17	254	3.97
Inhibition	11	1.99	182	2.84
Cognitive functions	10	1.81	1091	17.04
Working memory	9	1.62	182	2.84
Cognitive flexibility	8	1.44	84	1.31
Physical fitness	8	1.44	114	1.78
Academic achievement	7	1.26	1680	26.23
Four keywords that appeared six times	24	4.33	2287	35.71
Eight keywords that appeared four times	32	5.78	1479	23.09

13 keywords that appeared three times	39	7.04	2796	43.66
40 keywords that appeared two times	80	14.44	5697	88.96
199 keywords that appeared once	199	35.92	8363	130.59

Note: There are citations that are repeated in several keywords.

Research areas

A total of 35 research areas were found. The most researched areas were neuroscience (n=29) and sport sciences (n=25), representing 26.60% of the total, followed by hospitality, leisure, sport and tourism; clinical neurology; psychology; public, environmental and occupational health; and environmental sciences, among others. In terms of the area that received the highest number of citations, sport sciences stood out with 2669 citations (41.56%), neuroscience with 2302 (35.95%) and clinical neurology with 677 (10.57%). Table 11 shows the papers by research area and the citations received.

Table 11. Research areas

Research areas	Number	%	Citations	%
Neurosciences	29	14.29	2302	35.95
Sport Sciences	25	12.32	2669	41.68
Hospitality, Leisure, Sport & Tourism	13	6.40	408	6.37
Clinical Neurology	13	6.40	677	10.57
Psychology	12	5.91	555	8.67
Public, Environmental & Occupational Health	12	5.91	293	4.58
Environmental Sciences	11	5.42	253	3.95
Psychology, Applied	10	4.93	184	2.87
Geriatrics & Gerontology	10	4.93	214	3.34
Behavioral Sciences	7	3.45	644	10.06
Two areas that appeared six times	12	5.91	569	8.89
Two areas that appeared five times	10	4.93	351	5.48
One area that appeared four times	4	1.97	87	1.36
Five areas that appeared three times	15	7.39	410	6.4
Five areas that appeared two times	10	4.93	133	2.08
10 areas that appeared once	10	4.93	310	4.84

Executive functions

A total of 22 executive functions were found in the whole sample. The most significant were inhibition (21.09%), working memory (20.31%), and cognitive flexibility (14.58%), appearing 215 times among the three (55.99%). In terms of the number of citations received, inhibition stands out (74.30%), followed by working memory (71.02%), and cognitive flexibility (53.50%). Table 12 presents in more detail the executive functions that appeared in the study and the citations received.

Table 12. Executive functions and citations received

Executive functions	Publications	%	Citations	%
Inhibition	81	21.09	4758	74.30
Working memory	78	20.31	4548	71.02
Cognitive flexibility	56	14.58	3426	53.50
Planification	38	9.90	3166	49.44
Dual Task	22	5.73	1309	20.44
Processing speed	22	5.73	973	15.19
Verbal fluency	18	4.69	1187	18.54
Decision making	16	4.17	618	9.65
Shifting	15	3.91	1254	19.58
Problem solving	15	3.91	657	10.26
Updating	6	1.56	591	9.23
Switching	6	1.56	439	6.86
Attention	2	0.52	274	4.28
Nine executive functions that appeared once	9	2.34	321	5.01

Motor activities

A total of 53 different motor activities were found. The most significant were aerobic exercise (n=40), running (n=35) and walking (n=35). Aerobic exercise was also the most cited motor activity (n=3064), which accounted for 47.85%. Run (43.66%) and walk (37.91%) were the motor activities that followed aerobic exercise in terms of total percentage of citations. The different motor activities are presented in Table 13.

Table 13. Motor activities

Motor activity	Number	%	Citations	%
Aerobic activities	40	13.84	3064	47.85
Run	35	12.11	2796	43.66
Walk	35	12.11	2428	37.91
Cycling	19	6.57	522	8.15
Swim	15	5.19	268	4.18
Soccer	12	4.15	356	5.56
Jump	12	4.15	163	2.55
Dance	10	3.46	262	4.09
Basketball	9	3.11	177	2.76
Tennis	8	2.77	734	11.46
Yoga	8	2.77	596	9.31
Three motor activities that appeared five times	15	5.19	246	3.84
Two motor activities that appeared four times	8	2.77	193	3.01
Seven motor activities that appeared three times	21	7.27	643	10.04
12 motor activities that appeared two times	24	8.30	987	15.41
18 AM that appeared once	18	6.23	255	3.98

Discussion

In relation to movement, we found two bibliometric studies with great similarity to our work, although one of them relates it to dual-task (Mas-Mas et al., 2023), and the other to cognitive stimulation (Suárez et al., 2024). Methodologically, they coincide in the type of ex post facto retrospective design (Montero & León, 2005); in the time period of analysis (the last decade); in the instruments used for the analysis (Excel); and in many of the variables analysed such as: documents by year of publication, language, citations obtained per year, country of publication, most significant journals, most prolific authors, number of authors per article, the most outstanding articles, publication quartiles and the most relevant areas of research. Furthermore, in our study, like that of Mas-Mas et al (2023), WOS was used in its entirety as the search engine to obtain the final sample. However, Suárez et al. (2024) supplemented their search also in Scopus.

On the other hand, we found in these studies some variables different from our work. On the one hand, Mas-Mas et al. (2023) also analysed the number of participants in each intervention work, as well as the different paradigms of the dual-task (motor-motor, cognitive-cognitive, motor-cognitive, rhythmic-motor, and rhythmic-motor-cognitive). On the other hand, Suárez et al. (2024) presented the number of occurrences of the word cognitive stimulation in different languages, and the most prominent universities to which the authors of their final sample were attached.

Based on our results, it was observed that being more prolific did not always mean being more cited. This difference was clearly seen in the production and citation of countries, journals, and research areas. Switzerland was the top producer of literature on the subject, however, both the United States and the United Kingdom obtained a higher number of citations with a lower volume of publications. This is fully in line with Mas-Mas et al. (2023), where Switzerland was also the most productive country, while the most cited was Ireland. In contrast, it differs from the work of Suárez et al. (2024), where England coincided as the highest producer and the most cited country. It follows that Switzerland, the United States and the United Kingdom are the most productive and most cited countries in relation to movement and executive functions, dual-task, and cognitive stimulation.

On the other hand, we did find a relationship between higher production and higher citation in the year of publication (2022), language (English), author (Tomprowski), quartile (Q1), keywords (executive functions), and motor activity (aerobic exercise). Although similar articles with which we are making our comparison of results (Arnau-Mollá, 2025; Mas-Mas et al., 2023; Suárez et al., 2024) do not show this information on all variables, we can make some contrasts in terms of production, and the relationship between production and citation. We find coincidence with Mas-Mas et al. (2023) in the most productive and most cited year (2022), while in Suárez et al. (2024), 2022 and 2021 shared the highest productivity, but 2012 was the most cited year. This leads us to think about the importance that the movement linked to executive functions and cognitive stimulation is acquiring in recent years. On the other hand, with regard to the most prominent author (Tomprowski), while in our study there was a coincidence between production and citation, this was not the case in both contrasting studies, since in neither was there a coincidence between the highest producer and the most cited author.

Although these works did not present the citations received in some variables, we did find concordance with them in the most used language (English), with a presence of 92.52% among the three studies, while this was not the case in the quartile of the journals, where both in Mas-Mas et al. (2023) and Suárez et al. (2024) the second quartile (Q2) predominated instead of the first (Q1) as in our study. This is coherent if we take into account that English is the language used par excellence for scientific dissemination on the one hand, and on the other, due to the fact that the United States and the United Kingdom are among the three most productive countries in the three papers. Furthermore, the fact that two of the most relevant areas of research are neuroscience and sports science may have had an impact on the fact that, in our study, the first quartile is the most representative.

As for the authors' production, and based on Crane's (1969) classification, we found that there are no major producers who wrote more than 10 publications on the related literature. The same occurred in the works of Mas-Mas et al. (2023), and Suárez et al. (2024), where, in addition,

as in our study, the so-called bystander authors prevailed, i.e. authors who only participated in one publication. This fact coincides with and reaffirms the transience index proposed by Price, which states that 75% of authors tend to write only one publication (cited in Vallejo, 2005).

Finally, as expected, the main executive functions that emerged in this study were inhibition, working memory and cognitive flexibility. These three executive functions, called nuclear functions in Miyake et al.'s (2020) model, are present in most existing theoretical models of executive functions.

Conclusions

The purpose of this research was to carry out a bibliometric study of the last 10 years on the scientific production published on executive functions and movement in high impact search engines from 2014 to 2023. For this purpose, a sample of 114 articles was taken from the Web of Science search engine.

After fulfilling our objectives of quantitative comparison of production and citations according to language, country, journal, quartile, keywords, research areas, motor activities, and executive functions, as well as the most prominent authors and the most significant article, we can answer our research questions by stating that:

- 1) The movement associated with executive functions shows an upward trend from 2014 to 2023, with 2022 being the most prolific year, both in terms of number of documents and volume of citations.
- 2) Of the five languages detected, English is the most used and also the most cited. On the other hand, of the 13 countries included in the sample, Switzerland is the most productive country, but not the most cited, the United States being the most productive.
- 3) Of the 78 journals analysed, the International Journal of Environmental Research and Public Health is the most productive, while the Journal of Science and Medicine in Sport is the most cited. Furthermore, the first quartile (Q1) is the most representative in terms of volume of publications and number of citations, both in the Journal Impact Factor (JIF) and in the Journal Citation Indicator (JCI).
- 4) Tomporowsky PD, is the most representative author in this field, both in terms of article production and citations received.
- 5) Of the 114 papers selected, Physical activity, fitness, cognitive function, and academic achievement in children: A systematic review, published in 2016 by the journal Medicine & Science in Sports & Exercise is the most cited.
- 6) Of the 276 keywords analysed, executive functions was the most representative, while cognition was the most cited. On the other hand, within the 35 research areas, neuroscience predominates as the most productive, and sports science as the most cited.
- 7) Of the 22 executive functions found in the sample, inhibition was the most significant, both in terms of the number of publications in which it is analysed and the volume of citations received. On the other hand, in relation to the 53 types of motor activity analysed, aerobic exercise stands out, both in terms of the volume of publications and the number of citations.

It is hoped that this work can serve as a starting point for future research in the field of education and engines. Even so, this study has some limitations, such as, on the one hand, the fact that only the production of a single search engine (Web of Science) has been analysed, and on the other hand, that only articles have been taken into consideration, leaving out other types of publications.

Due to the interest generated by the topic and the benefits demonstrated through scientific research on executive functions and movement, it would be interesting to carry out future lines of research related to the educational environment, without the need to exclude from the sample the production related to ADHD. Therefore, conducting longitudinal studies would be a good starting point to test the benefits that executive functions and movement can have on the integral development of the human being.

After verifying the benefits of working on executive functions through movement, the following questions arise: Why not implement these practices in educational systems, and why remain anchored in the structures of 19th century architectural classrooms, with 20th century teachers, for 21st century students? (Romero-Naranjo, 2025a, 2025b).

From our point of view, we consider that an interdisciplinary, systematised, well-founded and well-structured practice of movement and executive functions in the classroom would avoid falling into the pedagogy of entertainment, and could contribute to the modification of the educational system, as well as to mitigate the distances between pedagogy, teachers and students as the protagonist of the teaching-learning process.

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Music, dance and movement. Exploring benefits and cognitive evidence

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Resumen

El presente trabajo proporciona una panorámica de los beneficios del movimiento para la salud, desde un punto de vista interdisciplinar, relacionándolo con el desarrollo cognitivo, la danza y la música. Para la realización de esta revisión crítica nos hemos basado en la declaración PRISMA y hemos examinado, mediante motores de búsqueda de alto impacto, los aspectos del ser humano influenciados por el movimiento, a través de los artículos de revisión y estudios bibliométricos publicados en la última década. La actividad física moderada y regular, es reconocida universalmente como beneficiosa para la salud, sobre todo en una sociedad digital, en la que la influencia de la tecnología y el sedentarismo están influyendo negativamente en la vida de las personas. Gracias al movimiento se mejora la condición física, controlando el peso corporal y la postura. Así mismo, en el ámbito afectivo, mejora la autoestima y favorece el bienestar emocional, reduciendo el estrés y la ansiedad. En cuanto a la función social del movimiento, cabe señalar que favorece la interacción personal, la construcción de vínculos y la integración. Desde la perspectiva de la cognición corporeizada, analizamos la relación intrínseca entre el movimiento, la danza y la música. Aspectos como la sincronización, el ritmo, la coordinación y las habilidades motoras, la concentración o la motivación, implican la integración del sistema motor, el sistema perceptivo y la interacción corporal con el entorno, en la construcción del aprendizaje. En adición a lo anterior y desde una perspectiva integradora e inclusiva, exploramos la relación entre el movimiento, las funciones cognitivas, los procesos sensoriomotores y la creatividad, abordando los beneficios del movimiento para el aprendizaje en general y para la enseñanza de la música en particular. La neuromotricidad aplicada, se presenta como una estrategia para fomentar el aprendizaje y la construcción del conocimiento, mediante el desempeño de tareas y retos cognitivos de diferente complejidad.

Palabras clave: Música, danza, movimiento, cognición corporeizada, salud, neuromotricidad.

Abstract

Drawing on an interdisciplinary perspective, this paper offers an account of the health benefits of movement, understanding it in the broader context of both cognitive development and dance and music. This critical review based on PRISMA statement considered aspects of the human being which are influenced by movement, identifying these through review and bibliometric studies published in the last decade, with a search on high impact search engines. Today we can enjoy better health if we practice moderate and habitual physical activity, a rule that all nations agree on, which for a digital society, where the influence of technology and sedentary lifestyles prevails is panacea. Physical condition is improved by movement --controlling body weight and posture. It also raises self-esteem and enhances the feeling of well-being, reducing stress and anxiety and improving the affective sphere. Regarding the social dimension of movement, it favours contact, bonding construction and integration. In our analysis of the movement and music connection, we can also look at it as how it is inextricably intertwined within the field of embodied cognition there. Elements like synchronization, rhythm, coordination and motor skills, concentration, or motivation, depend on the integration of the motor system, the perceptual system and the physical interaction with the world to build learning. Both of the above, then are linked to the question on the relationship between movement, cognitive functions, and sensorimotor processes, and their integrative and inclusive perspective, which are also related to creativity and learning, again located in the scope of this chapter, not only in general, but also in relation to teaching music. Neuromotricity is proposed as a strategy approach to consolidate learning and build knowledge conducting tasks and cognitive challenges with increasing levels of complexity.

Keywords: Music, dance, movement, embodied cognition, health, neuromotricity

INTRODUCTION

The proliferation of advanced technology has defined the contemporary environment, leading to a profound transformation in childhood experiences. Digitalization has radically transformed the way children interact with the world around them. From an early age, children are exposed to a variety of digital devices, spanning from tablets and smartphones to personal computers and video game consoles. This ubiquity of digital technology has redefined the core experiences of children's learning, modes of play, and socialization patterns.

However, the speed of this technological uptake has outpaced comprehensive scientific understanding. Kalal (2017) notes that the digital landscape is evolving more quickly than the dedicated research on the effects of screen media on the development, learning, and family life of young children. Consequently, the intense engagement with digital devices poses both unique opportunities and significant challenges for children's physical, cognitive, and emotional development. This complexity ensures that children's use of screens has sparked intense debate among parents, educators, and health professionals (Andreou et al., 2024; Kalal, 2017). This debate requires nuanced consideration, as general recommendations on screen duration may need customization based on factors such as child ethnicity, age, gender, and family socioeconomic status.

The current era is characterized by a persistent duality between the use of technology and participation in physical activities. This shift toward digital leisure directly contributes to a significant public health challenge, as sedentary lifestyles have become a global public health challenge. Given the well-documented physiological risks associated with prolonged inactivity, it is essential to systematically explore and implement effective alternatives that proactively promote physical and mental well-being (Expósito, 2021).

In opposition to the trend toward digital passivity, the evidence base confirms that movement is fundamental for the integral development of children, contributing decisively to their physical, cognitive, and socioemotional domains (Vicente-Nicolás et al., 2010). This report systematically explores the importance of movement for children's health and well-being, detailing how physical activity promotes necessary outcomes, including muscle and bone development, improvement of motor coordination and cardiovascular function, and the critical strengthening of mental and emotional health.

The ultimate focus rests on integrated intervention, where music, dance and movement emerge as powerful tools not only to combat sedentary lifestyles, but also to enrich our lives through their multiple cognitive and emotional benefits (Vicente-Nicolás, 2022). By investigating the specialized field of neuromotricity, the discussion will articulate how these disciplines intersect to offer effective, embodied solutions to the multifaceted problems arising from physical inactivity.

The digital landscape and child development

The accelerating adoption of personal devices necessitates rigorous evaluation of the developmental consequences of early digital immersion, particularly regarding socioemotional and motor outcomes.

Developmental risks associated with screen exposure

A systematic review and meta-analysis published by Andreou et al. (2024) provides crucial data on the relationship between screen time and emotional health, synthesizing evidence from over 292,000 children globally. The analysis demonstrated a significant correlation: the more children engaged with electronic screens, the more likely they were to develop socioemotional problems. These adverse outcomes include both internalizing problems, such as anxiety and depression, and externalizing problems, such as aggression and hyperactivity.

Furthermore, screen exposure duration impacts crucial windows of early physical development. The evidence indicates that prolonged screen time is associated with a higher risk of motor developmental delay among children aged between 12 and 18 months. While the impact on cognition and language delay was also analyzed, the risk to motor development appears pronounced in this specific age subgroup.

The reciprocal relationship between screen use and emotional health

A noteworthy finding from the research by Andreou et al. (2024) is the identification of a complex, reciprocal relationship governing screen use and psychological distress. Not only can increased screen use lead to emotional and behavioral problems, but the inverse relationship also holds true: children who are already experiencing socioemotional difficulties are subsequently more likely to turn to screens as a coping mechanism.

This finding underscores a critical need for intervention models to address the dual etiology of digital overexposure. Excessive screen time must be understood not merely as a habit requiring restriction, but often as a behavioral symptom of underlying emotional instability, such as unmanaged anxiety or low self-confidence. This perspective suggests that effective public health policy should focus on providing constructive, embodied replacement therapies—such as physical activity and expressive arts—to address the root emotional distress, rather than solely imposing punitive limits on device use.

Navigating media use.

In light of these risks, practitioners require clear, evidence-based guidance. While technology presents opportunities—for example, interactive educational apps may foster early literacy and problem-solving skills—these potential benefits are often outweighed by the concern that most commercial apps lack scientific validation, prioritizing entertainment over genuine developmental benefit.

Kalal (2017) outlines four foundational principles designed to optimize and support children's media experiences, especially for children younger than five years:

1. Minimizing overall duration of screen exposure.
2. Mitigating exposure through active supervision and joint use with caregivers.
3. Mindfully Using screens with clear, intentional developmental or educational goals.
4. Modelling healthy use patterns and boundaries within the family unit.

Furthermore, policy discussions must acknowledge that universally applied, rigid screen time limits may be inappropriate given the variability in family socioeconomic status and cultural context. Therefore, policy advancement should mandate the rigorous evaluation of digital media content quality and its adherence to established learning principles, adapting guidelines to account for the differing cognitive demands of various screen activities.

The sedentary epidemic and physical activity as primary prevention

The rising global prevalence of sedentary behavior has established physical activity as an essential resource for mitigating chronic disease risk and promoting public health resilience.

The global burden of physical inactivity

Sedentary behavior (SB) and physical inactivity (PI) are recognized internationally as primary modifiable risk factors contributing significantly to the causes of morbidity and mortality worldwide, affecting vulnerable populations across the lifespan. A sedentary lifestyle is strongly associated with an increased risk of chronic diseases, including cardiovascular and cerebrovascular conditions, hypertension, diabetes, obesity, and hyperlipidemia. This chronic disease burden is increasing across all age groups, posing a substantial health problem globally.

The impact of this epidemic extends beyond clinical health, translating into significant societal consequences. The increase in chronic disease prevalence linked to PI is directly correlated with rising healthcare expenditures, complications in workforce attendance and productivity, and compromised academic success. Consequently, the promotion of physical activity must be considered a critical strategic intervention for maintaining not only individual health but also broader economic stability and national resilience.

Physical activity as a key to disease prevention and health stabilization

Physical activity and exercise offer a highly effective, non-invasive means for both primary disease prevention and secondary treatment. As articulated by Andreu-Cabrera (2020), for an untrained citizen, sport and physical activity go beyond being a simple cathartic habit, as they can be a key to prevent diseases. The physiological benefits of increased physical activity are systemic, positively influencing most systems in the body and supporting the mitigation of chronic disease risk. Research indicates that achieving moderate physical activity intensity is generally the most beneficial level for overall health outcomes.

Exercise, immune system resilience, and psychological health

The protective effects of movement are particularly significant in mitigating the compounded risks associated with infectious agents and psychological stressors. Physical activity is an important ally in the fight against viruses and their psychological effects.

- Immunological and psychological benefits: Numerous studies confirm that exercise strengthens the immune system and effectively reduces symptoms of depression and anxiety.
- Targeted mental health strategy: Targeted public health policies should specifically encourage increased physical activity levels and mandate the replacement of sedentary behavior (SB) with equivalent quantities of moderate or vigorous physical activity (MPA or VPA), as this

specific behavioral change actively reduces the odds of symptoms related to anxiety and depression. This principle holds profound relevance for high-stress cohorts, such as university students, where physical activity is proven to be an effective strategy for managing stress and improving mental well-being.

Policy, crisis, and the digital facilitation of movement

Effective public health responses leverage physical activity as a systemic strategy, demonstrated both through proactive government policy and reactive adaptation to global crises.

Recognizing the robust therapeutic value of physical engagement, certain governments have taken action in this regard, such as the Australian national health system that offers extensive resources against depression through sport and movement, which has brought very good benefits globally (Liddle et al., 2017; Vella et al., 2023).

Vella et al. (2023) developed a comprehensive, evidence-based set of nine actionable guidelines focused on protecting and promoting mental health and overall well-being within organized community sport in Australia. These strategies are systemic and include: promoting well-being and reducing mental health stigma, increasing mental health literacy, developing dedicated mental health action plans, appointing mental health champions, and ensuring psychologically safe coach development.

Supporting the efficacy of sport environments as mental health platforms, Liddle et al. (2017/2019) found that coaches recognize the identification of mental health needs among athletes as being within their professional scope. This acknowledgment positions community sport settings as vital, non-clinical resources for building mental health literacy and providing early support pathways.

The rapid onset of the COVID-19 pandemic and subsequent movement restrictions led to an unprecedented societal shift. During COVID-19 confinement, the social response to movement restrictions generated an unprecedented sport phenomenon: physical activity at home. This transition saw a wide dissemination of exercise routines across digital channels, including social networks, traditional media, institutional communication, and YouTube channels.

This widespread digital adoption of exercise was critical because prolonged confinement, while necessary to restrict pathogen spread, simultaneously increased inactivity and triggered heightened levels of anxiety and depression. The use of e-Health platforms and exercise videos delivered via mobile technology and the internet proved to be a feasible method for preserving both physical function and psychiatric well-being during a time of widespread restriction.

In this critical context, technology was crucial both for the practice of physical activity and for favoring interpersonal communication at a distance. The availability of smartphone fitness programs enabled individuals experiencing social isolation to maintain their fitness and health through structured, home-based activities.

The pandemic demonstrated that digital platforms serve as an essential infrastructure for movement resilience when traditional physical spaces are unavailable. These technologies allowed users to track exercise progress, receive personalized feedback on technique, and continuously refine their workouts. This transformative capability ensures that digital tools mitigate the

compound health risks associated with inactivity and social isolation simultaneously, transforming an isolated exercise experience into a motivating, structured, and socially connected phenomenon.

Movement and the foundations of integral child development

The comprehensive, long-term health trajectory of an individual is inextricably linked to the successful acquisition of fundamental movement skills (FMS) during childhood. As established by developmental science, movement is fundamental for the integral development of children, fostering growth across physical, cognitive, and socioemotional dimensions (Vicente-Nicolás et al., 2010). The mastery of fundamental movement skills (FMS)—which encompasses locomotor skills (e.g., running, hopping), manipulative or object control skills (e.g., catching, throwing), and stability skills (e.g., balancing)—is widely understood to provide the crucial foundation for establishing an active lifestyle throughout the lifespan.

The relationship between early FMS proficiency and long-term public health outcomes has been systematically reviewed, revealing several strong correlations that validate the prioritization of movement competency in educational settings. The evidence indicates a strong positive association between FMS competency and physical activity levels among children and adolescents. Furthermore, a distinct positive relationship was established between FMS competency and cardio-respiratory fitness (CRF). Conversely, an essential inverse association was confirmed between FMS competency and adverse weight status.

These findings confirm that the early acquisition of motor skill mastery acts as a vital developmental "gateway skill." Children lacking this foundational competence may experience perceived incompetence, leading them to avoid participation in sports and physical activities. This avoidance initiates a negative cascade, resulting in reduced cardio-respiratory fitness and increased risk of unfavorable weight status. Therefore, the instruction of FMS shifts from a simple physical education goal to a primary public health mandate essential for the prevention of chronic disease throughout an individual's life. It is important to note, however, that the association between FMS competency and other potential benefits—such as global self-concept, muscular fitness, and flexibility—remained uncertain at the time of the review due to an inadequate number of studies.

The Synergy of music, dance, and neuromotricity

The interdisciplinary practice of music and dance provides highly effective, holistic therapeutic and developmental benefits, driven by their ability to induce neurobiological change, a core concept within neuromotricity. Music holds a unique position in human experience due to its universality and inherent biological power. Music, since time immemorial, has been a form of communication and expression deeply rooted in the human experience (Blacking, 1973). Blacking's influential work posited that music-making is a fundamental and universal attribute of the human species. Its profound ability to evoke emotions, stimulate memories and strengthen social connections makes it an unparalleled medium for intervention in various health problems. Music serves as a means to express the human condition and effectively transcends social divisions and class boundaries.

Dance is intimately linked to music, and by integrating body movement, it amplifies music's effects. This combined practice not only improves physical fitness but also facilitates deep self-expression and community connection.

- **Holistic Enrichment and Sedentary Combat:** The synergy of music, dance, and movement offers numerous cognitive and emotional benefits, enriching personal lives and providing an engaging, effective countermeasure to address physical inactivity (Vicente-Nicolás, 2022).
- **Personal and Community Expression** (De las Heras, 2022): Dance facilitates both personal and community expression, serving as a medium for storytelling, celebration, and communal bonding across centuries. Dance Movement Therapy (DMT) utilizes the body as a vehicle for emotional expression, releasing neurotransmitters like dopamine that promote well-being and stress reduction. This approach is a powerful tool for young individuals grappling with increasing rates of depression, anxiety, and behavioral disorders.

The strategic integration of dance into the curriculum provides multi-faceted developmental support. Moscoso, Bayas & Astudillo (2021) highlight the contributions of dance to education from the social, physical, intellectual and affective points of view, emphasizing the necessity of incorporating appropriate forms of dance within the educational environment.

- **Pedagogical integration:** Quality art lessons, including dance, contribute to children's holistic development, character motivation, and conflict-resolution skills by integrating concepts from history, art, and physical education. Creative exercises, particularly improvisation, enhance both communication and overall child development.
- **Inclusivity and educational mandate:** Dance activities must be structured within an educational framework to ensure inclusivity, providing benefits to all children regardless of their initial interest, aptitude, or prior experience.

This chapter delves into the intersection of these disciplines, exploring how neuromotoricity can offer effective solutions to the problems arising from physical inactivity. Neuromotoricity, or the study of the control and coordination of movement by the nervous system, provides the mechanistic understanding of their combined power.

- **Synergistic neuroplasticity:** Research indicates that when movement is systematically combined with music and dance, the effects are synergistic, leading to a greater impact than when these activities are performed separately. This synergy effectively boosts neuroplasticity by stimulating the creation of new pathways of neuronal connections, thereby improving cognitive abilities.
- **Neurobiological mechanism:** The complex mental coordination required by dance, especially when synchronized with music, creates a neurological effect described as a “pleasure double play”. Music stimulates the brain’s reward centers while the movement of dance simultaneously activates the sensory and motor circuits. Key brain regions activated during dance learning and performance include the motor cortex (for planning and execution), the somatosensory cortex (for motor control and eye-hand coordination), the basal ganglia (for smooth movement coordination), and the cerebellum (for integrating sensory input and planning complex motor actions).
- **Clinical translation:** The neurobiological power of dance has significant therapeutic applications. For example, dance is being used effectively to treat neurological movement disorders, such as Parkinson's disease. Furthermore, in clinical studies concerning young

female populations with functional abdominal pain disorders (FAPDs), intervention involving dance combined with yoga proved more effective than conventional healthcare methods in reducing maximum pain aspects.

In relation to music, dance and movement, one of the disciplines that has developed the most in recent years is neuromotricity, through the BAPNE method, which has produced more than 50 publications in WOS (Simbolon, 2024). A large number of emerging themes related to the body and movement, as basic axes of educational action, have emerged from this line of research. Among them, the following stand out: Motor skills and neuromotricity (Andreu-Cabrera et al., 2024), Neuromotricity and interdisciplinarity (Romero-Naranjo & Andreu-Cabrera, 2023), neuromotricity and solfeggio (Romero-Naranjo, 2020), neuromotricity and body schema (Romero-Naranjo, Andreu-Cabrera & Arnau-Mollá, 2023), neuromotricity and executive functions (Romero-Naranjo et al., 2023; (Romero-Naranjo & Navarro-Camacho, 2025), infant neuromotricity (Romero-Naranjo, Andreu-Cabrera & Arnau-Mollá, 2024). All this information allows us to reflect on the number of existing high-impact publications, which could subsequently be a great contribution to future bibliometric studies or systematic reviews.

Fundamentals of music, dance and movement

Dance, one of the oldest and most universal forms of human expression, can be defined as a set of organized body movements performed in specific temporal sequences and often accompanied by music. The movements themselves are imbued with cultural and emotional meaning and can serve a multitude of purposes, from entertainment and celebration to storytelling and specific rituals. In the context of dance, movement refers to any displacement or posture adopted by the body. Movement can be structured, as in formal dance, or free and spontaneous, as in improvisation. It is movement that makes dance an art form, as it is the only medium through which dancers can express ideas, emotions and narratives through physical movements. The history of music is as vast and varied as that of dance; it spans thousands of years, encompassing all human cultures. The origins of music as an art form are lost in prehistory. However, speculation is that the earliest forms of music were vocal, with humans using their voices to create rhythmic and melodious sounds. Over time, people began to employ primitive instruments, such as drums and flutes made from animal bones, and music became considerably more complex. Advanced civilizations such as ancient Egypt, Greece and Rome had elaborate musical systems. In Egypt, dance was a way of honoring the gods and was performed in temples and tombs. The ancient Greeks integrated dance into most of their religious and theatrical festivals, and developed specific types of dance, such as tragic and comic dance. The Romans adopted most of these traditions but also created some of their own, such as gladiator dances (Beaman, 2017). In the Middle Ages, European music diversified with Gregorian chant in churches and troubadour songs in courts. Also in the Middle Ages, dance in Europe was influenced by the Church, at times forbidden and at others tolerated as a manifestation of religious devotion. Folk dances reflecting local and regional traditions began to emerge. The Renaissance was a period of renewal and experimentation in music, and harmony and polyphony became the key notes (Feves, 1989). The advent of the printing press would allow for the wider circulation of scores, spreading the influence of musicians throughout the continent. Courtly dance would become popular during the Renaissance, and the more refined and stylized forms that emerged at this time would give rise to ballet as we know it at the court of France (Peng, 2024). In the Baroque and Classicism, instrumental music would flourish, giving rise

to forms such as the sonata, symphony and concerto. Composers such as Bach, Handel, Haydn and Mozart would raise music to unprecedented heights. At the same time, 19th century music was characterized by intense emotional expression and the expansion of forms and structures. Both classical ballet, at its height with Maria Petipa and Tchaikovsky in the 19th century, as well as the newly emerging contemporary dance movements were influenced by this time of innovation. The 20th century presented a revolution in music, with the advent of jazz, blues, rock, and eventually pop and electronic music. Technology changed the way music is created and distributed, and musicians began to experiment with new sounds and styles (Navarro-Maciá & Romero-Naranjo, 2024). Modern and postmodern dance in the 20th century created new forms of movement and expression, incorporating influences from around the world and creating novel techniques.

Physical benefits of dance and movement

Hippocrates (450 B.C.) is credited with the following postulate: “All parts of the body that have a function, if used sparingly and exercised in the work to which each is accustomed, become healthy, well developed and age more slowly; but if not used and left idle, they become prone to disease, have poor growth and age rapidly”.

Dance is an excellent cardiovascular exercise that strengthens the cardiovascular system. In general terms, it improves our lung capacity and blood circulation. Different studies show that there are clear benefits in different diseases such as Parkinson's, arthritis, fibromyalgia, diabetes, dementia, depression, and even cancer. A person who moves and exercises constantly will have better quality of sleep and improve their quality of life. The relationship between physical and mental exercise and health is unquestionable (Grandos & Cuellar, 2018), (Ramirez et al. 2004), (Gonzalez Jurado 2004), (Martisen, 1994) states that physical exercise can be a therapeutic complement in mild forms of depression. Rosa-Guillamón (2018) states that physical fitness is a biological indicator of health status. On the other hand, the absence of physical exercise supposes the origin of different diseases. Other factors, such as age, diet and genetics, often together with sedentary lifestyles and other types of risk indicators such as hypertension and obesity result in cardiovascular diseases that reduce quality of life and longevity. Therefore, the best preventive activity would be to perform cardiovascular exercise on a regular basis and dance is an excellent aerobic physical exercise. As pointed out by (Milanovic et al., 2015), resistance training and high intensity training cause great improvements in VO2 max. And VO2 max. is one of the best indicators to know our cardiopulmonary health. (Castillo-Garzón, 2007) In the same line, (Lavie et al., 2015), highlights physical exercise as a routine measure for people with cardiovascular diseases and uses epidemiological studies that prove it. The research conducted by Zeng (2017) presented a study where he synthesized the result of various trials and they showed that 80% of the studies where physical activity and motor skills were related evidenced a substantial improvement in motor performance, and another 80% of the studies that related physical activity and academic performance evidenced an improvement in skills such as language acquisition, memory, attention and academic performance in general (Zakharova, Maydankina & Zakharova, 2020).

Lee (2007) tells us that as we increase the amount of exercise the benefits increase, up to a certain level, where after that we find adverse effects. Calabrese (2005) “the process by which exposure to a low dose of a chemical agent or environmental factor, which is harmful at high doses, induces an adaptive response and/or a beneficial effect in the cell or organism” And one of the most important

hormetic agents is physical exercise. Physical exercise induces adaptations in metabolism, body composition, cardiovascular and respiratory systems (Lee et al., 2010). (Pedersen & Saltin, 2006) explain the relationship between a reduction in the cancer rate among people who exercise regularly versus those who do not.

Mental and emotional benefits of dance and movement

Motor and cognitive development are closely related (Warburton et al., 2013). There are several studies that show that cognitive difficulties coexist with motor deficits. Piaget already predicted that motor development is a precursor of cognitive development (Zhou, 2024) (Piaget, 1952). The researcher Ridler (2006), in his study states that early motor development is related to better executive function. Psychomotor development brings together the psychological and the motor. It is another way of saying that it combines the affective, the emotional with the motor or bodily, in short, with what has to do with action. And this is encompassed with the relationship, socialization and learning because this is how we relate to the world: through action and movement, learning and socialization (Mendiara, 2008).

The brain has different motor areas: On the one hand, the primary motor cerebral cortex, in the posterior part of the frontal lobe. It coordinates with the premotor areas for the execution of movement. The neurons of the primary motor cortex are organized by body parts and send signals through their axons until they end in the muscles, causing them to contract, and represents the last stage in the motor process: the execution of the movement (Sallés 2015). Two areas of the frontal cortex, neighboring the primary motor cortex, are necessary for movement planning: the premotor cortex and the supplementary motor cortex. One of the key elements of dance is the ability to move and position ourselves in space. Thus, in order for the areas in charge of movement to do their job, it is essential that they receive information from the environment and the position of the body: proprioception, which sends information to the sensory cortex in the parietal lobe, generating a body schema. When dancing, sensory, visual and proprioceptive information reaches the posterior part of our parietal lobe, where it is processed and sent to the movement planning and execution areas in the frontal lobe. As we dance these structures communicate in a loop. In addition, there are other structures that regulate the activity of the motor cortex: the cerebellum. It receives information both from the motor cortex and from the proprioceptive organs and the inner ear, which is responsible for balance. Thus, the cerebellum integrates all this information to coordinate complex movements, foreseeing and correcting possible execution errors.

Dancing involves spatial awareness, sense of body position, balance, coordination and metrics and is the result of extreme neuroactivity. Moreover, to dance it becomes indispensable what characterizes the artistic practice: the intention and emotional expression (Amado, 2022), which depends on the aforementioned structures with the emotional system of our brain: the limbic system. Thus, the study "Representation of embodied cognition features in dancers spinning on the extended mirror neuron system: A resting-state functional magnetic resonance imaging study", within the research topic 'Effects of performing arts training on brain, (socio)cognitive and motor (socio)cognitive functions across the lifespan' (Ching-Ju Yang, 2023), states that the results of the MRI scans performed, showed that dancers had greater connectivity between different brain regions versus non-dancers; and greater connectivity between the cerebellum and the mirror neuron system and limbic system. It follows that during dance learning, changes are generated in

the brain networks, thanks to its neuroplasticity. Dance training changes brain function and makes dancers more aware of their bodily states. The educational system is increasingly aware of the benefits of dance and its relationship with emotional intelligence. Social skills are necessary in daily life and in school. Including dance in the curriculum is supportive of mental health. This idea is pointed out by (Biddle & Asare, 2011). Emotional health has a biological basis and its development is susceptible to improvement by physical exercise. (Payne & Costas, 2020) claim that dance can increase emotional literacy and thus be able to recognize them better and manage them to give an adequate response.

Movement as a vital foundation for an integral development

Through movement and dance, the individual is socially integrated, as it is an art that unites body, movement and music, as a form of expression and social integration. And it is that the human being has always had the need to communicate through bodily expression. 'The dance is a universal activity, of all the humanity from the beginning of the history'. (Popplow 1973) states that dance is the oldest form of physical exercise. And it had three functions: external, (hunting, fertility); internal (spiritual forces, ceremonies), and social. As I said in the previous section, dance combines physical movement with artistic expression through the body. And through it, social bonds, expression and socialization are created. The corporal expression is very important for the integral development of the students. It involves becoming aware of your body schema in order to use it in an expressive way. Stokoe and Schächter (1994). The dance supposes a cultural manifestation, of the societies in which they arise and form part of their traditions. It is the most primitive expression of rhythm and the most ancient artistic expression (García 1997). In addition, dance has an aesthetic message (Castañer, 2000). The exercise of dance improves self-esteem and body image, while improving communication processes and social skills. It helps to regulate emotions and feelings while developing the aesthetic sense and creativity. Dance has a cultural, aesthetic, ludic and hedonistic function (García 1997). Moderate and regular physical activity is universally recognized as beneficial to health, but what is the relationship between movement and the integral development of people? There are several studies that analyze the benefits of physical activity for the development of cognitive functions, sensorimotor processes or creativity, among others (Alvarez-Bueno, 2017; Casey, 2018). Let us now see how movement is from the first years of life, a facilitator of learning and how physical activity influences the integral development of the human being during all stages of life, almost always with positive influences. Physical activity is fundamental to early childhood development and affects many aspects related to their health (Zeng, 2017). Implementing physical activity in children's schools should be a priority because of the positive effects it has on children's physical and mental health (Dobbins, 2013). In a digital society, where the influence of technology and sedentary lifestyles have a negative influence, schools should value the importance of movement in the integral development of children and work on inculcating physical activity in children in collaboration with their families. The practice of physical activity is also related to an improvement in cognitive functions, not only in school-age and growing subjects, but also in adults (Bherer, 2013). A lifestyle that implements physical exercise will favor improvements in attention, concentration and memory. Ploughman says that exercise is brain food and emphasizes the relationship between exercise and cognitive functions, especially in young people with some type of disability (Ploughman, 2008). Clinical studies show how exercise increases brain volume in areas related to executive processing, which improves cognition and increases phonemic ability. During physical exercise, proteins and neurotransmitters are released that lead to

increased hippocampal volume and can increase the thickness of the prefrontal cortex: CNDF and VEGF increase, dopamine, norepinephrine and serotonin are generated (Erickson, 2015). This is why physical activity is also related to sleep. Sleep is an essential process for cognitive development. During sleep, the brain performs important functions such as: restoring energy and repairing damaged cells thanks to adenosine; regulating emotions, stress and mood by producing serotonin; strengthening neuronal connections and consolidating memory and learning, among others.

The benefits of physical exercise are not only at an internal level, but are also related to physical changes noticeable to the human eye, such as weight and posture control or body toning. This is explained by the fact that moderate physical activity, continued over time, increases the size of the heart and therefore improves circulation, increases muscle mass, widens the lungs and strengthens the bones (Kimm, 2005).

As we have already seen in previous sections, there are many studies that relate the practice of physical exercise with disease prevention (Blondell, 2014; Wannamethee, 2001; Warburton, 2006), but there is even evidence that relates the practice of moderate physical activity on a regular basis with the improvement of pathologies such as hypertension, diabetes, cardiovascular diseases, some types of cancer such as colon or breast cancer or depression, among others (Fong, 2012; Kandola, 2019). More and more studies are linking movement with improved mental health, associating physical exercise with improvements in self-esteem, anxiety and depression (Biddle, 2019). Most studies have been conducted in young subjects, but there is also evidence with children, adults and even older people, also establishing relationships between exercise and dementia or Alzheimer's disease (Scarmeas, 2009). All this leads us to think that, for an integral development of the human being, physical activity must be present in our daily lives throughout our lives.

Educational perspective from embodied cognition

Embodied cognition emphasizes the role of the sensory and the motor as a fundamental part of cognition itself, there is no radical separation between cognition, the agent body and the environment, so the body is also capable of modulating, limiting and constructing mental activity, as recently stated by Giese & Keightley (2024).

From this perspective of embodied cognition it could be said that movement should be integrated into learning (Floglia & Wilson, 2013). Movement in the classroom is not novel. Precursors of the New School such as Pestalozzi already said that children should learn from activity. These bases were established by authors such as Decroly, Maria Montessori or Freinet, who considered that movement should be a transversal element for experiential and meaningful learning based on manipulation, discovery and experimentation, in addition to contributing to the relationship between students and their peers. One of the most debated issues in the current educational research scene is physical activity as an enhancer of cognitive development and therefore of learning. In this sense, we tend to relate physical activity with sport and relate it to areas of the curriculum such as Physical Education or leisure time such as the playground. But what about other areas such as mathematics, music, languages or science? Can't they be related to movement? Of course, but this requires a change in the methodology of the teaching-learning process because it implies establishing active habits in educational centers and banishing the image of the classroom with tables and chairs so that students remain seated for a whole morning (Ramos et al., 2023).

Movement tends to be linked to the early ages, so that as the educational system advances, there is less time for movement in the classroom (Learreta, 2021). In early childhood education there are numerous methodologies implemented today that favor student movement: working in corners and workshops, learning environments (Rodríguez, 2020) or even living and active education schools that allow free movement in environments through experimentation and discovery through play and manipulation. Movement is not relegated to an area of the curriculum, but rather, in the early childhood stage, an interdisciplinary (De las Heras & Cisneros, 2021) and global treatment of physical activity as a means and facilitator of meaningful learning is advocated (Martins & Quero, 2023). In the primary education stage, methodological changes begin to take place, especially from the second and third cycle onwards, which mean that movement is relegated to the background or even, some teachers no longer consider it as part of the teaching-learning process. This trend continues and becomes more accentuated if we go up the educational level, since movement and physical activity are not usually contemplated in most of the curricula of the areas of secondary education, high school, training cycles or university degrees. Undoubtedly, this is an error of approach, perhaps associated with tradition and possibly related to the lack of knowledge or poor training that teachers receive to be able to implement physical activity as a fundamental element of their methodology.

Schools provide a unique opportunity to reduce sedentary lifestyles and increase students' physical activity. Whether teachers exploit predesigned programs and resource guides or implement their own strategies, integrating movement into the classroom can be achieved through two different strategies: physically active classrooms and active breaks (Webster, Russ, Vazou, Goh, & Erwin, 2015). Méndez-Giménez analyzes the academic, cognitive and physical outcomes of these two strategies, concluding that integrating physical activity in the classroom has a positive impact on academic, cognitive and health outcomes in all areas of the curriculum (Méndez-Giménez, 2020). Next, we will see how the benefits are even more accentuated if we relate movement with applied neuromotricity, which is presented as a strategy to promote learning and knowledge construction, through the performance of tasks and cognitive challenges of different complexity, as recently stated with its relationship with mirror neurons research led by Yang in 2023.

Neuromotricity as a strategy to encourage movement

One of the areas of the primary education curriculum that can be most related to movement, in addition to physical education, is the area of music and dance. Aspects such as synchronization, rhythm, coordination, motor skills, concentration or motivation, involve the integration of the motor system, the perceptual system and body interaction with the environment, in the construction of learning.

Applied neuromotricity are presented as a strategy to promote learning and the construction of knowledge through the performance of tasks and cognitive challenges of different complexity. But how can we work neuromotricity in the classroom? One method that can be applied to both active breaks and physically active classes is the BAPNE method. It is a method of cognitive, socioemotional, psychomotor and neurorehabilitative stimulation based on neuromotricity. Through Biomechanics, Anatomy, Psychology, Neuroscience and Ethnomusicology, its creator, Javier Romero Naranjo, justifies with a neuromotor approach the role of the body and movement in cognitive stimulation. The method is closely linked to the area of Music and Dance, since it uses

body percussion as a didactic resource focused on the stimulation of executive and cognitive functions, but it can be applied in all areas of the curriculum, as well as in active breaks due to the amount of practical resources it offers. Through the BAPNE method and from the perspective of embodied cognition, we analyze the intrinsic relationship between movement, dance and music. Movement goes hand in hand with music, dance and, of course, play, which in a playful way helps us to develop in the world around us working cognitive functions such as orientation, language, memory, praxias, attention, executive functions, gnosias, visuospatial skills and social cognition (Romero-Naranjo, 2019). Since the early stages of history, healing properties have been attributed to dance (Hanna, 1995), but now even therapeutic effects are attributed to it. There are several studies that relate the practice of dance with a significant improvement in patients with dementia, arthritis, fibromyalgia, cardiovascular diseases or even breast cancer (Padilla-Moledo, 2013). To dance, we need to move, so different areas of the brain related to the motor system (primary motor cortex) are activated. To coordinate movements in a systematic and organized way, we need the activation of two areas of the frontal cortex: the premotor cortex (activates the planning of movements) and the supplementary cortex (allows the realization of voluntary movements). Dancing activates motor and sensory neural circuits and as it is usually accompanied by music, the reward centers of the brain are stimulated at the same time. Dancing involves the activation of several brain structures and therefore causes us to develop spatial awareness, sense of body position, balance and coordination (Gay-Juarez, 2020). The beginnings of dance suggest that it was used as a language tool for human beings, that is, for a social purpose. Movement modifies the attitude towards social barriers, allows people to connect with each other through expression, music and steps. The feeling of merging the self with the other as a consequence of interpersonal synchrony and the release of endorphins during rhythmic exertion activities, including musical interaction and dance, helps to strengthen their relationships, stimulates affection, the feeling of belonging to a tribe, to a community (Tarr, 2015). Movement, music and dance are inclusive, integrating and compensating tools for inequalities, so they become the perfect instrument to develop the teaching practice and respect the criteria of inclusion and equity required by the current regulations in the educational field. The BAPNE method, based on the approach of coordination challenges for our body and problem solving for our brain, can be applied in an interdisciplinary way, mixing subjects such as physical activity and sport sciences, music and learning a new language, etc. All this through stimulating movement activities of increasing complexity for our brain (Romero-Naranjo, 2023). The BAPNE method therefore becomes an ideal methodology to carry out in the music classroom and to extend it to other areas of the curriculum, thus providing an interdisciplinary and global character, so necessary for meaningful learning (Romero-Naranjo & Liendo-Cárdenas, 2025a, 2025b).

Conclusions

This chapter reflects on the digital age we live in and the use of screens, as well as the importance of physical activity in childhood to promote holistic and healthy development. We highlight the need to take a holistic approach that recognizes both the benefits and risks associated with digital technology and physical movement. We conclude that collaboration between parents, educators, health professionals, and the community at large is very important to create environments that support a balanced and active lifestyle for children. Music and dance have been and continue to be fundamental pillars of human expression. Over the centuries, both art forms have evolved, reflecting and often anticipating changes in society and culture. Understanding their foundations

and history not only enriches our appreciation of these disciplines, but also connects us to the human experience in its most elemental and universal form. Neuromotricity is an emerging discipline that possibly provides broad benefits at the cognitive level, whose activities are non-injurious and can be performed with high frequency (Romero-Naranjo & Andreu-Cabrera, 2021; Romero-Naranjo, 2025a, 2025b). In this context, neuromotricity, understood as the interrelation between the nervous system and motor capacity, acquire particular relevance. This discipline ranges from coordination and movement control to the cognitive effects of physical exercise (Andreu-Cabrera, Romero-Naranjo & Lorenzo-Lledó, 2024). Recent research has shown that activities such as dance can significantly improve neuroplasticity, memory and other cognitive functions, offering a natural and accessible solution to mitigate the effects of sedentary lifestyles.

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De la teoría al movimiento: un estudio bibliométrico sobre pausas activas en el ámbito educativo

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Resumen

El objetivo de esta investigación bibliométrica es analizar la producción científica sobre las pausas activas en el ámbito educativo entre 2015 y 2024, con énfasis en sus beneficios sobre la función cognitiva, ejecutiva, el rendimiento académico y el bienestar del alumnado, desde educación infantil hasta el nivel universitario. La búsqueda del corpus se realizó en dos bases de datos de alto impacto: Scopus y Web of Science (WOS), quedando una muestra de 92 publicaciones, en su mayoría artículos. Los criterios de inclusión que se tuvieron en cuenta fueron: publicaciones entre 2015 y 2024, estudios centrados en pausas activas en contextos educativos, investigaciones sobre su impacto en funciones cognitivas, rendimiento académico o motivación, artículos indexados en Scopus o WOS, escritos en español, inglés o chino simplificado, e investigaciones en cualquier nivel educativo. Se analizaron indicadores como el número de publicaciones por año, autores más productivos, revistas de mayor impacto, términos sinónimos más usados y características metodológicas como duración e intensidad de las intervenciones. Los resultados reflejan un crecimiento sostenido desde 2016, con predominio de artículos en inglés y un fuerte enfoque en los niveles de primaria y secundaria. Se destacan beneficios físicos y cognitivos, especialmente en atención, disfrute y rendimiento académico. En conclusión, las pausas activas muestran efectos positivos en las funciones cognitivas, ejecutivas y en la motivación estudiantil, además de contribuir a reducir el sedentarismo en el aula. Sin embargo, se requiere continuar investigando para generar evidencia más robusta que respalde su aplicación práctica en entornos educativos diversos.

Palabras clave: Pausas activas, función cognitiva, función ejecutiva, actividad física.

Abstract

The aim of this bibliometric research is to analyze the scientific production on active breaks in education between 2015 and 2024, with emphasis on their benefits on cognitive and executive function, academic performance and student well-being, from early childhood education to university level. The corpus search was performed in two high-impact databases: Scopus and Web of Science (WOS), leaving a sample of 92 publications, mostly articles. The inclusion criteria taken into account were: publications between 2015 and 2024, studies focused on active pauses in educational contexts, research on their impact on cognitive functions, academic performance or motivation, articles indexed in Scopus or WOS, written in Spanish, English or simplified Chinese, and research at any educational level. Indicators such as the number of publications per year, most productive authors, journals with the highest impact, most used synonymous terms and methodological characteristics such as duration and intensity of the interventions were analyzed. The results reflect a sustained growth since 2016, with a predominance of articles in English and a strong focus on primary and secondary levels. Physical and cognitive benefits are highlighted, especially in attention, enjoyment and academic performance. In conclusion, active breaks show positive effects on cognitive, executive functions and student motivation, in addition to contributing to reducing sedentary lifestyles in the classroom. However, further research is needed to generate more robust evidence to support their practical application in diverse educational settings.

Keywords: Active breaks, cognitive function, executive function, physical activity.

INTRODUCCIÓN

La literatura especializada en el empleo de las pausas activas en el ámbito educativo ha ido adquiriendo gran relevancia en las últimas décadas. Diversos autores hacen alusión a la creciente deficiencia de la red atencional del alumnado, circunstancia que repercute directamente en la duración de su capacidad de concentración en las tareas académicas. De la misma forma, la Organización Mundial de la Salud (OMS) hace alusión a la necesidad de reducir el sedentarismo,

así como, de fomentar hábitos saludables (OMS, 2010). Estos son algunos de los motivos por los que se hace necesario la progresiva introducción de recursos pedagógicos como la pausa activa, que fomenten el movimiento, el bienestar emocional y la mitigación de la fatiga cognitiva.

Primeras contribuciones

A pesar de que los primeros antecedentes se sitúan en el año 1920, la consolidación de las pausas activas como un enfoque sistemático para promover cambios en la salud física y el bienestar mental empezó a consolidarse en años recientes. Pese a ello, resulta complejo presentar un momento exacto en el que se iniciaron en su desarrollo e investigación en las aulas.

Si bien el término de pausa activa ha sido extensamente estudiado en el ámbito educativo, su aplicación se extiende a otros campos como el laboral y el médico, incluyendo este último su vertiente fisioterapéutica. Originaria de Polonia bajo la denominación inicial de gimnasia de pausa o gimnasia laboral, la pausa activa se concibió originalmente como una estrategia para mejorar el rendimiento de los operarios industriales. No obstante, en la actualidad autores como Batista-Ferreira et al. (2024) continúan profundizando en su influencia en el contexto laboral. Asimismo, el ámbito deportivo ha realizado investigaciones relevantes sobre la pausa activa (Gheorghe & Mereuta, 2024), al igual que la fisioterapia (Parra, 2024).

Es fundamental reconocer los distintos contextos laborales en los que se ha investigado la pausa activa y su impacto en la mejora de la calidad de vida de los trabajadores. Pese a ello, el presente estudio se enfocará específicamente en analizar la pausa activa en el ámbito educativo.

Beneficios de las metodologías activas en el alumnado

El uso de metodologías activas en el aula constituye una herramienta clave para optimizar el rendimiento académico, potenciar la atención y el fomento del bienestar físico y emocional de los estudiantes (González-Fernández et al., 2021; Pastor-Vicedo et al., 2019; Schmidt et al., 2022). Las metodologías activas se fundamentan bajo un enfoque pedagógico que sitúa al estudiante en el centro del proceso de aprendizaje a través de dinámicas participativas que estimulan la atención, la motivación (Vaquero-Solís et al., 2020) y la retención del conocimiento. Esta metodología busca superar la rigidez de las clases tradicionales mediante la incorporación de actividades físicas, lúdicas y de atención plena que favorecen un entorno educativo más estimulante (Contreras-Jordán et al., 2020).

La pausa activa como recurso para implementar metodologías activas: inciso en las diferencias entre pausas activas y recreos activos

Si bien las pausas activas y los recreos activos comparten objetivos similares como es el disminuir la actividad sedentaria prolongada en la escuela, existen diferencias sustanciales entre ambos.

Por un lado, los recreos activos están referidos a intervenciones estructuradas llevadas a cabo en el patio escolar con el fin de aumentar la actividad física del alumnado durante ese momento de ocio favoreciendo la interacción social entre los discentes, así como brindándoles mayor libertad de movimiento (Papadopoulos et al., 2022; Petrigna et al., 2022).

Mientras que, por otro lado, las pausas activas están definidas como interrupciones breves de las tareas académicas, estructuradas o no, implementadas dentro o fuera del aula bajo supervisión

directa del docente (Infantes-Paniagua et al., 2021). Se desarrollan dentro del horario lectivo e incorporan el movimiento físico y/o una estimulación cognitiva atrayente que ayuda a impulsar la salud físico-emocional de alumnos y alumnas.

Niveles educativos de implementación de las pausas activas

La implementación de las pausas activas posee un amplio abanico de estudio. Melguizo-Ibáñez et al. (2024) y Bailey (2023) analizaron la influencia de las mismas en el campo de la educación infantil. Otros muchos autores llevan a cabo sus investigaciones en contextos de la educación primaria (Arenas et al., 2024; Carrasco-Uribarren et al., 2023; García, 2023; Gelabert et al., 2023; González-Fernández et al., 2023). A su vez, la educación secundaria es otro nivel potencialmente estudiado (Barriónuevo et al., 2023; Chatzopoulos et al., 2023; González-Pérez et al., 2024; Maiztegi-Kortabarria et al., 2024; Reinboth et al., 2024; Rosa-Guillamón & Carrillo-López, 2024). Niveles como bachiller o grados universitarios, junto con educación infantil, son los menos examinados (Lobach et al., 2024; Rosa-Guillamón & Carrillo-López, 2024).

Paradigmas de las pausas activas

Se plantean las áreas en las que se estudian los efectos de la pausa activa como paradigmas, por divisarlos como patrones claros, tomados como referencia para actuar, visualizándolos como una guía para la orientación práctica. De esta manera, se especifica que la pausa activa puede bella a un área u otra dependiendo del tipo de tareas o actividades que se lleven a cabo, por lo que es importante destacar los diferentes paradigmas establecidos a lo largo de los años según los hallazgos de la investigación sobre este tema.

Paradigma de la actividad física

Tal y como demanda la OMS (2010), las pausas activas son reconocidas por diversos autores como una estrategia efectiva para reducir el sedentarismo e incrementar los niveles de actividad física durante la jornada escolar entre estudiantes de todos los niveles educativos (Solís, 2020; Sortwell et al., 2024; Zerf et al., 2021).

Estas pausas consisten en breves períodos de actividad física que se realizan como descanso de la instrucción académica y pudiendo clasificarse como actividades estructuradas o no. Numerosos estudios han destacado su importancia al promover mejoras en la condición física, la salud general y el bienestar emocional de los alumnos. No solo se considera imprescindible aumentar la actividad física en el aula para disminuir el sedentarismo y prevenir enfermedades como la obesidad (Pastor-Vicedo et al., 2019), sino que también diversas investigaciones resaltan la necesidad de fomentar la enseñanza de hábitos de vida saludables. En este sentido, la OMS (2016), en su *Informe de la comisión para acabar con la obesidad infantil*, subraya el papel crucial de las escuelas, el entorno familiar y otros espacios socializadores y educativos en la orientación de niños y adolescentes hacia una dieta equilibrada y la práctica regular de actividad física. Estas acciones son esenciales para que los jóvenes adquieran hábitos de vida saludables a largo plazo. Por ello, se presenta la inactividad física como uno de los determinantes del sobrepeso y la obesidad y, además, un factor de riesgo para el desarrollo de enfermedades crónicas no transmisibles (Aguilar et al., 2018).

Paradigma de la activación cognitiva

Las pausas activas también son un recurso poderoso para optimizar las funciones cognitivas de los estudiantes, incluyendo la atención, la memoria de trabajo y la capacidad de concentración. Autores como Vaca (2007) introducen el concepto de “cuñas motrices”, describiéndolas como periodos cortos de actividad física de 5 a 10 minutos, diseñadas para actuar como una bisagra entre momentos de alta demanda atencional. Estudios recientes, como el de Ruiz-Ariza et al. (2022), evidencian que programas estructurados con pausas de 4 minutos a intensidad moderada-alta son efectivos para mejorar las funciones cognitivas, especialmente la atención sostenida. Asimismo, el programa *Move to Improve* (Dunn et al., 2012) revela que la integración de actividad física en el aula contribuye a un aumento significativo en la atención y concentración de los estudiantes durante las tareas académicas. Del mismo modo, el programa *Aprendo Moviéndome* (Peláez-Flor & Prieto-Ayuso, 2021), estructurado en pausas de 10 a 12 minutos, también ha mostrado resultados positivos en la atención y el desempeño académico de los alumnos (Barrionuevo et al., 2023; Calella et al., 2020; Rosa-Guillamón & Carrillo-López., 2024; Layne et al., 2021; Marsigliante et al., 2023; Müller et al., 2021; Solís, 2020).

Las pausas activas son un recurso educativo directamente vinculado con la obra *The Embodied Mind* (Varela et al., 1991). Este enfoque sostiene que la mente no funciona de manera aislada en el cerebro, sino que los procesos cognitivos están profundamente influenciados por el cuerpo y por su interacción constante con el entorno físico y social. A partir de esta perspectiva, se desarrolla la Teoría del Enactivismo (Varela, 1999), la cual defiende que la cognición no es un proceso interno desconectado, sino una forma de regular la relación entre el ser humano y su entorno, adaptándose a las demandas y normas del contexto. En este ámbito de estudio, las pausas activas cobran sentido como estrategias que favorecen la integración entre cuerpo y mente, mejorando la atención, la concentración y el bienestar a través del movimiento. Estas prácticas permiten que el aprendizaje no se reduzca a lo sedentario, sino que involucre el cuerpo como parte esencial del proceso cognitivo.

Otros enfoques complementarios, como la *Mente Extendida* (Hurley, 1998), proponen que esta puede extenderse más allá del cerebro, incorporando herramientas, objetos y entornos en su funcionamiento. Asimismo, la Psicología Ecológica (Gibson, 1968) estudia la interdependencia entre las personas y su entorno, destacando de qué forma esta relación influye en el bienestar y en la construcción de la identidad.

Paradigma de la activación ejecutiva

Además de los beneficios en las funciones cognitivas, las pausas activas o descansos activos tienen un impacto significativo en las funciones ejecutivas, mejorando habilidades como la planificación, la regulación emocional y la resolución de problemas. Melguizo-Ibáñez et al. (2024) afirman que las pausas activas son una herramienta efectiva para fortalecer estas funciones, convirtiéndolas en un recurso valioso dentro del ámbito educativo. Estas habilidades son esenciales para que los estudiantes puedan organizar, priorizar y ejecutar tareas complejas con éxito. La implementación regular y estructurada de pausas activas no solo contribuye a mejorar estas capacidades, sino que también fomenta un ambiente de aprendizaje más dinámico y efectivo. En este sentido, los autores coinciden en que las pausas activas, cuando se aplican de manera sistemática, ofrecen un impacto positivo en la memoria de trabajo, el control inhibitorio y la capacidad para resolver problemas,

aspectos fundamentales para el éxito académico y el desarrollo integral del estudiante (Arenas et al., 2024; Chatzopoulos et al., 2023; Kjellenberg et al., 2024; Suarez-Manzano et al., 2017).

Paradigma del compromiso estudiantil

Las pausas activas también cumplen un rol fundamental al incrementar la participación, el compromiso y la motivación de los estudiantes en el aula. García. (2023) plantea pausas de 10 minutos, de 2 a 3 veces al día, diseñadas para reconectar la atención de los alumnos y dinamizar la actividad docente, evitando el aburrimiento o la desconexión. Por su parte, Reyes-Amigo et al., (2024) proponen pausas estructuradas en tres fases: calentamiento, desarrollo y vuelta a la calma, con el objetivo de mantener la atención y el dinamismo en el aula.

El programa *Move to Improve* (Dunn et al., 2012) también evidencia un aumento en la participación y la disposición de los estudiantes para participar en las actividades académicas tras la aplicación de pausas activas. De manera similar, *Bizzy Break!* (Murtagh et al., 2013) muestra mejoras tanto en la motivación como en el disfrute de las tareas escolares gracias a la implementación de descansos planificados.

Diversos autores destacan el uso de las pausas activas como una estrategia eficaz para reducir el estrés y la ansiedad en el entorno escolar, favoreciendo así un clima emocional más equilibrado y propicio para el aprendizaje. En este contexto, disciplinas como la neurociencia y la ergonomía han demostrado que los periodos breves de actividad física no solo mejoran el rendimiento cognitivo, sino que también contribuyen significativamente al bienestar emocional del alumnado.

Paradigma del bienestar fisiológico

Las pausas activas que integran técnicas de relajación y manejo emocional, como ejercicios de respiración, meditación o el *mindfulness* se consolidan como herramientas efectivas para aliviar la tensión emocional, disminuir los niveles de ansiedad y fomentar un ambiente de aprendizaje positivo y saludable (Infantes-Paniagua et al., 2021; Marsigliante et al., 2023; Méndez-Giménez, 2020; Muñoz-Parreño et al., 2021). De la misma forma, se puede contextualizar a la pausa activa como un recurso para la autorregulación individual del alumnado.

Tipologías en las pausas activas

Partiendo de las anteriores definiciones y según la orientación de la pausa activa, se puede llevar a cabo una clasificación por tipologías.

Por un lado, se encuentran las pausas simples, que son aquellas que se centran en el movimiento corporal y en el ejercicio físico, relegando a un segundo plano la carga cognitiva. Este tipo de pausa activa puede desarrollarse enfocándose en el trabajo aeróbico como son las sentadillas, flexiones, saltos o carrera y que influyen en la plasticidad sináptica, la neurogénesis y los ganglios basales, lo que da lugar a un dominio mayor del control neuronal (Van den Berg et al., 2016). Además, un trabajo de ejercicios de fuerza produce que el sistema músculo-esquelético se reconozca como un órgano secretor y comience a ejercer efectos endocrinos específicos en el funcionamiento del cerebro dando lugar a un aumento en la capacidad atencional, actuando sobre las estructuras subcorticales y sus volúmenes (Kjellenberg et al., 2024; Mazzoli et al., 2019; Mazzoli et al., 2021; Van den Berg et al., 2016). Este tipo de pausas pueden estar estructuradas, o no estructuradas, teniendo

mayor repercusión las estructuradas, por ejemplo las rutinas Tábata (Plaza et al., 2024).

Por otro lado, se encuentran las pausas complejas, orientadas a fomentar el esfuerzo físico por medio de actividades que portan contenido curricular, mayoritariamente matemático (Layne et al., 2021; Pizà-Mir et al., 2022; Sneck et al., 2022; Sneck et al., 2023; Syväoja et al., 2024; Vetter et al., 2020). Esta tipología de pausa activa proporciona beneficios en las funciones cognitivas de orden superior como son la atención, la percepción y la actualización. A su vez, mejoran el rendimiento académico y, más concretamente, el rendimiento matemático. De la misma forma, se produce una mejora en las funciones ejecutivas, especialmente en la inhibición, la memoria de trabajo, la flexibilidad cognitiva y la fluidez verbal (Álvarez-Bueno et al., 2017; Jiang et al., 2024; Kjellenberg et al., 2024; Mazzoli et al., 2019; Ninahuaman et al., 2024).

Finalmente, se encuentran las pausas sensoriales vinculadas al mindfulness, la respiración consciente o la relajación. Estas se instruyen en menor medida ya que las pausas simples y complejas son las que más resultados robustos esclarecen. Pese a ello, estudios como el de Müller et al. (2021) demuestran que dichas pausas fomentan la mejora de la comprensión lectora y la prevención del deterioro cognitivo.

Duraciones en las pausas activas

La duración e intensidad son factores clave y variables en la estructuración de las pausas activas, lo que influye directamente en sus beneficios. Las intervenciones oscilan entre 2 y 30 minutos. Las pausas breves, de 2 a 5 minutos, suelen repetirse varias veces al día y se asocian con mejoras en el flujo sanguíneo cerebral y la memoria de trabajo, además de facilitar su integración en el aula (Egger et al., 2019; González-Fernández et al., 2020; Masini et al., 2024; Mazzoli, 2020; Méndez-Giménez et al., 2022; Reinboth et al., 2024). En contraste, las pausas de 10 a 20 minutos, aplicadas una vez al día, se vinculan con mejoras en las funciones cognitivas (Aguilar et al., 2018; Dugger et al., 2020; Gelabert et al., 2023; Jiménez-Parra et al., 2022a; Müller et al., 2021; Ruiz-Ariza et al., 2021; Fernández-Montoya et al., 2020; Van den Berg et al., 2016).

Los docentes perciben las pausas cortas como menos disruptivas, pero la frecuencia y duración total pueden ser determinantes para incrementar la actividad física diaria y potenciar beneficios cognitivos y ejecutivos. Lobach et al. (2024) proponen una pausa bailada de 8 minutos tras una clase teórica, mientras que Mazzoli et al. (2019) solicita a los docentes realizar una tarea motora de 4 minutos dos veces al día durante una semana. Ruiz-Ariza et al. (2022) proponen un programa de ocho semanas con cuatro pausas diarias de 4 minutos. Egger et al. (2019) propone dos pausas de 10 minutos o 15 (Fiorilli et al., 2021). Otros autores presentan preferencias por pausas de 3 a 5 minutos varias veces al día (Gallè et al., 2020; Holik et al., 2021; Kjellenberg et al., 2024; McLellan et al., 2022). Algunos otros, exploran pausas de hasta 30 minutos para mejorar la atención sostenida, implementadas en contextos con alta exigencia cognitiva (Infantes-Paniagua et al., 2021; Méndez-Giménez, 2020). Por ello, se afirma que la duración, intensidad y tipo de actividad determinan el impacto de las pausas activas sobre el rendimiento cognitivo, ejecutivo y físico de los estudiantes.

Intensidades en las pausas activas

La intensidad con la que se implementan las pausas activas es un factor crítico ampliamente analizado en la literatura científica. Esta abarca desde niveles ligeros hasta vigorosos, y su elección

debe alinearse con los objetivos pedagógicos específicos. Para definir claramente los niveles de intensidad de la actividad física, tomamos los puntos de corte propuestos por Kain et al., (2020) basados en conteos por minuto (cpm): ligera (205–976 cpm), moderada (977–1527 cpm) y vigorosa (más de 1528 cpm).

Bajo estos puntos de corte unos autores optan por intensidades de ligeras a moderadas (Arenas et al., 2024; García, 2023; González-Fernández et al., 2020; Muñoz-Parreño et al., 2021; Riese, 2023); en cambio, otros recomiendan intensidades de moderadas a vigorosas para potenciar beneficios físicos y funciones ejecutivas (Arribas-Galarraga & Maiztegi-Kortabarría, 2021; Masini, Marini, Leoni et al., 2020; Ruiz-Ariza et al., 2022); mientras que otros emplean pausas con intensidades vigorosas o muy vigorosas (Broad, 2023; González-Fernández et al., 2021; Masini, Marini, Gori et al., 2020; Müller et al., 2021; Muñoz-Parreño et al., 2020).

Destaca el interés de autores como Muñoz-Parreño et al. (2020) y González-Fernández (2021) por analizar cómo varía el impacto de las pausas activas según su intensidad. En general, se observa una tendencia a implementar combinaciones de intensidades, siendo las más frecuentes ligera-moderada o moderada-vigorosa.

Aunque no existe un consenso absoluto, Pastor-Vicedo et al. (2021), a través de la hipótesis de la "U" invertida, plantea que existe un punto óptimo de intensidad donde los beneficios cognitivos son máximos, mientras que intensidades por debajo o por encima pueden resultar ineficaces o contraproducentes. Por ello, la complejidad física y la carga cognitiva de las pausas activas deben ajustarse a las habilidades motrices del alumnado. Una intensidad inadecuada puede generar ansiedad o desconexión emocional y conductual. En cambio, actividades atractivas, motivadoras y adecuadas al grupo promueven mayor compromiso cognitivo y físico, favoreciendo el rendimiento académico.

Parámetros más investigados

De una mano se presentan las funciones cognitivas, desglosadas en la atención, la atención medida junto con la concentración y los lapsos de atención (González-Fernández et al., 2020; Kjellenberg et al., 2024; Mazzoli, 2020; Mazzoli et al., 2021; Pizà-Mir et al., 2022). Asimismo, con respecto a las funciones ejecutivas, destaca la memoria de trabajo, la inhibición y la flexibilidad cognitiva (Egger et al., 2019; Jiang et al., 2024; Melguizo-Ibáñez et al., 2024; Muñoz-Parreño et al., 2021; Ninahuaman et al., 2024).

Si se referencia al rendimiento académico, generalmente se tiende a examinar el desempeño académico y su posible mejora a raíz de las mismas. Con más precisión, se analiza su influencia en el campo de las matemáticas, valorando el aumento del rendimiento matemático tras una breve pausa lectiva, en el cálculo matemático, en las multiplicaciones o en la fluidez aritmética, incluyendo, posibles estados de ansiedad en algunos ámbitos de la misma asignatura (Holik et al., 2021; Kuan et al., 2024; Loturco et al., 2022; Masini et al., 2024; Muntaner-Mas et al., 2024).

En cuanto a la motivación, la autoimagen y el bienestar, se presenta de forma reiterada la percepción de la pausa activa con respecto al aumento de la motivación, del disfrute e, incluso, de la autoestima del alumno o alumna con sus mismas capacidades.

La mejora de la conducta escolar y el cambio en el clima del aula también se han tratado mediante

la pausa activa, no solo bajo el punto de vista del alumnado, sino también a través de las percepciones de los docentes (González-Pérez et al., 2024; Jiménez-Parra et al., 2022b; Lobach et al., 2024; Mendoza-Muñoz, Calle-Guisado et al., 2022; Vaquero-Solís et al., 2020).

Finalmente, aunque en menor proporción, se mide el uso positivo de la pausa activa con alumnado con diversidad funcional como TDAH (Arenas et al., 2024; Mazzoli, 2020).

Instrumentos y test más utilizados

La diversidad de variables implicadas en los parámetros anteriores ha impulsado el desarrollo y adopción de múltiples herramientas de medición siendo las más destacadas los acelerómetros para medir el nivel, la intensidad y la duración de la actividad física; el Test D2 para evaluar la atención y concentración; la tarea de flanqueo para analizar el control inhibitorio y la atención selectiva; o incluso, la Escala de Disfrute de la Actividad Física modificada (PACES), para valorar la influencia de las pausas activas en las actitudes del alumnado. De igual modo, se ha hecho uso de instrumentos cualitativos como la observación directa y sistemática o las entrevistas o los grupos focales para extraer in situ experiencias y percepciones que nutran las investigaciones (Biring, 2024; Egger et al., 2019; Fernández-Montoya et al., 2020; Masini et al., 2024; Mazzoli et al., 2019).

Capacitación docente en el recurso de la pausa activa

La implementación de este recurso no está exenta de desafíos. Entre las principales barreras destacan la insuficiente capacitación docente, la resistencia al cambio metodológico y la percepción de que estas actividades pueden interrumpir el ritmo académico (Jiang et al., 2024; Lander et al., 2023; Méndez-Giménez & Pallasá-Manteca, 2023; Porter et al., 2024; Sortwell et al., 2024; Syväoja et al., 2024). No obstante, la literatura disponible respalda que, cuando estas prácticas se aplican de forma estructurada y adaptada al contexto escolar, resultan ser altamente efectivas para alcanzar los objetivos educativos. Véase el aumento de la consideración como hecho primordial que los docentes estén capacitados para implementar de forma efectiva las pausas activas. Se divisa que aún existe una falta de consenso sobre su impacto real en las funciones ejecutivas y cognitivas del alumnado, así como en su bienestar dentro de las instituciones educativas.

Programas validados para implementar las pausas activas

Ante la creciente necesidad de reducir el sedentarismo y la fatiga mental en el aula, se han desarrollado diversos programas de pausas activas, algunos centrados en evidenciar sus beneficios generales y otros en evaluar actividades o duraciones específicas (Reyes-Amigo et al., 2024; Zapata-Lamana et al., 2024).

¡Uno de los primeros fue Take 10! Creado en 1999 en EE. UU por el International Life Sciences Institute (ILSI) bajo la dirección de Pate y Young. Este programa integró actividad física moderada o intensa con contenidos académicos (matemáticas, lengua, ciencias) en pausas de 10 minutos, con el objetivo de combatir el sedentarismo, prevenir la obesidad infantil y mejorar la concentración y el rendimiento académico. En 2012, ¡DAME 10!, desarrollado en España, surgió como una adaptación cultural de *Take 10!* manteniendo su estructura y objetivos (Ministerio de Sanidad, Servicios Sociales e Igualdad, 2012).

Por otra parte, el programa *PLBreaks*, diseñado por Mendoza-Muñoz, Carlos-Vivas et al. (2022), busca mejorar la alfabetización física y la composición corporal en escolares portugueses, integrando actividades físicas breves y estructuradas enfocadas en habilidades motrices, conocimiento del movimiento y actitudes positivas hacia la actividad física.

En el ámbito de las pausas activas complejas, destacan dos programas centrados en matemáticas. Por un lado, *Moving Math* (Sneck et al., 2022) y el Instituto Erikson, utiliza juegos corporales para enseñar conceptos matemáticos básicos como números y formas geométricas. Por otro lado, *Math on the Move*, que combina la enseñanza matemática con actividad física moderada a vigorosa para mejorar el rendimiento académico en primaria (Rosenfeld, 2016).

Por la gran cantidad de análisis y la diversidad de resultados extraídos de las mismas investigaciones, el objetivo principal del presente estudio bibliométrico es analizar la producción científica sobre las pausas activas en el ámbito educativo durante la última década (2015-2024) con el fin de identificar sus beneficios en la función cognitiva, ejecutiva, en el rendimiento académico y en la promoción de salud y bienestar del propio alumnado. Para ello, pretendemos dar resupuesta a las siguientes preguntas de investigación:

1. ¿Cuál es la evolución cronológica de la productividad?
2. ¿Cuál es el nivel educativo en el que tiene más influencia la pausa activa según el corpus literario obtenido?
3. ¿Qué paradigmas de actuación se pueden apreciar dependiendo del ámbito en el que se trabaje la pausa activa?
4. ¿Qué relación existe entre las pausas activas y el rendimiento académico?
5. ¿De qué manera pueden contribuir las pausas activas a la disminución del cortisol y la mejora del bienestar emocional en el aula?
6. ¿Cuáles son las metodologías más eficaces para implementar en el aula la pausa activa?
7. ¿Qué factores influyen en la aceptación y percepción de las pausas activas por parte de los docentes?
8. ¿Qué factores influyen en la percepción de las pausas activas por parte de los estudiantes?
9. ¿Se considera importante la formación docente en el recurso educativo de la pausa activa?
10. ¿Qué tipo de instrumentos de evaluación se utilizan en los estudios de intervención?
11. ¿Qué diseño es el más empleado junto con el uso del pre y post test y la comparación con grupo experimental y control?

MÉTODO

Este estudio se basa en una revisión bibliométrica de carácter retrospectivo, siguiendo un diseño ex post facto (Montero & León, 2005). En las siguientes secciones se detalla el proceso de selección de los artículos incluidos en el análisis y se presentan los resultados obtenidos. A su vez, se

determinan las búsquedas realizadas y la selección de documentos, con su clasificación pertinente en función de los descriptores y los análisis de los datos que proporcionan (Rosa et al., 1996).

Muestra

El cribado del corpus literario se realizó entre septiembre y diciembre de 2024. Tras la aplicación de los criterios de inclusión a la estrategia de búsqueda, la muestra seleccionada para este trabajo consta de n=92 documentos publicados en el periodo temporal 2015-2024 y extraídos de las bases de datos Web of Science (WOS) y Scopus.

Instrumentos

Se utilizó el *Web of Knowledge* desarrollado por El Instituto de Información Científica (ISI), una plataforma de investigación que integra un potente motor de búsqueda (Web of Science) y diversas bases de datos multidimensionales. Esta herramienta permite realizar búsquedas exhaustivas en artículos científicos, patentes y actas de congresos, además de ofrecer análisis bibliométricos y recursos de gestión bibliográfica. A su vez, también se empleó Scopus, otra base de datos bibliográficos de resúmenes y citas prestigiosas a nivel global que alberga datos referentes a la producción investigadora publicada en una extensa gama de revistas académicas, monografías, actas de congreso y registros de patentes. Los datos de todos estos documentos se procesaron y analizaron con el programa Excel. La información extraída de cada artículo fue codificada y categorizada según un esquema de variables previamente definido, considerando su relevancia para los objetivos de la investigación.

Procedimiento y análisis

Se desarrolló una estrategia de búsqueda exhaustiva, combinando diversos términos clave a través de operadores booleanos para construir una estrategia de búsqueda inicial. Dado que, tanto WOS como Scopus, son portales internacionales, se ha optado por configurar la estrategia en inglés. La base de la misma es la unión de las siguientes palabras: “*active breaks*”. Se hizo uso de diversos sinónimos a través de los cuales se podía acceder a una gran cantidad de publicaciones interesantes en cuanto al tema central de la investigación, estos son: “*brain breaks*”) y “*mental breaks*”. En la Tabla 1 se presenta toda la información acerca de los distintos términos que definen a la pausa activa.

Tabla 1

Sinónimos de pausa activa

Términos	WOS	Scopus	Repetición	%
<i>Active Breaks</i>	20	11	31	33.70
<i>Physical activity</i>	13	3	16	17.39
Descansos activos	8	7	15	16.30
<i>Physical activity breaks</i>	1	1	6	6.52

<i>Activity breaks</i>	3	1	4	4.35
<i>Brain breaks</i>	2	2	4	4.35
Descansos físicamente activos	0	2	2	2.17
<i>Physical active breaks</i>	1	1	2	2.17
<i>Physically active breaks</i>	1	1	2	2.17
<i>Active Classroom Breaks</i>	1	0	1	1.09
<i>Active School Breaks</i>	0	1	1	1.09
Actividad física	0	1	1	1.09
<i>Mental breaks</i>	1	0	1	1.09
<i>Physical exercise</i>	1	0	1	1.09
<i>Physical Exercise Activity</i>	0	1	1	1.09
<i>Physical literacy breaks</i>	1	0	1	1.09
<i>Physically active</i>	1	0	1	1.09
<i>Physically active learning</i>	1	0	1	1.09
<i>Short breaks</i>	1	0	1	1.09
Total general	92		92	100

Por otra parte, se realizó una búsqueda en 9 idiomas distintos con el objetivo de afinar al máximo el resultado final de la muestra. En la Tabla 2 se puede observar más detalladamente.

Tabla 2

Términos por idioma de publicación

Idioma	Término	WOS	Scopus
Español	Descanso activo	0	14
Alemán	Aktive pause	0	0
Inglés	<i>Active breaks, Brain breaks, mental breaks, activity rest</i>	0	12

Francés	<i>Pauses actives</i>	1	0
Chino simplificado	积极休息	0	1
Coreano	활성 휴식 시간	0	0
Italiano	<i>Pause active</i>	0	0
Japonés	アクティブブレイク	0	0
Ruso	активные перемены	0	0

A las palabras base se le fueron añadiendo diferentes términos para recabar información sobre la influencia de la pausa activa en los distintos ámbitos educativos tomados como foco para analizar los beneficios del implemento de la misma en el aula. Posteriormente, se realizaron pruebas para evaluar la eficacia de cada combinación, se seleccionaron aquellos términos que maximizaban la precisión de los resultados y se descartaron aquellos que no aportaban valor. Como se puede apreciar, todos los términos introducidos se escribieron entre comillas para acotar la búsqueda y aclarar los casos en los que los términos están compuestos por dos vocablos. Además, se utilizó un asterisco (*) al principio y al final de algunos términos para garantizar que el motor de búsqueda incluyera también los resultados de todas las palabras derivadas de la seleccionada. De esta manera, se fueron uniendo terminologías y, por ende, construyendo estrategias de búsqueda. Con el uso y la combinación de todas estas palabras, se obtuvo una estrategia de búsqueda bastante extensa.

Posteriormente, se amplió la estrategia combinando los términos base con palabras clave adicionales para analizar la influencia de las pausas activas en diversos contextos educativos: (*adolescent and adolescents and "academic performance" and "active breaks" and biology and "brain breaks" and "brain relaxation" and childhood* and "cognitive functions" and "descansos activos" and "discapacidad intelectual" and "dual task" and "dual tasks" and "educación and education" and "executive function" and "executive functions" and "foreign language" and "high school" and inhibition and "infant education" and language and math* and motivation and "mental breaks" and "personal opinion" and physics and "primary school" and "school performance" and "sustained attention" and university and university and teachers and childhood**).

El resultado total de las búsquedas entre los documentos que se encontraron en ambas bases de datos fue de 1027. Sin embargo, se fueron eliminando investigaciones conforme se iba analizando título, resumen y palabras clave de cada uno de ellos. Tras dicha criba, el número descendió razonablemente a 47 artículos en Scopus y a 137 investigaciones en WOS. Esta tanda de artículos se analizó con más detalle y se procedió a eliminar aquellos artículos que estaban duplicados. Por ello, los artículos de Scopus con los que se trabajó fueron 31, mientras que en WOS fueron 92. Posteriormente se realizó un nuevo cribado, de forma que, por motivos de escasa calidad y por el filtro temporal que se propuso, la cifra final de artículos en Scopus se concretó en 31 y en WOS 47 artículos.

Por medio de una búsqueda en la bibliografía de los artículos más citados, se identificaron 14 estudios relevantes para añadir al corpus literario. Dichos artículos, estaban publicados tanto en

Scopus como en WOS. No obstante, considerando que WOS es la base de datos principal de extracción, estos 14 artículos se sumaron al total de 47 artículos iniciales. Como resultado, se contabilizaron 31 artículos provenientes de Scopus y 61 de WOS.

Para ser incluidos en la muestra los documentos debían cumplir los siguientes criterios de inclusión: 1) Artículos publicados entre 2015 y 2024. 2) Estudios que analizaran la pausa activa en el ámbito educativo. 3) Investigaciones que abordaran el impacto de las pausas activas en la función cognitiva, ejecutiva, el rendimiento académico o la motivación estudiantil. 4) Debían estar publicadas en revistas de alto impacto indexadas en Scopus o Web of Science. 5) Artículos en español, inglés y chino simplificado. 6) Estudios que incluyan cualquier nivel educativo.

Finalmente se procedió a fijar una sola firma de los autores con el fin de evitar error en números y porcentajes de publicaciones de los mismos.

RESULTADOS

Artículos por año de publicación

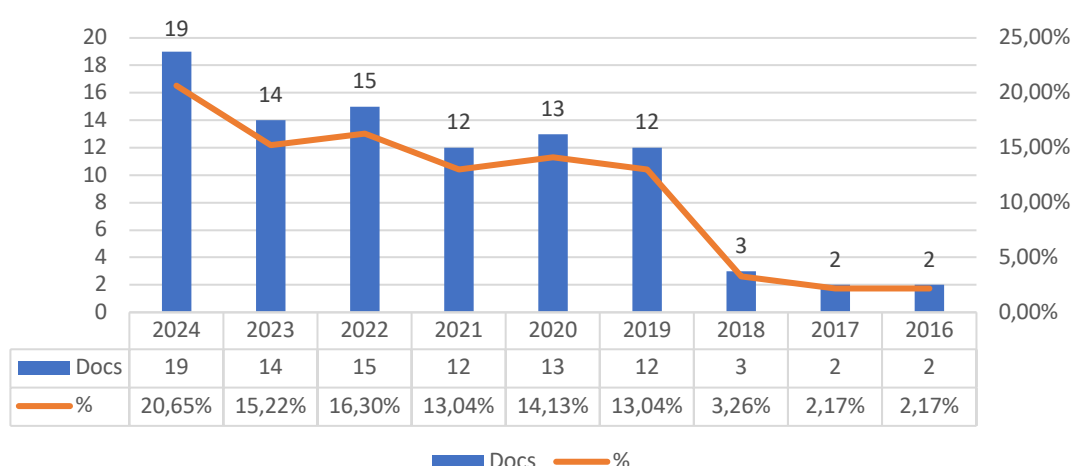
Desde 2016 hasta 2024 emergieron un total de 92 documentos. El año más prolífico fue el 2024 con 19 publicaciones (20.65%). Es destacable que en los tres últimos años (2022, 2023 y 2024) se publicó un total de 48 documentos, albergando entre los tres el 52.17% de la muestra analizada.

Por otra parte, y digno de mención es el notable incremento de las publicaciones observado a partir de 2019, pasando de 2 (2016 y 2017) o 3 (2018) a más de 10 en los sucesivos años (2019 a 2024).

En la Figura 1 se presenta de forma más detallada la evolución de la literatura en base al año de publicación.

Figura 1

Artículos por año de publicación



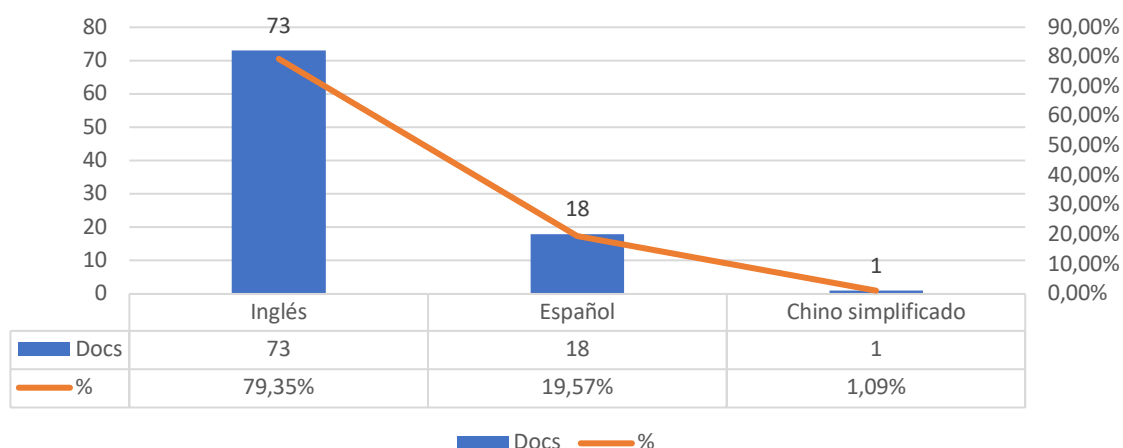
Idiomas por documento

Se hallaron tres idiomas diferentes. La mayoría de los documentos (79.35%) fueron publicados en

inglés, mientras que el 19.57% se publicó en español, y el 1.09% en chino simplificado. En la Figura 2 se muestra la presencia de los tres idiomas en los artículos analizados.

Figura 2

Idioma por documento



Países con más productividad documental

Aparecieron un total de 14 países. El más prolífico fue Suiza con 24 publicaciones (26.09%), seguido de España con el 23.91% de los documentos y Estados Unidos con el 20.65%. Siete países publicaron un solo documento cada uno (7.63%). La representación de países latinoamericanos, aunque en menor medida, apunta al interés global de los continentes hacia este tema. En la Tabla 3 se presentan los países con más productividad documental.

Tabla 3

País con más productividad documental

País	Cantidad	%
Suiza	24	26.09
España	22	23.91
EEUU	19	20.65
Reino Unido	12	13.04
Dinamarca	3	3.26
Turquía	3	3.26
Polonia	2	2.17
Países con una publicación	7	7.63
Total general	92	100

Artículos según la revista en la que se han publicado

Se registraron un total de 65 revistas diferentes de entre todos los estudios examinados. La mayoría de las revistas pertenecían al ámbito educativo y deportivo. También hay un porcentaje elevado de revistas pertenecientes al ámbito de la medicina y salud. La revista que recoge un mayor número de publicaciones es Retos con un total de 7 documentos (7.37%).

Con respecto a los cuartiles, predominó el Q1 con el 46.7%, seguido del Q2 con 30 artículos (32.60%). En último lugar, se encuentra los cuartiles 3 y 4 con una presencia mínima en el estudio. Con 13 artículos posee una presencia del 14.35%, siendo el Q4 el cuartil que menos peso presentó. Podemos observar en la Tabla 4 los documentos según la revista y sus cuartiles.

Tabla 4

Artículos según la revista en la que se han publicado

Revistas	NE %	Q1 %	Q2 %	Q3%	Q4 %	Total %
RETOS			6 4.91			6 6.52
International environmental research and public health			5 3.91			5 5.43
Frontiers in Public Health		3 3.26				3 3.26
Environmental research and public health			3 1.91			3 3.26
Journal of science and medicine in sports		3 3.26				3 3.26
Apunts educación física y deportes		3 3.26				3 3.26
Sustainability		3 3.26				3 3.26
Revista española de salud pública				2 0.91		2 2.17
PLOS ONE		2 2.17				2 2.17
Sports tk					2 0.91	2 2.17
BMC Public Health		2 2.17				2 2.17
Research Quarterly for exercise and sport		2 2.17				2 2.17
British Journal of Educational Psychology		2 2.17				2 2.17

Children					2	0.91								2	2.17	
Biology					2	2.17								2	2.17	
Revistas con 1 aparición	6	6.52	21	22.8	14	12.9	7	5.91	2	0.91	50	54.35				
Total general					43	46.7	30	32.6	9	9.78	4	4.35	92	100		

Ámbitos de estudio

La muestra seleccionada incluyó 17 ámbitos de investigación diferentes. Veinte artículos estudiaron la pausa activa en el ámbito de la salud, posicionándose este como el ámbito más investigado (21.74%). Le siguió el área de la educación con quince publicaciones (16.30%). Los ámbitos de medicina y deporte con el (13.04%) respectivamente, fueron los siguientes más estudiados. En la Tabla 5 se muestra los ámbitos en los que se han estudiados los beneficios de las pausas activas con la cantidad de artículos publicados por ámbito.

Tabla 5

Ámbitos de estudio

Ámbitos de estudio	Documentos	%
Salud	20	21.74
Educación	15	16.30
Medicina	12	13.04
Deporte	12	13.04
Psicología	9	9.78
Ciencias sociales	5	5.43
Ciencias	4	4.35
Sostenibilidad ambiental	3	3.26
Tecnología	2	2.17
Biología	2	2.17
NE	2	2.17
Fisioterapia	1	1.09
Neurociencia	1	1.09

Medicina deportiva	1	1.09
Ciencias y artes	1	1.09
Psicología y educación	1	1.09
Formación del profesorado	1	1.09
Total general	92	100

Tipos de documentos y número de autores por publicación

Se hallaron dos tipos de documentos diferentes, artículos y tesis doctorales. Predominó el artículo de revista con 89 publicaciones (94.57%).

En relación al número de autores por documento se encontraron desde publicaciones en solitario (5.43%) hasta escritas por 23 autores, predominando la autoría múltiple. El número de autores por documento más significativo fue 4 en 19 publicaciones (20.65%).

En la Tabla 6 se puede apreciar con más detalle los datos relativos al tipo de publicación y número de autores por documento.

Tabla 6

Tipos de documento y número de autores por publicación

Autores por documento	Artículos	%	Tesis	%	Total	%
1	2	2.17	3	3.26	5	5.43
2	3	3.26			3	3.26
3	8	8.70			8	8.70
4	19	20.65			19	20.65
5	14	15.22			14	15.22
6	9	9.78			9	9.78
7	15	16.30			15	16.30
8	6	6.52			6	6.52
9	3	3.26			3	3.26
10	1	1.09			1	1.09
11	1	1.09			1	1.09
12	5	5.43			5	5.43

15	1	1.09			1	1.09
16	1	1.09			1	1.09
23	1	1.09			1	1.09
Total	89	96.74	3	3.26	92	100.00

Documentos por autor y autores más prolíficos

Se hallaron 421 autores diferentes que participaron en la muestra 544 veces. El 79.10% de los autores (333) participó en un solo documento. El autor más prolífico fue Francisco Tomás González-Fernández con 7 trabajos (7.61%). En la Tabla 7 se presenta la relación de documentos por autor.

Tabla 7

Documentos por autor y autores más productivos

Autores más productivos	Documentos	%
Francisco Tomás González-Fernández	7	7.61
Caterina Pesce	6	6.52
Heidi J. Syväoja	5	5.43
Sirpa Sneek	5	5.43
Emiliano Mazzoli	5	5.43
Laura Dallolio	4	4.35
Jo Salmon	4	4.35
Alice Masini	4	4.35
Álvaro Infantes-Paniagua	4	4.35
11 autores con tres documentos	33	35.87
67 autores con dos documentos	134	145.65
333 autores con un documento	333	361.96
Total participaciones	544	591.30

Nota: Un mismo documento se ha contabilizado a cada uno de sus autores.

Artículos más citados

Se reflejó que los autores más prolíficos no fueron los más citados. El número de citas recibidas por los 92 artículos que conforman la muestra hasta diciembre de 2024 fue de 5544 entre WOS (2783) y Scopus (2761). Si bien se analizaron de forma conjunta, los primeros doce autores más citados pertenecían a un mismo grupo de investigación (Joan et al., 2016), el cual recibió un total de 1369 citas, correspondiendo al 49.19% de las citas de WOS y al 53.68% de Scopus. Este número procede de un solo artículo.

Los siguientes autores más citados varían en función de la base de datos analizada. Por un lado, en WOS la autora más citada es Heidi J. Syväoja seguida de Sirpa Sneek ambas con 229 citas (8.23%), autoras que trabajan de forma conjunta habitualmente. En Scopus, encabezó la lista la autora Caterina Pesce con 453 citas (16.41%) del total de las citas de dicha base de datos. En la Tabla 8 se presentan los artículos más citados.

Tabla 8

Artículos más citados

Referencia	Citas WOS	%	Citas Scopus	%	Citas Google Scholar	%
Joan Poitras,V., Gray, C. E., Borghese,M. M., Carson, V., Chaput, J.P., Janssen, I., & TRemblar, M. S. (2016). Systematic review of the relationship between objectively measured physical activity and health indicatorsin school.aged children and youth. <i>Applied physiology, nutrition, and metabolism</i> , 41 (6), S197-S239.	1369	49.19	1482	53.68	2424	45.71
Egger, F. Benzing, V. Conzelmann, A., & Schmidt, M. (2019). Boost your brain, while having a break! The effects os long-term cognitively engaging physical activity break son children´s executive functions and academic achievement. <i>PloS one</i> , 14(3), e0212482.	115	4.13	102	3.69	240	4.53
Masini, A., Marini, S., Gori, D., Leoni, E., Rochira, A., & Dallolio, L. (2020). Evaluation of school-based interventions of active breaks in primary schools: A systematic review and metaanalysis. <i>Journal of science and medicine in sport</i> , 23(4), 377-384.	113	4.06	117	4.24	222	4.19
Arenas, D., Bodi-Torralba, M., Oliver, A., Cantallops, J., Ponseti, F. J., Palou-Sampol, P. & Muntaner-Mas, A. (2024). Effects of active break son educational achievement in children with and without ADHD: study protocol and rationale of the Break4Brain Project. <i>Frontiers in Psychology</i> , 15, 1451731.	97	3.49	0	0.00	0	0.00

Mavilidi, M. F., Drew, R., Morgan, P. J., Lubans, D. R., Schmidt, M., & Riley, N. (2020). Effects of different types of classroom physical activity break son children´s on-task behaviour, academic achievement and cognition. <i>Acta paediatrica</i> , 109 (1), 158-165.	87	3.13	80	2.90	163	3.07
Syväoja, H. J., Sneek, S., Kukko, T., Asunta, P., Räsänen, P., Viholainen, H., & Tammelin, T. H (2024). Effects os physically active maths lessons on children´s maths performance and maths-related affective factors: Multi- arm cluster randomized controlled trial. <i>British Journal of Educational Psychology</i> , 94(3), 839-861.	82	2.95	0	0.00	5	0.09

Paradigmas más estudiados

Se hallaron cinco grandes paradigmas al analizar los artículos: actividad física, activación cognitiva, activación ejecutiva, compromiso estudiantil y bienestar fisiológico. La mayoría de los estudios se enfocan en el aumento de la actividad física en el entorno educativo (33 artículos; 12.00%), seguido por la mejora de la atención (6.12%). Otros beneficios investigados incluyen el rendimiento académico (14 publicaciones; 5.09%), la memoria de trabajo (8 estudios), la antropometría, el rendimiento en matemáticas, la inhibición y el disfrute. El 61.82% de los beneficios reportados corresponden a parámetros explorados en un único estudio. La Tabla 9 expone todos los paradigmas desglosados.

Tabla 9

Paradigmas más estudiados

Paradigmas más estudiados	Repeticiones	%
Actividad física	33	12.00
Atención	17	6.18
Rendimiento académico	14	5.09
Memoria de trabajo	8	2.91
Antropometría	7	2.55
Rendimiento en matemáticas	6	2.18
Inhibición	6	2.18
Disfrute	6	2.18
Concentración	4	1.45

Comportamiento	4	1.45
Parámetros con menos de 4 repeticiones	170	61.82
Total general	275	100

Comparación de distintos tipos de pausas activas

El uso de distintos tipos de pausas activas varían en función del autor. Se divisó que existen investigaciones que intercalaron hasta cuatro tipos de pausa activa en una sesión. Con el fin de extraer resultados más robustos, en investigaciones como la de Sneek et al. (2023) utilizaron diversos grupos experimentales, concretando pausas activas con distinta intensidad y duración, para de este modo, poder comparar los beneficios que aportaban cada una de ellas a los distintos parámetros estudiados.

Predominan las investigaciones cuyos grupos experimentales utilizaron un solo tipo de pausa activa con una duración e intensidad determinadas (63.04%), seguidas por las que hicieron uso de dos (16.30%), y finalmente las que utilizaron más de tres (1.09%). Los datos de recogen de forma más detallada en la Tabla 10.

Tabla 10

Comparación de distintos tipos de pausas activas

Comparación de distintas pausas activas	Veces que se repite	%
Una	58	63.04
Dos	15	16.30
No especificado	12	13.04
Tres	6	6.52
Cuatro	1	1.09
Total general	92	100

Duraciones de las pausas activas

La elección de la duración viene precedida por el parámetro que se quiera trabajar. Se encontraron investigaciones con duraciones fijas de 4, 5, 10 y 15 minutos, o duraciones variables que englobaron de entre 2 a 5 minutos.

La duración más empleada fue la de diez minutos, seguida de las de cinco minutos. Las menos empleadas son aquellas que son demasiado cortas o aquellas que son muy largas, ya que estas últimas son más complejas a la hora de introducir en el currículo escolar. En la Tabla 11 se pueden analizar todas las duraciones de las pausas activas.

Tabla 11*Duraciones en las pausas activas*

Duración pausa activa	Cantidad repetición	%
10	12	16
5	9	12
15	8	10.67
5;10	7	9.33
20	3	4
4	3	4
5;10	3	4
2;5	2	2.67
5;20	2	2.67
4;5	2	2.67
3	2	2.67
12	2	2.67
De entre 30'' a 1 h de pausas activas ²⁰		26.67
Total general	75	100

A partir de la Tabla 12, con el fin de valorar la cantidad de investigaciones que se efectuaron con diversas intensidades, así como, su ubicación de desarrollo (dentro o fuera del aula) se hace alusión únicamente a los artículos de intervención de la muestra (n=65).

Intensidades de las pausas activas

La intensidad también se divide en dos grandes bloques: intensidades fijas e intensidades variables durante una misma pausa activa. Se apreció que los tres niveles de intensidades más usados son aquellos que varían de entre una intensidad ligera a una intensidad vigorosa.

Las más representativas fueron las pausas activas de intensidad moderada-vigorosa con 21 documentos y el 32.31% del total de la muestra. A esta le siguieron las variantes de ligeras a vigorosas, en la que suelen llevar a cabo pausas activas con calentamiento, ejecución y vuelta a la calma. Este nivel de intensidad aparece en 12 documentos y tiene un peso del 18.46% del total.

Finalmente, en menor medida se emplearon las pausas activas con una intensidad ligera- moderada (13.85%).

Autores como Lobach et al. (2024) o Mavilidi et al. (2020) especificaron que las pausas con intensidad moderada-vigorosa son las más efectivas a la hora de mejorar las funciones cognitivas del alumnado. Con respecto a las menos representativas, se encuentran la intensidad fija ligera (Watson et al, 2019a) y la intensidad variable moderada/moderada-vigorosa (Arenas et al., 2024) con una presencia del 1.54% respectivamente. En la Tabla 12 se encuentran todos los datos desglosados.

Tabla 12

Intensidades de la pausa activa

Intensidad	Documentos	%
Moderada-vigorosa	21	32.31
Ligera-vigorosa	12	18.46
Ligera-moderada	9	13.85
No Especifica	7	10.77
Moderada	7	10.77
Vigorosa	6	9.23
Vigorosa-muy vigorosa	1	1.54
Ligera	1	1.54
Moderada/moderada-vigorosa	1	1.54
Total general	65	100

Frecuencia de uso y ubicación para el desarrollo de la pausa activa

Se expone la frecuencia de uso de la pausa activa a lo largo del día escolar que gira entorno entre una a seis veces, así como, la ubicación elegida para llevarla a cabo. La mayoría de los estudios indican que las pausas activas se implementan de forma diaria (n=23). A su vez, 51 elementos especifican que se realiza dentro del aula.

De todos ellos, tres estudios llevaron a cabo la investigación fuera del aula en entornos como el patio o el pabellón de deportes del centro y otros tres, intercalaron las ubicaciones para el desarrollo de la pausa activa. En la Tabla 13 se muestran los datos presentados.

Tabla 13*Frecuencia de uso y ubicación para el desarrollo de la pausa activa*

Frecuencia diaria	Dentro	Fuera	Mixto	No especificado	Total general	% Intervención
1	16	3	3	1	23	35.38
2	6		2		8	12.31
3	6				6	9.23
4	4		1		5	7.69
5	1				1	1.54
6	1				1	1.54
1 a 2	4				4	6.15
2 a 3	1				1	1.54
No especificado	12		4		16	24.62
Total general	51	3	10	1	65	100

Estipulación horaria

Se observaron preferencias por tres horarios concretos: en la clase de matemáticas, por la mañana y/o al medio día, y a mitad de cada clase. Mientras que el 27.17% de la muestra no estipula un horario fijo para desarrollar la pausa activa y el 35.87% no lo especifica, estudios como el de Chatzopoulos et al. (2023) o Masini (2024) exponen la obtención de resultados positivos implementando la pausa activa en la asignatura de matemáticas que, como norma general, es la que más esfuerzo mental demanda (5.53%). En menor medida, Mazzoli et al. (2019) presentan el desarrollo de las mismas de 9:00 am y las 11:00 am, y de 11:30 am y la 1:00 pm (2.17%). Se pueden analizar los datos con más detalle en la Tabla 14.

Tabla 14*Estipulación horaria*

Estipulación de un horario fijo	Documentos que lo fijan	%
No especificado	33	35.87
No lo estipulan	25	27.17
En clase de mates	5	5.43

9:00 am y las 11:00 am, y 11:30 am y la 1:00 pm ²		2.17
A mitad de clase	2	2.17
Opciones de horario que solo se repiten 1 vez	25	27.17
Total general	92	100

Niveles educativos donde se imparten las pausas activas

Más de la mitad de los estudios (55.38%) se centran en educación primaria, mientras que el 16.92% se realizan en secundaria. Un 9.23% (6 publicaciones) abarcan tanto primaria como secundaria y un 4.62% combinan secundaria y bachillerato. Los niveles menos estudiados son bachiller (3.08%) y educación infantil (4.62%).

Debemos especificar que ciertos niveles educativos comparten el número de publicaciones, por tanto, se duplica la cantidad de documentos en esos niveles educativos. De ahí que el total absoluto en educación primaria sea de 42 publicaciones, tal como se presenta en el apartado de discusión. La Tabla 15 facilita la información completa.

Tabla 15

Niveles educativos donde se imparten las pausas activas

Etapas educativas	Documentos	%
Ed. Primaria	36	55.38
Ed. Secundaria	11	16.92
EP/ES	6	9.23
Universidad	4	6.15
Ed. Infantil	3	4.62
Bachiller	2	3.08
Profesores	1	1.54
ES/Bachiller	1	1.54
EP/profesores	1	1.54
Total general	65	100

Nota: Ed: educación; EP: educación infantil; ES: educación secundaria.

Formación docente para el empleo de la pausa activa

Inicialmente, las pausas activas eran impartidas por los propios investigadores (21.54%). Con el tiempo, y a medida que aumentaron el dominio, la comprensión y los resultados obtenidos, se empezó a otorgar importancia a la formación del docente para que fuese él quien impartiera y estructurara las pausas activas, considerando las necesidades y potencialidades de su alumnado. Asimismo, 43 documentos respaldan al docente como instructor de la pausa activa (66.15%), de los cuales 30 defienden la formación docente para desarrollar las pausas activas de la mejor manera posible (46.15%) y 10 (15.38%) no lo hacen. En la Tabla 16 se muestra con más detalle la formación docente en el empleo de las pausas activas.

Tabla 16

Formación docente para el empleo de la pausa activa

Instructor pausa activa	Formación docente				No especificado	%	Total general		%
	No	%	Si	%					
Profesores	10	15.38	30	46.15	3	4.62	43		66.15
Investigador	8	12.31	2	3.08	4	6.15	14		21.54
No especificado	2	3.08	2	3.08	2	3.08	6		9.23
Monitores	1	1.54	0	0	1	1.54	2		3.08
Total general	21	32.31	34	52.31	10	15.38	65		100

Instrumentos de medición de la pausa activa

Encontramos 187 instrumentos de medición en la muestra total de la investigación bibliométrica. Los instrumentos más utilizados fueron los acelerómetros con 28 documentos (9.24%), seguido del test D2 con 12 (3.96%) y el test Flanker con 10 (3.30%). Del mismo modo, los grupos focales (2.64%), entrevistas (2.31%) y las grabaciones (1.32%) también estuvieron presentes. El resto de instrumentos mostraron una presencia menos robusta. En la Tabla 17 se detallada el instrumento de medición junto con los parámetros que analiza y el total de veces que se repiten a lo largo de la muestra.

Tabla 17

Instrumentos de medición

Instrumentos	Parámetros que analiza	Reps.	%
Acelerómetro	Nivel, intensidad y duración de la actividad física	28	9.24
D2	Atención, concentración y errores cometidos	12	3.96
Flanker	Control inhibitorio y atención selectiva	10	3.30

Grupos focales	Percepciones, opiniones, actitudes y experiencias		2.64
Escala de Disfrute de la actividad física modificada	Nivel de disfrute en tarea	8	2.64
Entrevistas	Percepciones, opiniones, actitudes y experiencias	7	2.31
Observación directa sistemática	Frecuencia y duración de conductas concretas	6	1.98
Prueba de matemáticas (MATH)	Habilidades matemáticas como el cálculo o razonamiento	6	1.98
Alpha-Fitness	Forma física: resistencia, fuerza y composición corporal	4	1.32
N-Back	Memoria de trabajo	4	1.32
Stroop de colores y palabras (SCWT)	Inhibición, atención selectiva y velocidad de procesamiento	4	1.32
Go/No-Go	Inhibición de respuesta, control de impulsos y atención sostenida	4	1.32
Tarea de vigilancia psicomotriz (PVT)	Lapsos de atención	4	1.32
Entrevistas semiestructurales	Narrativas individuales, interpretación de fenómenos	4	1.32
Grabaciones	Registro verbal o no de un comportamiento	4	1.32
Cuestionario de actividad física para niños (PAQ-C)	Nivel general de actividad física	3	0.99
Escala de Borg	Esfuerzo percibido durante la actividad física	3	0.99
Evaluaciones antropométricas	Medición del peso, talla, IMC, etc.	3	0.99
Prueba de memoria de trabajo para ordenar listas	Capacidad de retención	2	0.66
Podómetro	Conteo del número de pasos diarios		0.66
CAPL-2	Alfabetización física: competencia motriz y actividad f	2	0.66
FUNA	Funciones ejecutivas mediante la computerización		0.66
Cuestionarios	Variables psicométricas como la motivación o ansiedad	2	0.66
Woodcock-Muñoz	Habilidades cognitivas y logros académicos		0.66
Diario docente	Registro de conductas observadas		0.66
Polar H10	Sensor de frecuencia cardíaca	2	0.66
Encuesta de comportamiento y activos del aula-Maestro	Comportamiento y clima del aula	2	0.66

Software Neurosky Experimentor	Actividad eléctrica cerebral (EEG)		0.66
Mamas	Ansiedad matemática específica		0.66
IEDA	Factores psicosociales del desarrollo adolescente	2	0.66
Instrumentos que se emplean solo 1 vez		157	51.82
Total general		303	100

Nota: Reps.: Repeticiones.

Enfoques

Los artículos recogidos en la muestra se dividen en: documentos con intervención (65) y documentos sin intervención (28). Con respecto a los artículos de intervención, se desglosan tres enfoques: cuantitativos (51 documentos); cualitativos (9) y mixtos (11). Con referencia a los artículos que no presentan una intervención se encuentran: revisiones sistemáticas (12), revisiones sistemáticas con meta-análisis (8) y revisiones de largo alcance (1).

Destacando únicamente a los documentos de intervención (65), se observa una distribución heterogénea según el tipo de diseño empleado y el uso de evaluadores pre y post test. En su mayoría se trabajó con investigaciones cuantitativas, presentando tanto grupo control como grupo experimental y se utilizó un pre test antes del desarrollo de la pausa activa y un post test (58.46%). Únicamente se encuentran dos investigaciones que emplearon solo post test, y 11 que utilizaron solo grupo experimental.

Con respecto al enfoque cualitativo (9.23%), las investigaciones que se centraron en este enfoque únicamente presentaron grupo experimental, de los cuales, uno no empleó pre test y post test y 5 sí.

Finalmente, de la misma forma que el cuantitativo, el enfoque mixto en su mayoría hace uso de grupos experimental y control (10.77%) con la medición pre y post test. Pese a ello, hay 3 documentos en los que se forma un solo grupo experimental, de los cuales 1 empleó un pre y post test mientras que en dos artículos no los emplearon. La Tabla 18 muestra los datos anteriormente expuestos.

Tabla 18

Enfoques

Enfoque	Tipo grupo	NE no	post test	pre-post test	Total general	%
Cualitativo	Solo experimental	1		5	6	9.23
Cuantitativo	Experimental/control	1	1	36	38	58.46
	Solo experimental	3	1	7	11	16.92
Mixto	Experimental/control			7	7	10.77

Solo experimental	2			1	3	4.62
Total general	1	6	2	56	65	100

Nota: NE: no especificado.

DISCUSIÓN

Con respecto a la primera pregunta de investigación, ¿Cuál es la evolución cronológica de la productividad?, el análisis evidencia un aumento progresivo en la producción científica a partir de 2019 con especial relevancia en el año 2024.

En relación a la segunda pregunta de investigación, ¿Cuál es el nivel educativo en el que tiene más influencia la pausa activa según el corpus literario obtenido?, se observa que en la mayor parte de estudios realizados (42 documentos) llevaron a cabo en la educación básica primaria. Este dato respalda a las afirmaciones de Masini, Marini, Gori et al. (2020). En contraposición, Ruiz-Ariza et al. (2021) centraron su investigación en la influencia positiva de la pausa activa sobre el alumnado de educación secundaria, siendo estos dos niveles los más analizados. No obstante, autores como Contreras-Jordán et al. (2022), Lander et al. (2023), Lobach et al. (2024), Pizà-Mir et al. (2022) y Srimaharaj et al. (2018) apostaron por analizar la capacidad de la pausa activa para mejorar la calidad de vida de estudiantes universitarios con resultados positivos al implementar pausas activas de 8 minutos basadas en la danza de músicas con ritmos latinos con resultados satisfactorios (Lobach et al., 2024).

Dotando de respuesta a la tercera pregunta de investigación, ¿Qué paradigmas de actuación se pueden apreciar dependiendo del ámbito en el que se trabaje la pausa activa?, se corrobora que los beneficios que aportan las pausas activas se agrupan mayoritariamente en cinco paradigmas.

El primero es el cognitivo, respaldado por autores como Barrionuevo et al. (2023), Fernández-Montoya et al. (2020), Holik et al. (2021), Kjellenberg et al. (2024), Muñoz-Parreño et al. (2021) y Sneck et al. (2022), destacando la mejora de la atención (Holik et al., 2021) y la memoria de trabajo (Muñoz-Parreño et al., 2021). No obstante, autores como Ninahuaman et al. (2024) mostraron resultados no concluyentes, y otros, como Mazzoli (2020) presentaron resultados negativos.

El segundo es el de la activación ejecutiva, defendido por autores como Barrionuevo et al. (2023), Layne et al. (2021), Muñoz-Parreño et al. (2021), Padial-Ruz et al. (2022) y Egger et al. (2019), cuyos resultados no llegaron a poseer significatividad en la investigación de Méndez-Giménez et al. (2022).

El tercer paradigma es el del bienestar fisiológico, en el que se destaca el apoyo de autores como Biring. (2024), Egger et al. (2019) o Mazzoli et al. (2021) concluyendo una reducción significativa del estrés (Biring, 2024) y un aumento del disfrute (Lobach et al., 2024). En contraposición, Biring (2024) incidió en la importancia de estructurar pausas activas coherentes con las capacidades del alumnado al que van dirigidas. Estas no pueden poseer intensidades muy vigorosas o duraciones muy extensas si la capacidad aeróbica o las habilidades motrices de los mismos no son aptas para ello, ya que, de forma contraria a la deseada, estos alumnos y alumnas sufrirán picos de ansiedad. De la misma forma, con respecto al alumnado con TDAH, es sumamente importante introducir el

recurso de la pausa activa de forma paulatina para que no padezcan cambios bruscos en las rutinas diarias.

El cuarto paradigma es el compromiso estudiantil, ya que, gracias a la pausa activa, el alumnado presenta compromiso emocional a la par que un mejor comportamiento y actitud con respecto a las tareas lectivas (Dugger et al., 2020; Jiménez-Parra et al., 2022b; Masini et al., 2024; Masini, Lanari et al., 2020).

Finalmente, el quinto paradigma destacado es el paradigma de la actividad física, siendo el más investigado (Gelabert et al., 2023; González-Fernández et al., 2020; Holik et al., 2021; Marsigliante et al., 2023; Masini, Lanari et al., 2020; Mavilidi et al., 2020; Méndez-Giménez et al., 2022; Muñoz-Parreño et al., 2020).

Respecto a la cuarta pregunta de investigación, ¿Qué relación existe entre las pausas activas y el rendimiento académico?, autores como Masini, Marini, Gori et al. (2020), Mavilidi et al. (2020) o Petrigna et al. (2022) presentaron resultados positivos en dicho parámetro. Pese a ello, estudios comparativos como la revisión sistemática de Jiang et al. (2024) determinaron los hallazgos como no concluyentes. De la mano del rendimiento académico, se destaca el rendimiento matemático como el que más beneficios curriculares obtiene de las pausas activas (Sneck et al., 2019) por la concentración y esfuerzo mental que conlleva la propia materia. Con opiniones dispares se presenta la investigación de Layne et al. (2021).

Atendiendo a la quinta pregunta de investigación, ¿De qué manera pueden contribuir las pausas activas a la disminución del cortisol y la mejora del bienestar emocional en el aula?, se concluye que la pausa activa es un recurso educativo que, por la motivación y desconexión que brinda al alumnado, reduce considerablemente los niveles de cortisol que estos puedan padecer por la fatiga mental fruto de deficiencia en la red atencional de los discentes.

Con respecto a la sexta pregunta de investigación, ¿Cuáles son las metodologías más eficaces para implementar en el aula la pausa activa?, se identifica que las intervenciones más eficientes presentan duraciones de entre cinco y diez minutos, intensidades moderadas a vigorosas, y una aplicación frecuente. Su reiteración y continuidad generan mejoras en funciones cognitivas superiores, como la atención y la concentración (Petrigna et al., 2022; Plaza et al., 2024; Ruiz-Ariza et al., 2021). Asimismo, las pausas estructuradas que integran contenidos curriculares favorecen parámetros de las funciones ejecutivas, como la flexibilidad cognitiva, la fluidez y la actualización (Muñoz-Parreño et al., 2021).

Con referencia a la séptima y octava preguntas de investigación, ¿Qué factores influyen en la aceptación y percepción de las pausas activas por parte de los docentes?, y ¿qué factores influyen en la percepción de las pausas activas por parte de los estudiantes?, se aprecia un contraste claro. Mientras los docentes prefieren pausas de intensidad ligera por considerarlas menos disruptivas, el alumnado manifiesta una mayor preferencia por aquellas de mayor intensidad, percibiéndolas como más eficaces (Masini et al., 2024; McLellan et al., 2022).

Derivada de esta, se puede presentar la novena pregunta de investigación, ¿Se considera relevante la formación docente para la adecuada impartición de la pausa activa? El incremento del corpus científico sobre el tema coincide con la creciente relevancia de la formación del profesorado para su correcta implementación. Watson et al. (2019b) y Vetter et al. (2020) destacaron que una mayor seguridad

docente incrementa la disposición a integrar y sostener las pausas activas en el currículo.

Con respecto a la décima pregunta de investigación, ¿Qué tipo de instrumentos de evaluación se utilizan en los estudios de intervención?, predomina la medición de variables físicas sobre las cognitivas o ejecutivas. En su mayoría, los autores hicieron uso de los acelerómetros que, aunque emplearon múltiples versiones, fue el dispositivo con más presencia (Kain et al., 2020; Masini, Marini, Leoni et al., 2020; Mazzoli et al., 2019; Mazzoli et al., 2021). Sin embargo, Carrasco-Uribarren et al. (2023) y Petrigna et al. (2022) apostaron por el uso de podómetros, aunque combinando su uso con el de los acelerómetros. En cuanto a los ámbitos cognitivo y ejecutivo, autores como Contreras-Jordán et al. (2020) o Maiztegi-Kortabarría. (2024), apoyaron la prevalencia de test como el D2 o el de la tarea por Flanqueo de Eriksen (Álvarez-Bueno et al., 2016; Chatzopoulos et al., 2023; Suarez- Manzano et al., 2018).

Finalmente, haciendo referencia a la undécima pregunta de investigación, ¿Qué diseño es el más empleado junto con el uso del pre y post test y la comparación con grupo experimental y control?, se especifica que la mayoría de documentos analizados presentan enfoques cuantitativos. Este hecho realza la robustez de los resultados, ya que para concluirlos, se hicieron comparaciones entre grupos control y grupos experimentales, con mediciones pre y post test de los parámetros estudiados para evaluar profundamente la significatividad, o no, de los hechos (Reyes-Amigo et al., 2024; Syväoja et al., 2024; Sortwell et al., 2024; Sneek et al., 2023; Tománek et al., 2019; Zapata-Lamana et al., 2024) en comparación con aquellas investigaciones que hicieron uso únicamente de un post test o de un grupo experimental sin la equiparación de resultados con un grupo control (García, 2023) o, directamente, sin pre ni post test (Schmidt et al., 2022).

CONCLUSIÓN

El objetivo de este estudio bibliométrico fue analizar la producción científica sobre las pausas activas en el ámbito educativo para identificar los beneficios que aportaban a la función cognitiva, ejecutiva, al rendimiento académico y a la promoción de salud y bienestar del propio alumnado, abarcando desde infantil hasta la educación universitaria. La muestra constó de $n=92$ documentos de alto índice de impacto hallados entre el 2015 y 2024 en buscadores científico-académicos primarios (WOS-Scopus), con el fin de que sirviera como base sólida para futuras investigaciones sobre el tema.

El análisis bibliométrico realizado evidenció un crecimiento sostenido del interés académico por las pausas activas en el ámbito educativo, especialmente a partir del 2019. Los estudios revisados coincidieron en destacar beneficios sobre la atención, el bienestar emocional y el rendimiento académico, con mayor investigación en la educación primaria. A pesar de la diversidad metodológica y algunos vacíos de investigación, los hallazgos respaldan la incorporación de la pausa activa como un recurso educativo eficaz y necesario para proyectar entornos escolares más saludables y efectivos a nivel fisiológico y cognitivo.

Aunque el presente estudio bibliométrico proporciona una visión completa sobre el impacto y la evolución de las pausas activas en el ámbito educativo, es importante reconocer ciertas limitaciones. En primer lugar, el corpus analizado se limita a 92 estudios lo que, aunque representativo, no recoge la totalidad de la producción científica sobre el tema existente, puesto que no se tuvieron en cuenta los motores de búsqueda secundarios de menor impacto. Asimismo, el uso de dos únicas bases de

datos (WOS-Scopus) podría significar la exclusión de ciertas publicaciones relevantes (Romero-Naranjo, 2025a, 2025b).

A partir de las limitaciones identificadas, emergen diversas oportunidades para futuras investigaciones. En primer lugar, resulta pertinente desarrollar estudios experimentales longitudinales con grupo control y diversos grupos experimentales, que permitan evaluar con precisión los beneficios asociados a diferentes duraciones, intensidades y frecuencias de las pausas activas. También sería valioso profundizar en los programas validados existentes, diferenciando claramente entre metodologías, métodos, programas y sistemas de enseñanza. Finalmente, futuras investigaciones podrían centrarse en el diseño de modelos pedagógicos que integren de forma estructurada las pausas activas en distintos niveles educativos, con el fin de analizar sus efectos específicos en cada uno de ellos.

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The body in musical production and perception: comparing taxonomies and the integrative proposal of the BAPNE Method

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Abstract

The role of the body in the processes of musical production and perception has been studied by various authors using different methodological approaches and for different purposes. The numerous taxonomies that have emerged in the course of this research reflect, on the one hand, the impossibility and difficulty of containing the various facets of a broad and complex phenomenon within absolutist parameters and, on the other hand, provide a multifaceted description of the investigative perspectives through which this theme has been developed. The BAPNE Method, in particular, presents a distinction in the use of body percussion according to areas that take into account various dimensions of the human being, making it possible to construct a pedagogical-didactic proposal to be used for the stimulation of executive and cognitive functions. This chapter, therefore, offers a classification of the main taxonomic models that have established themselves in various fields at an academic level. The description of their distinctive features will form the basis for reflection on their validity and the need for their integration or remodelling.

Keyword: BAPNE Method, body percussion, phenomenology, neuromotricity.

Resumen

El papel del cuerpo en los procesos de producción y percepción de la música ha sido estudiado por diversos autores según diferentes enfoques metodológicos y con diferentes fines. Las numerosas taxonomías surgidas en el curso de estas investigaciones reflejan, por un lado, la imposibilidad o dificultad de contener las diversas facetas de un fenómeno amplio y complejo dentro de parámetros absolutistas y, por otro, ofrecen una descripción polifacética de las perspectivas de investigación a través de las cuales se ha desarrollado este tema. El método BAPNE, en particular, presenta una distinción del uso de la percusión corporal según ámbitos que tienen en cuenta diversas dimensiones del ser humano, lo que permite construir una propuesta pedagógica y didáctica que se puede utilizar para estimular las funciones ejecutivas y cognitivas. Por lo tanto, en este capítulo se ofrece una clasificación de los principales modelos taxonómicos que se han consolidado en diversos campos a nivel académico. La descripción de sus elementos peculiares constituirá la base para desarrollar una reflexión sobre su validez y sobre la necesidad de su integración o remodelación.

Palabras clave: Método BAPNE, percusión corporal, fenomenología, neuromotricidad.

INTRODUCTION

The study of the role of the body in the musical experience is widely covered in research conducted by various authors in different disciplinary fields, demonstrating that this relationship does not only involve physical and musical aspects, but also extends into other disciplinary areas. The need to classify a complex phenomenon has led several authors to develop ways of classifying it according to parameters that could transfer an abstract relationship into a concrete description that is as objective as possible, analysable and even measurable. These taxonomies can be classified according to criteria:

1. Philosophical and phenomenological.
2. Didactic and pedagogical.

3. Physiological.
4. Biological
5. Notational.
6. Coreological.
7. Anthropological.
8. Neuroscientific
9. Methodological and interdisciplinary.

1. Philosophical and phenomenological systematisation

The study of the role of the body in musical experience has found an important theoretical foundation in Edmund Husserl's phenomenology (2002a, 2002b), which, after being at the centre of intense academic debate throughout the 20th century, continues to exert a profound influence. According to Husserl, there is no such thing as pure, abstract consciousness, detached from intentional movement (noesi); on the contrary, consciousness is always directed towards an object (noema), understood not as a material thing in itself, but as a set of objective correlates that emerge from subjective perceptual experience in relation to that object. Rejecting the Cartesian conception, Husserl replaces the “ego cogito” with the “ego cogito cogitatum” and attributes to the body an essential role in the construction of both the identity of the subject and the world around them.

As pointed out by Gregorio Vicente Nicolás (2009) in his doctoral thesis, Husserlian thought has influenced numerous authors who have sought to apply phenomenological principles to the perceptual and cognitive processes involved in human experience (Brelet 1949; Clifton 1983; De Jaegher 2007, Fuchs, 2018, Gallagher, 1995, 2005, Greene 1984; Meyer 1956; Sheet-Johnstone, 2019, Varela, 2025, Zuckerkandl 1973), including musical perception (Tanaka & Donnarumma 2019; Pelinski 2005; Peñalba 2005; Schutz & Kersten 1976).

In particular, Rubén López-Cano (2005), in his article *Los cuerpos de la música: introducción al dossier música, cuerpo y cognición*, highlights the indissoluble link between motor skills and sound, between movement and music, analysing the actions that musicians perform on their instruments and the resulting bodily interactions, including accessory and discrete movements. The author therefore proposes a taxonomy of the different ways in which the body participates in the musical experience, divided into eleven points. It includes:

- a) Motor activity that produces musical sound
- b) Motor activity that accompanies the production of musical sound
- c) Proprioception

- d) Actions, postures or bodily pathologies developed with/in music
- e) Neurology, physiology, sensorimotor skills and higher cognitive levels in hearing
- f) Motor activity manifested in musical perception
- g) Covert motor activity in musical perception
- h) Metaphorical projection of bodily cognitive schemas
- i) Musical emotions
- j) Bodily semiotisation of music
- k) Bodily discourses on music

In this comprehensive taxonomy, the Mexican author, while identifying “motor activity producing musical sound” as the primary musical form, does not mention what appears to be the most immediate and natural way of using the body for musical purposes: body percussion, or the direct use of the body itself – struck, beaten or rubbed – to produce sounds and rhythms.

2. Didactic and pedagogical systematisation

At the beginning of the 20th century, a pedagogical trend emerged that attributed decisive importance to movement in educational and training processes, with roots already present in the thinking of Friedrich Fröbel ([1844] 1888, 1912). However, this approach met with modest opposition from some critics (Sánchez-González et al. 2018), which did not, however, hinder the development of music pedagogy. Among these, the most important approach focused on the use of the body was that devised by:

- a) Émile Jaques-Dalcroze (1912), who developed the concept of “eurhythmics”, a method of learning music based on the physical origin of rhythm, with the aim of “creating, with the help of rhythm, a rapid and regular flow of communication between the brain and the body”.
- b) Carl Orff (1978), creator of the Orff-Schulwerk method, in which movement forms part of the teaching approach and is considered a preparatory tool for instrumental practice.
- c) Edgar Willems (1992a, 1992b), according to whom rhythm resides in the movement of the body, which is why he developed a series of exercises based on instinctive movement designed to awaken the “motor imagination, the key to musical rhythm”.

3. Physiological

Attention to the body forms the foundation of several therapeutic approaches according to which human well-being and psycho-biological balance are closely connected to bodily structure and physiological expression. Among these:

a) The Feldenkrais Method b) Ida Pauline Rolf's Structural Integration c) Nikolai Bernstein. Neurophysiology and motor control

3.1. The Feldenkrais Method

The Feldenkrais Method (Feldenkrais, 2011) is primarily defined as an approach to motor learning and an experiential research pedagogy focused on improved functionality (Alokla et al., 2025). It is a discipline rooted in the possibilities offered by our embodiment (Ménasé, 2023). Practice is based on exploration rather than instruction and focuses on the learning process rather than the imitation of a model, since the individual himself constitutes the model (Hancock, 2015). The method is not conceived as a set of techniques to be applied, but as a process that encourages curiosity and experimentation. It can also be defined by its mechanism of action on the nervous system because it: a) promotes progressive neuromuscular reorganization and improves movement efficiency without excessive muscular effort; b) stimulates all kinds of learning by enhancing central nervous system plasticity and refining the quality of sensory information; c) is grounded in the sensorimotor dimension and in the informative and organizational capacities of “learning circuits.” It uses movement and its articulation as a means of learning and a principle of individual development. It helps people connect (or match) their thoughts, sensations, feelings, actions, and reactions.

3.2. Ida Pauline Rolf's Structural Integration

Structural Integration (SI) represents the culmination of the pioneering work of Ida Pauline Rolf (1989), an extraordinarily versatile figure who revolutionized the field of bodywork and profoundly transformed the way human beings perceive themselves and their bodies. Rolf investigated the human condition in relation to the environment, focusing on the link between parts and the whole. Instead of treating symptoms, she developed an ordered and progressive series of manipulations aimed at changing the way the body's structure relates to Earth's gravitational field. From this insight was born the famous “10-session series,” a manipulative sequence whose primary goal is the organization of the body within the field of gravity.

The privileged medium of this intervention is the fascia—the protein-collagen matrix that constitutes connective tissue—which is reorganized and released to allow optimal structural alignment with gravity. Structural Integration is therefore a process of ordering that, by acting on connective tissue, restores a correct relationship with Earth's gravitational field: in this harmonious relationship the individual's energy is enhanced, and gravity itself ceases to be a compressive force and becomes a true therapist. The centrality of gravity emerges clearly in the aging process and structural collapse: from the macroscopic to the cellular level, the body hologram is continually influenced by planetary gravitational and magnetic pressure. All living organisms undergo this compression, but only humans possess the potential capacity to evolve toward conscious verticality. Structural and functional support is achieved by organizing around a central vertical axis: the “Line” (The Line), the cardinal concept of Rolf's work. This Line is not a mere anatomical abstraction, but represents the ideal flow of gravitational influence passing through the body from the crown of the head, beyond the soles of the feet, to the center of the Earth. It is not a segment that stops at the body's boundaries, but a continuous vector that connects the individual to the entire planetary gravitational field. Understanding and embodying this Line is the cornerstone of the entire Rolfian approach.

3.3. Body-Mind Centering

Body-Mind Centering® (BMC®) is a dynamic and experiential approach to the study of embodiment, movement, and consciousness, developed by Bonnie Bainbridge Cohen (2020). It can be described as a continuous experiential journey into the living and ever-changing territory of the body, applying anatomical, physiological, psychophysical, and developmental principles. On this journey, mind—understood as thoughts, feelings, energy, soul, and spirit—acts as the explorer. The goal is to reach an understanding of how mind is expressed through the body in movement, and the quality of that movement is a manifestation of how mind is expressing itself at that moment through the body. “Centering” in BMC is therefore not a fixed endpoint, but a process of balancing based on visual, somatic, artistic, musical, and meditative dialogue and experience. The approach can be applied to an almost unlimited number of fields, including dance, athletics, therapeutic disciplines, expressive arts, and educational contexts.

3.4. Nikolai Bernstein. Neurophysiology and motor control

Nikolai Bernstein, Russian neuroscientist (1896–1966), is renowned for his theory on the construction and coordination of movements in humans and animals, in which he emphasizes a holistic, evolutionary, and non-reductionist approach, integrating mechanics, physiology, and mathematics. His theory, developed from the 1920s and culminating in works such as *On the construction of movements* ([1947] 2021), emphasizes a hierarchical and dynamic approach to motor control. He thus developed a completely original definition of movement coordination, understood as the process by which the central nervous system overcomes the redundant number of degrees of freedom of the human motor apparatus. This problem, known as “the degrees-of-freedom problem” in movement science, identifies the challenge of motor control in managing the multiple movement possibilities offered by joints (e.g., the elbow has one degree of mobility, while the shoulder and hip have three) (Bernstein, 2020).

According to his theory, movement coordination is organized in hierarchical levels (e.g., tonic level for muscle tone, synergistic level for coordinated patterns, spatial level for orientation, action level for complex tasks). Each level communicates with a “common language,” and during learning control shifts from higher (conscious) to lower (automatic) levels. This allows adaptability and evolution of movements. At the basis of Bernstein’s theoretical paradigm are several key concepts:

a) Motor synergies: Functional groups of muscles and joints that work together as coordinated units to solve the degrees-of-freedom problem. Instead of controlling each muscle individually, the CNS organizes synergies for efficient movement patterns, integrating muscular and non-muscular forces (e.g., gravity or inertia). b) Sensory corrections and reflex circle: Movements are not only central commands but involve continuous sensory feedback through a “reflex circle.” The CNS sends commands and receives real-time corrections from sensors (proprioception, vision, touch), allowing dynamic adaptations. Bernstein criticized the oversimplified application of Pavlov’s reflex theory, emphasizing that living movements are internally initiated by the organism. c) Physiology of activity: In contrast to a purely reactive view (reflexes to external stimuli), Bernstein proposed that movements are “active” and originate from within the organism. This concept underscores internal initiative and feedback integration for autonomous regulation, forming the basis of modern motor control theory. d) Motor learning and skill development: Learning is a process of transition:

initially movements are controlled by higher hierarchical levels (with conscious effort), but with practice they shift to lower levels (automatic), reducing degrees of freedom while increasing flexibility, adaptability, and trainability. Movements evolve toward greater efficiency and variability. e) Principle of equal simplicity: In complex movements, the CNS prefers topologically similar and simple solutions that minimize computational effort. This helps explain how similar motor patterns emerge in different contexts.

These concepts have profoundly influenced movement science, biomechanics, rehabilitation, and sport, and are considered foundational for dynamical systems theory.

4. Biological

Esther Thelen's theory (1994), developed especially in collaboration with Linda B. Smith, frames development as an emergent product arising from real-time change within a complex dynamic system involving multiple decentralized local interactions. Thelen's approach, also known as the embodiment hypothesis (or embodied cognition), argues that intelligence is not merely a matter of symbolic reasoning, but is created and realized through physical actions in the world. The emblematic example Thelen uses to support her theory is "crawling." This action does not exist as a genetic or neurological "program" but is a coherent behavior that self-organizes as a solution to the problem of moving (e.g., crossing the room) when the child has sufficient strength and coordination for quadrupedal posture but not enough balance for upright walking. When children learn to walk, the crawling pattern is destabilized by the new patterns of standing and walking.

Thelen challenged the traditional view that separates mental processes into "feel-think-act." Cognition is seen as embodied, distributed, and inseparable from perception and action processes. For example, the object-concept is not a belief that mediates between perception and action, but is embodied in the sensorimotor system itself. Movement is crucial, and the processes that give rise to motor behavior are also the repository of knowledge and the engine of evolutionary change. Thelen's dynamic systems theory suggests that, while biological constraints lead to globally similar developmental outcomes (e.g., all children learn to walk), the system is also highly non-linear. This means that small changes in one component can lead to reorganization and large behavioral differences. This sensitivity to initial conditions and developmental history explains why development at the micro-level is more "messy" and tied to the idiosyncratic real-time activities of the individual child.

5. Notational

The problem of movement transcription, particularly of dance, is a central issue in choreological and musicological studies, since it clashes with the ephemeral nature of this art form. As Elisa Anzellotti states (2020), "writing about dance" and "writing dance" are two distinct actions. To achieve a true writing of dance, an extensive set of characters is required to allow a complete graphic representation of every single movement. As Hutchinson Guest points out (1998), attempts to represent choreographies and their kinetic sequences can be classified into five modalities:

a) words and abbreviations b) floor patterns ideally traced by dancers during performance c) stick figures d) adaptation of the musical score to movement notation e) abstract symbols

With the exception of the first, each movement notation system is analyzed by the author according to five parameters:

a) representation of the body parts used b) direction and level in which the movement develops c) temporal scanning of the movement d) flexions e) rotations f) foot positions g) turns and pirouettes h) walking, jumping i) arm movements

The description of each model is accompanied by an analysis of the advantages and disadvantages of its use.

6. Psychological

Richard Schmidt has been one of the most influential researchers in the field of motor psychology and motor learning. His best-known contribution is the Schema Theory of Motor Learning, first published in 1975 (Schmidt, 1975) and subsequently refined. The central concepts of his theory are:

a) Recall schema – Responsible for the selection and initiation of movement. – Relates four types of information: § Initial conditions (body position, environment position, etc.) § Specific parameters assigned to the movement (force, speed, duration, etc.) § Actual outcome of the movement § Perceived sensory consequences (proprioceptive, visual feedback, etc.) – The more varied experiences we accumulate, the more robust and flexible the recall schema becomes → we can produce novel movements in new situations (generalization ability).

b) Recognition schema (or expectancy schema) – Used to evaluate movement outcome (error detection). – Allows comparison between expected and actual outcome and correction of error in the next execution.

c) Generalized Motor Program (GMP) – Schmidt proposed that we do not store a separate program for every possible variant of a movement (impossible due to the huge number of variants). – Instead, there exists an abstract, invariant program (relative structure: order and relative timing of components) that can be parameterized (force, speed, amplitude, limbs used). – Example: the GMP for throwing is the same whether throwing a baseball, a stone, or a dart; only the parameters change.

d) Fundamental role of practice variability – One of the most cited and pedagogically applied findings: practicing with variability (different distances, speeds, tools, conditions) builds strong, transferable motor schemas.

7. Choreological

7.1. Labanotation

Rudolf Laban's notation system (1926, 1928a, 1928b) is based on a vertical three-line staff on which human body movement and the polyrhythmic and polykinetic complexity of human movement are

represented. It consists of three parallel vertical lines that create columns in which actions of different body parts can be written simultaneously and consecutively. In this way the staff directly represents the dancer standing upright, immediately making lateral body symmetry visible: consequently, symmetrical movements produce perfectly mirrored indications on the page. Moreover, precisely because the performer identifies the staff with his or her own vertical axis, the continuous flow of movement can be represented without interruption, through symbols that follow one another uninterruptedly along the columns (Figure 1).

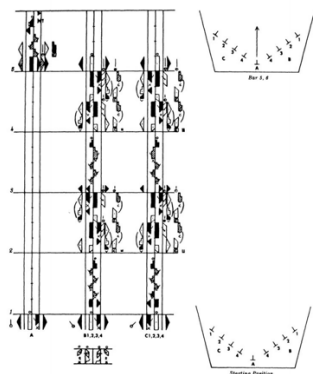


Figure 1. Example of Labanotation (Guest, 1998)

Time is made visual by the length of the symbols: greater length corresponds directly to longer duration of the gesture. This length variation allows rhythmic relationships between different body parts, as well as subtle overlaps or phase shifts in the start or end of simultaneous actions, to be indicated with extreme ease and flexibility. Minimal temporal differences—which in traditional notation would require exact counting of thirty-second or sixty-fourth notes—are immediately perceptible at a glance, without calculation.

Directions are also intrinsically visual: each symbol, by its shape, directly indicates the spatial direction it represents. Block symbols, when grouped, generate patterns that can be read as coherent sets rather than isolated signs. These blocks provide the supporting structure of the movement, while secondary details and modifications are indicated by small accessory signs, ensuring a clear and immediate visual hierarchy.

Among movement transcription systems, the method devised by Rudolf Laban, known as Kinetography Laban or Labanotation, is “the most complete and scientific [notation] system ever developed” and still today the “most widely used,” especially in choreological and ethnochoreological studies. At the same time, because of its complexity and the manifest difficulties of reading and use by those without specific training, Labanotation has also been the object of criticism by several authors.

7.2. Laban/Bartenieff Movement Analysis

Building on Labanotation, Irmgard Bartenieff developed a movement analysis method whose distinctive features, the movement fundamentals, lie in the emphasis placed on connectivity—highlighting the flow between singular and collective dimensions of movement—and in the

application of somatic and analytical principles aimed at integrating the individual with his or her environment. Because of its close relationship with the Laban method, it is also called LBMA (Laban/Bartenieff Movement Analysis) (Hackney, Weeks & Bartenieff, 2004).

For Bartenieff, body, artistic action, and bodily expressiveness of the subject in the world take on an expanded and flexible reading. The organism is seen as an integrated whole (body/mind/action), and the purpose of mobility investigation is not limited to self-recognition but is completed in interaction with space, with the other, and in the creation of networks with the collective. For this reason LBMA introduces analytical categories such as Body, Effort, Shape, Space, Phrasing, and Relationship (BESS). Bartenieff's analysis method stands out for its ability to combine deep somatic understanding of movement—through exploration of internal principles such as connectivity and basic neurokinesiological domains—with a structured analytical framework (LBMA/Effort-Shape) that allows systematic and detailed observation for therapeutic purposes as well.

7.3. Gurdjieff Movements

Georges Ivanovič Gurdjieff was a controversial spiritual teacher who, shortly before the Russian Revolution, began teaching in Russia and later in Europe a practical-esoteric system called the “Fourth Way” (from the book of the same name by P.D. Ouspensky).

His central message was that human beings live in a state of hypnotic sleep, are reactive machines moved by external stimuli, identified with a false personality that hides true essence. To awaken one must: • recognize one's automatism, • unmask the image we have of ourselves, • work simultaneously on body, emotions, and intellect, • “die” to the mechanical personality in order to “be reborn” conscious.

Unlike the three traditional ways (fakir → body, monk → emotions, yogi → mind), the Fourth Way is practiced in everyday life, without monasteries or retreats, using relationships, work, and difficulties as material for awakening. Sacred dance, movements, and exercises were central tools because, for Gurdjieff, knowledge is transmitted first and foremost through the body.

The classification of Gurdjieff's “Movements,” as described by Wim van Dullemen (2020), includes: a) Movements, “in which dancers move head, arms, legs and perform positions with the body while remaining in place”; b) Displacements, in which dancers “must move and perform a series of steps, finally returning to the starting position” (p. 204); c) Transpositions, where “dancers do not move back and forth in their small labyrinth, but must exchange places with another dancer who in turn has left his place to take someone else's.”

As the Dutch musician states, “describing all the variants in displacements and transpositions of the Movements would require [...] an entire book” (p. 205). Among these, the most emblematic for understanding Gurdjieff's theory are the “Movements” and the “Multiplications” of the enneagram (Figure 2). The enneagram is a geometric symbol first published in P.D. Ouspensky's *Frammenti di un insegnamento sconosciuto*. It is created by dividing the circumference of a circle into nine equal sections. The resulting points are numbered starting from the top as 9, then clockwise 1 through 8. Points 9-3-6 are connected by straight lines forming an equilateral triangle (Law of Three). The remaining six numbers are connected (1-4-2-8-5-7-1) by straight lines. The

entire figure—circle, triangle, and the hexad—forms the enneagram and defines the space and rules for performing Gurdjieff's movements.

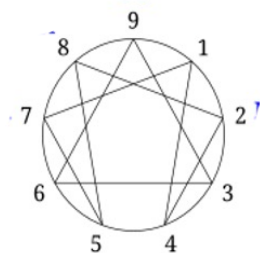


Figure 2. Enneagram (own elaboration).

7.4. William Forsythe and de-structured movement

William Forsythe is a central figure in redefining the conceptual and disciplinary boundaries of both ballet and choreography in the broader sense. He is globally recognized for having innovated ballet in a way that had not been done for a long time, challenging the ossification of thought that had prevented ballet from fully developing as a contemporary art form. The most salient aspects of William Forsythe's theory (Groves, 2012) focus on the notion of expanded choreography, its distinction from dance, and the importance of "choreographic objects."

Forsythe's movement analysis uses digital tools and non-conventional notation to visualize and deconstruct kinetic mechanisms. Of particular relevance are *Improvisation Technologies*, a pedagogical CD-ROM created to explain and demonstrate the working methods for improvisation used by the Ballett Frankfurt through verbal and visual explanations of underlying kinetic mechanisms, and *Synchronous Objects* (2009), in which a digital score was created to visualize the choreographic functioning of *One Flat Thing*, reproduced (2000) through indexing, mapping, and diagramming of its cues, movement themes, and organizational structures (Leon, 2020).

8. Anthropological systematization

Labanotation was fundamental for the development of comparative and transcultural studies of dance and movement style such as Alan Lomax's choreometrics (1968a, 1968b, 1971), whose genesis lies in the earlier cantometrics model developed by Lomax himself.

The term Choreometrics is defined as "the study of dance and movement style as a measure of society" and uses film as data for cross-cultural comparative analysis of movement style. The project is based on the hypothesis that every culture possesses a dance style composed of choreutic patterns (movements, postures, gestures) that are culturally transmitted and closely linked to social organization. Lomax argued that differences in dance styles do not reside in purely aesthetic factors, but in cultural factors such as gender relations, modes of production, and environmental adaptation. Dance can therefore be considered primarily as representation and reinforcement of a cultural model, and only secondarily as individual emotional expression. According to this study,

many aspects of movement previously considered idiosyncratic actually vary according to culture type.

For the project, Lomax and his collaborators used an empirical, descriptive, and cross-cultural comparative approach, analyzing hundreds of films of traditional dance from different populations (over 700 clips). Lomax believed that movements related to work activity were especially crucial in defining stylistic features of dance. For example, the forward-leaning posture typical of farmers using short-handled hoes is reflected in the main choreutic figures of West Africa.

The project identified two principal “measures of dance style” analyzed in the documentary *Dance & Human History*:

1. Arm movement: classified into three qualities associated with cultural traits: linear (one-dimensional), curved (two-dimensional), and spiral (three-dimensional). For example, populations with strongly stratified social structures and practicing agriculture tend to move arms in spirals.
2. Trunk movement: classified as single-unit (typical of hunters in cold climates) or multi-unit (typical of tropical farmers).

Lomax went so far as to claim that, by mapping dance styles associated with social structures, it would be possible to reconstruct humanity’s historical path, showing migratory movements and their traces in choreutic styles.

Interest in corporeality and gesture, known as cultural kinesics (or somatization of sound), was later taken up and developed in Italy by Diego Carpitella, influenced precisely by Lomax’s work.

9. Neuroscientific

Recent neuroscientific discoveries have profoundly influenced studies on body and movement, also in relation to artistic forms of expression such as music and dance. Among these, Steven Brown (Steven Brown & Parsons, 2006) focuses on the neuroscience of dance, considering it a fundamental form of human expression and an extraordinary evolutionary novelty. Our natural capacity for rhythm, which leads us to move unconsciously to music, is regarded as an almost non-existent evolutionary novelty in other mammals or in the animal kingdom in general. Dance is therefore defined as a confluence of movement, rhythm, and gestural representation that initially evolved as a sound-related phenomenon.

Another interesting author in this line is Scott Brown. His proposed theory focuses on the need for a unified approach to the psychological study of the arts, countering their current segregation into individual domains (music, dance, theater, literature, visual art). The theory is presented in his 2024 article “The performing arts combined: the triad of music, dance, and narrative.” His goal is to establish a conceptual theoretical framework for inter-domain research in the performing arts, starting from the simplest coupling level: pairwise art combinations. Brown emphasizes the numerous advantages of inter-domain research on the arts, including:

1. Reflecting cultural integration
2. Understanding cognitive and neural mechanisms that allow art forms to combine
3. Testing co-evolutionary theories of the arts
4. Identifying shared vs. unique processing resources
5. Achieving deeper understanding of each art form through comparison.

10. Methodological and interdisciplinary systematization

The systematization of the role of the body in musical production, perception, and understanding processes finds an interdisciplinary methodological framework within the Metodo BAPNE. Created in 1998 by PhD Francisco Javier Romero-Naranjo, the BAPNE Method is defined by its creator as a method of cognitive, socio-emotional, psychomotor, and neuro-rehabilitation stimulation (Arnau-Mollá & Romero-Naranjo, 2020). Its primary goal is not musical learning per se, but cognitive stimulation and the development of executive functions (working memory, cognitive flexibility, inhibition) of the brain (Miyake & Friedman, 2012; Miyake et al., 2000; Tirapu-Ustárroz & Luna-Lario, 2008; Tirapu et al., 2008).

The name BAPNE is an acronym that encapsulates its five founding disciplines, which provide the theoretical and scientific justification for all proposed activities:

The body-percussion taxonomy it employs follows criteria:

1. Biomechanical: Contributes to the study of movement from a physical-mechanical perspective, analyzing movement according to biomechanical planes and axes (sagittal, longitudinal, and horizontal) conditioned by our bipedal nature.
2. Anatomical: Supports understanding of gross and fine motor possibilities that the body can express thanks to its bone/muscle structure and bipedal posture, which allows limb dissociation and speech.
3. Neuropsychological: Romero-Naranjo defined the concept of neuromotricity as the discipline that studies the neurological processes influencing the generation and control of human motricity, and as an educational and neuro-rehabilitation methodology that specifically targets brain executive functions.
4. Neuroscientific: Provide scientific explanation of the proposed exercises and the purpose of activating different brain lobes in relation to cognitive and executive functions, maintaining high and prolonged concentration. The methodology is based on neuromotricity (Andreu-Cabrera & Romero-Naranjo, 2021, 2024) and its application for the development of executive and cognitive functions (Álvarez-Morales & Romero-Naranjo, 2019; Arnau-Mollá & Romero-Naranjo, 2020; Carretero-Martínez et al., 2014; Castelló-Juan et al., 2019; Díaz-Pérez, 2016; Latre-Navarro, 2019; Moral Bofill, Vicedo Mollá & Romero-Naranjo, 2020; Ros-Silla et al., 2019; Torró-Biosca et al., 2019).

5. Anthropological/functional: The BAPNE Method defines body percussion as «the art of striking the body to produce various types of sounds for didactic, therapeutic, anthropological and social purposes» (Romero-Naranjo, 2013, p. 443). It therefore develops a classification (taxonomy) of body percussion according to uses, functions, and meanings it takes on in different cultures (e.g., ritual/symbolic actions, work songs, pedagogical purposes, etc.), built on Alan Merriam's model (Romero-Naranjo, 2017, 2025a, 2025b) and later expanded into twelve domains thanks to anthropological/ethnomusicological research (Di Russo, Arnau-Mollá & Romero-Naranjo, 2024).

Conclusions

The complexity of the “body-music” phenomenon makes a single, absolute taxonomy impossible. What has been presented in this chapter shows that, in over a century of research, no author or school has succeeded in enclosing in one exhaustive model all the dimensions (physical, cognitive, emotional, cultural, pedagogical, therapeutic, neurological) in which the body participates in musical production and perception. Existing taxonomies are always partial and reflect the specific objectives of their field of origin (phenomenological, pedagogical, physiological, neuroscientific, anthropological, choreological, etc.). All the taxonomies examined therefore present gaps. López-Cano's phenomenological taxonomy (2005), though very complete (11 categories), surprisingly omits the most direct and primordial form of bodily sound production: body percussion; the great 20th-century pedagogical methods (Dalcroze, Orff, Willems) use the body in a propedeutic way but with purely musical aims; somatic schools (Feldenkrais, Rolfing, Body-Mind Centering) and neurophysiological ones (Bernstein, Thelen, Schmidt) offer fundamental keys to movement and motor learning but were not designed for music. Notational (Labanotation, Forsythe, etc.) and anthropological systems (Lomax) focus on dance or cultural movement rather than on rhythmic-percussive sound production with the body, while recent neuroscientific approaches recognize the importance of movement-sound coupling but remain descriptive and do not propose an operative didactic methodology.

The BAPNE Method, on the other hand, proposes a classification that intends to overcome precisely these shortcomings by achieving a taxonomy through true interdisciplinary integration. It can be considered, within studies on the body-music relationship, the most complete and updatable taxonomy of body percussion existing to date (12 anthropological-functional domains + five scientific criteria). This taxonomy clearly highlights that the body in music cannot be reduced to a single dimension (instrument, expressive medium, notational object, cultural marker, or mere activator of brain areas); only a radically interdisciplinary approach—bringing together biomechanics, anatomy, neuroscience, anthropology, and pedagogy—can do justice to its complexity. (Romero-Naranjo, 2025a, 2025b) The BAPNE Method therefore represents, at the current state of research, the most advanced and integrative taxonomic and methodological proposal in this field, capable of transforming body percussion from an ancillary or folkloric practice into a scientific tool for cognitive stimulation and global personal development.

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Ethnomusicology as a theoretical and practical pillar of the BAPNE method.

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Abstract

Since its inception, ethnomusicology has always paid considerable attention to the body. The description and analysis of the relationship between the physical elements that constitute it and the musical production it expresses within each cultural context has led to the emergence of a specific field of ethnomusicology, the developments of which have influenced various areas of research. Within this framework, the BAPNE Method offers an emblematic example of the study of body percussion through the integrated contribution of five disciplines. Ethnomusicology, in particular, offers the methodological proposal the possibility of adopting theoretical paradigms and investigative tools but, above all, of directing anthropological analysis and reflection on the cultural and social processes that body percussion reflects and can determine. In this chapter, therefore, we will analyse the characteristics and ethnomusicological elements that led to the inclusion of ethnomusicology in the conception and creation of the BAPNE Method and describe its contributions to the field of musical anthropology.

Keywords: ethnomusicology, BAPNE Method, neuromotricity, body percussion.

Resumen

Desde sus inicios, la etnomusicología siempre ha prestado una atención considerable al cuerpo. La descripción y el análisis de la relación entre los elementos físicos que lo constituyen y la producción musical que expresa en cada contexto cultural han dado lugar a la aparición de un campo específico de la etnomusicología, cuyos avances han influido en diversas áreas de investigación. En este marco, el método BAPNE ofrece un ejemplo emblemático del estudio de la percusión corporal a través de la contribución integrada de cinco disciplinas. La etnomusicología, en particular, ofrece a la propuesta metodológica la posibilidad de adoptar paradigmas teóricos y herramientas de investigación, pero, sobre todo, de orientar el análisis antropológico y la reflexión sobre los procesos culturales y sociales que la percusión corporal refleja y puede determinar. En este capítulo, por lo tanto, analizaremos las características y los elementos etnomusicológicos que llevaron a la inclusión de la etnomusicología en la concepción y creación del Método BAPNE y describiremos sus contribuciones al campo de la antropología musical.

Palabras clave: etnomusicología, método BAPNE, neuromotricidad, percusión corporal.

INTRODUCTION

The history of ethnomusicology, which has its roots in earlier comparative musicology, has been marked by a profound evolution in its theoretical and methodological paradigms, driven by a desire to understand the “music of the Other” and, subsequently, the “musical Other” itself (Cámara de Landa & Tuzi, 2023). This transformation has involved the name of the discipline, its object of study, its theoretical foundations and its methods of field research. For this reason, contemporary ethnomusicology is defined by a remarkable multiplication of themes and a growing eclecticism in the adoption of theoretical and methodological perspectives, often borrowed from other areas of knowledge (Myers, 2001). The study of the body, in particular, has represented (and still constitutes) one of the main fields of investigation that has evolved in parallel with the discipline itself, moving from an initial functionalist and comparative assessment (the origin of music, physical behaviour as ethnographic data) to an anthropological analysis of the body linked

to neurophysiological and social mechanisms, and finally to performance and embodied cognition (the body as a vehicle of meaning and sensory knowledge). In all these areas, the use of visual documentation (visual ethnomusicology) has been fundamental in capturing and analysing the essential kinesic and proxemic components of musical practices.

In the BAPNE Method, specifically, ethnomusicology (the “E” in the acronym BAPNE) is one of the five fundamental disciplines on which the methodology is based (Biomechanics, Anatomy, Psychology, Neuroscience and Ethnomusicology) due to its ability to provide the anthropological and sociological framework necessary to justify and systematise the use of body percussion not only as an educational or co-therapeutic practice, but as a culturally significant phenomenon (Romero-Naranjo, 2008, 2013; 2025).

1. Ethnomusicology of the body. Themes and theoretical approaches.

The body is a crucial and multidisciplinary element in ethnomusicology, as it represents the primary vehicle of musical action, behaviour, ritual and cultural meaning. Enrique Camara De Landa, in his book *Ethnomusicology* (2003), states that the study of this topic has developed within the discipline with characteristics such as to determine the birth of a true “etnomusicologia del corpo” (p. 177). There are many topics addressed and methodological approaches adopted throughout the history of ethnomusicology within this field of research, which, by way of example, can be traced back to four different areas:

1. Foundational approaches.
2. Ethnomusicology and biological dimensions.
3. Body, performance and effective ritual.
4. Cognitive, phenomenological and reflective perspectives.

1.1. Foundational approaches.

The early stages of the discipline recognised the body as a primary element of music. André Schaeffner ([1936] 1999), building on the work already done by Richard Wallashek (1893), argues for the existence of a bodily origin of instrumental music (Figure 1), as opposed to the logogenic theories (Levman 1992) developed by Herbert Spencer (1864, 1867, 1890, 1906), which are in turn based on those of Charles Darwin ([1859] 1994). According to the French author, in its primitive forms, it always presupposes dance in which «l'uomo batte il suolo con i piedi o con le mani, percuote il suo corpo in cadenza, lo agita parzialmente o interamente per animare gli oggetti e gli ornamenti sonori che indossa» ([1936] 1999, 25) and, in this way, “si copre di musica” (p. 70).

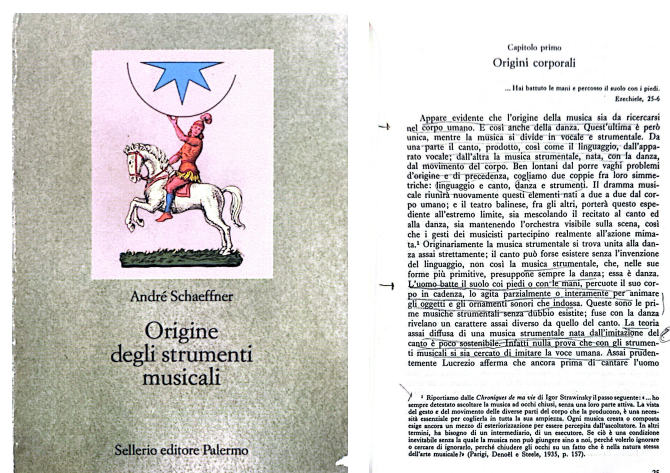


Figure 1. Cover and first page of Schaeffner's book ([1936] 1999).

In the field of comparative musicology, these conclusions have generated a contrast between universalistic conceptions and ethnocentric views of music. While Stephen Blum (1991) stated that “the fact that similar body movements have accompanied the same melodic motions in different times and places points to the existence of “a unitary acoustic-moto movement as the common root” (p. 12), Hornbostel, comparing the musical behaviour of Europeans with that of Africans, stated that ‘we proceed from hearing, they from motion’ (1928, p. 53). In the perspective outlined by Blum, a few years later Alan Merriam ([1964] 1983) imposed his anthropological approach on the question, identifying physical behaviour as one of the four types of behaviour related to the production and organisation of sound and emphasising its enormous technical importance and relevance for solving problems of cultural diffusion. Attention was then turned to instrumental musical performance techniques, vocal style and gestural habits related to performance technique, including elements of proxemics and kinesics analysis, such as socially accepted body positions, gestural habits related to performance technique, functional interrelationships between body postures and non-gestural cultural phenomena, the psychological and psychiatric implications of physical behaviour, and other phylogenetic or biological aspects such as the human organism's responses to music.

1.2. Ethnomusicology and biological dimensions

Starting in the 1970s, many ethnomusicologists focused on studying the biological and physiological foundations of music-making. Among them was John Blacking, who in *How Musical is Man and The Anthropology of the Body* (1977) gave rise to what was defined as a “biology of music-making” (Camara de Landa & Tuzi, 2003, p. 110), focusing on musical traits as primary elements to be analysed in an anthropological study of physical behaviours closely connected to brain functions, psychological processes and culturally acquired behaviours: a physiological study of brain functions in combination with psychological mechanisms and acquired cultural behaviours. Proxemics, i.e. socially shared body positions, and kinesics, i.e. gestural and behavioural attitudes in motion, are considered ‘cultural facts’ (Carpitella 1979, 10) and have been applied, for example, to analyse musical control during a dance performance (Hanna, 1977) in which music can play a mediating role between interiority and exteriority in rituals of possession and shamanism, as reported by Gilbert Rouget (1990) in *Music and Trance, or therapeutic resolution* (a sort of

choreographic-musical exorcism) in which the body and musical rhythm in certain rituals can express society's capacity for physical and spiritual regeneration (Planke, 2015).

1.3. Body, performance and ritual effectiveness

The study of performance in ethnomusicology has elevated the body to a multidimensional field of analysis capable of uniting the entire sensory universe of human beings (Royce, 2002), including the psychic, acoustic, cognitive and social aspects of shared musical experience. Performance analysis can therefore act as a link between detailed formal musical analysis and the broader context in which music is performed. The possibility of using technological tools that allow the recording of musical performances is an almost indispensable method of investigation, enabling the transcription and understanding of certain aspects of the performance, the memorisation and recall of specific moments, its use in dialogical ethnomusicological processes and its use in educational contexts, such as seminars or conferences (Baily, 1988).

Visual ethnomusicology (such as films and videos) has thus taken on increasing importance within the discipline and has been increasingly used in field research to investigate kinetic and gestural codes within a given culture, particularly in the context of musical performance (Hood 1971; D'Amico, 2012). This is demonstrated by studies conducted between the 1970s and 1980s on extra-verbal languages based on proxemic and kinesic elements acquired through film footage with the aim of “introdurre ad una lettura cinesico-culturale del tessuto sociale italiano, con particolare riguardo alla cosiddetta “fascia folclorica” (Carpitella, 1979, p. 10), can be considered the forerunners of a multitude of visual ethnomusicology research projects undertaken in Italy (Adamo, 2010; Morelli, 2021, Cosentino, Di Mauro & Giordano, 2021). In non-European contexts, film and audiovisual documentation.

In non-European contexts, film and audiovisual documentation is used in different cultural contexts: in India, it is used to capture hand movements during Hindustani musical performances, revealing insights into how musicians conceive their music (Clayton & Leante, 2015), to describe the discrepancy between the auditory image and the image played by magwilo xylophone players and the hand clapping of a Fõ girl in Togo (Kubik, 1965, 1972) or to reflect on the ability of performance, especially dance, to influence social dynamics related to gender, age and power (Ede, 2017).

1.4. Cognitive, phenomenological and reflective perspectives

The most recent ethnomusicological studies consider bodily experience to be closely related to mental processes and subjective experience. This is demonstrated by the application of hermeneutic phenomenology which, starting with Merleau Ponty (1993), has been applied in psychiatry to investigate the relationship between mental illness as a reflection of bodily disorders (Fuchs, 2018), and in cognitive science to affirm the importance of the dynamic interaction of the organism with the environment for the development of cognition (Gallagher, 1995, 2005), and in sociology, to support the bodily nature of interpersonal relationships (De Jaegher, 2007), choreutic, to support the thesis of the kinetic root of the human being, antecedent to perception and reflection (Sheet-Johnstone, 2019), scientific-philosophical, to describe the dynamic and embodied interaction of the organism with the environment and its impact on cognitive development (Varela,

2025) and musical development (López-Cano, 2005; Pelinski 2005; Peñalba 2005), to understand the musical experience within the processes of production and perception. In this approach, the body is crucial, leading to a deep understanding of oneself, as in the state of “being musical” described by Jeff Todd Titon (1997), in which the individual is completely transported and the body is involved in an “embodied curiosity” (p. 75). Analysing the practical learning experience, as in the case of playing the Bulgarian gaida described by Rice (1994), can also reveal that kinetic movements (in this case, those of the fingers) can allow the researcher to understand musical concepts that theoretical analysis alone could not explain. The dialogue that ethnomusicology has established with theories of embodied cognition (Embodied, Enactive, Embedded, Extended) can be seen in *Musicae Scientiae*, 92, the periodical of ESCOM, the European Society for the Cognitive Sciences of Music, published in 2001, which highlights the centrality of the body as a key aspect of cognitive processes related to sound. Among these is Eric Clarke's (2001) text, which analyses the relationship between music and movement both in a real sense (dance, swaying) and an imaginary sense (the virtual reality generated in the listener's mind), arguing that movement is a central aspect of musical meaning.

2. The contribution of ethnomusicology to the study of body percussion

Body percussion is a specific research topic within the ethnomusicology of the body because, as Francisco Javier Romero-Naranjo (2013) states, it can be defined as “the art of striking the body to produce various types of sounds for didactic, therapeutic, anthropological and social purposes” (p. 443). Ethnomusicology, in fact, allows us to study the use of body percussion through an anthropological and sociological perspective that enables us to reflect on the use of the body for musical purposes, considering body percussion as a form of cultural expression (Abels 2019; Agawu 2016; Alonso-Sanz and Romero-Naranjo 2014, 2015; Blacking 1967, 1977, [1973] 1986; Borgatti 1976; Durkin 2010; Fox 1995; György and Pesovar 1961; Hanna 1977; 1979; Hill 2010; Hopkin 1984; Hubbard 1922; Romero-Naranjo 2008, 2013; Rouget 1977a, 1977b, 1990; Schütz 1992; Wirtz 2007a, 2007b, 2018; Youngerman 1974, or even subcultural (Dodds 2015; Kartomi 1980; Magrini, 2003; Thomas 2017; Wilkinson 1994), as a constituent element of certain choreographic expressions (Kartomi 2007; Kubik 1965, 1972, 1987, 2010; Lomax 1968a, 1968b, 1971; Ortiz 1965, Rakočević, 2015, Royce 2002; Sachs [1933] 2015, Tani 1983), in work songs (Gioia 2006; Korczynski, Pickering and Robertson 2013) and in children's coordination games (Bishop 2014; Carbajo-Martínez 2009; Casals-Ibáñez and Riera-Martínez 2015; Coberly 2020; Hubbard 1982, Merrill-Mirsky 1986, Prigent 2013; Romero-Naranjo and Romero-Naranjo 2013). The specific contribution that this discipline can offer to furthering the study of the subject concerns:

1. Anthropological and cultural foundation. This includes:

a) Historical documentation. Knowledge of body percussion in different cultures is largely due to the initial contributions of travellers, chroniclers, missionaries and researchers who recounted what they observed on their travels, creating veritable ethnographies of musical forms similar to body percussion. Sources of this kind have provided anthropological information on the use of the body in music and dance in different cultures in the past (Abbé Desmanet 1767; Jobson 1623; Kolb 1742; Länder and Länder 1832; Laing 1825;

Livingstone 1861), Asia (Polo, 2003), the Americas (Atkins 1737; Colombo 1985; Labat 1722; Moreau de Saint-Méry 1796, 1801) and Oceania (Cook 1842).

b) Analysis of the cultural context and its relationship with the body. Ethnomusicology helps us understand that the body of a musician or dancer is not just a physical/biological object (Thomas & Ahmed 2004) but a “cultural body” whose characteristics are defined in relation to the context to which it belongs (Noland 2009).

2. Taxonomies and analytical methodologies. Ethnomusicology allows for the development of useful frameworks for the analysis and academic research of body percussion. These can follow various criteria, including:

a) biomechanical, i.e. taking into account the parts of the body, distinguished by planes and axes, used in the performance of body percussion according to biomechanical criteria;

b) geographical, i.e. mapping the use of body percussion in different parts of the world, discriminating against any cultural criteria;

c) musical, i.e. classifying body percussion according to specific repertoires, genres or cultural contexts in which body percussion is used, taking into account, however, in particular, the rhythmic, timbral and performative functions that it fulfils;

d) notational, i.e. classifying body percussion through the analysis of the transcription systems adopted by different authors;

e) cultural, meaning creating a taxonomy of body percussion that takes into account the cultural contexts in which it is used, analysing its uses, functions and meanings (Merriam [1964] 1983), such as to determine its social relevance (Josep Martí & Collins, 2024).

3. Research methodologies and applications. Ethnomusicology provides the theoretical and methodological framework that allows us to:

a) analyse repertoires and contexts, i.e. study the use of body percussion in specific dance and music repertoires and cultural contexts;

b) adopt suitable tools for conducting field research (Delitala, 1992);

c) analyse movement by adopting the most suitable methodologies validated in ethnomusicological literature;

d) study body percussion, paying particular attention to its musical characteristics and its relationship with the kinesthetic, proxemic and choreographic dimensions of body percussion;

e) to deepen the learning processes through which the skills and competences necessary for body percussion can be acquired;

f) to employ ethnomusicological theoretical paradigms in the study of body percussion in order to analyse certain cultural processes belonging, for example, to the dialogical and participatory dimension of ethnomusicology;

g) apply the results of ethnomusicological research in other disciplinary fields such as education, neuropsychology, therapy, etc.

3. Etnomusicologia nel Metodo BAPNE

The BAPNE method is a ‘method of cognitive, socio-emotional, psychomotor and neurorehabilitative stimulation based on neuromotor skills whose objective is to work on executive functions’ (Romero-Naranjo 2019, p. 2). It was developed in 1998 (Arnau-Mollá and Romero-Naranjo 2022a) by Dr Francisco Romero-Naranjo, full professor at the University of Alicante, internationally recognised as a pioneer in the field of neuromotor skills and motor coordination. Encouraged by musicologist Lothar Siemens to move to Berlin, he obtained his PhD with a thesis on Baroque polyphonic music at the Alexander von Humboldt University under the supervision of musicologist Hermann Danuser and the co-direction of Lothar Siemens and Rosario Álvarez. His interest in body percussion stems from his passion, from a very young age, for the music of other cultures. He therefore travelled to Morocco, Senegal, Burkina Faso and Ghana to conduct field research. Observing the musical behaviour of these cultures and their deep connection with movement led Romero-Naranjo to reflect on the role of the body in learning rhythm and music in culture. His thinking therefore aims to import the African model into the Western world so that it can contribute to the educational development of children and the personal well-being of all categories of people.

His experience in Africa, combined with a holistic view of human existence fuelled by a family background of professionals from various disciplines (education, psychology, architecture), led him to undertake a project to justify and systematise body percussion through the creation of a method identified by the acronym BAPNE.

As described by Antonio Arnau-Mollá and Francisco Romero-Naranjo (2022a), the development of the BAPNE Method, from its inception to the present day, is part of an evolutionary process that can be traced back to seven stages, whose common thread is the need to provide a theoretical justification for each fundamental aspect of the methodology based on continuous scientific evidence obtained mainly through quantitative methods. The effort involved in this arduous task is contained in academic literature produced by Romero-Naranjo as sole author or in collaboration with other scholars who are part of the Neuromotricidad y alfabetización motora research group, of which he is the director (Arnau-Mollá and Romero-Naranjo, 2022b, 2022c, 2024). Established in 2023 within the Department of Humanities at the University of Alicante, it has fifteen lines of research (Arnau-Mollá & Romero-Naranjo, 2024, 1027-1028), such as:

- 1) Neuromotor skills.
- 2) BAPNE method.
- 3) Body percussion, body expression, creativity and education.

- 4) Motor development and motor learning.
- 5) Ethnomusicology and movement.
- 6) Cognitive functions, executive functions and movement.
- 7) Eye tracking, electroencephalogram, functional magnetic resonance imaging, ergospirometry, electromyography and movement.
- 8) Motor literacy.
- 9) Developmental disorders, music, movement and physical activity.
- 10) Play, music, plastic arts, physical activity and sport. Conferences, symposiums and events.
- 11) Technical consultancy in neuromotor skills and motor literacy. BAPNE FIT.
- 12) Neuromotor and digital skills.
- 13) Neuromotor skills, clapping games, nursery rhymes and gender.
- 14) Neuromotor skills and Alzheimer's, Parkinson's, ADHD, ASD and brain injuries.
- 15) Neuromotor skills in education. Mathematical competence. Learning a foreign language. Cognitive solfeggio, performing arts and theatre.

Ethnomusicology is one of the five pillars of the BAPNE Method (Biomechanics, Anatomy, Psychology, Neuroscience and Ethnomusicology) and its importance is crucial as it provides cultural, anthropological and sociological justification for the use of body percussion on which its methodological approach is based.

The reasons why ethnomusicology is fundamental to the BAPNE Method lie in the literature produced by the research group that refers to it, which includes:

1. Theoretical and anthropological justification. Ethnomusicology provides the theoretical foundation for framing body percussion as a phenomenon that goes beyond mere motor or musical technique. Through ethnomusicology, therefore, BAPNE allows us to:

- a) acquire sources that enable the development of research on body percussion (Di Russo & Romero-Naranjo, 2024a)
- b) define the cultural role of the use of percussion, providing an anthropological and sociological perspective (2024b);
- c) reflect on the role of body percussion as behaviour and process as a form of musical/anthropological expression capable of reflecting or determining cultural processes, in line with the theories of Alan Merriam (Romero-Naranjo, 2013).
- d) acquire theoretical paradigms capable of conducting research in different social and cultural contexts and integrating them with those developed in other scientific disciplines (Di Russo, Romero-Naranjo & Terribili, 2024);
- e) provide an interpretation of uses, functions and meanings, rigorously illustrating the different bodily sounds that can be produced, recognising that each sound produced with the body (beating the chest, thighs, clapping hands, etc.) corresponds to specific meanings and symbols within the communities studied (Romero-Naranjo, 2008, 2017).

2. Research methodologies and tools. Ethnomusicology is essential to the investigative structure of the BAPNE Method, especially for qualitative studies and the empirical basis of practical applications. The methodologies and tools offered by this discipline contribute to:

- a) providing research elements and perspectives on body percussion in the field of ethnomusicology (Di Russo & Romero-Naranjo 2024c);
- b) develop taxonomies according to the uses, functions and meanings it assumes in body percussion communities, taking into account biomechanical, geographical and musical criteria (Romero-Naranjo 2008, 2013).
- c) conduct field research such as that carried out in Spain on the Ball dels Moretons in Majorca (Di Russo & Romero-Naranjo 2022), the Esku-dantza in the Basque Country (Di Russo, Asrmendi Telleria & Romero-Naranjo, 2024), and Las panaderas in Castile (Di Russo et al. 20022) based on precise ethnographic accounts;
- d) integrate methods of analysis of body percussion, taking into account its musical characteristics and its relationship with the kinesthetic, proxemic and choreographic dimensions (Di Russo et al. 2024a, 2024b).
- e) adopt methods of transcription of body percussion that are most suitable for achieving the specific aims of the research (Figure 2).



Figura 8. Notazione Metodo BAPNE con linea melodica (Romero-Naranjo 2017, 156).

3. Application developments in research. Ethnomusicology serves as a bridge between cultural knowledge and the neuromotor application of the BAPNE method, especially in the educational and therapeutic context in which the BAPNE method uses cognitive stimulation activities based on neuromotor body percussion activities developed on rhythmic-musical-choreographic proposals expressed within different cultural contexts. This is made possible by a process of cultural reworking and re-semantisation carried out according to the principles of the methodology, taking into account the anthropic characteristics of the new cultural context in which they are

proposed and in the awareness that learning cannot be separated from the use of the body (Romero-Naranjo & Camacho Navarro, 2025).

4. New research perspectives. Through its literature, the BAPNE Method has demonstrated that body percussion is a topic of ethnomusicological interest that can be applied to new fields of investigation, such as the musical repertoire of bands, choral and chamber music repertoire, or even encourage the production of new band literature and the creation of new pieces that use body percussion based on the principles of kinesthetic and rhythmic sequence construction of the BAPNE Method (Di Russo et al. 2023; Di Russo, Romero-Naranjo & Pelizza, 2024).

Conclusions

Body percussion is an important topic of investigation within ethnomusicology due to the ability of the body, combined with music, to reflect and produce “culture”. The development that the discipline has undergone throughout its history has led to an expansion of research areas and topics, rendering a single-discipline investigative approach insufficient. The theoretical paradigms and research methodologies adopted by ethnomusicology have been refined with the aim of allowing these studies to be deepened through an anthropological approach capable of highlighting cultural manifestations and the processes that produce them. The BAPNE Method, characterised by its interdisciplinary nature, has adopted ethnomusicology as a fundamental discipline of its pedagogical-didactic approach. Its objective is to understand the use of body percussion, starting from its formal aspects but transcending them into a cultural dimension that allows deeper meanings to be highlighted and applications to be made in different fields of knowledge (Romero-Naranjo, 2025a, 2025b).

In summary, using a metaphor, we could say that the BAPNE Method, thanks to ethnomusicology, can be compared to an archaeologist who, upon finding a clay pot (body percussion), does not limit himself to measuring its shape (rhythmic structure) and physical composition (anatomy), but seeks to understand who created it, why (the ritual or social function), how it was used in everyday life (the cultural context) and how this tradition has been handed down or modified over time (the history of the practice).

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Neuroludism: biological, cerebral and cultural bases of play in the configuration of human identity

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Resumen

El capítulo desarrolla el concepto de neuroludismo como un modelo biocultural que integra tres planos del juego: conducta biológica, experiencia neurocognitiva y práctica culturalmente significada, para explicar cómo las experiencias lúdicas configuran la identidad humana a lo largo del ciclo vital. Se argumenta que el juego, presente en múltiples especies y apoyado en bases neuroquímicas específicas, actúa como dispositivo evolutivo que entrena el movimiento, regula las emociones y fortalece los vínculos sociales. A partir de una genealogía que va de las teorías clásicas del juego a la neurociencia afectiva y la neuromotricidad, se define operativamente el neuroludismo, se precisan sus fronteras frente a gamificación y neuromotricidad, y se formulan principios organizadores (universalidad, variabilidad, plasticidad, transespecie). El texto revisa evidencias etológicas y neurocientíficas, analiza la dimensión histórico-cultural del juego y presenta estudios de caso que muestran cómo las prácticas lúdicas motrices en contextos educativos, terapéuticos y comunitarios funcionan como interfaz entre cerebro, cuerpo y cultura, proponiendo el neuroludismo como paradigma emergente y programa de investigación interdisciplinar.

Palabras clave: Neuroludismo, juego biocultural, identidad humana, neurociencia del juego, motricidad lúdica

Abstract

The chapter develops neuroludism as a biocultural model that integrates three levels of play—biological behaviour, neurocognitive experience and culturally meaningful practice—to explain how play helps shape human identity across the lifespan. It argues that play, present in many species and supported by specific neurochemical systems, functions as an evolutionary device that trains movement, regulates emotions and strengthens social bonds. Drawing on a genealogy from classical play theories to affective neuroscience and neuromotricity, the chapter offers an operational definition of neuroludism, clarifies its boundaries with gamification and neuromotricity, and formulates organising principles (universality, variability, plasticity, cross-species). It reviews ethological and neuroscientific evidence, examines the historical-cultural dimension of play and presents case studies showing how motor play practices in educational, therapeutic and community settings act as an interface between brain, body and culture, positioning neuroludism as an emerging paradigm and interdisciplinary research programme.

Keywords: Neuroludism, biocultural play, human identity, neuroscience of play, playful motor activity.

1. INTRODUCTION: WHY TALK ABOUT NEUROLUDISM TODAY

1.1. Scientific and social context of the study of play

In recent decades, play has ceased to be considered a mere childhood pastime and has become a central object of study in multiple disciplines, from evolutionary biology and comparative ethology to neuroscience, developmental psychology, anthropology and educational sciences. This expansion responds to the realisation that playful behaviours fulfil key adaptive functions: they facilitate the learning of motor, cognitive and social skills, contribute to emotional regulation and promote group cohesion in numerous species, including humans.

At the same time, in contemporary societies, play has gained unprecedented visibility through phenomena such as the gamification of work and educational environments, the rise of video games and e-sports, and the proliferation of hybrid play practices between the physical and digital worlds. Syntheses from the science of learning warn that it is not enough to add 'game elements' to any activity, but that it is necessary to respect principles of curiosity, scaffolding and active participation for the design to be truly educational (Hirsh-Pasek et al., 2015). These processes have

generated a double movement: on the one hand, the potential of play as a pedagogical, therapeutic and social innovation tool is recognised; on the other hand, the need for theoretical frameworks capable of explaining how the biological mechanisms, brain processes and cultural dynamics that underpin the playful experience are articulated is becoming more evident.

In this scenario, the study of play can no longer be limited to describing observable behaviours or classifying types of activities, but requires models that integrate traditionally separate levels of analysis. The question is no longer simply 'what is play' or 'what is it for', but how neurobiological systems, motor skills and cultural meanings that shape individual and collective identity are intertwined in playful practice. In this context, *neuroludism* is proposed as an umbrella term that explicitly names the convergence between brain, body and culture in play practices, emphasising its structural role in shaping human identity throughout the life cycle.

1.2. Shortcomings of classical approaches (biological, psychological, cultural separately)

Classical approaches have made decisive contributions to our understanding of play, but they tend to operate in silos that hinder a full understanding of the phenomenon. Biology and ethology have highlighted the adaptive value of play as 'training' for survival: they have described how playful behaviour allows motor patterns to be rehearsed, hunting or flight strategies to be refined and social hierarchies to be consolidated in different animal species. The 'training for the unexpected' hypothesis argues that the controlled variability offered by play prepares animals to cope with disturbances and surprises in real situations (Spinka, Newberry, & Bekoff, 2001). However, many of these approaches have paid less attention to the symbolic and cultural dimension of human play and to the contextual modulations that influence the expression of playful behaviours.

For their part, developmental psychology and cognitive psychology have studied play as a privileged setting for exploration, creativity, and the development of executive functions, but they have often done so without systematically integrating findings from affective neuroscience or evidence from comparative biology. This has resulted in models that are very valuable for describing developmental stages and the benefits of play, but less robust when it comes to explaining the brain and body mechanisms that underpin these functions. Reviews of play and learning in childhood have documented consistent associations between rich play participation and better outcomes in creativity, language, and problem solving (White, 2012).

Finally, cultural approaches have shown that play is an organising force in social life, a generator of meaning and a vehicle for the transmission of values, norms and knowledge, from archaic rituals to contemporary sports and recreational practices. Classic analyses of children's play show that, beyond entertainment, playful situations constitute a privileged space for reordering symbols, roles, and social meanings (Schwartzman, 1978). However, these frameworks tend to underestimate or treat tangentially the neurobiological basis that makes certain forms of play pleasurable, motivating and transformative for the subject. Considering the historical and social trajectory of play, some authors propose understanding it as a constitutive dimension of the human condition, rather than as a marginal or supplementary activity (Henricks, 2020). The result is a fragmented picture: there is abundant knowledge about isolated pieces of the playful phenomenon, but there is no theory that coherently articulates the biological, cerebral, motor and cultural levels.

This fragmentation has theoretical and practical implications. On a theoretical level, it hinders the construction of explanatory models that encompass the cross-species continuity of play and, at the same time, the cultural uniqueness of human practices. On the applied level, it limits the design of educational and therapeutic interventions that are truly based on the convergence of neuroscientific evidence, motor understanding, and sensitivity to the sociocultural contexts in which playful activities take place. Overcoming these shortcomings requires a new, explicitly integrative framework.

1.3. Justification for an integrative neuro-bio-cultural neuro-play perspective

The neuroludic perspective is proposed precisely as a response to these limitations, defining a field of study that approaches play from the convergence of biology, neuroscience, and culture, with special attention to the motor dimension. Under this approach, play is conceived as a biologically and culturally integrated process in which the following are intertwined:

- neurobiological mechanisms shared by multiple species (e.g., the activation of reward circuits and specific neurochemical systems during play activity),
- motor and bodily patterns that are developed and refined through play,
- and symbolic, normative and relational frameworks that give meaning and social function to human play practices.

Neuroludism is therefore not limited to 'applying neuroscience to play', but rather formulates a change of perspective: play is placed at the centre as an experience in which the brain, body and culture are co-configured. This reinterpretation explains, for example, why certain traditional motor games, despite their material simplicity, generate states of flow, strengthen social bonds and stimulate processes of neural plasticity associated with coordination, attention and emotional regulation.

Furthermore, the neuroludic perspective explicitly incorporates the transspecies dimension already documented in ethological literature, integrating data on animal play (in mammals, birds and other groups) with neuroscientific and cultural research on human play. This integration opens up the possibility of identifying general principles of play as an 'evolutionary device' and, at the same time, of understanding how human cultures have developed a vast repertoire of complex forms of play on this biological basis. In this way, neuroludism is presented as a biocultural model that can contribute to reordering and synthesising a hitherto dispersed field, offering a fertile conceptual framework for theoretical and applied research. In short, neuroludism is proposed here as the name of an emerging field that places play at the centre of the brain-body-culture framework, with direct implications for understanding human identity as a biocultural phenomenon.

1.4. Objective of the chapter, guiding questions and relevance to doctoral research

The main objective of this chapter is to systematically formulate and develop the concept of neuroludism, arguing its relevance as an integrative framework for the study of play and showing its potential to articulate evidence from biology, neuroscience, motor skills and culture. The aim is for neuroludism to be not just a new terminological label, but a conceptual proposal capable of

generating hypotheses, guiding research designs and informing interventions in areas such as education, health and social innovation.

To achieve this objective, the chapter is organised around several guiding questions that will accompany the reader throughout the text:

- To what extent can data from the biology and ethology of play be integrated with available neurochemical and neurofunctional evidence?
- How does play, through motor skills and bodily experience, contribute to the configuration of human identity and cognitive and emotional capacities?
- What do historical and anthropological readings of play contribute to a neuroludic understanding of the phenomenon, and how can they be reinterpreted from this new framework?
- What implications does neuroludism have for the design of educational, therapeutic and community environments that rely on play as a driver of development and cohesion?
- What types of doctoral research projects can benefit from this approach, and how can methodologies be developed that integrate ethological, neuroscientific and sociocultural data?

The relevance of the chapter for doctoral research lies in the fact that it offers a conceptual and methodological framework for those who wish to place play at the centre of their doctoral theses from a genuinely interdisciplinary perspective. By proposing neuroludism as a biocultural model, doctoral students are invited to design studies that cross disciplinary boundaries, combining, for example, analysis of playful behaviour in natural contexts with neurophysiological measurements and cultural interpretations of the practices observed.

In an academic context where theoretical originality, methodological soundness and the social impact of research are particularly valued, neuroludism presents itself as a promising avenue for generating doctoral theses with high potential impact. This chapter therefore aims to offer both a conceptual map and a starting point for the design of future research exploring play as a driver of identity from the intersection between brain, body and culture.

2. Definition of neuroludism

The term neuroludism is introduced in this chapter with a dual aspiration. On the one hand, it seeks to offer a precise label to designate the integrated study of play as an experience in which neurobiological, motor and cultural processes converge, beyond existing partial approaches. On the other hand, it aims to articulate a biocultural framework that allows previous findings on play, motor skills and culture to be reinterpreted from a unified perspective. Compared to similar concepts, such as neuromotor skills or gamification, neuroludism is proposed as a paradigmatic horizon that places play at the centre of the debate on human identity and evolutionary continuity with other species.

2.1. Conceptual genealogy: from *Homo ludens* to affective neuroscience and neuromotor skills

The notion of neuroludism does not arise in a vacuum, but rather is part of an intellectual genealogy that begins with the great cultural theories of play, is enriched by ethology and evolutionary biology, and is transformed by the emergence of affective neuroscience and contemporary approaches to neuromotricity. From a historical-cultural perspective, it has been argued that many legal, artistic, and political institutions emerge from playful matrices that predate their formalisation, placing play at the very heart of culture (Huizinga, 1938). Furthermore, classic works on play have shown that playful practices are not mere entertainment, but a constitutive substrate of institutions, symbols and forms of social organisation, thus anticipating the idea that playful experience participates in the construction of individual and collective identity. The classic classification of games into *agon*, *alea*, *mimicry* and *ilinx* anticipates the idea that the forms of play organise social and bodily experience according to differentiated but partially combinable logics (Caillois, 1958). From this perspective, playful narratives about risk, fortune or death can be understood as symbolic rehearsals in which subjects bring into play alternative versions of themselves and their belonging to the group (Sutton-Smith, 2001).

In parallel, biology and comparative ethology incorporated play into the evolutionary debate, interpreting it as an adaptive investment strategy that favours survival and adjustment to the environment in numerous species. Early formulations of play already emphasised its character as a 'rehearsal for life', interpreting juvenile playful behaviour as early training for skills needed in adulthood (Groos, 1898). This tradition opened the door to considering play as a cross-species phenomenon, with patterns observable in mammals, birds and other groups, rather than as an exclusively human eccentricity. The decisive shift came with affective neuroscience and the neurobiology of play, demonstrating that playful activity is systematically associated with the activation of brain reward circuits, the release of certain neurotransmitters, and synaptic plasticity processes closely linked to learning and emotional regulation. Studies with rodents have shown that social play intensely activates reward circuits and that deprivation of play in early stages subsequently alters emotional regulation and sociability (Vanderschuren, Achterberg, & Trezza, 2016).

Against this backdrop, neuromotor skills have been developed as a field of study that emphasises the role of complex movement, coordination, and rhythm in the development of cognitive and socio-emotional functions, making it clear that the body in motion is a central mediator between the brain and the environment. The proposal of neuroludism draws on these currents: it recovers the cultural intuition that play structures social life, incorporates biological and ethological evidence about its adaptive function, and relies on neuroscience and neuromotricity to describe how play literally organises the brain and behaviour. This intersection gives rise to the need for a term that specifically names the convergence between neurobiological, motor, and cultural processes in the playful experience. The ten pillars of neuromotor skills propose a framework of rhythmic, attentional, emotional, and bodily components that place complex motor experience at the centre of the development of higher functions (Romero-Naranjo, 2023c).

2.2. Delimitation of the object of study: boundaries of neuroludism

The delimitation of the object of study is an essential condition to ensure that neuroludism does not become a vague or overly broad concept. Strictly speaking, neuroludism is concerned with analysing the interrelationship between:

- the cerebral and neurochemical mechanisms that are activated in play situations,
- the motor and bodily configurations that shape playful action,
- and the cultural frameworks that give meaning, norms and functions to these practices.

Therefore, research that explicitly or implicitly integrates these three levels of analysis falls within the field of neuroludism. For example, studies that examine how certain motor play dynamics in childhood contribute to the development of executive functions, relying on neurophysiological measures and contextualising activities in specific play traditions, fit squarely within the core of neuroludism. In the Mediterranean region, children's play activity forms a genuine motor and symbolic ecosystem in which children explore rules, roles and community belonging from a very early age (Andreu-Cabrera, 2006). Psycho-pedagogical analysis of traditional games shows a motor richness far superior to that of many regulated sports practices, which reinforces their interest as a natural neuromotor laboratory (Andreu-Cabrera, 2010). Also part of the object of study are cross-species comparisons that link animal play patterns with neurochemical changes and social learning relevant to the species, provided that the connection between the brain, body and ecological or social context is expressed.

However, neuroludism does not claim to encompass all research on play or all applications of playful techniques. Works that merely describe rules or types of games without addressing their neurobiological correlates or motor dimension remain on the periphery, or directly outside the scope, as do neuroscientific studies that induce responses of pleasure or reward in the laboratory without considering the structurally playful nature of the tasks or their cultural inscription. Similarly, purely instrumental approaches, which use play as a simple motivational tool without questioning its impact on identity, corporeality or the organisation of neural networks, remain conceptually separate from the core of neuro-ludic interest.

2.3. Operational definition and distinctive features compared to gamification, neuromotricity and the psychology of play

Based on this delimitation, an operational definition can be proposed for use in research and academic debate. In summary, neuroludism can be defined as the interdisciplinary field that studies play as an experience in which neurobiological, motor and cultural processes converge, with special attention to how this convergence contributes to the configuration of identity, cognition and social life throughout evolution and in different historical contexts. This definition highlights three key elements: the convergence of levels (brain-body-culture), the experiential nature of play, and its impact on individual and collective identity.

Unlike gamification, which focuses on introducing game dynamics, mechanics and elements into non-playful contexts for mainly motivational or performance purposes, neuroludism does not focus on system design, but rather on understanding what play does in and with the subject at the

neurobiological, motor and cultural levels. While gamification takes play as a methodological resource, neuroludism takes play as an ontological and epistemological object.

In relation to neuromotricity, neuroludism shares a concern for the role of movement and complex coordination in the development of higher functions, but broadens the focus to explicitly incorporate the symbolic and sociocultural dimension of playful practices and to anchor the analysis in the experience of play, not just in structured motor exercise. It can be said that neuromotor skills deal with the how of movement in its relationship with the brain, while neuroludism deals with the how of play, understanding play as a specific form of movement, interaction and meaning. From this perspective, neuromotor skills are proposed as a new paradigm in which rhythmic and coordinative practice is understood not only as physical training, but also as a device for structuring cognitive and social skills (Romero-Naranjo & Andreu-Cabrera, 2023a).

Finally, with regard to the psychology of play, neuroludism takes on board many of its contributions on development, creativity and emotional regulation, but recontextualises them within a framework that systematically integrates neuroscientific evidence and cultural analysis. The distinctive feature of neuroludism is not so much its exclusive empirical content, but rather the type of questions it asks: how are patterns of brain activation, gestures and body schemas, and social meanings articulated in the same playful experience? What implications does this articulation have for understanding identity and adaptation?

2.4. Epistemological scope and paradigmatic potential of neuroludism as an interdisciplinary field

From an epistemological point of view, neuroludism is proposed as a framework capable of reorganising and connecting research traditions that, until now, have advanced in parallel with little dialogue. By placing play at the centre as a 'natural laboratory' where brain mechanisms, motor patterns and cultural structures intersect, neuroludism is configured as a space of intersection between affective neuroscience, evolutionary biology, ethology, anthropology of play, cultural studies and physical activity and sports sciences. This crossroads nature gives it paradigmatic potential: it can function as a frame of reference from which to reinterpret previous findings and formulate new research questions.

Its scope is not limited to better describing play, but also addresses central questions about human nature and evolutionary continuity with other species. By showing that many of the functions attributed to play (learning, emotional regulation, technical innovation, social cohesion) are based on shared neurochemical foundations and comparable motor patterns, neuroludism contributes to questioning the sharp separation between the 'natural' and the 'cultural'. In this way, it approaches other biocultural paradigms that attempt to overcome classic dichotomies in the humanities and life sciences.

Furthermore, neuroludism has the potential to generate applied research agendas in education, health and public policy by offering a common language for dialogue on play-based interventions that simultaneously respect the neurobiological complexity, bodily reality and cultural density of playful practices. From the perspective of doctoral training, this framework allows for the development of thesis projects that cross methodologies (ethological observation,

neurophysiological analysis, cultural case studies, quasi-experimental designs in educational or clinical contexts) without losing conceptual coherence.

In short, neuroludism is presented not only as a new term, but as a paradigmatic proposal with the capacity to reorder the field of play studies, consolidate bridges between disciplines, and offer a solid basis for high-impact research that addresses play as a phenomenon in which biological, neural, and cultural levels systematically intersect.

3. Play as a trans-species biological phenomenon

3.1. Ethological criteria for identifying playful behaviour

Comparative ethology has attempted to establish criteria for distinguishing playful behaviour from other forms of behaviour such as actual aggression, purely instrumental exploration or sexual interaction. Among the most widely accepted features are: the apparent mismatch between means and ends (animals 'rehearse' utilitarian behaviours in low-risk contexts), the presence of play signals (postures, gestures or vocalisations that indicate that the behaviour is 'as if' and not actual aggression), the flexible repetition of motor sequences, and the spontaneous reversal of roles during interactions. These criteria make it possible, for example, to differentiate between a play fight between young gorillas and a hierarchical fight, or between playful chasing among cubs and actual predatory behaviour. Comparative descriptions of play in mammals, birds, and other groups show that these criteria are met in a wide variety of ecological contexts, reinforcing their usefulness in defining the phenomenon of play in the field of ethology (Fagen, 1981).

Another key element is context: playful behaviours tend to occur in situations of relative safety, with basic resources available and no immediate threats, reflecting their nature as 'training in cushioned conditions'. In addition, play is characterised by a positive emotional tone or, at least, by a mixture of controlled excitement and curiosity, supported by neurochemical changes that facilitate exploration and socialisation. From a neuro-play perspective, these ethological criteria are fundamental because they provide a solid empirical basis for identifying when a playful experience is taking place in which specific brain circuits and motor patterns are activated, even in species very distant from humans.

3.2. Evidence of play in invertebrates, fish, reptiles and birds

For a long time, the literature on play focused almost exclusively on mammals, especially primates and social carnivores. However, recent studies have documented behaviours that meet play criteria in more distant taxonomic groups, such as certain invertebrates, fish and reptiles, suggesting that play may be a more widespread trait than previously assumed. For example, sequences of apparently non-functional manipulation of objects, pursuits without immediate predatory purpose, and 'simulations' of sexual or aggressive behaviour have been observed in species that were not previously associated with complex playful repertoires.

In fish, reptiles and amphibians, repeated interactions with objects in the environment, abrupt and improvised changes in direction of movement, and pursuit behaviours that do not result in the capture or consumption of prey, but seem to be oriented towards motor rehearsal and exploration of the environment, have been described. In birds, the evidence is even more abundant: corvids and psittacines manipulate improvised tools, play with air currents, fog or snow, and engage in

social games that include chasing, acrobatic flights and intraspecific 'jokes'. These observations, systematised by contemporary ethology, show that play is not the exclusive heritage of mammals, but a phenomenon that appears, in different forms and degrees of complexity, in multiple evolutionary lineages.

3.3. Play in mammals: patterns of simulated fighting, chasing and social exploration

In terrestrial mammals, play manifests itself in a particularly rich way in the form of simulated fighting, playful chasing and social exploration, with variations depending on the species, age and ecological context. Fighting games between cubs of canids, felines and primates include ritualised attacks and defences, controlled bites, exaggerated falls and frequent pauses, accompanied by clear signals that mark the non-aggressive nature of the interaction. These patterns allow individuals to practise motor sequences that will later be crucial for hunting, defence or establishing hierarchies, but minimise the risk of actual harm.

In species such as cetaceans, the presence of complex cognitive abilities and elaborate social structures has also been linked to rich play repertoires, reinforcing the relationship between play, the social brain, and behavioural flexibility (Marino, 2002). Playful pursuit is also common in social mammals: the roles of pursuer and pursued are alternated, unexpected changes in direction or speed are introduced, and trajectories that are inefficient from an energy point of view but very rich in terms of motor learning are explored. Furthermore, play provides a privileged setting for social exploration: through playful interactions, individuals learn to interpret communicative signals, regulate the intensity of their actions, and anticipate others' reactions. In primates, it has been documented that the playful faces and specific gestures that accompany these interactions act as implicit "contracts" that allow relational boundaries to be tested without triggering serious conflicts. From a neuro-play perspective, these games of fighting, chasing, and social exploration are true "laboratories" in which motor, emotional, and cognitive systems are co-developed. Microstructural analysis of fighting games in mammals shows that small variations in the way of 'playing fight' have important consequences for the organisation of the prefrontal cortex and adult social competence (Pellis & Pellis, 2009).

3.4. Adaptive functions of play: survival, motor rehearsal, emotional regulation and social cohesion

The interpretation of play as mere entertainment has been largely superseded by empirical evidence showing its role in various adaptive functions. From this perspective, play not only trains useful behaviours, but also acts as a space for creative experimentation that generates novel and flexible solutions to changing h y environments (Bateson, 2015). Firstly, play contributes to survival by providing a context for motor rehearsal in which the skills necessary for obtaining food, defence and escape are practised without assuming the risks associated with real situations. In evolutionary terms, play can be interpreted as a sophisticated solution to the dilemma between exploring and exploiting, as it allows new strategies to be tested without immediately compromising the individual's survival (Gopnik, 2020). Examples of simulated hunting, chasing imaginary prey, or manipulating objects reminiscent of food resources illustrate how play prepares the individual for future challenges, improving energy efficiency and the ability to respond to unforeseen events.

Secondly, playful activity facilitates emotional regulation: numerous studies indicate that social play is associated with controlled releases of tension, increases in neurotransmitters linked to well-being, and the consolidation of strategies for managing stress and fear. This regulatory dimension is particularly evident in social mammals, where group play sessions act as "safety valves" that rebalance the affective climate of the group. Thirdly, play has a clear role in social cohesion: it fosters trust, strengthens dyadic and group bonds, and allows hierarchies to be explored and negotiated in a relatively safe environment. In the field of animal welfare, the presence and quality of social play have been shown to be relevant indicators of emotional state and quality of life (Held & Špinka, 2011).

From a neuro-ludic perspective, these functions cannot be understood in isolation: motor training, emotional regulation and social cohesion are supported by shared neurochemical mechanisms, patterns of activation of brain reward circuits and specific motor configurations that are repeated, with variations, in different species. Play thus appears as a 'biological device' that integrates learning, emotion and social organisation in the same behavioural scenario.

Taken together, these adaptive functions show that play is a privileged setting for sculpting individual identity profiles and modes of group belonging.

3.5. Continuities and differences between species: towards a comparative biology of play

A comparative examination of play in different species reveals a fruitful tension between continuities and differences. On the one hand, the presence of playful behaviours in diverse taxonomic groups and the finding that these behaviours are associated with similar neurochemical changes suggest that play can be considered an evolutionary trait with shared biological bases. A broad evolutionary review suggests that play emerges repeatedly in different lineages as a conserved trait, associated with contexts of relative safety and sensitive periods of development (Burghardt, 2014). The activation of reward systems, the release of certain neurotransmitters, and the involvement of brain structures linked to pleasure, motivation, and learning have been documented in both non-human animals and humans, reinforcing the idea of a cross-species 'play chemistry'. Neuroimaging studies in canids, for example, show that participation in playful activities is related to patterns of brain activation and h tion compatible with complex forms of expectation, attachment, and social exploration (Berns, 2017).

On the other hand, differences in the complexity of motor sequences, the symbolic density of interactions, and the cultural insertion of playful practices are evident, especially when comparing human and animal play. Systematic comparisons between children and animals highlight that early playful exploration is a central driver for the development of cognitive and socio-emotional skills throughout life (Power, 2023). In humans, play incorporates explicit rules, narrative roles, fictional elements, and institutionalised frameworks (from rituals to regulated sports), adding additional layers of meaning and social organisation. These differences do not invalidate the continuities, but rather show how the same biological substrate can give rise to increasingly complex playful configurations as cognitive abilities and cultural density increase.

Towards a comparative biology of play, the task is to identify general principles of play—such as training in low-risk conditions, generating behavioural variability, and modulating social cohesion—while describing the specific forms it takes in each species and context. For

neuro ludism, this comparative perspective is crucial: it allows us to situate human play within an evolutionary continuum, recognise what it shares with other species, and clarify what differentiates it, especially in terms of symbolisation, identity construction, and articulation between brain, body, and culture. From a neuro ludic perspective, this comparative playful biology provides the evolutionary substrate on which human forms of play are constructed as identity configurators.

4. Neuroscientific bases of play

4.1. Reward and motivation systems involved in playful activity

Affective neuroscience has shown that play consistently activates the brain's reward and motivation systems, in a manner comparable to other rewarding stimuli but with its own functional profile. A specific play system has also been described, partially independent of other emotional systems, whose activation during play interactions is associated with very characteristic patterns of vocalisation and social seeking (Panksepp, 1998). In particular, playful activities are associated with the activation of the mesolimbic dopaminergic circuit, which includes areas such as the ventral tegmental area and the nucleus accumbens, as well as the involvement of cortical and subcortical systems involved in reward anticipation and decision-making. This activation not only generates a feeling of pleasure, but also drives the active search for play situations and sustains the repetition of playful patterns throughout development. These data have led to the suggestion that some brains can be described as 'highly motivated to play', integrating differences in neurotransmitters, reward networks and personality traits (Siviy, 2016).

Play also involves a unique combination of novelty, surprise and predictability that makes it an optimal context for motivated learning. The alternation of moments of excitement and pause, the controlled uncertainty about the outcome of the interaction and the absence of serious negative consequences in most cases produce a motivational state in which the individual is highly willing to explore and take moderate risks. From a neuro ludic perspective, play can be understood as a 'fine regulator' of the reward system: it provides repeated doses of rewarding experiences that reinforce motor, cognitive and social exploration, while progressively adjusting the brain's sensitivity to different types of rewards and the signals that anticipate them.

4.2. Key neurotransmitters during play: dopamine, serotonin, oxytocin and beta-endorphins

The neurochemical dimension of play has been the subject of numerous studies, which point to the coordinated involvement of several neurotransmitters and neuromodulators. Among these, dopamine stands out for its role in motivation, reinforcement and anticipation of rewards: during playful activities, significant increases in dopamine have been described in regions such as the nucleus accumbens, associated with the expectation of pleasure and the learning of new relationships between actions and consequences. This dopaminergic release reinforces the repetition of adaptive playful behaviours, contributing to the consolidation of effective motor, cognitive and social patterns. In neuroaffective terms, playful interactions are accompanied by specific patterns of activation of systems related to positive emotions, making them a privileged context for associating pleasure and learning (Burgdorf & Panksepp, 2006).

Serotonin, for its part, has been linked to mood regulation, inhibition of excessive impulses and modulation of anxiety, all of which are relevant to the development of balanced social play.

Adequate levels of serotonin seem to favour playful interactions in which individuals manage to keep excitement within tolerable limits and respect each other's play signals, preventing simulated fighting or chasing from turning into real aggression. Oxytocin, known for its role in social bonding and trust, increases in contexts of cooperative play and positive affective interaction, reinforcing cohesion among participants. Finally, beta-endorphins, associated with feelings of pleasure and pain relief, contribute to the subjective experience of well-being during play and may help explain why playful activities are spontaneously used as a strategy to relieve stress and emotional distress.

4.3. Relevant brain networks and structures (nucleus accumbens, prefrontal cortex, amygdala, cerebellum)

From the point of view of brain organisation, play involves the coordinated activation of extensive networks that encompass both subcortical structures and high-level cortical regions. The nucleus accumbens is located at the centre of the reward system, integrating dopaminergic signals and modulating motivation to initiate and maintain playful behaviours. In parallel, the amygdala and other limbic structures contribute to evaluating the emotional relevance of play situations and modulating approach or avoidance responses based on previous history and context.

The prefrontal cortex, especially in its dorsolateral and orbitofrontal portions, participates in planning, inhibitory control, and contingency assessment functions, allowing individuals to adjust their playful behaviour to the implicit or explicit rules of the game and anticipate the possible consequences of their actions. This prefrontal involvement is especially evident in complex games that require changing strategies, taking turns, or assuming different roles. The cerebellum, traditionally associated with motor coordination, is now also recognised as a relevant actor in cognitive and affective processes, and in the context of play it is involved in the synchronisation of movements, the fine adjustment of motor sequences and the temporal integration of actions and perceptions. In this vein, it has been described how systematic body percussion contributes to refining body schema and laterality, enhancing awareness of one's own posture and its dynamic adjustment in group activities (Romero-Naranjo, Andreu-Cabrera, & Arnau-Moll, 2023). Recent work in neuromotor skills shows that the combination of body percussion, bimanual coordination, and singing requires high executive control and promotes integration between sensorimotor and prefrontal systems (Romero-Naranjo & Andreu-Cabrera, 2021). From a neuroludic perspective, play can be seen as a privileged setting in which these networks are co-activated and reorganised, facilitating the emergence of increasingly efficient patterns of functioning. Recent reviews of musical training in preschoolers indicate that systematic practice of rhythmic activities is associated with small but consistent gains in inhibitory control and working memory (Lu, Wang, & Zhang, 2025).

4.4. Play, synaptic plasticity, and the development of executive functions

Synaptic plasticity—the brain's ability to modify the strength of connections between neurons based on experience—is one of the neurobiological pillars of learning, and play has been identified as a powerful driver of these processes. Animal models have shown that participation in social play increases the expression of neurotrophic factors such as BDNF, suggesting a direct link between playful experience and the ‘fertilisation’ of neural networks involved in learning (Gordon et al., 2003). During childhood and adolescence, periods that are particularly sensitive to experience, intense and varied play activities promote the consolidation and reorganisation of circuits involved

in motor coordination, attention, working memory and other higher cognitive functions. However, reviews of programmes aimed at improving executive functions warn that not all proposals backed by 'neuro' discourse achieve consistent effects, underscoring the need for rigorous designs in play-based interventions as well (Diamond & Ling, 2016). Increases in dopamine and other neuromodulators during play facilitate long-term potentiation in synapses connecting sensorimotor, limbic, and prefrontal areas, reinforcing networks that are useful for solving playful challenges.

In this sense, play acts as a 'natural training' for executive functions: it requires maintaining attention in a changing environment, inhibiting impulsive responses in order to follow rules, updating plans based on the actions of others, and making strategies more flexible when the game demands it. Recent syntheses on musical training in children show that structured rhythmic activities are linked to robust improvements in working memory and , inhibition, and cognitive flexibility, effects consistent with the neuro-play hypothesis on rhythmic practice (Cai, Zhang, & Chen, 2025). Synthesis studies on musical training suggest that the rhythmic coupling between body and sound acts as a 'temporal training' mechanism that sharpens attention in time and promotes near and far transfers to other cognitive tasks (Miendlarzewska & Trost, 2014). Neuromotor intervention proposals based on complex playful patterns indicate that rhythmic coordination and motor variability are associated with improvements in executive skills and postural adjustment in a school context (Andreu-Cabrera, Romero-Naranjo, & Lorenzo-Lledó, 2024). These demands translate into the repeated practice of prefrontal skills in an emotionally positive context, which seems to be particularly effective for their development and stabilisation. From a neuroludism perspective, this role of play in synaptic plasticity is interpreted as a central pathway through which emotional regulation styles, attention patterns, and forms of self-narrative that are part of identity are consolidated. In fictional play, the substitution of objects and roles forces children to coordinate meanings, social cues, and impulse control, which translates into higher levels of social engagement and behavioural regulation (Bamberger & Lillard, 2012). Observational studies in early childhood education settings show that children who are more involved in cooperative fictional play also tend to have better social and communication skills in the school playground (Li, Hestenes, & Wang, 2016). It has been suggested that the enduring appeal of fictional play lies precisely in the fact that it allows children to explore alternative scenarios safely, gradually adjusting their understanding of their own and others' mental states (Lillard, 2017).

4.5. Cross-species neurochemistry of play and its evolutionary significance

A particularly relevant aspect for neuroludism is the observation of shared neurochemical patterns in the play of different species. Comparative studies show that the activation of dopaminergic systems, the release of serotonin and other neuromodulators, and the involvement of structures such as the nucleus accumbens are not limited to humans, but also appear in mammals and, with variations, in other animal groups. This coincidence suggests that play is based on an evolutionarily conserved "neurochemical infrastructure" that has been selected for its benefits in terms of learning, adaptation, and social cohesion.

The evolutionary significance of this shared neurochemistry can be interpreted on several levels. On the one hand, it provides a mechanism for linking pleasurable experiences with behaviours that increase the likelihood of survival, such as practising motor and social skills in safe contexts. On

the other hand, it allows play to function as a modulator of group dynamics, strengthening bonds and facilitating cooperation between individuals who share an environment. In humans, this neurochemical basis is intertwined with the symbolic and cultural complexity of play, giving rise to practices that not only serve to train skills, but also to create worlds of meaning, identities, and forms of belonging. Recognising this cross-species continuity is one of the pillars of neuroludism, showing that the ability of play to shape the brain and behaviour is supported by a shared neurochemical infrastructure that human cultures have exploited in increasingly complex ways.

5. Historical-cultural dimension of play and the emergence of neuroludism

5.1. Playful manifestations in ancient societies: iconography, texts and ritual practices

Archaeological and textual records show that play has accompanied human societies since their earliest forms of organisation, long before there was any explicit conceptualisation of its educational or therapeutic function. In various cultures of the Near East, Pharaonic Egypt and the Mediterranean basin, reliefs, paintings, steles and objects representing playful activities, both childish and ritualistic, associated with agricultural cycles, religious ceremonies or community celebrations have been preserved. Anthropological analyses of play also highlight its intertwining with ritual and ceremonial practices, where the boundary between the playful, the sacred and the political becomes particularly porous (Hamayon, 2016). This iconographic evidence indicates that play did not occupy a marginal place, but was integrated into the heart of symbolic and social life.

Texts from classical antiquity refer to the value of games in the education of citizens, the training of physical skills and the transmission of norms and values. Board games, physical competitions and dramatic performances were linked to civic and religious festivities, showing that recreational practices operated as regulated spaces where roles were rehearsed, hierarchies were negotiated and group cohesion was reinforced. Studies on Mediterranean children's play show how these practices articulate times, spaces, and neighbourhood ties, becoming an organising axis of daily life (Andreu-Cabrera, 2009a). From a neuro-play perspective, these early manifestations can be interpreted as scenarios in which the biological and neurocognitive mechanisms of play were used to construct collective identities and cultural systems of meaning.

5.2. Play as a matrix for artistic, educational and sporting practices

Throughout history, play has functioned as a matrix for multiple practices that are now classified as artistic, educational or sporting, but which share a common playful substrate. The performing arts, from primitive theatrical forms to the great dramatic genres, retain elements of role-playing, simulation and experimentation with identities, emotions and imaginary situations. Similarly, many musical and dance activities emerge from rhythmic and motor games in which body coordination, improvisation and social interaction are central, generating experiences of synchrony that have specific neurophysiological effects on bonding and emotional regulation. Contemporary anthropology has emphasised that the playful experience does not only define 'what is done', but also a particular way of relating to contingency and risk, marked by experimentation and openness to change (Malaby, 2009).

In the educational sphere, traditional games and structured play activities have historically functioned as informal pedagogical devices through which children learn rules of coexistence, communication skills and complex motor skills. Ethnographic studies on childhood show that play

is one of the main scenarios in which children negotiate rules, hierarchies and forms of belonging, thus constructing situated versions of childhood (James, 1998). The analogies detected between traditional games from different areas of the Mediterranean reveal the existence of shared patterns of play that sustain collective identities beyond national borders (Andreu-Cabrera, 2009b). The institutionalisation of modern sport, with its detailed rules, competition systems and rituals of recognition, can be seen as a cultural sophistication of ancestral patterns of play involving competition, cooperation and the display of physical skills. In humans, participation in shared musical play activities has been associated with increases in prosocial behaviour, confirming the role of coordinated play in building group cohesion (Kirschner & Tomasello, 2010). From a neuro-playful approach, these transformations do not nullify the biological core of play, but rather amplify and channel it into institutional frameworks that allow its effects on the brain, body, and social life to be refined and directed. Thus, these playful matrices can be understood as historical devices for shaping personal and collective identities.

5.3. Classical theories on play and culture (Huizinga, Caillois and contemporary developments)

Classical theories of play in the human sciences have systematically emphasised its cultural dimension. Huizinga argued that many central institutions—law, war, politics, art—have formal structures that can be understood as extensions of playful forms: delimitation of specific spaces and times, establishment of rules, creation of roles, and dramatisation of conflicts within relatively safe frameworks. Caillois, for his part, proposed typologies of play that distinguish, among others, games of competition, chance, simulation, and vertigo, showing the diversity of playful experiences and their relationship to different psychological and social needs.

Contemporary developments have broadened these perspectives by analysing play as a practice that produces and reproduces symbolic capital, conveys norms of gender, class and power, and acts as a laboratory for emerging forms of subjectivity in globalised and digitised contexts. However, these theories, although fundamental to understanding the cultural dimension of play, have paid less attention to the neurobiological and motor mechanisms that underpin it. From the perspective of neuroludism, it is proposed to re-read these contributions, integrating them with evidence from neuroscience and comparative biology, so that play is understood simultaneously as a cultural structure and as an experience anchored in the body and the brain.

5.4. From traditional play to digital environments: continuities and ruptures in play culture

The expansion of digital and interactive environments has profoundly transformed the forms of play available, generating both continuities and ruptures with previous play traditions. On the one hand, many video games, online gaming platforms and virtual reality experiences reproduce classic structures of challenge, cooperation and competition, as well as archetypal narratives rooted in myths and traditional stories. On the other hand, they introduce new intensities of immersion, anonymity, relativism, and ubiquity, modifying patterns of social interaction, perception of time, and the relationship between body and environment.

From a neurocognitive perspective, digital environments can modulate reward systems and attentional circuits in different ways by offering frequent reinforcers, immediate feedback, and progression systems designed to keep players engaged. These characteristics have sparked debates

about the educational and therapeutic potential of certain digital games, but also about the risks of overstimulation, dysregulation, and the replacement of physical and face-to-face play experiences.

Neuroludism is proposed as a useful framework for analysing these transformations, as it allows us to compare how different game formats—traditional, sports, digital—differently shape the relationship between brain, body and culture, and what implications these configurations have for identity and health.

5.5. From playful culture to neuroludism: historical continuity and conceptual leap

The historical trajectory of play, from ancient societies to contemporary digital environments, shows remarkable continuity in its function as a space for symbolic experimentation, learning and cohesion, but also a progressive increase in the complexity of its forms and the density of its institutional articulations. This continuity provides the substrate for the conceptual leap proposed by neuroludism: recognising that playful practices, in all their historical and cultural variants, have always been places of convergence between biological, neural and cultural processes, even if this convergence had not been explicitly formulated in scientific terms.

Neuroludism does not break with cultural readings of play, but rather extends and reinterprets them in light of available neurobiological and motor evidence. The "leap" consists of moving from understanding play solely as a cultural category to conceiving it as a biocultural phenomenon that participates directly in the organisation of the brain, the configuration of motor skills and the construction of individual and collective identities. In this way, the long history of play culture becomes a privileged field of study for observing how, in different times and places, human beings have exploited, more or less intuitively, the neuroludic capacities of their own organism. By articulating this historical-cultural dimension with biological and neuroscientific foundations, the chapter seeks to show that neuroludism is both a result of this history and a proposal for thinking about its future continuity. In this sense, neuroludism functions as a key to reinterpreting the history of playful culture as a history of the articulation between brains, bodies, and symbolic worlds.

6. Neuro-ludism and motor skills: from the body to the symbol

6.1. Playful motor skills as an interface between brain, body and environment

Playful motor skills can be understood as a privileged space for interaction between the brain, body and environment, in which movements are not only aimed at solving instrumental tasks, but also at exploring possibilities, trying out variations and constructing shared meanings. In play situations, gestures, movements and postures are organised into sequences that combine motor efficiency with creativity and variability, which distinguishes them from other more rigid or purely functional forms of action. This exploratory dimension turns the body into an active mediator between neural dispositions and the affordances of the physical and social environment.

From a neuro-ludic perspective, playful motor skills act as a dynamic interface in which the brain receives continuously updated sensory information, generates predictions about the outcome of actions, adjusts motor plans and evaluates the responses of other players. In this closed circuit, movement patterns are refined as synaptic connections are modified and new coordinations between sensorimotor, limbic, and executive systems are consolidated. Motor play thus not only

expresses internal states but also contributes to shaping them, configuring emotions, expectations, and ways of being-in-the-world that are inseparable from the body in motion.

6.2. Motor games and the development of complex neuromotor skills

Motor games—from races, chases and simulated fights to dances, clapping games or group coordination dynamics—constitute an intensive training ground for complex neuromotor skills. These activities require the integration of balance, hand-eye coordination, postural control, fine adjustments of strength and precision, as well as rapid changes in the direction and rhythm of the action. All of this involves the simultaneous participation of brain networks involved in planning, executing and monitoring movement, creating an optimal environment for the development of neuromotor skills.

In educational and therapeutic contexts, it has been shown that certain structured physical games can enhance executive functions, improve sustained attention and working memory, and promote emotional self-regulation, precisely because they combine motor challenges with cognitive and social demands in a playful setting. From an educational perspective, contexts that respect children's playful initiative and expand their margins of autonomy are associated with higher levels of curiosity, self-regulation and subjective well-being (Gray, 2013). Repeated practice of these games during childhood and adolescence helps to consolidate neuromotor repertoires that are transferable to other activities, from academic learning to adaptation to changing environments. For neuroludism, motor games are not only a practical application, but also a natural laboratory where we can observe how playful experience organises both the nervous system and behaviour.

6.3. From gesture to meaning: symbolisation, rules and roles in play contexts

In play, gestures are not limited to their biomechanical dimension, but acquire meaning within shared symbolic frameworks. A jump, a run or a simulated blow can represent the escape from an imaginary danger, the conquest of a territory or the interpretation of a character, depending on the rules and narratives that structure the playful situation. This transition from gesture to symbol implies that the body becomes a support for processes of representation, allowing participants to 'pretend' that they are something else, are in another place or are living in another time, while remaining anchored in sensorimotor reality.

The rules of the game act as framing devices that delimit which movements are acceptable, how they are interpreted, and what consequences they have within the playful world. Taking on roles—leader, pursuer, caretaker, adversary—requires coordinating gestures with social expectations and narratives, thus integrating motor, cognitive, and cultural levels. From a neuro-ludic perspective, this transition from gesture to meaning shows how play constitutes a bridge between neural activity and symbolic construction: the patterns of brain activation associated with certain movements stabilise alongside networks of meaning, so that bodily action and cultural meaning are co-constituted.

6.4. Neuromotor skills, rhythm and coordination in playful physical activities

Playful activities that incorporate rhythm and coordination—such as clapping games, body percussion, cooperative dances, or group dynamics based on rhythmic patterns—are a particularly fertile field for the neuro-playful study of motor skills. These games require synchronising

movements with auditory or visual signals, adjusting tempo, anticipating changes and coordinating with other participants, which intensely activates cerebellar-cortical networks, fronto-parietal circuits and limbic systems involved in emotional regulation and the sense of belonging.

Research in neuromotor skills has shown that these types of practices can improve motor planning, laterality, spatial orientation, and the ability to inhibit automatic responses in order to adapt to the group pattern. At the same time, rhythmic synchronisation generates shared affective states that reinforce cohesion and trust, mediated by neurochemical changes associated with pleasure and social bonding.

From a neuroludism perspective, these practices are interpreted as paradigmatic examples of how rhythmically structured physical play becomes a tool for sculpting neural networks, refining coordination, and weaving social and symbolic bonds.

6.5. Action, emotion and cognition from a neuroludic perspective

A neuroludic reading of motor skills highlights that action, emotion and cognition are not separate domains that add up in an additive way, but rather intertwined dimensions of the same playful experience. In play, the subject acts by moving, feels while acting and interprets what is happening, constructing meanings that reconfigure their relationship with themselves and with others. Movement patterns influence the quality of emotions (e.g., the intensity of arousal or the feeling of control), and these emotions, in turn, modulate attention, memory, and decision-making within the game.

Neuroludism therefore proposes understanding motor play as a privileged setting where the co-emergence of neural configurations, affective states, and cognitive processes, mediated by specific cultural practices, can be observed. This perspective has direct implications for the design of educational and therapeutic interventions: it is not just a matter of 'adding play' to pre-existing activities, but of designing playful experiences that intentionally integrate motor challenges, opportunities for emotional regulation and meaningful cognitive tasks. In this way, playful motor skills become the operational core of neuroludism, showing that it is in the body at play that the brain, emotion, thought and culture are tangibly intertwined.

7. Neuro-playfulness as a biocultural model

7.1. Components of the model: biological, neuroscientific and cultural dimensions

Neuroludism is proposed as a biocultural model in which play is understood simultaneously as biological behaviour, neurocognitive experience and practice laden with cultural meanings. In its biological dimension, the model integrates ethological and evolutionary data showing how play appears in numerous species, fulfils adaptive functions and is associated with relatively stable patterns of ontogenetic development. This biological basis includes both morphological and motor aspects as well as behavioural repertoires that are repeated with intra- and interspecific variations.

In its neuroscientific dimension, neuroludism incorporates findings on the activation of reward circuits, the involvement of structures such as the nucleus accumbens, the amygdala, the prefrontal cortex and the cerebellum, and the involvement of neurotransmitters such as dopamine, serotonin, oxytocin and beta-endorphins during play activity. Finally, the cultural dimension encompasses the

historically situated forms that play takes in different societies, its insertion into rituals, educational systems, artistic and sporting practices, as well as the symbolic and normative meanings conferred on it by human communities. The biocultural model articulates these three levels not as overlapping layers, but as co-constitutive dimensions of the neuroludic experience.

7.2. Organising principles of neuroludism (universality, variability, plasticity, transspecies)

The neuroludic model is structured around several organising principles that allow us to understand the complexity of play without losing sight of its regularities. The principle of universality points to the widespread presence of playful behaviours and neurochemical bases associated with play in multiple species, as well as the historical omnipresence of play in diverse human cultures. This principle does not imply absolute uniformity, but rather the existence of a common functional 'core': motor rehearsal in low-risk contexts, emotional regulation, social exploration and the generation of behavioural variability.

The principle of variability recognises, in turn, the enormous diversity of forms that play takes on depending on phylogenetic, ontogenetic and sociocultural factors. Plasticity constitutes a third central principle: play is presented as a space where neural circuits, motor repertoires and cultural norms are reorganised, allowing the individual to adapt to changing environments and develop flexible identities. Finally, the transspecies principle emphasises that play is not exclusive to humans, but shares mechanisms and functions with other species, allowing us to study evolutionary continuities and, at the same time, differentiate the specificities of human play in terms of symbolisation and cultural complexity. Together, these four principles provide neuroludism with a conceptual structure capable of integrating data from very different sources.

7.3. Cross-species case studies that exemplify the biocultural model

Cross-species case studies offer a particularly fertile field for illustrating the neuroludic model as a biocultural approach. Observations of fighting and chasing games in bonobos, canids, and other social mammals show how these behaviours combine motor rehearsal, emotional regulation, and bond building, supported by neurochemical changes similar to those described in humans during playful activities. In dolphins, otters, and certain birds, games with objects—such as bubble rings or improvised tools—have been documented that function as technological training and creative exploration of the environment, directly connecting play, fine motor skills, and adaptive innovation.

In the case of humans, research on traditional Mediterranean children's games, clapping games and group dynamics linked to neuromotor skills shows how certain playful structures simultaneously stimulate motor coordination, attention, working memory and social cohesion. These examples allow us to see, in parallel, how the same biological and neurochemical 'scaffolding' is expressed in very diverse play repertoires, modulated by historical and cultural contexts. From a neuro-play perspective, these case studies are not interpreted in isolation, but as converging evidence that play acts as a biocultural interface where evolution, neurodevelopment and symbolic construction are intertwined.

7.4. Articulation of neuroludism with emerging paradigms (neuroeducation, neuroaesthetics, neuromotricity)

Neuroludism is not presented as an exclusive paradigm, but as an articulating framework that dialogues with other emerging approaches. It shares with neuroeducation an interest in applying neuroscientific knowledge to the improvement of teaching-learning processes, but it contributes a specific focus on play as a privileged context for the development of executive functions, emotional regulation, and intrinsic motivation. Rather than understanding play as an added resource, neuroludism conceives it as the organising axis of educational environments that integrate movement, emotion and cognition.

In relation to neuroaesthetics, neuroludism converges on the idea that aesthetic and playful experiences activate brain networks of reward, attention and meaning, generating states of deep involvement and exploratory pleasure. However, the neuroludic focus is on the interactive and motor dimension of play, rather than on aesthetic contemplation. Finally, neuroludism has a particularly close relationship with neuromotor skills: both are based on the centrality of the body in neurocognitive development, but neuroludism extends the analysis to the symbolic and cultural dimension of playful motor practices. This articulation allows bridges to be built between movement-based interventions, active pedagogical approaches, and cultural frameworks that give meaning to physical games.

7.5. Current limitations, open debates and theoretical challenges of the model

Despite its integrative potential, neuroludism faces several limitations and theoretical challenges that need to be made explicit in order to avoid uncritical adoption of the model. Firstly, the empirical evidence that simultaneously articulates biological, neural and cultural levels remains limited: there is an abundance of solid work in each of these areas separately, but truly integrative studies that combine ethological observation, neurophysiological measurements and sociocultural analysis in the same research design are less frequent. This scarcity currently hinders the formulation of robust general laws within the neuroludic paradigm.

Secondly, there are ongoing debates about the best way to conceptualise human play in relation to animal play: some authors warn of the risk of overemphasising trans-species continuities and underestimating the specificity of symbolisation and cultural institutionalisation in the human species. Another challenge lies in avoiding neurobiological reductionism that interprets play exclusively in terms of brain activation or neurotransmitter release, ignoring the fact that these processes are always mediated by historical, normative and power contexts. Neuro-play theory recognises that the model is under construction and requires constant dialogue with other theoretical traditions in order to refine its categories, validate its hypotheses and better define its scope.

Finally, the development of neuroludism as a biocultural paradigm involves significant methodological challenges: designing longitudinal studies that capture the impact of play on neurodevelopment, integrating qualitative and quantitative data, and establishing shared criteria for identifying and classifying neuroludic practices in educational, clinical, and community contexts. Taking on these challenges is a necessary condition for neuroludism to consolidate itself as a solid

frame of reference, capable of guiding doctoral research, informing public policy, and contributing substantially to the debate on the role of play in human life and the evolution of species.

Taking on these challenges is part of the neuroludic project itself, understood as a long-term research programme on the role of play in the biocultural configuration of human identity.

8. Implications of neuroludism in education, health and social innovation

8.1. Neuroludism and the design of educational environments based on play and neuromotor skills

The neuroludic approach offers a powerful framework for rethinking the design of educational environments, placing motor and symbolic play at the centre of the learning experience rather than as an accessory resource. Synthesis reports on neuroscience and learning through play highlight that well-designed playful experiences combine challenge, emotional support and personal meaning, creating optimal conditions for brain plasticity (Zosh et al., 2017).

From this perspective, classrooms, playgrounds and community spaces are conceived as settings where movement, playful exploration and social interaction activate reward systems, promote synaptic plasticity and exercise executive functions in a natural and e ly way. The deliberate integration of complex motor games, rhythmic dynamics, and cooperative activities allows students to develop neuromotor, cognitive, and socio-emotional skills simultaneously. This approach proposes understanding play as a spectrum of experiences ranging from free play to guided activities, provided that the child's agency and a positive emotional climate are preserved (Zosh et al., 2018).

In practical terms, this involves designing pedagogical proposals that combine graded physical challenges, clear but flexible rules, and opportunities for symbolic creation, harnessing the potential of play to generate states of flow and intrinsic motivation. Collaboration between specialists in physical education, neuroeducation, and neuromotor skills is key to building curricula that systematically integrate neuro-playful experiences, adapted to different stages of development and the diversity of the student body. In this way, neuro-playfulness becomes a central axis of active pedagogies that seek to align the brain, body, and culture in the educational process. The educational applications of the BAPNE method show that body percussion tasks can be integrated into the curriculum in an interdisciplinary way as a tool for working on attention, memory and group cooperation (Romero-Naranjo & Andreu-Cabrera, 2023b). In early childhood education, the development of neuromotor development tables linked to playful activities has made it possible to specify which types of rhythmic tasks are most appropriate for each age group (Romero-Naranjo, Andreu-Cabrera, & Arnau-Moll, 2024).

8.2. Therapeutic potential of neuro-play practices in mental health and neurorehabilitation

Recent paediatric recommendations insist that play should be considered a basic necessity for healthy development, rather than an optional luxury subordinate to academic work (Yogman et al., 2018). In the field of mental health, neuro-play practices offer a valuable resource for addressing difficulties in emotional regulation, motivation, social interaction, and sensorimotor integration. Cooperative games, role-playing, and rhythmic physical activities can help modulate mood, reduce

stress and anxiety levels, and strengthen communication and empathy skills by activating reward circuits and releasing neurotransmitters associated with pleasure and social bonding.

In neurorehabilitation, neuroludism suggests that functional recovery programmes can benefit from the incorporation of playful tasks that combine motor and cognitive objectives in contexts that are meaningful to the patient. For example, games of balance, coordination, and spatial orientation designed with a progressive and adaptive logic can promote the reorganisation of neural networks after neurological injuries or diseases, increasing adherence to treatment thanks to the component of enjoyment and sense of achievement. From this perspective, therapy ceases to be merely a set of prescribed exercises and becomes a structured play experience that mobilises the subject's biological, neural, and cultural resources.

Neuroludism allows us to conceptualise these therapeutic practices as interventions on embodied identity, in which neural circuits, motor repertoires and narratives of self are reconfigured simultaneously.

8.3. Play, social cohesion and inclusion: applications in community and cultural contexts

The implications of neuroludism also extend to the community level, where play can act as a tool to strengthen cohesion, promote inclusion and rebuild fragmented social fabrics. Intergenerational play activities, festivals based on traditional games, and participatory art projects with motor and symbolic play components can create meeting spaces where inequalities are temporarily diluted and more cooperative forms of coexistence are rehearsed. The neuroludic component is evident in the way these events activate the body, generate shared emotions and produce collective narratives, influencing both subjective well-being and the perception of belonging.

In contexts of cultural diversity, the revival and adaptation of traditional games can facilitate mutual recognition and dialogue between groups, while preserving the physical and symbolic knowledge that forms part of the intangible heritage of communities. Neuro-ludism provides a language to explain why these practices are not mere folkloric recreations, but interventions with an impact on social health, collective self-esteem and the transmission of values.

8.4. Interactive technologies, artificial intelligence and emerging neuroludic scenarios

The development of interactive technologies and artificial intelligence opens up new possibilities for the creation of neuroludic scenarios in which the relationship between the brain, body and environment is reconfigured. Virtual and augmented reality environments, video games with motion sensors, and platforms that adapt the level of challenge in real time to the user's physiological responses allow for the design of highly personalised playful experiences, potentially useful in both education and health. These technologies can intensify immersion and motivation, but they also raise questions about the quality of the bodily and social experience when play is mediated through digital interfaces.

From a neuroludism perspective, the challenge is to harness the potential of these tools to create environments that stimulate motor skills, creativity and meaningful interaction, avoiding designs focused solely on capturing attention or maximising usage time. Collaboration between experts in neuroscience, game design, technological ethics and public policy is essential to guide the

development of artificial intelligence systems that respect the biocultural principles of play and promote neuroludic experiences that foster the integral development of individuals.

8.5. Ethical and public policy considerations in the application of neuroludism

The application of neuroludism in education, health, and social innovation raises important ethical and public policy issues. Firstly, knowledge about the reward and motivation mechanisms associated with play can be used in an ambivalent way: it can serve to design more inclusive learning environments and more effective therapies, but also to build entertainment or work systems that exploit users' vulnerability, encourage addictive behaviour or reinforce inequalities. It is therefore essential to establish regulatory frameworks and codes of good practice to guide the responsible use of neuro-ludic strategies.

Secondly, public policies should recognise the value of play as a right and as a biocultural health resource, guaranteeing spaces and times for recreational activities in schools, health centres, neighbourhoods and work environments. Furthermore, family environments that value free play and actively participate in it are associated with higher levels of habitual playfulness in children and more appropriate patterns of self-regulation (Whitebread & Bingham, 2014). Reports on play policies emphasise that the reduction of opportunities for free play in childhood has cumulative effects on well-being, creativity and community participation, making the protection of play a structural issue as well as an educational one (Lester & Russell, 2008). This involves investing in infrastructure, professional training and programmes that integrate play structurally, rather than merely as an accessory. From a neuroludic perspective, it is proposed that these policies be conceived as investments in collective neuroludic capital: shared capacities to use play in emotional regulation, social cohesion, and cultural innovation. Addressing these issues explicitly is a necessary condition for neuroludicism not to be limited to a theoretical framework, but to translate into tangible changes with a positive ethical and social impact.

These ethical and political considerations are inseparable from the neuroludic proposal, which conceives of play as a powerful biocultural resource whose responsible management is key to individual and collective well-being.

9. Lines of research on neuroludism

9.1. Priority research questions in the biology and neuroscience of play

From the perspective of biology and neuroscience, neuroludism raises a set of priority questions aimed at clarifying the mechanisms that link play, adaptation and development. Among these, the following stand out: How does the temporal organisation of play (frequency, duration, intensity) vary throughout the life cycle and how does it relate to critical windows of neural plasticity? What are the differences and similarities in the neurochemical patterns of play between species with different degrees of social and cognitive complexity? To what extent are individual variations in propensity to play associated with genetic, epigenetic or early experience differences that affect the configuration of reward and executive control systems? It has been reported that the propensity to play and the intensity of the playful response vary between individuals, suggesting differences in the sensitivity of motivational and social approach systems (Siviy, 2016).

Another priority area concerns the impact of play on the prevention of disorders and the promotion of mental health: research is proposed into the extent to which regular participation in complex neuro-play activities can mitigate the effect of risk factors (chronic stress, social isolation, adverse childhood experiences) on brain structure and function. These questions require longitudinal, comparative and intervention studies that combine neurophysiological, behavioural and contextual measurements, explicitly articulated from the conceptual framework of neuroludism.

9.2. Research agendas in anthropology, cultural history and game studies

In the fields of anthropology, cultural history, and game studies, neuroludism opens up research agendas focused on understanding how societies have used play to consciously or unconsciously modulate the neuromotor, affective, and cognitive configuration of their members. Key questions include: How do the predominant forms of play in a culture relate to its conceptions of the body, childhood, education, and power? How have historical changes—industrialisation, urbanisation, digitalisation—reconfigured 'neuro-ludic regimes', that is, the opportunities, restrictions, and uses of play in different social groups?

It is also relevant to explore how traditional games, ritual practices, and contemporary forms of recreational leisure can be interpreted as cultural technologies that exploit, amplify, or regulate human neuroludic capacities. This requires methodologies that combine historical and ethnographic analysis with interpretations informed by neuroscience and evolutionary biology, avoiding both biological reductionism and disconnection from bodily and neural substrates.

9.3. Experimental, observational and mixed designs with a neuroludic approach

The development of neuroludism as a field requires research designs capable of integrating different levels of analysis. At the experimental level, studies can be designed that manipulate specific characteristics of playful activities—for example, degree of cooperation vs. competition, motor complexity, symbolic load—and evaluate their differential effects on neurophysiological indicators, cognitive performance, and emotional variables. These experiments can be conducted in both controlled laboratory settings and ecological contexts (classrooms, playgrounds, community centres), using techniques such as functional neuroimaging, electrophysiological recordings, or peripheral measures of stress and arousal.

In the observational realm, longitudinal studies that follow groups of children, adolescents, or adults in different cultural settings can help identify how patterns of participation in specific games are associated with neuromotor, socio-emotional, and academic development trajectories. Mixed designs, combining quantitative data (frequency of play, biological indicators, psychometric scales) with qualitative data (experience reports, ethnographic observations, discourse analysis), are particularly well suited to capturing the biocultural complexity of neuro-ludic practices.

9.4. Methodological challenges: integration of ethological, neuroscientific and sociocultural data

One of the main methodological challenges of neuroludism lies in the coherent integration of ethological, neuroscientific and sociocultural data. The temporal and spatial scales of these sources differ: ethological observations in animals may focus on micro-sequences of behaviour,

neuroscientific studies focus on milliseconds of brain activity, while historical and cultural analyses span decades or centuries. Articulating these levels requires carefully designed triangulation strategies, explicit theoretical frameworks, and analytical tools capable of bringing heterogeneous dimensions into dialogue.

Another challenge is cross-species comparison: transferring categories designed to describe human play to other species can induce anthropomorphism, while ignoring human specificities reduces understanding of the symbolic and cultural dimension of play. Shared protocols are therefore needed for the codification of playful behaviours, clear criteria for the selection of comparable neurobiological indicators, and interpretative frameworks that avoid both abusive homogenisation and disciplinary fragmentation. Finally, neuro-playful research must pay attention to issues of representativeness and bias: many studies focus on a few species and cultures, which limits the generalisation of results.

9.5. Synergies with doctoral programmes and international research networks

Neuroludism offers fertile ground for the development of doctoral projects with a strong interdisciplinary component, which can be articulated in programmes in biology, neuroscience, education, anthropology, psychology, sports science and cultural studies. Theses inspired by this framework may explore, for example, the impact of neuroludic interventions in school contexts, the role of play in neurological rehabilitation, transformations in play culture in digital environments, or cross-species comparisons of play patterns and their neurochemical correlates. These projects require co-direction between different areas and the construction of shared languages that facilitate communication between disciplines.

Furthermore, the advancement of neuroludism will be reinforced by the creation of international research networks that bring together teams from different countries interested in play as a biocultural phenomenon. These networks can promote multicentre studies, strengthen data comparability, and encourage the circulation of innovative methodologies, as well as the training of young researchers in integrative approaches. From a science policy perspective, supporting these synergies means recognising the potential of neuroludism to contribute to global debates on education, health, well-being and social cohesion, and positioning it as one of the priority areas in high-impact interdisciplinary research agendas.

9.6. Key message: why talk about neuroludism now

The journey taken throughout this chapter allows us to summarise a key message: talking about neuroludism today means recognising that play is not merely an educational resource or a secondary form of entertainment, but a biocultural device that organises the brain, body and culture throughout life. Proposing neuroludism as a concept means giving a name to this convergence, offering a framework capable of integrating ethological, neuroscientific and sociocultural data under the same explanatory logic (Romero-Naranjo, 2025a, 2025b). In an academic context that demands theoretical originality, methodological soundness and social impact, neuroludism is emerging as a fertile paradigm for reordering the study of play and opening up new agendas in education, health and social innovation. Interventions based on rhythm and movement in socially disadvantaged contexts have shown improvements in self-regulation skills and group participation, even over relatively short periods (Williams & Berthelsen, 2019). By placing play at the centre of

the configuration of human identity, this approach invites us to rethink public policies, curriculum designs and intervention programmes based on the question of how we want our ways of playing, feeling and being to be articulated in the coming decades.

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Developing flexible thinking through movement: Connections between the growth mindset and BAPNE

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Abstract

This research explores the theoretical and practical intersections between Carol Dweck's Growth Mindset theory and the BAPNE method, a practice focused on neuromotor skills for cognitive and socio-emotional stimulation through body percussion. Given the notable rise in interest in neurological and learning processes within psychology and education, and the increased incorporation of movement, rhythm, and coordination in physical activities, this study addresses a significant gap in the extant literature by analyzing how these two distinct approaches can achieve a synergistic effect in educational settings. The Growth Mindset is centered on the premise that skills and intelligence are cultivable through dedication, practice, and perseverance, contrasting with the fixed mindset which views abilities as innate and unchangeable. It emphasizes reinterpreting failure as a learning opportunity and highlights the critical role of effort praise in fostering a willingness to confront challenges. The BAPNE method, grounded in five interdisciplinary fields—biomechanics, anatomy, psychology, neuroscience, and ethnomusicology—uses body percussion and motor coordination to enhance executive functions. A comparative analysis identifies a substantial and complementary bidirectional relationship between the two perspectives, despite their divergent origins. Both approaches are founded on the concept of brain plasticity, and both emphasize the value of effort and persistence, regarding errors as an inherent component of the learning process. BAPNE provides an experiential platform where students tangibly demonstrate the value of effort by acquiring complex rhythmic and motor skills, implicitly embodying the growth mindset concept of the 'power of yet'. Moreover, its rhythmic, sequential nature fosters metacognition and directly trains executive functions like attention, working memory, and inhibitory control, which are fundamental to the self-regulation required by a growth mindset. In turn, students with an existing growth mindset approach BAPNE activities with greater openness to error and tolerance for frustration, thereby maximizing the method's cognitive and socio-emotional benefits. This integration, particularly through the use of progressively sequenced fine motor activities, is presented as a powerful catalyst for enhancing self-perception and cognitive development, suggesting that future interventions should seamlessly combine BAPNE's bodily approach with explicit messages about the malleability of abilities.

Keywords: Growth Mindset, BAPNE, Body Percussion, Neuromotricity, Executive Functions, Brain Plasticity, Flexible Thinking.

Resumen

Esta investigación explora las intersecciones teóricas y prácticas entre la teoría del «crecimiento mental» (Growth Mindset) de Carol Dweck y el método BAPNE, una práctica centrada en las habilidades neuromotoras para la estimulación cognitiva y socioemocional a través de la percusión corporal. Dado el notable aumento del interés por los procesos neurológicos y de aprendizaje en el ámbito de la psicología y la educación, y la creciente incorporación del movimiento, el ritmo y la coordinación en las actividades físicas, este estudio aborda una importante laguna en la bibliografía existente al analizar cómo estos dos enfoques distintos pueden lograr un efecto sinérgico en entornos educativos. La mentalidad de crecimiento se centra en la premisa de que las habilidades y la inteligencia se pueden cultivar mediante la dedicación, la práctica y la perseverancia, en contraste con la mentalidad fija, que considera que las habilidades son innatas e inmutables. Hace hincapié en reinterpretar el fracaso como una oportunidad de aprendizaje y destaca el papel fundamental de elogiar el esfuerzo para fomentar la voluntad de afrontar retos. El método BAPNE, basado en cinco campos interdisciplinarios —biomecánica, anatomía, psicología, neurociencia y etnomusicología— utiliza la percusión corporal y la coordinación motora para mejorar las funciones ejecutivas. Un análisis comparativo identifica una relación bidireccional sustancial y complementaria entre las dos perspectivas, a pesar de sus orígenes

divergentes. Ambos enfoques se basan en el concepto de plasticidad cerebral y ambos enfatizan el valor del esfuerzo y la persistencia, considerando los errores como un componente inherente al proceso de aprendizaje. BAPNE proporciona una plataforma experiencial en la que los estudiantes demuestran de forma tangible el valor del esfuerzo mediante la adquisición de habilidades rítmicas y motoras complejas, encarnando implícitamente el concepto de mentalidad de crecimiento del «poder del todavía». Además, su naturaleza rítmica y secuencial fomenta la metacognición y entrena directamente funciones ejecutivas como la atención, la memoria de trabajo y el control inhibitorio, que son fundamentales para la autorregulación que requiere una mentalidad de crecimiento. A su vez, los estudiantes con una mentalidad de crecimiento ya existente abordan las actividades de BAPNE con una mayor apertura al error y tolerancia a la frustración, maximizando así los beneficios cognitivos y socioemocionales del método. Esta integración, en particular mediante el uso de actividades motoras finas secuenciadas progresivamente, se presenta como un potente catalizador para mejorar la autopercepción y el desarrollo cognitivo, lo que sugiere que las intervenciones futuras deberían combinar a la perfección el enfoque corporal de BAPNE con mensajes explícitos sobre la maleabilidad de las habilidades.

Palabras clave: Mentalidad de crecimiento, BAPNE, percusión corporal, neuromotricidad, funciones ejecutivas, plasticidad cerebral, pensamiento flexible.

INTRODUCTION

In recent years, there has been a notable increase in the level of interest in neurological and learning processes within the fields of psychology and education. Concurrently, the incorporation of movement, rhythm, and coordination in physical activities has witnessed a marked rise in popularity. Among the methodologies that reinforce the idea of an interdisciplinary approach to stimulating cognitive and executive functions through the inclusion of body movement, the BAPNE method is worthy of particular note (Romero-Naranjo & Andreu-Cabrera, 2023a, 2023b, Andreu-Cabrera et al., 2024). The method under discussion makes use of body percussion as a tool for learning, whilst also upholding the principle of teaching and learning as a progressive process. Sayago et al. (2021) analyse the socio-emotional aspects of the methodology, establishing that it is not authoritarian and offers flexibility tailored to the student's level. The methodology promotes an emotionally safe environment through group activities, in which mistakes are perceived as a natural part of the learning process and an opportunity for growth.

In this particular regard, a starting point could be established to link the methodology with Carol Dweck's growth mindset. A thorough review of the extant literature reveals an absence of any specific study that has been identified which directly links this concept to body percussion. However, research has been conducted on the use of body percussion as a pedagogical resource, analysing its application in educational contexts (Arnau-Mollá & Romero-Naranjo, 2022). The incorporation of body percussion into the neuromotor paradigm may have the capacity to enhance growth mindset in student populations.

The present research aims to explore the intersection between the BAPNE method, a practice based on neuromotor skills for cognitive, socio-emotional, psychomotor and neurorehabilitative stimulation through body percussion, and the Growth Mindset theory proposed by Carol Dweck. Firstly, the objective is to identify the approaches of each in the field of learning. In the following section, an analysis is presented of the common points, possible interactions and elements that would allow these approaches to be linked together. This analysis takes into account the characteristics of one that could be reflected in the other, and how they could be combined to enhance their benefits. The overarching objective is to furnish concrete illustrations that underscore the efficacy of this methodological integration within an educational framework, with

the ultimate goal of enhancing the self-perception and cognitive and emotional development of the participants.

GROWTH MINDSET THEORY

The concept of a growth mindset, as proposed, extensively studied and developed by psychologist Carol Dweck, is of particular interest in this context. The term is used to denote the belief that skills and intelligence are not immutable traits, in contrast to the fixed mindset, which assumes that individuals have limited abilities due to innate factors that are somewhat static and unchangeable. In the field of education, this notion has gained prominence due to its impact on factors such as motivation, academic performance, the capacity to overcome challenges, and resilience. This has led to a surge in interest in empirical research and its practical implementation.

Dweck, a professor of psychology at Stanford University, is the central figure in the development of this theory. The foundation of her work is rooted in extensive research, initiated during the period spanning from 1970 to 1980, which centres on the notion that students' causal attributions concerning their academic achievements or setbacks exert a direct influence on their behavioural patterns, motivational levels, and academic performance. As Dweck (1999) observes, the interpretation of personal experiences can influence individual differences in thinking, feeling or acting, thereby shaping responses to similar circumstances.

One of her most influential contributions is found in the experimental study published in 1998 in the *Journal of Personality and Social Psychology*, which analysed the impact of different types of feedback on the motivation of approximately 400 fifth-grade students. The findings indicated that students who received praise for their effort exhibited a greater propensity to cultivate a growth mindset, characterised by an enhanced inclination to confront challenges, perseverance in the face of adversity, and an optimistic disposition towards learning. Conversely, those who were lauded for their innate intelligence (a trait often associated with a fixed mindset) exhibited reduced tolerance for failure and a pronounced preference for tasks that were less challenging, strategically avoiding circumstances that could potentially compromise their intellectual self-image. This finding has been widely replicated and forms the empirical basis for mindset theory, highlighting the influence of implicit beliefs about intelligence on academic performance and self-regulation of learning (Mueller & Dweck, 1998).

Dweck later refined and expanded on these ideas in her book *Mindset: The New Psychology of Success*, in which she summarises how mindsets, specifically fixed mindsets and growth mindsets, shape not only the educational sphere, but also contexts such as work, interpersonal relationships and personal development. Her central hypothesis argues that individuals' beliefs and attitudes about their own abilities could profoundly influence how they face challenges and achieve success. Thus, those who adopt a growth mindset tend to interpret failure as a learning opportunity, while those with a fixed mindset often avoid challenges for fear of appearing incompetent (Dweck, 2006).

Although Carol Dweck pioneered the development of the growth mindset concept, various researchers have contributed to the expansion and application of this theoretical framework in educational contexts. David Yeager, a regular collaborator of Dweck's, is an expert in the field of growth mindset-based interventions. He has researched how these interventions can be scaled up and integrated into public education policies. A study published in *Psychological Science* (Yeager

et al., 2016) demonstrated the efficacy of these interventions during adolescence, a pivotal stage for identity formation and socio-emotional development. Another of the most robust and recent studies led by Dweck and her collaborators is the National Study of Learning Mindsets (Yeager et al., 2019, *Nature*). The experiment described in this study involved 12,490 ninth-grade students, who were randomly selected to constitute a nationally representative sample of public schools in the United States. Researchers implemented a structured online intervention consisting of two brief sessions (each lasting less than 30 minutes) designed to cultivate a growth mindset. The findings of the investigation indicated substantial enhancements in the academic performance of students with below-average initial results, along with an increase in enrolment in advanced mathematics courses, particularly in institutions where this methodological approach is endorsed. The study under discussion emphasised the adaptability of mindset interventions and their potential to reduce educational inequalities.

In a similar strand of research, Angela Duckworth, a leading expert on the concept of grit (i.e. perseverance and passion for long-term goals), has established a correlation between growth mindset and sustained persistence. Duckworth et al. (2007) posit that both the conviction of one's ability to enhance one's state, and the determination to persevere in the face of adversity, are complementary constructs that collectively exert a synergistic effect on academic performance and personal development.

THE BAPNE METHOD

The BAPNE method is grounded in five interdisciplinary fields: biomechanics, which facilitates comprehension of bodily movement in space through the utilisation of planes and axes; anatomy, which provides precise movement instructions for specific bone and muscle structures; psychology, which guides movement from a therapeutic perspective; neuroscience, which elucidates the neurological mechanisms underlying each movement and offers insights into the potential stimulation of cerebral lobes; and ethnomusicology, which enables the analysis of bodily movement across diverse cultural contexts (Romero-Naranjo & Andreu Cabrera, 2023a).

The BAPNE method is a multifaceted approach to cognitive, socio-emotional, psychomotor and neurorehabilitative stimulation, based on neuromotor skills. The primary objective of the BAPNE method is to enhance cognitive functions, with a particular focus on executive functions. In order to achieve the aforementioned stimulation, the teaching of body percussion and motor coordination is employed for very specific purposes (Romero-Naranjo, 2025a, 2025b).

Common characteristics

The study by Dweck & Leggett (1988) on the social-cognitive approach to motivation and personality suggests that an individual's goals shape their behaviour and attitudes, generating behaviours oriented towards improvement and mastery of skills, or, conversely, towards helplessness. In this sense, language can be considered a factor that produces changes in the nervous system, shapes thinking, reorganises perception and regulates behaviour (Luria & Yudovich, 1978).

Dweck (2006) proposes that self-perception, or the development of self-concept, should not be based on praise for innate intelligence, but on the recognition of effort and the value of learning as constantly evolving processes. This perspective transforms self-esteem into an active construct,

which is not passively granted, but cultivated through the experience of overcoming challenges (Alberca, 2017). In this sense, although the BAPNE method does not explicitly propose the verbal expression of this concept, it implicitly incorporates the aforementioned principles into its pedagogical structure, where the trainer guides participants through progressive sequences that allow them to experience achievable challenges. The careful structuring of sessions at a rhythmic and physical level is conducive to a positive experience of effort, thereby fostering attitudes that value the process over the result. This is evidenced by the concept of process praise versus intelligence praise (Mueller & Dweck, 1998; Gunderson et al., 2013; Paunesku et al., 2015). The employment of development-oriented language, such as the utilisation of phrases such as 'the challenge not yet achieved (yet)', in conjunction with the adept management of internal dialogues, is imperative in fostering incremental beliefs about capabilities. In this context, the attitude towards error is redefined, challenges are sought, lessons are learned from them, and it is assumed that skills can be developed. This standpoint is in alignment with the assertions put forward by Merzenich (2013) concerning the concept of brain plasticity, which posits the notion that individuals possess the capacity to enhance their cognitive abilities across a wide range of domains. In this sense, BAPNE can be regarded as an experiential tool that subliminally embodies the concept of the 'power of yet' versus the 'tyranny of now'. This phenomenon assists students in comprehending their potential for self-development, facilitating the transition from a state of proficiency in a particular skill to one of continuous growth and evolution (be vs. become).

It can thus be verified that there are potential points of connection between the growth mindset and the BAPNE method. The former revolves around feedback, educational interventions, and sessions of explanation, discussion, writing, and motivation through verbal language, while BAPNE focuses on movement and neuromotor practice to stimulate cognitive and executive functions, although it also sometimes includes session closings with brief exchanges of ideas between the trainer and trainees.

Relationship or synergy between Growth Mindset and BAPNE

In order to analyse the relationships between these two concepts, the following methodology will be employed:

1. With regard to the concept of brain plasticity, it is important to note that both the growth mindset theory and the BAPNE approach are founded on this theoretical framework as a basis for learning and development. In BAPNE sessions, the evolution of learning in movements is demonstrably evidenced. It is evident that a student who engages in BAPNE and consequently enhances their coordination and attention may internalise the notion that their abilities are not fixed. This, in turn, serves to reinforce a growth mindset.
2. The same perspective can be applied to the concepts of effort and persistence. The challenges experienced in BAPNE, including the dissociation of hand and foot movements during singing, can be regarded as a practical model of progress, a process that is not immediate. Through consistent effort and repetition, progress is achieved and tolerance for frustration is cultivated. It is evident that students can experience a tangible sense of achievement in their learning, affirming their ability to progress towards mastery of a particular skill.

3. Despite the apparent differences in the underlying theoretical frameworks, a comparative analysis of these approaches reveals a degree of complementarity, particularly with regard to the integration of the body as a vehicle for learning, thereby fostering an environment that is both emotionally positive and motivating. The experiential and playful approach adopted in this context is consistent with the strategies proposed by Dweck, including the emphasis on making learning a positive and process-oriented experience. Body percussion, being a playful and collaborative activity, has the potential to reduce anxiety about failure and encourage an open attitude to challenge, which are fundamental elements in the development of a growth mindset. Furthermore, the rhythmic, sequential and self-correcting nature of BAPNE activities promotes metacognition, as it encourages students to become aware of their own learning processes, monitor their mistakes, adjust their strategies and reflect on their progress. The combination of bodily experience, motivation and metacognitive reflection has been demonstrated to enhance not only performance, but also autonomy and self-regulation skills.
4. The executive functions developed by BAPNE, such as sustained attention, planning, and inhibitory control, are fundamental to self-regulation, an implicit component of the growth mindset. Those who adopt this mindset must learn to regulate their emotions and thoughts in the face of setbacks. BAPNE activities have been shown to provide a practical way to train these skills, thereby strengthening students' ability to persevere.
5. The notion that skills are cultivable and contingent on effort rather than innate ability is a fundamental principle of BAPNE exercises. This approach fosters an environment conducive to the cultivation of self-confidence, as each exercise is meticulously designed to present a series of challenges that are systematically overcome, thereby reinforcing the perception of enhanced individual and collective capabilities and achievements.

The following table is provided for illustrative purposes:

Potential connection points	Growth Mindset	BAPNE®
1. Brain plasticity	It promotes the belief that human faculties are capable of modification and development.	It stimulates new neural connections through neuromotoricity, body percussion, coordination and rhythm.
2. Effort and persistence	The notion that skills can be enhanced through deliberate practice, the implementation of suitable strategies, and a commitment to effort is emphasised. Errors are regarded as an inherent aspect	BAPNE activities require constant practice and coordination, and consequently, may encounter initial difficulties. Error is considered an inherent component of motor learning. Repetition is a catalyst for

	of the process, deeming effort to be of greater significance than innate ability. It is widely accepted that perseverance is conducive to the development of intelligence and abilities, and that it engenders a process of constant improvement.	progress, and the judicious sequencing of exercises enables the escalation of difficulty and the progressive overcoming of challenges.
3. Learning styles	Rational, emotional and relational learning styles that are achieved through the provision of feedback and the practice of reflection.	The integration of the body and movement into the process is a fundamental aspect of the methodology, emphasising active, playful, physical, and cooperative engagement. This approach fosters the development of metacognitive processes by promoting conscious reflection on one's own actions in the teaching-learning process.
4. Executive functions	These are required to monitor learning processes and maintain a resilient attitude toward mistakes. Reflection facilitates the focusing of attention and the regulation of emotions.	BAPNE is characterised by a series of exercises designed to enhance attention, working memory, inhibition, cognitive flexibility, and planning.
5. Emotional development / Self-confidence	The promotion of increased self-esteem and self-confidence is achieved through the encouragement of the belief that skills can be improved through practice with proper guidance.	Through a series of exercises, participants progress sequentially in terms of rhythm, physicality, and cognition. Group activities engender a sense of self-assurance, thereby facilitating individuals in confronting subsequent challenges.

Comparison between Growth Mindset and BAPNE® Method

PRACTICAL EXAMPLE

Drawing upon a neuropsychological approach to movement, Luria (1974) posits that human movement is influenced by communication and social interactions, as it is based on complex neurological mechanisms. In this sense, he determines that adequate functional organisation of the brain, promoted through psychomotor skills, significantly increases the chances of development

and learning in childhood. The implementation of various psychomotor activities has been identified as a key factor in facilitating this development (Romero-Naranjo, 2019).

Consequently, for educators who undertake neuromotor sessions utilising the BAPNE method, it is paramount to be acquainted with activities that facilitate the development of executive functions through student movement.

The BAPNE method has been developed to address fine motor skills as a fundamental aspect of developing an appropriate growth mindset and avoiding a fixed mindset, in which the individual neither enriches nor evolves.

The importance of appropriate sequencing in the development of fine motor skills is emphasised by the findings of this study. It is suggested that appropriate sequencing can prevent a fixed mindset and encourage a growth mindset.

The following description outlines a comprehensive sequence for developing fine motor skills in accordance with the BAPNE method. This approach is designed to foster a growth mindset, emphasising that errors are an integral component of the learning process. Furthermore, it underscores the significance of dedication and perseverance in attaining success and achieving accomplishments.

The BAPNE approach is predicated upon the premise that the development of fine motor skills is contingent upon the consistent presentation of challenges to students, within an environment that values effort as a fundamental value and mistakes as opportunities for improvement.

Moreover, in the development of fine motor skills, the fundamental aspect is the process itself, the work and effort involved in the process, without evaluating the final product.

The BAPNE method is characterised by its consistent utilisation of reward strategies in the sequence of its activities, with the objective of counteracting a fixed mindset and promoting a growth mindset.

Furthermore, the BAPNE method has been demonstrated to stimulate the frontal and prefrontal lobes through the implementation of fine motor skills activities.

The activities are performed in conjunction with specific movements, which are executable in accordance with song lyrics or psychomotor melodies that utilise prosodic accent. It has been demonstrated that, in this manner, the stimulation is primarily focused on the aforementioned cerebral lobes, in addition to fostering bodily awareness, hand-eye coordination, writing skills, laterality, and the development of executive functions.

The tasks are meticulously designed to achieve early stimulation in four key domains: the development of hand-eye coordination, phonetics, gestural motor skills, and facial motor skills.

The BAPNE method provides a systematic framework for the precise classification of fine motor skills (Carretero-Martínez & Romero-Naranjo, 2020):

- Crossing
- Rotation

- Manual dissociation
- Alternance
- Precision
- Symbolic

It is important to note that these categories are not correlative and are worked on alternatively.

The BAPNE method is presented as an exemplar of a technique that fosters and operates on the basis of a growth mindset. The progressive sequencing of its activities is identified as a fundamental element in this process. This approach is designed to prevent the development of learned helplessness among students and to ensure adequate adaptation to motor and cognitive demands. The following section will present a comprehensive account of the complete sequencing of a BAPNE activity.

The following procedure will employ a simple manual dissociation activity as a basis.

Manual dissociation is one of the classifications of fine motor skills proposed by the BAPNE method. This particular psychomotor skill is characterised by the ability to execute different movements with each hand, that is, to dissociate their positions and modify them independently.

SEQUENCE 1

Psychomotricity 5-5 y 1-1

- Firstly, prior to the process of dissociation, it is recommended to engage in movement in parallel, executing the change with both hands.



Psychomotor dissociation with 1-5

- Subsequently, both hands initially assume different positions, and then the right hand, which previously exhibited one finger, now displays five; the left hand, which previously exhibited five fingers, now exhibits one. The change of hands is performed simultaneously.



SEQUENCE 2

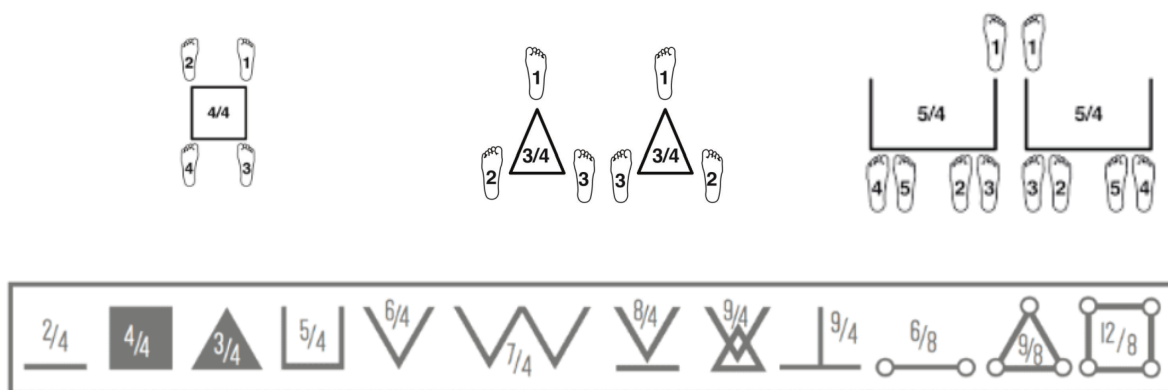
Psychomotor dissociation with 1-5 incorporates the intonation of a melody. A melody could be exemplified as such:

Campanero



SEQUENCE 3

Psychomotor dissociation with 1-5, and a geometric shape (square, triangle) is added to the melody in the lower body. The lower body shape can be one or several alternately.



Metrics proposed in BAPNE®

SEQUENCE 4

Psicomotricidad de disociación con 1-5 with a geometric shape in the lower body (square, triangle). In this sequence, an additional element of attention is incorporated into the dissociation psychomotor skills with 1-5 of the hands and a geometric shape (square, triangle) of the feet. In this phase, the teacher poses a question to the students, who are required to respond, with examples including a mathematical operation, the capital of a country, or an antonym. In summary, this approach has been demonstrated to enhance students' level of attention.

DUAL TASK

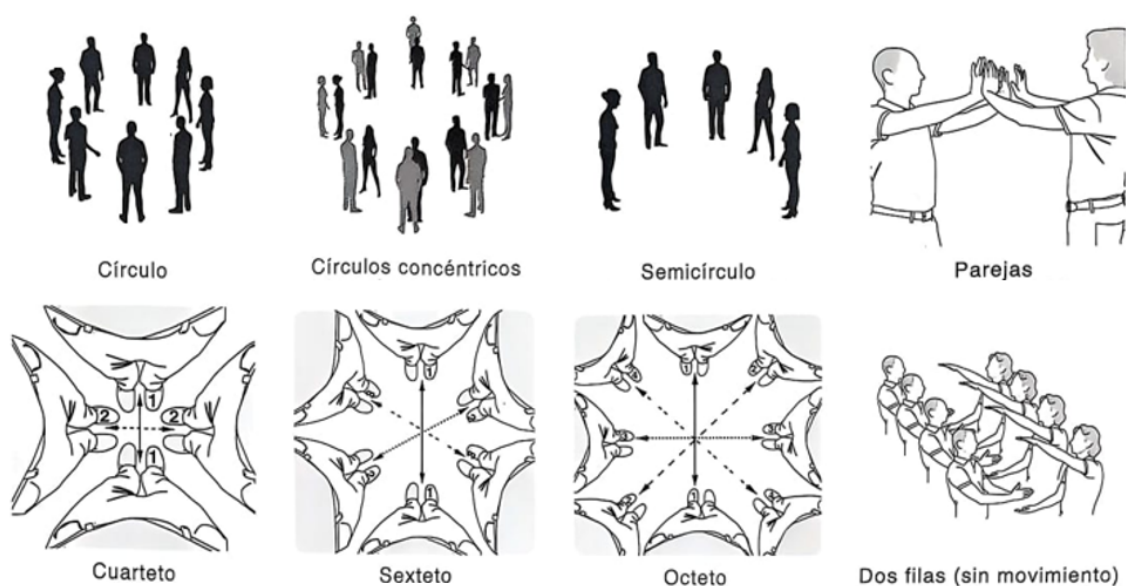
BERLÍN / GERMANY
BLACK / WHITE
TRANSLATE / ENGLISH SPOKEN
2X2 / 3+2

SEQUENCE 5

This sequence combines fine motor dissociation skills with a fundamental activity from the BAPNE method glossary called Clap Change.

On this occasion, the participant will continue to perform dissociation psychomotor skills with 1-5, intonation of a melody and geometric shapes (square, triangle) in the lower body and, according to the teacher's instructions, must change the dissociation of 1-5 in the hands.

It should be noted that this activity can be performed in any of the group setups contemplated by the BAPNE method.



Group setups in BAPNE®

It should be noted that the fundamental aspect of this activity, as with all activities in the BAPNE glossary, is not the final product of the activity, but rather the process itself. In this sense, through their effort and work, students improve and strengthen their self-confidence, which allows them to move forward and improve, avoiding fixed mindsets and fears that would prevent them from doing so.

If BAPNE is to be implemented by teachers or facilitators with an emphasis on process, progress and resilience (rather than immediate perfection), the method has the potential to become a powerful catalyst for cultivating a growth mindset.

The integration of specific small interventions, relevant questions, and a series of reflection-oriented questions within the BAPNE session has the potential to amplify the impact of the method. A student who adopts this mindset may approach body percussion sessions with a greater openness to making errors and acquiring knowledge, thereby optimising the cognitive and socio-emotional benefits of the method. This establishes a reciprocal relationship between the two approaches. It is posited that BAPNE, when utilised as a practical tool, has the capacity to reinforce the concept of a growth mindset, which, in turn, could serve to amplify the impact of BAPNE.

CONCLUSIONS

Dweck's growth mindset theory is centred on the premise that skills and intelligence can be cultivated through dedication, practice, and the capacity to persevere in the face of obstacles. This psychological approach emphasises the importance of intrinsic motivation, persistence, and reinterpreting failure as a learning opportunity, as opposed to a fixed mindset, which views abilities as innate and unchangeable (Dweck, 2006).

Despite the absence of longitudinal studies that directly examine and establish a link between BAPNE and an increase in growth mindset, research conducted by Romero-Naranjo et al. (2023a, 2023b) demonstrates cognitive and emotional benefits, including improved attention, memory, and anxiety management. These conditions have the potential to predispose students to adopt incremental beliefs about their abilities (Romero-Naranjo & Liendo-Cárdenas, 2025a, 2025b).

When analysing and comparing the growth mindset with BAPNE, several common points are identified that focus on the comprehensive development of the individual. Despite their divergent origins, a substantial and complementary bidirectional relationship has been demonstrated between these two perspectives. The growth mindset, predicated on reflection, feedback and psychological processes associated with the perception of effort and improvement, contrasts with the BAPNE method, which is founded on neuromotor learning and cognitive stimulation through movement. This relationship is of particular pertinence within the educational field (Romero-Naranjo & Navarro-Camacho, 2025). Specifically, BAPNE provides an experiential platform in which students experience the value of effort in acquiring complex rhythmic and motor skills. Conversely, individuals who already possess a growth mindset may approach BAPNE activities with greater openness to error, a willingness to continuously improve, and tolerance for frustration, thereby enhancing the cognitive and socio-emotional benefits of the method. The proposed practical example illustrates how a structured sequence of activities can promote transitions towards a growth mindset, thus avoiding the perpetuation of rigid thinking patterns or a fixed mindset.

The integration of metacognitive reflection questions during the concluding phase of a BAPNE session has the potential to reveal new lines of research, thereby facilitating the exploration of how rhythmic bodily practices influence students' beliefs and attitudes towards learning.

In order to rigorously validate the relationship between BAPNE and growth mindset, it will be necessary to adopt an interdisciplinary and empirically robust methodological approach. It is recommended that future research endeavours focus on the development of interventions that seamlessly integrate the bodily and rhythmic approach of BAPNE with explicit messages concerning the malleability of cognitive abilities. These interventions should be systematically evaluated to ascertain their impact on participants' beliefs. This approach would facilitate the establishment of a more robust empirical foundation for investigating the potential of rhythm and movement to transform the psychology of learning and promote the comprehensive development of students.

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Neuromotor approach for active breaks in work environments – Implementing the BAPNE method in Angola

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Abstract

This study addresses the critical necessity of enhancing cognitive performance and operational safety within industrial settings characterized by high-risk exposure and a potentially underqualified workforce, focusing specifically on a beverage factory in Angola. Given the prevailing concerns regarding sedentary lifestyles and mental fatigue in the workplace, the research proposes the implementation of Active Breaks (ABs) incorporating a high cognitive load, specifically through the adoption of the BAPNE method. The BAPNE method is grounded in a neuromotor approach, utilizing a combination of body percussion and dual tasks to integrate physical movement with rhythmic and cognitive exercises, thereby directly stimulating executive functions. Despite the extensive bibliographic evidence confirming the efficacy of ABs in enhancing attention within scholastic environments, a significant lacuna persists in the literature explicitly linking neuromotor activity or body percussion to the industrial workplace, particularly within the African context. Consequently, this investigation employs a qualitative methodology to gather and analyze the perceptions of factory operators regarding the impact of these brief interruptions on their learning processes and attentional capacities. The findings, derived from eight guided interviews with randomly selected participants, validate the practical justification for this intervention. Operators reported an immediate effect of 'awakening' the mind and restoring concentration following the break, serving to counteract the monotony and fatigue inherent in routine, repetitive tasks. Crucially, participants perceived a direct transfer of cognitive benefits to the precision required for factory tasks, such as adhering to protocols and handling data, noting that the learning was 'better retained in our minds'. In conclusion, Active Breaks incorporating the BAPNE method's cognitive load are demonstrated to be an effective mechanism for immediate cognitive activation. This approach transcends mere physical movement by directly stimulating executive functions like attention and cognitive flexibility. Furthermore, the intervention positively influences socio-emotional aspects, fostering motivation, satisfaction, and a reduction in nervousness, which is pivotal for adherence. The study recommends future research utilizing mixed and quantitative designs to validate the durability and sustainability of these cognitive and socio-emotional benefits over the long term.

Keywords: Active Breaks, Neuromotricity, BAPNE Method, Executive Functions, Attention, Occupational Safety, Angola.

Resumen

Este estudio aborda la necesidad crítica de mejorar el rendimiento cognitivo y la seguridad operativa en entornos industriales caracterizados por una exposición de alto riesgo y una mano de obra potencialmente poco cualificada, centrándose específicamente en una fábrica de bebidas en Angola. Dadas las preocupaciones predominantes sobre los estilos de vida sedentarios y la fatiga mental en el lugar de trabajo, la investigación propone la implementación de descansos activos (AB) que incorporen una alta carga cognitiva, específicamente mediante la adopción del método BAPNE. El método BAPNE se basa en un enfoque neuromotor, utilizando una combinación de percusión corporal y tareas duales para integrar el movimiento físico con ejercicios rítmicos y cognitivos, estimulando así directamente las funciones ejecutivas. A pesar de la amplia evidencia bibliográfica que confirma la eficacia de los AB para mejorar la atención en entornos escolares, persiste una laguna significativa en la literatura que vincule explícitamente la actividad neuromotora o la percusión corporal con el lugar de trabajo industrial, particularmente en el contexto africano. En consecuencia, esta investigación emplea una metodología cualitativa para recopilar y analizar las percepciones de los operarios de fábrica sobre el impacto de estas breves interrupciones en sus procesos de aprendizaje y capacidades de atención. Los resultados, obtenidos a partir de ocho entrevistas guiadas con participantes seleccionados al azar, validan la justificación práctica de esta intervención. Los operadores informaron de un efecto inmediato de «despertar» la mente y recuperar la concentración tras el descanso, lo que servía para contrarrestar la monotonía y la fatiga inherentes a las tareas rutinarias y repetitivas. Es fundamental señalar que los participantes percibieron una transferencia directa de los beneficios cognitivos a la precisión requerida para las tareas de la fábrica, como el cumplimiento de los protocolos y el manejo de datos, y señalaron que el aprendizaje «se retenía mejor en nuestras mentes». En conclusión, se ha demostrado que los descansos activos que incorporan la carga cognitiva del método BAPNE son un mecanismo

eficaz para la activación cognitiva inmediata. Este enfoque trasciende el mero movimiento físico al estimular directamente funciones ejecutivas como la atención y la flexibilidad cognitiva. Además, la intervención influye positivamente en los aspectos socioemocionales, fomentando la motivación, la satisfacción y la reducción del nerviosismo, lo cual es fundamental para el cumplimiento. El estudio recomienda futuras investigaciones que utilicen diseños mixtos y cuantitativos para validar la durabilidad y la sostenibilidad de estos beneficios cognitivos y socioemocionales a largo plazo.

Keywords: Descansos activos, neuromotricidad, método BAPNE, funciones ejecutivas, atención, seguridad laboral, Angola.

INTRODUCTION AND CONTEXTUALISATION

The socio-economic context in Angola, a nation that has emerged from a protracted civil conflict, is characterised by inadequate human capital development. The nation's education system has historically exhibited deficiencies, with a disproportionate emphasis on infrastructure development rather than on enhancing the calibre and proficiency of its teaching staff. It is evident that students are not adequately proficient in demonstrating their learning outcomes, and the harmonised test scores are substandard, with a mean of 326 points out of a possible 625 (Paulo, 2021). In this environment, and given the generally poor state of social security in southern Africa, workers, especially those in high-risk sectors such as mining and transport, face gruelling working hours which, when combined with low wages and precarious conditions, can lead to high levels of stress, mental fatigue and musculoskeletal discomfort (Briones-Vozmediano, 2024). In such circumstances, the consequences of deficiencies in attention and cognitive rigidity are manifest as direct risks to operational safety and productivity (Morgade Marrero, 2025).

This situation underscores the necessity to reinforce operators' cognitive abilities, particularly in routine and recurring tasks that demand sustained attention and the capacity to respond expeditiously to unanticipated events. Executive functions, which have been metaphorically referred to as the 'Swiss Army knife' of the prefrontal cortex (Romero-Naranjo & Andreu-Cabrera, 2023a), are vital in accident prevention. Within this set of skills, attention and cognitive flexibility are critical components. It is posited that workers could enhance their capacity to predict and manage unanticipated circumstances effectively, adapting their approaches in response to alterations in task planning or protocol. Consequently, the implementation of an intervention programme grounded in neuromotor skills, such as the BAPNE method, is deemed appropriate, as its objective is to stimulate executive functions and the utilisation of dual tasks, thereby aiming to directly influence workers' attention span, processing speed and flexibility. This approach offers a novel instrument for enhancing occupational well-being and safety within the Angolan context.

The issue of occupational safety and health in southern Africa is characterised by the presence of high-exposure sectors, where risks are concentrated. This phenomenon is further compounded by the presence of an underqualified workforce, which increases the likelihood of accidents. Despite the prevalence of research addressing the occupational hazards in the region, including mining and agriculture, where employees frequently encounter job insecurity, elevated stress levels and musculoskeletal disorders, it is imperative to emphasise that the enhancement of cognitive performance is equally crucial in standard industrial operational contexts. In the context of a beverage factory in Angola, the success of operations and the prevention of errors are contingent upon the sustained and selective attention of operators during recurring tasks, in addition to strict

compliance with qualified protocols. This is particularly relevant when handling machinery such as washers, fillers, labellers and returnable glass bottle inspectors.

A prevailing concern regarding sedentary lifestyles and mental fatigue at work has rendered Active Breaks (AB) an effective strategy, defined as structured, brief periods of physical activity, typically lasting less than 15 minutes, designed to disrupt routine and enhance well-being. It is theorised that, under optimal management, they have the capacity to enhance executive function. The extant research suggests that the most beneficial ABs for cognitive performance are those that are short in duration, vigorous in intensity, and have a high cognitive load. This is because the cognitive effort component is a crucial factor in improving attention and concentration.

In light of the necessity to stimulate executive functions, particularly the capacity to adapt, plan and control attention in order to minimise the risk of error in the workplace, this chapter proposes the implementation of the BAPNE method as a neuromotor-based approach. BAPNE employs a combination of body percussion and dual tasks, integrating movement with rhythmic and cognitive exercises to enhance executive functions. Despite the preponderance of bibliographic evidence on the efficacy of ABs in enhancing attention and cognitive performance within the school setting, a notable lacuna persists in research elucidating the correlation between neuromotor activity or body percussion and the industrial workplace. The present study thus focuses on the practical experience of incorporating the BAPNE method as active breaks within the training programmes for operators at the aforementioned beverage factory. The objective of this study is to utilise a qualitative approach to collect and analyse the participants' perceptions of the impact of these brief interruptions on their learning process and attentional abilities.

In the first instance, the objective of this study is to develop the rationale and essential characteristics of active breaks with cognitive load in the workplace. In addition, the study will highlight their role in promoting attention for learning and the performance of routine tasks. Secondly, it describes the neuromotor activities that are introduced into training programmes for factory operators and, finally, the text presents qualitative feedback from some participants on the implementation of BAPNE active breaks. The purpose of this feedback is to obtain information on the practical justification for the use of these breaks, adherence, satisfaction, and the perception of support in attentional processes, motivation and improvement of the training environment (Romero-Naranjo, 2025a, 2025b).

ACTIVE BREAKS AND NEUROMOTRICITY

Fundamentals of Active Breaks

The extant literature on active breaks has historically focused on the educational environment, with a marked predominance of school-related literature. A body of research has indicated that the implementation of AB interventions has been associated with enhancements in students' attention and concentration (Pastor-Vicedo et al., 2021; Watson et al., 2017). Nevertheless, conducting research in the workplace poses certain challenges. Despite the existence of pilot programmes that concentrate on the physical and well-being aspects (Batista-Ferreira et al., 2024; Lyubykh et al., 2022; Taylor, 2005), such as reducing sedentary behaviour and fatigue (Scoppolini Massini et al., 2024), the majority of these studies focus on enhancing quality of life and routine task performance, without providing evidence that the benefits extend to more cognitively demanding tasks

(Albulescu et al., 2022). Recent workplace studies have begun to incorporate the cognitive dimension, as evidenced by the works of Buuck & Jansen (2023), Latino et al. (2025), and Morgade Marrero (2025). These studies have included the examination of cognitive stimulation techniques designed to enhance mental flexibility in high-risk work environments. Nevertheless, there remains a paucity of evidence on the application of ABs with high cognitive load in the workplace, and there is a gap in the literature explicitly linking these interventions to neuromotricity or body percussion in the industrial context, especially on the African continent.

ABs can be defined as brief, structured periods of physical activity or exercise. They are designed to interrupt sedentary behaviour or other routine activities. The aim of this is to counteract adverse effects of a continuous working day. Specifically, positive effects on physical and psychological well-being have been demonstrated, with reductions in perceived stress and mental fatigue and increases in energy levels. Furthermore, the intervention has been shown to alleviate physical discomfort and exert a positive influence on mood and general well-being (Albulescu et al., 2022; Infantes-Paniagua, 2021; Latino et al., 2025; Scoppolini Massini et al., 2024).

In order to ensure that active breaks contribute meaningfully to cognitive function and do not merely result in distraction or dispersion, it is imperative to consider the following characteristics: brevity, intensity, and high cognitive load. It has been posited that intervals of less than 10 minutes are optimal for ensuring that the learning (or work) period is not compromised, whilst also maintaining its practicality and effectiveness. It has been demonstrated that vigorous or moderate intensity exercise tends to generate greater benefits in cognitive performance. The integration of cognitive components into the cognitive break is a key factor in increasing attention and improving processing speed, rather than simply physical exertion. The incorporation of activities necessitating motor-cognitive coordination or the implementation of dual tasks has the potential to enhance executive functions, including decision-making and adaptation to changes in high-risk work environments (Fischetti et al., 2024; Morgade Marrero, 2025; Pastor-Vicedo et al., 2024).

Neuromotricity and BAPNE Method

In order to elevate active breaks beyond the realm of mere physical exercise and ensure a direct contribution to cognitive performance, it is essential that they incorporate elements that complement and relate to language. Furthermore, the content should support the development of executive functions. Neuromotor skills delineate a distinct distinction between the theoretical and practical concepts of motor skills and psychomotor skills. Motor skills are defined as the ability to control voluntary body movements, such as walking or jumping. Psychomotor skills integrate cognitive and sensorimotor interactions in a psychosocial context. Neuromotricity adds cognitive stimulation through dual tasks, among other executive functions (Andreu-Cabrera & Romero-Naranjo, 2021; Andreu-Cabrera et al., 2024). The correlation between cognitive and executive functions and the attentional network is of particular significance, as it underscores the importance of enhancing and developing all facets of working memory, inhibition, and cognitive flexibility. These competencies are indispensable for achieving success in various domains, including professional settings. It is vital to emphasise that the capacity for adaptation to prevailing circumstances represents a pivotal instrument in the realm of accident prevention. This capacity enables personnel to proactively anticipate and effectively respond to unanticipated events, thereby mitigating the risk of adverse incidents (Morgade Marrero, 2025).

The BAPNE method, developed by PhD. Francisco Javier Romero-Naranjo, uses body percussion as a teaching tool to stimulate executive functions. The ability to perform dual task, that is, the capacity to execute two unrelated tasks concurrently, has been demonstrated to elevate cognitive levels by integrating physical movement with the performance of rhythmic structures. This integration occurs while the subject engages in cognitive actions such as verbalising arithmetic operations, responding to opposites, or recalling words from a narrative. This paradigm is rhythmic/motor/cognitive. The deliberate integration of these components has been shown to directly stimulate a range of executive functions, including processing speed, working memory, verbal fluency, and cognitive flexibility (Romero-Naranjo, 2021; Andreu-Cabrera et al., 2024; Romero-Naranjo & Liendo Cárdenas, 2025a, 2025b; Romero-Naranjo & Navarro-Camacho, 2025).

The practice of body percussion, in the context of ABs with neuromotor skills, would be justified by its impact on the brain. The activation of the nervous system has been demonstrated to enhance attention, thereby improving concentration and cognitive performance immediately following the intervention. Physical movement has been demonstrated to stimulate the release of neurotransmitters such as dopamine and noradrenaline, which have been linked to attention, motivation and alertness. Furthermore, it has been demonstrated to promote neural plasticity and the formation of new structures within the brain. As demonstrated in the research by Arnau-Mollá et al. (2024), Romero-Naranjo & Andreu-Cabrera (2023b), and Romero-Naranjo et al. (2023a, 2023b), an increase in heart and respiratory rates has been shown to enhance brain oxygenation and information processing capacity. Consequently, the integration of active recovery periods within the BAPNE framework, emphasising neuromotor competencies, would ensure that interruptions in the workday are not only physical, but also provide effective cognitive stimulation, enhancing attention and mental flexibility in Angolan operators.

METHODOLOGY AND QUALITATIVE ANALYSIS

The implementation methodology and qualitative analysis employed in this study comprised a methodological approach and a qualitative study based on participants' perceptions and feedback, such as guided interviews.

A. Participants and Study Environment

The operators of the beverage factory have a diverse and segmented background. It is estimated that approximately 50% of the workers have been in the employ of the company for more than 20 years, having joined the organisation subsequent to the civil war. This segment of the population has become habituated to arduous work and has not received professional training due to the circumstances that initially brought them into the workforce. A second group, younger and with a greater emphasis on formal schooling, was perceived as less disciplined or less aligned with the traditional work culture based on physical effort. In light of the observed deficiencies in cognitive abilities, particularly the pronounced challenges in reading comprehension (i.e., functional illiteracy), and the necessity to occupy roles that demand a higher level of cognitive engagement and increased exposure to risk, the company's management opted to introduce psychometric selection assessments. For this group, a voluntary cognitive levelling programme was proposed. The second programme constitutes a component of a corporate initiative that is focused on

facilitating comprehension of fundamental procedures, risks and actions to be undertaken during the operation of the primary machinery in the factory, through a simplified and visual approach.

The present study introduces active breaks through neuromotricity, and is of a qualitative nature, focusing on the practical experience of the intervention. The data presented has been collected through eight guided interviews with a random selection of operators participating in the training sessions. The purpose of these interviews was to assess the perceived impact and overall satisfaction with the implementation of short movement breaks. In this context, qualitative research facilitates the analysis of observed phenomena and the formulation of hypotheses for subsequent quantitative research.

B. Description of the training programmes

- a. Verbal and numerical skills levelling programme, which has been structured as a voluntary programme, with the objective of fostering comprehension of instructions and cultivating logical-mathematical reasoning skills. These objectives are directly linked to the need to stimulate selective attention and working memory. The programme was designed for 120 workers, who were divided into four groups of 30 participants. The programme was delivered over a period of eight weeks, with classes held in training rooms on a bi- or tri-hourly basis.
- b. Programme on operational protocols of machinery, including, but not limited to industrial washing and filling machines. Participants are required to acquire and/or re-acquaint themselves with knowledge pertaining to memory, logic, analysis and decision-making in relation to machine procedures, temperature and pressure records, steps and protocols for compliance with established standards, and so further. This is requisite at basic levels for operators and supervisors responsible for training and standardising the processes of the main machines. The training courses are of a one-week duration, with sessions lasting between six and eight hours per day. Participants are divided into groups of eight, with the theoretical element of the course taking place in the training room and the practical element taking place in the factory.

C. Description of the BAPNE active breaks implemented

The active breaks that have been implemented are of a very brief nature, namely micro-breaks, and these have been developed with consideration for the cultural context and the time available. The present study is based on the sequences proposed in the research by González-de-Benatuil et al. (2022, 2024) and Romero-Naranjo & González-de-Benatuil (2022). In the first programme (academic levelling), during each 2-hour class, one or two strategic interruptions were made, without warning or without making the participants aware of the introduction of these breaks, in the most basic and simplified way, and always following the principle of dual task. In addition to a preliminary stretch, the participants were instructed to perform a rhythmic pattern of minimal complexity. This was accompanied by an enquiry, typically pertaining to logic, mathematics, elementary operations or the sequence of days of the week in pairs (applied to the work shift schedule). In the second training session, the verbal forms are more closely related to descriptions of

procedures while performing a simple rhythmic pattern, such as clapping (i.e. verbal fluency).

D. Results and analysis of qualitative feedback

a. Perceived impact on performance and concentration

- i. Analysis of perceptions of improved attention and concentration immediately after the break, in line with the need to process information effectively.

The interview participants indicated that the active break had an immediate effect of 'awakening' the mind and restoring concentration. As one interviewee explained, 'the activity allowed my head to clear and put everything in its place'. He suggested that, given that attention levels can drop at key moments, an activity helps to 'restore concentration levels'. Another participant stated that they feel 'more active' when returning to their routine after participating in a movement activity. It was generally perceived that the exercises 'awaken curiosity' and maintain alertness, thereby counteracting the tendency to drowsiness.

- ii. Analysis of the impact of BAPNE active breaks on the mitigation of monotony and fatigue inherent to routine and repetitive activities

The interviewees' work activities were characterised as 'very routine', with working days of up to 12 hours. It was perceived that 'breaking the routine' at times was a positive occurrence. One interviewee posited that this 'temporary and very brief' interruption serves to stimulate the cognitive processes involved in the production process. The active break is positioned as a strategy to prevent physical and mental exhaustion.

- iii. Perception of the applicability of cognitive benefits to factory tasks (protocols, logical-mathematical reasoning)

The perceived cognitive benefits were considered applicable and valuable for factory tasks. The break was perceived as a mechanism that helps the operator to "clear their mind" in order to "return to continuity" in the production process.

Specifically, in relation to tasks requiring precision, such as protocols, numbers and graphs, participants stated that the learning was 'better retained in our minds'. The exercise was found to facilitate "brain activation", and the subsequent execution of tasks in a manner that is 'aware of what is needed'. This may be illustrated by the enhancement of attention to the correct ranges in measurements or the accurate entry of data, thus preventing the introduction of errors. This finding suggests a perceived transfer of enhanced attention and cognitive activation directly to the precision required in the factory.

b. Subjective assessment, motivation and adherence

The programme was met with a positive response overall. One participant described the training as 'very different' and the interaction as 'broader and more interactive', which

generated motivation. Another interviewee considered that the "dynamics", if the worker understands their objective, can be viewed in a favourable light and as an "added value".

Despite the absence of explicit mention of the terms 'fun' and 'challenging' during the interviews, it can be inferred that the activities were stimulating and attractive, with an appropriate and challenging level of difficulty.

c. Perception of the justification for using ABs in the workplace

ABs exhibited a marked positive influence on the socio-emotional aspects and mood of participants during training.

One interviewee reported a reduction in nervousness and an increase in relaxation following the break. According to the aforementioned participant, this feeling helps participants to feel more confident in asking questions and to feel more motivated. The majority of respondents reported experiencing an improvement in mood and a reduction in stress levels.

Another interviewee considered that, even if it seems unnecessary, the 'dynamic' is an 'added value' to stimulate focus. According to the subject, the activity has the capacity to 'awaken participants' by facilitating the process of 'opening one's mind'.

d. Discussion of the literature review

The qualitative results obtained in the workplace are consistent with findings in school settings regarding attention and motivation. It was perceived by the workers that active periods of rest and recreation helped to 'wake up the mind' and 'return to levels of concentration'. As evidenced by the extant literature on the subject, the systematic review by Pastor-Vicedo et al. (2021) confirms that 'attention and concentration' is one of the most frequently addressed topics in research on ABs in students. The BAPNE method is founded on neuromotor skills, which are characterised by the linkage of movement to cognitive and executive functions, including working memory, cognitive flexibility and the attentional network. In this work environment, the benefits observed by workers were clearly cognitive in nature, including 'activating the brain' and helping specific information to be 'better retained in the mind' for tasks that required precision, and learning to 'explain better to colleagues' while performing tasks.

This concept extends beyond the mere act of physical movement, as active breaks are meticulously designed to mitigate physical and mental fatigue, thereby enhancing concentration and promoting optimal functioning in both routine and high-risk environments (Batista-Ferreira, 2024; Buuck & Jansen, 2023; Fischetti et al., 2024; Lyubykh et al., 2022; Morgade Marrero, 2025; Scoppolini et al., 2024).

The utilisation of rhythmic and coordinated movements as a mechanism to directly engage and stimulate the functions that control attention and other cognitive processes suggests that the value of active breaks lies not only in physical stretching or changing position, but also in the cognitive awakening they generate.

CONCLUSIONS AND RECOMMENDATIONS

The present study provides evidence for the efficacy of active breaks with cognitive load through neuromotricity. This is evidenced by the finding that movement is linked with the most relevant executive functions in the workplace, namely flexibility, working memory and attention. Following the description of the pilot implementation of brief activities employing the BAPNE method in operator training, qualitative feedback was collected, thereby validating the practical justification for its utilisation.

The implementation of these ABs proved to be an effective mechanism for immediate cognitive activation for operators at the beverage factory in Angola, the subject of this research. The participants reported that the break had a positive effect on their cognitive performance, facilitating higher levels of concentration. This facilitates precision in factory tasks, such as protocols and data, and better information retention.

The value of this approach lies in its cognitively demanding nature, which transcends mere physical movement, directly enhancing executive functions such as attention and cognitive flexibility. Moreover, the interruption disrupts the monotonous nature of protracted days, thereby fostering motivation, satisfaction, and a sense of relaxation or reduced nervousness, which is pivotal for adherence.

In order to enhance the validity of the cognitive effects, it is recommended that the study be replicated with mixed and quantitative designs that incorporate control groups and utilise validated measures of executive functions. Furthermore, it is pertinent to investigate the durability and sustainability of long-term cognitive and socio-emotional benefits, as the BAPNE method is proposed as a valuable cognitive stimulation tool to prevent physical and emotional burnout and enhance processes that improve worker performance and well-being.

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Teaching Artist and creativity via the BAPNE Method

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Abstract

The aim of this paper is to bring together the conceptual ideas of Teaching Artist (TA) and the BAPNE method through pedagogical and neuropsychological bridges. The TA is posited as the conceptual architect whose professional practice is defined by eight intrinsic pillars of creative thinking: developing the craft, committing and persisting, visualising, expressing, observing, reflecting, expanding and exploring, and understanding artistic worlds. These pillars require educational methodologies capable of generating demonstrable and measurable creative and cognitive transfer that goes beyond subjective aesthetic production. BAPNE provides this mechanism through a systematised proposal for rhythmic coordination based on neuromotor skills. We demonstrate that the eight pillars of TA provide the essential framework for systematically implementing and improving BAPNE activities, such as “Il cubo parlante” (The Talking Cube). This intervention, by demanding continuous adaptive motor planning and simultaneous cognitive control, systematically modulates the intricate neurological interaction between the spontaneous Default Mode Network (DMN) and the deliberate Executive Control Network (ECN). This modulation directly strengthens the Executive Functions (EFs)—cognitive flexibility, inhibition, and planning—which are the neurobiological substrates of creativity. Crucially, the TA leverages their expertise (Artistry and Pedagogy) to elevate “Il cubo parlante” beyond a fixed protocol, generating interdisciplinary extensions into core academic curricula and fostering trans-artistic collaborations with other artistic disciplines (e.g., visual art, dance). This synthesis validates that the BAPNE method furnishes the Teaching Artist with an academically justifiable, neuro-informed instrument to drive measurable creative, socio-emotional, and cognitive outcomes, establishing a new paradigm for rigorous, evidence-based arts pedagogy.

Keywords: Teaching Artist, BAPNE Method, Neuromotricity, Embodied Cognition, Creativity.

Resumen

El objetivo de este paper es la unir las ideas conceptuales de Teaching artist (TA) y el método BAPNE a través de puentes de unión de carácter pedagógico y neuropsicológico. El AT se postula como el arquitecto conceptual cuya práctica profesional se define por ocho pilares intrínsecos del pensamiento creativo: desarrollar el oficio, comprometerse y persistir, visualizar, expresar, observar, reflexionar, ampliar y explorar, y comprender los mundos artísticos. Estos pilares exigen metodologías educativas capaces de generar una transferencia creativa y cognitiva demostrable y medible, que vaya más allá de la producción estética subjetiva. BAPNE proporciona este mecanismo a través de una propuesta sistematizada de coordinación rítmica basada en la neuromotricidad. Demostramos que los ocho pilares del TA proporcionan el marco esencial para implementar y mejorar sistemáticamente las actividades de BAPNE, como «Il cubo parlante» (Il cubo parlante). Esta intervención, al exigir una planificación motora adaptativa continua y un control cognitivo simultáneo, modula sistemáticamente la intrincada interacción neurológica entre la red por defecto (DMN) espontánea y la red de control ejecutivo (ECN) deliberada. Esta modulación refuerza directamente las funciones ejecutivas (EF), es decir, la flexibilidad cognitiva, la inhibición y la planificación, que son los sustratos neurobiológicos de la creatividad. Fundamentalmente, el AT aprovecha su experiencia (artística y pedagógica) para elevar «Il cubo parlante» más allá de un protocolo fijo, generando extensiones interdisciplinarias en los planes de estudio académicos básicos y fomentando colaboraciones transartísticas con otras disciplinas artísticas (por ejemplo, artes visuales, danza). Esta síntesis valida que el método BAPNE proporciona al artista docente un instrumento académicamente justificable y basado en la neurociencia para impulsar resultados creativos, socioemocionales y cognitivos medibles, estableciendo un nuevo paradigma para una pedagogía artística rigurosa y basada en la evidencia.

Palabras clave: Teaching artist, Método BAPNE, Neuromotricidad, Cognición corporeizada, Creatividad.

I. INTRODUCTION

The contemporary professionalization of the Teaching Artist (TA) marks a significant evolution in arts education (Booth, 2003). Eric Booth is undeniably the foundational and most recognized figure in the field of Teaching Artistry, making him an indispensable reference for any academic work on the subject. His status as a preeminent authority stems from his unique combination of roles: a practicing, award-winning artist (actor, musician, and entrepreneur) who also pioneered the systematic conceptualization and professionalization of the Teaching Artist (TA) role globally. Furthermore, Booth's influence is practical as well as theoretical: he co-founded the Teaching Artist Development Labs at the Juilliard School, served as a consultant for numerous major arts organizations worldwide, and created the first national TA residency program in the US. His impact is therefore dual-layered: he is the chief theorist who articulated the TA's transformative potential (as the "sleeping giant of social change"), and the primary architect who built the professional infrastructure—the training programs, the conferences, and the literature—that defines the field today.

Eric Booth's definitive conceptualization of the "Teaching Artist" (TA) provides an exceptionally robust theoretical foundation for its mandatory inclusion in high-level academic discourse, establishing it not as a merely peripheral or temporary occupation but as a crucial, dynamic nexus where authentic artistic practice intersects with and drives transformative pedagogy. His work, notably articulated across *The Teaching Artist's Bible* (2009) and *Making Change: Teaching Artists and Their Role in Shaping a Better World* (2023), establishes the TA as a practicing professional artist who deliberately cultivates the complementary skills, sensibilities, and habits of mind of a virtuosic educator. The core epistemic grounding lies in the TA's dual function: maintaining a vibrant, authentic artistic career while simultaneously leveraging the unique power of their art form to actively facilitate deep, personally meaningful, and skill-based learning experiences *in, through, and about the arts* for diverse participants in non-traditional settings like schools, hospitals, and community centers. Booth argues that TAs embody an expanded professionalism that goes beyond performance or exhibition, serving as catalysts for individual and social change. He posits that teaching artistry is the "sleeping giant of social change," capable of activating innate human artistry and fostering essential personal capacities such as empathy, collaboration, discipline, and complex problem-solving. This is achieved by creating "safe-and-charged" environments where artistic processes—like improvisation, inquiry, and reflection—are used as powerful tools to construct understanding, bridge socio-cultural divides, and effect tangible community impact. Consequently, the TA model offers a powerful and necessary paradigm shift for arts education and community engagement, providing a rich, empirically grounded framework for scholarly exploration into the co-creative synergy between aesthetic mastery and transformative learning.

TAs have moved beyond the role of transient 'visiting artists' to become highly specialized educators whose practice is governed by defined core competencies and stringent accountability frameworks (Barniskis, 2014; Castro, 2012; Graham & Goetz Zwiern, 2010; Hall & Thomson, 2017). This trajectory is driven by the imperative that arts integration must demonstrate rigorous effectiveness and cognitive transferability, moving past subjective, anecdotal justification toward frameworks underpinned by empirical cognitive science (Barnes, 2015;). The professional *Teaching Artist* is fundamentally tasked with cultivating the crucial 21st-century competencies (the 4Cs)—creativity, critical thinking, communication, and collaboration (Gilbert et al., 2025; Hall, 2010;

Huddy & Stevens, 2011). To achieve this mandate, TAs require a methodology that not only engages students aesthetically but also provides verifiable evidence of cognitive impact (Garber, 1995; Rabkin, 2012; Saraniero, 2009). The Biomechanics, Anthropology, Psychology, Neuroscience, and Ethnomusicology (BAPNE) method, with its foundation in neuromotricity and dual-task protocols, offers this scientific mechanism.

1.2. Defining the Teaching Artist through the pillars of creative practice

The essence of the Teaching Artist's role is not merely the delivery of an art form, but the intentional transmission of the *creative mindset*. This mindset is systematically defined by a set of intrinsic habits, which serve as the eight foundational pillars of creative practice that guide the TA's pedagogy:

1. **Develop Craft** (Technique and Studio Practice)
2. **Engage & Persist** (Finding Passion and Sticking with It)
3. **Envision** (Imagining and Planning)
4. **Express** (Finding and Showing Meaning)
5. **Observe** (Looking Closely)
6. **Reflect** (Question, Explain, and Evaluate)
7. **Stretch & Explore** (Play, Use Mistakes, and Discover)
8. **Understand Art Worlds** (Context and Culture)

These eight pillars are not tangential skills but the core learning objectives of arts education. This paper establishes that the BAPNE method furnishes the TA with a scientifically precise instrument to target and assess these eight cognitive habits in a measurable manner. This paper asserts that the Teaching Artist's eight pillars of creative practice serve as the essential conceptual architecture for implementing, advancing, and broadening the neurocognitive benefits of the BAPNE method. We use the BAPNE activity, “Il cubo parlante”, as a scalable model to demonstrate how the TA's pedagogical expertise systematically enhances and extends the DT protocol into interdisciplinary and trans-artistic domains, thereby achieving the highest standards of evidence-based pedagogy.

II. THEORETICAL FOUNDATIONS.

The epistemological grounding for the BAPNE method, and the justification for the TA's pervasive use of kinesthetic and movement-based pedagogy, is the theory of Embodied Cognition (EC). EC is a profound theoretical shift that dismantles traditional Cartesian mind-body dualism, asserting that cognitive processes are inextricably rooted in the organism's physical body and its dynamic interactions with the environment (Romero-Naranjo, 2025a, 2025b).

Neuroscience confirms that learning is realized "first and better through the body and movement". This validates the TA's pedagogical choices, demonstrating that movement activities like Neuromotricity are not merely preferential learning styles but constitute core neurocognitive mechanisms for active knowledge construction. The EC framework provides the scientific

rationale for the TA's commitment to *Student-Centered instruction* and using the kinesthetic modality to ensure educational equity for diverse learners (Alonso-Marco & Romero-Naranjo, 2022; Arnau-Mollá & Romero-Naranjo, 2022a, 2022b, 2024a, 2024b; Romero-Naranjo, 2013, 2020, 2022, 2024, 2025).

The neuroscientific study of creativity reveals it to be a sophisticated cognitive process, not a singular muse. It operates through the dynamic, regulated interaction between two large-scale brain networks:

1. **Default Mode Network (DMN):** Associated with spontaneous thought, mind-wandering, and free association. It is the engine of *Divergent Creativity* (idea generation).
2. **Executive Control Network (ECN):** Involved in cognitive control, attention, decision-making, and inhibition. It is the engine of *Convergent Creativity* (idea evaluation and refinement).

Exceptional creative output requires the capacity to dynamically alternate and balance between the spontaneous thinking modes of the DMN and the critical control of the ECN. The BAPNE method, via its rigorous Dual-Task mechanism, is specifically designed to train the Executive Functions (EFs) of cognitive flexibility, inhibition, and working memory, which are precisely the skills needed to modulate this DMN/ECN interaction.

2.3. Neuromotricity vs. motricity.

The BAPNE method is grounded in Neuromotricity, a scientific concept distinct from general *motricity* or *psychomotor skills*. Neuromotricity is defined as the educational and neurorehabilitative procedure focused on cognitive and socio-emotional stimulation through specific work on EFs, where the Dual Task and the integration of language are essential (Andreu-Cabrera & Romero-Naranjo, 2021; 2024; Andreu-Cabrera et al., 2024; Romero-Naranjo & Andreu-Cabrera, 2023). Crucially, neuromotor activity *does not* involve cyclical, repetitive motor actions that can be automated (e.g., pedaling).

Instead, neuromotricity is characterized by:

- Constant variability: Motor actions are non-repetitive and require continuous, adaptive *praxis* planning.
- Functional dissociation: Requires simultaneous, distinct, and non-congruent motor patterns between the upper extremities (hands), lower extremities (feet), and the phonatory system (voice/language).

This distinction is vital for academic rigor, as it confirms that BAPNE activities provide a high and sustained cognitive load, directly targeting the ECN and thereby influencing creative capacity (Romero-Naranjo & Liendo-Cárdenas, 2025a, 2025b; Romero-Naranjo & Navarro-Camacho, 2025).

III. THE EIGHT FOUNDATIONAL PILLARS OF THE TEACHING ARTIST (TA).

The professional standards for Teaching Artists are articulated through core competencies that define the pedagogy of creative learning. The most refined model identifies eight *Studio Habits of Mind* that function as the professional pillars for the TA's creative instruction. The TA's mandate is to design and implement lessons that systematically develop these eight cognitive and behavioral skills using the art form as the vehicle.

3.1. Develop craft (Technique and studio practice)

This pillar centers on the mastery of skills, techniques, and the routine of the art form. For the TA, this involves demonstrating advanced Artistic Technique Mastery and establishing a formal, reproducible studio practice. The TA must move the student from novice imitation to fluent execution through structured practice, ensuring foundational skills are internalized to free up cognitive resources for higher-order thinking.

3.2. Engage & Persist (Finding passion and sticking with it)

This habit encompasses the development of sustained focus, concentration, and the resilience to endure challenges and setbacks inherent in the creative process. The TA must cultivate motivational leadership and empathy to foster this persistence. This is a commitment to seeing a creative project through, using grit and sustained effort.

3.3. Envision (Imagining and planning)

This pillar is the capacity to mentally picture a creative outcome, plan the necessary steps, and translate intention into execution. It involves the cognitive process of planning and generating a mental blueprint before the physical or verbal output begins. For the TA, this translates to rigorous Curriculum Development and the systematic definition of learning objectives.

3.4. Express (Finding and showing meaning)

This is the core communicative function of art—the ability to create work that conveys ideas, feelings, or a compelling message. The TA uses the art form as a language, enabling students to translate abstract ideas and inquiries into tangible or kinetic forms. This pillar necessitates that the TA facilitates Student-Centered Instruction and authentic opportunities for students to express original thoughts.

3.5. Observe (Looking closely)

This habit requires the student to acquire the focused attention necessary to see, perceive, and analyze the world, material, or phenomenon with acuity. For the TA, this is linked to cultivating selective attention and critical thinking. In practice, it involves structured exercises in active, deep attention, where the student notices subtleties in materials, technique, and surrounding environment.

3.6. Reflect (Question, explain, and evaluate)

Reflection is the metacognitive process of questioning the work, explaining the artistic choices made, and critically evaluating the outcome against the initial vision. The TA implements

this through formalized self-reflection, peer review, and the use of constructivist assessments. The explicit mandate to revise and improve work is central to this pillar.

3.7. Stretch & explore (Play, use mistakes, and discover)

This habit encourages risk-taking, curiosity, and embracing mistakes as necessary data for learning and innovation. It is the practice of engaging in deliberate 'play' to discover new possibilities, strategies, or techniques. The TA must cultivate a learning environment where flexibility and adaptability are prized over rigid adherence to fixed outcomes.

3.8. Understand Art Worlds (Context and culture)

The final pillar embeds the creative process within a larger historical, cultural, and disciplinary context. It requires understanding the role of the art form (e.g., music, dance) in various societies and cultures. The TA, grounded in Ethnomusicology (the 'E' in BAPNE), ensures that the instruction incorporates culture and context to promote cognitive variables related to intellectual development.

IV. THE TA AS CONCEPTUAL ARCHITECT. MAPPING CREATIVE PILLARS ONTO BAPNE

The Teaching Artist achieves pedagogical rigor by utilizing the BAPNE method—a proven system of neuromotor stimulation—as the core mechanism to cultivate these eight creative pillars. The activity "Il cubo parlante" serves as the precise, repeatable, and scalable model that operationalizes the DT challenge.

4.1. Pillar 1. Develop Craft

The TA focuses on translating complex motor actions into cognitive fluency, fulfilling the "Develop Craft" mandate. The BAPNE method achieves this through the systematic practice of non-repetitive *praxias* (learned, intentional movements).

- **BAPNE Mechanism:** The execution of alternating strikes and the introduction of dissociated foot movements compel the central nervous system to develop and refine fine and general dynamic coordination.
- **TA Enhancement:** The TA rigorously structures the rhythmic sequences, ensuring practice moves from conscious execution (high ECN load) to consolidation into procedural memory. By ensuring the *craft* of rhythmic motor control becomes increasingly automatic, the TA frees up crucial working memory capacity to focus on the simultaneous cognitive tasks (the verbal/arithmetic demands), which is the true driver of creative problem-solving.

4.2. Pillar 2. Engage & Persist

The demand for Engage & Persist is directly addressed by the sustained cognitive load of the BAPNE Dual-Task (DT).

- **BAPNE Mechanism:** The activity requires sustained attention and endurance to maintain the motor rhythm while managing the cognitive challenge, resisting fatigue and distraction.

The inherent difficulty of the DT paradigm (executing non-congruent patterns) is a designed obstacle.

- **TA Enhancement:** The TA employs **Motivational Leadership** and careful pedagogical pacing to manage the difficulty levels (Levels 1 through 8 of the cube), ensuring the challenge promotes growth without inducing frustration. The TA uses *Reflection* (Pillar 6) to connect the feeling of overcoming a difficult rhythmic sequence to the emotional and behavioral strategies required for creative persistence in any domain.

4.3. Pillar 3. Envision – planning, sequencing, and ideational praxia

The TA's requirement to cultivate *Envision* (Imagining and Planning) is satisfied by BAPNE's intensive activation of the Executive Function of planning.

- **BAPNE Mechanism:** The core commands "Turn" and "Change" act as real-time planning exercises. "Turn" demands Visoconstructive Praxia (mentally picturing the cube's rotation to present a new face) and Feed-forward Control (predicting the motor sequence). "Change" demands Ideational Praxia (the cognitive sequence of removing one object and replacing it with a thematically different one).
- **TA Enhancement:** The TA expands this planning from the motor domain to the artistic domain. For example, instead of merely executing the "Turn," the TA mandates that the turn signifies a planned shift in an emergent rhythmic composition or a predetermined structural change (e.g., from a polyrhythmic sequence to a melodic sequence), thus linking motor planning to macro-level artistic design (Envision).

4.4. Pillar 4. Express – Kinesthetic communication and meaning

The TA's commitment to enabling *Express* (Finding and Showing Meaning) finds validation in the theoretical basis of BAPNE.

- **BAPNE Mechanism:** BAPNE is rooted in *Embodied Cognition*. The use of Body Percussion, voice, and movement ensures that expression is kinesthetic, non-linguistic, and multi-modal. The DT requires the simultaneous verbal *Expression* (answering questions, singing, calculation) with the motor *Expression* (rhythm), forcing the meaning-making process across disparate modalities.
- **TA Enhancement:** The TA guides students to express abstract concepts through the *quality* and *dynamic* of the rhythmic execution. For instance, the TA might require a concept (e.g., 'conflict' in a narrative, or 'acceleration' in physics) to be expressed through a change in tempo or intensity of the body percussion, effectively utilizing the body as an interpretive device that embodies abstract ideas.

4.5. Pillar 5. Observe – Selective attention and attentional filtering

The fundamental creative habit of *Observe* (Looking Closely) is directly trained by BAPNE's attentional demands.

- **BAPNE mechanism:** The DT protocol requires constant, intensive selective attention. Participants must simultaneously filter out irrelevant environmental stimuli (noise, other groups) and internal distractions, while focusing on the rhythm, the partner's actions, and the teacher's verbal commands ("Turn," "Change").
- **TA enhancement:** The TA designs the interaction to necessitate acute observation. By incorporating peer-to-peer rhythm synchronization and requiring mutual problem-solving (e.g., identifying the moment the partner failed to switch a cube), the TA transforms the attentional requirement from a solitary task into a collaborative observation exercise, sharpening external awareness.

4.6. Pillar 6. Reflect – metacognition and self-regulation

The TA's pillar of *Reflect* (Question, Explain, and Evaluate) is achieved through structured assessment and metacognitive dialogue.

- **BAPNE Mechanism:** BAPNE's rigorous assessment rubric (Table 2 in BAPNE literature¹) focuses on objective metrics such as *Error Management and Self-Correction and Dual Task Performance*.
- **TA Enhancement:** The TA leverages this structure to drive metacognition. The TA moves beyond simply grading the performance, requiring students to *Explain* (the core component of the Reflect pillar): *How* did your motor action inhibit your verbal response? *Why* did you choose to prioritize the rhythmic sequence over the answer?¹ This practice of articulating the *process* (cognitive decision-making) reinforces self-regulated learning and critical evaluation. Furthermore, the TA employs *Teaching Artist Self-Reflection* and joint reflection with the classroom teacher to inform subsequent instructional steps.

4.7. Pillar 7. Stretch & Explore – DMN/ECN modulation and improvisation

The creative mandate to *Stretch & Explore* (Play, Use Mistakes, Discover) is the highest-level application of BAPNE's core neuro-mechanism.

- **BAPNE mechanism:** The DT paradigm forces the simultaneous activation of the DMN (spontaneous generation) and the ECN (controlled execution). By introducing opportunities for rhythmic *improvisation* within the fixed, complex structure of the body percussion sequence, the activity trains *Cognitive Flexibility*. Errors (DMN/ECN conflict) become necessary data for adaptive motor planning.
- **TA enhancement:** The TA introduces formal improvisation models (e.g., a "call and response" using body percussion patterns), requiring students to generate original rhythmic material *while* maintaining the DT load. The TA reframes mistakes as data, actively encouraging students to *discover* new solutions through motor and cognitive iteration, maximizing risk-taking.

4.8. Pillar 8. Understand art worlds – Ethnomusicology and cultural context.

The TA's responsibility to link the art form to *Understand Art Worlds* (Context and Culture) is intrinsically supported by the BAPNE framework.

- **BAPNE mechanism:** The BAPNE acronym includes *Ethnomusicology*. Activities like "Il cubo parlante" can be structured using culturally significant rhythmic forms, such as the Cuban Clave or the 12-bar Blues form.
- **TA enhancement:** The TA grounds the practice in cultural context. When the TA introduces the *praxias* (motor sequences), they explicitly connect these sequences to their origins (e.g., a particular regional dance or music tradition). This ensures that the technical execution of the movement is simultaneously understood as a cultural artifact and context. By using themed cubes related to global cultures, the TA deepens disciplinary knowledge and advances the commitment to educational equity by respecting diverse cultural expressions (Figure 1).



Figure 1. Models of cubes used in the activity “the talking cube.” Photo taken by the authors.

V. RIGOROUS ENHANCEMENT. INTERDISCIPLINARY AND TRANS-ARTISTIC EXTENSIONS

The professional Teaching Artist leverages the stability and verifiability of the BAPNE method to drive sophisticated interdisciplinary and trans-artistic pedagogical applications—a core function of Exemplary Pedagogy and Collaborative Design.

5.1. Interdisciplinary transfer.

The TA uses the inherent thematic versatility of "Il cubo parlante" to establish co-equal arts-integrated instruction, where learning and assessment are advanced equally in the arts and other core subjects. The rigor of the DT paradigm ensures that the cognitive benefits transfer effectively to academic content.

Core Subject	TA Strategy using "Il cubo parlante"	Cognitive transfer mechanism
Mathematics/Science	The TA structures the rhythmic patterns to represent complex fractions or geometric sequences. The verbal task involves calculating the next term in the sequence or	Strengthens <i>Visoconstructive Praxia</i> and <i>Cognitive Flexibility</i> by forcing rapid translation between abstract numerical/spatial concepts and concrete kinesthetic/verbal outputs.

	articulating physical properties (e.g., density, mass, texture) of the cubes.	
Literacy/Language	The TA uses the six faces of the cube to represent narrative elements (Character, Setting, Conflict). The "Turn" command forces an instantaneous plot development, requiring the participant to orally generate a grammatically correct sentence that advances the story, <i>while</i> maintaining the complex motor pattern.	Enhances <i>Verbal Production (Fluency)</i> and <i>Working Memory</i> by compelling lexical access and structured verbal response under the severe constraint of the dual-task load.

5.2. Trans-Artistic collaboration.

The TA's artistry and commitment to collaboration enable the BAPNE protocol to act as a trans-artistic bridge, connecting movement, rhythm, and sound to non-performing arts disciplines such as Visual Art, Theatre, and Dance.

1. **Choreography and dance:** The TA collaborates with a movement specialist. The rhythmic *praxias* of "Il cubo parlante" are translated into defined choreographic modules. The execution of the "Change" command forces an abrupt and intentional shift in the quality of movement (e.g., from staccato, dissociated movement to fluid, shared movement). This process directly develops the *Envision* and *Express* pillars by linking internal neuromotor control to external kinetic composition.
2. **Visual arts and neuroaesthetics:** The TA integrates the BAPNE session with a visual artist. The physical endurance and *Emotional Regulation* (Socio-Emotional Learning, SEL) cultivated during the intense DT are discussed in terms of *Neuroaesthetics*. The TA asks students to visually document the perceived emotional and cognitive effects of the *rhythmic struggle* (DMN/ECN conflict) in a graphic form (e.g., using color or line to represent 'sustained attention' or 'inhibition'). This moves the TA's practice from mere instruction to therapeutic and aesthetic investigation.

VI. DISCUSSION.

The TA's fourth pillar, *Outcomes, Assessment, and Reflective Practice*, is fully satisfied by BAPNE's empirical foundation. The synthesis provides a profound shift in arts assessment: BAPNE activities are rigorously evaluated not only by performance rubrics, but by measuring improvements in objective *Executive Functions* (EFs) using standardized neuropsychological tests (e.g., the Tower of London test).

This ability to quantify the neuro-pedagogical *process* (cognitive transfer) provides the Teaching Artist with unparalleled academic justification. The quantifiable, neuro-verified metrics legitimize

the arts intervention as a core cognitive enhancer, addressing institutional demands for robust accountability and resource justification.

The integration of BAPNE elevates the professional standing of the Teaching Artist by recasting their role as a highly specialized *neuropedagogue*. This necessitates a significant professional transition, requiring TAs to transition their pedagogy using foundational neuroscience concepts (ENCs) as organizing principles. This recasting is essential for long-term policy success, as it provides verifiable evidence that arts instruction is not merely enrichment but a core element of cognitive curriculum. The TA, acting as an *agent of change*, can leverage the structured, scientific nature of BAPNE to:

- **Advocate for equity:** Ensure that educational opportunities align with Universal Design for Learning (UDL) by offering a multi-modal, kinesthetic pathway for knowledge acquisition.
- **Inform curriculum:** Use evidence of enhanced EFs to argue for the mandatory inclusion of neuromotor training as a core intervention, suitable for diverse learners and special educational needs.

6.3. Limitations and future research mandates

To sustain the academic rigor demanded, future research must continue the trajectory of empirical validation. While the theoretical justification is robust, a methodological mandate exists to conduct large-scale, longitudinal Randomized Controlled Trials (RCTs) that directly compare the specific DT-based sequences of BAPNE against traditional arts methodologies. The focus must remain on quantitatively assessing the long-term modulation of the DMN/ECN networks during creative tasks and explicitly measuring the far transfer effects into non-artistic academic domains. The use of advanced neuroimaging techniques (e.g., fNIRS) during "Il cubo parlante" execution is required to empirically validate the proposed neurocognitive mechanisms in real-time.

VII. CONCLUSION

The present work has established that the rigorous synthesis between the defined professional framework of the Teaching Artist and the neuroscientifically justified mechanisms of the BAPNE method represents a decisive advancement for evidence-based creativity education. The eight foundational pillars of the TA's creative practice provide the essential conceptual structure for implementing, enhancing, and elevating BAPNE's core activity, "Il cubo parlante." The Teaching Artist, through the intentional application of their Artistry and Pedagogy, transforms the BAPNE Dual-Task paradigm from a neuromotor exercise into a comprehensive architecture for embodied creativity (Romero-Naranjo & Liendo-Cárdenas, 2025a; 2025b; Romero-Naranjo & Navarro-Camacho, 2025; Romero-Naranjo, 2025). By systematically training the EFs necessary to modulate the brain's spontaneous (DMN) and controlled (ECN) creative networks, the TA not only measurably enhances cognitive abilities but also extends this impact into sophisticated interdisciplinary and trans-artistic domains. This scientifically grounded methodology, with its capacity for verifiable, quantifiable cognitive outcomes, establishes the Teaching Artist and the BAPNE method as a leading, rigorous paradigm for the future of neuro-informed arts pedagogy.

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Teaching Artist, attachment, and neuromotricity. Theoretical-practical justification from the BAPNE Method.

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Abstract

Contemporary education faces the challenge of balancing high cognitive demand with the growing need for socio-emotional development. This theoretical *paper* proposes a cutting-edge pedagogical model founded on the convergence of three conceptual pillars: the transformative role of the Teaching Artist (TA), the principles of Attachment Theory (AT), and the neuromotor strategies of the BAPNE Method. It is argued that the effective implementation of Executive Function (EF) stimulation programs through rhythm and movement requires an affective precondition: the construction of a secure attachment bond with the teaching figure. The Teaching Artist, due to their inherent focus on the creative process and trial and error, is uniquely qualified to establish this emotional "secure base," neutralizing the fear of failure that consumes vital attentional resources. The triangulation of these elements establishes a Creative Bond Model, where emotional security is not an accessory, but a *cognitive bandwidth filter* that frees up resources for processing the Dual Task, a central element of BAPNE. Preliminary evidence suggests that the application of BAPNE, influenced by attachment experience, acts as a resilience factor and reduces trait anxiety in adolescents. The resulting model offers differentiated intervention guidelines based on the students' attachment style, optimizing stress modulation and neuromotor development. It is concluded that body percussion, mediated by conscious attachment, transforms educational practice into a corrective and resilient experience, promoting integral learning from a pedagogical "heart-based approach".

Keywords: Secure Attachment, Teaching Artist, BAPNE Method, Neuromotricity, Emotional Regulation.

Resumen

La educación contemporánea se enfrenta al reto de equilibrar las altas exigencias cognitivas con la creciente necesidad de desarrollo socioemocional. Este *artículo* teórico propone un modelo pedagógico innovador basado en la convergencia de tres pilares conceptuales: el papel transformador del artista docente (TA), los principios de la teoría del apego (AT) y las estrategias neuromotoras del método BAPNE. Se argumenta que la implementación efectiva de programas de estimulación de la función ejecutiva (FE) a través del ritmo y el movimiento requiere una condición previa afectiva: la construcción de un vínculo de apego seguro con la figura docente. El artista docente, debido a su enfoque inherente en el proceso creativo y el ensayo y error, está especialmente cualificado para establecer esta «base segura» emocional, neutralizando el miedo al fracaso que consume recursos atencionales vitales. La triangulación de estos elementos establece un Modelo de Vínculo Creativo, en el que la seguridad emocional no es un accesorio, sino un *filtro de ancho de banda cognitivo* que libera recursos para procesar la Tarea Dual, un elemento central de BAPNE. Las pruebas preliminares sugieren que la aplicación de BAPNE, influenciada por la experiencia de apego, actúa como factor de resiliencia y reduce la ansiedad rasgo en los adolescentes. El modelo resultante ofrece pautas de intervención diferenciadas en función del estilo de apego de los alumnos, optimizando la modulación del estrés y el desarrollo neuromotor. Se concluye que la percusión corporal, mediada por el apego consciente, transforma la práctica educativa en una experiencia correctiva y resiliente, promoviendo el aprendizaje integral desde un «enfoque pedagógico basado en el corazón».

Teaching Artist: Apego seguro, Artista docente, Método BAPNE, Neuromotricidad, Regulación emocional.

1. INTRODUCTION

The study of learning has migrated from a purely behavioral approach to a complex understanding that integrates cognitive neuroscience and developmental psychology. However, a significant gap persists between high-intensity brain stimulation methodologies (aimed at developing the prefrontal cortex, the seat of Executive Functions) and the foundations of affective psychology

(centered on the limbic system, the emotional regulator). Literature consistently shows that the optimal functioning of executive functions—such as inhibitory control, cognitive flexibility, and working memory—is intrinsically linked to the individual's neurophysiological state of calm and security.

Chronic stress systems, activated by the perception of threat or affective instability, consume vast resources of the prefrontal cortex. In educational practice, this interaction manifests in the classroom as a student's inability to concentrate or execute complex tasks, not due to an intrinsic lack of cognitive capacity, but due to the overload of the limbic system. Therefore, any methodology that aims to stimulate neuromotoricity and executive functions, such as the BAPNE Method, must first guarantee the affective stability of the learning environment. It is at this convergence point that the pedagogical and relational role of the Teaching Artist becomes indispensable, acting as the mediator who unifies cognitive demands with emotional support.

This theoretical *paper* is justified by the need to formalize this relational nexus, transforming an intuitive practice into a scientifically grounded model. It seeks to establish that affective security is the essential precondition that acts as a *cognitive bandwidth filter*, allowing information and the demands of neuromotor exercises to be processed efficiently, freeing the brain from the energetic load of chronic stress.

1.2. Delimitation of conceptual pillars

The role of the Teaching Artist (TA) is defined as a hybrid profile that transcends the mere teaching of artistic techniques. These professionals are involved in social transformation and in opening new pedagogical bonds (Gilbert et al., 2025; Hall, 2010; Huddy & Stevens, 2011). Unlike traditional pedagogical models focused on transmitting content, artistic practice, by its nature, demands a slow, constant maturation process, grounded in "trial and error" (Garber, 1995; Rabkin, 2012; Saraniero, 2009). This intrinsic acceptance of iteration and failure as part of the creative path positions the Teaching Artist as a pedagogical agent who can mitigate the pressure toward excellence measured solely by results, a factor that intensifies stress in students.

1.2.2. Attachment Theory

Attachment Theory (AT), originally developed by John Bowlby and refined by Mary Ainsworth, describes the lasting emotional bond formed between a child and their primary caregivers (Bowlby, 1979). This bond provides a sense of security and protection, serving as a "secure base" from which the individual can explore the world. Ainsworth identified three main attachment styles: secure, avoidant, and ambivalent (or anxious).

The quality of attachment has a significant impact on emotional development. Secure attachment favors an efficient response to stressful situations and allows for a greater capacity to experience healthy social interactions (Bretherton, 2013). Conversely, insecure attachment styles are associated with difficulties in emotional regulation and a reduced capacity to establish functional social relationships. In the school context, the adult presence and their sensitivity to adjusting their response to student distress are essential to prevent emotional overwhelm, which cannot be processed without a containing figure.

1.2.3. The BAPNE Method.

The BAPNE Method (Biomechanics, Anatomy, Psychology, Neuroscience, and Ethnomusicology) is an innovative program that uses body percussion as a didactic resource with a strong focus on stimulating Cognitive Functions and, above all, Executive Functions.¹ It is an experiential and playful learning method that articulates the design of activities through rhythmic bodily movement. With more than two hundred scientific publications, over four thousand academic citations, and several international research awards, the BAPNE method provides both practical resources and research in neuromotoricity, positioning itself as one of the most relevant methodologies today.

BAPNE's neuroscientific power lies in the application of the Dual Task paradigm, which forces the brain to simultaneously execute two or more processes (e.g., cognitive and motor). This trains the ability to allocate attentional resources and cognitive flexibility, leveraging the confirmed neural connection between auditory and motor areas, which explains our tendency to imitate the music we hear with movements.

The convergence of these three areas is articulated around the following central questions that guide this analysis:

1. In what way can the role and pedagogical practices of the Teaching Artist constitute an effective secondary attachment figure, creating an emotional "secure base" for the students?
2. How can the neurocognitive mechanisms activated by the neuromotor activities of the BAPNE method (dual task, executive functions) modulate emotional regulation, reinforcing behavioral patterns associated with secure attachment?
3. What is the emerging pedagogical model from this triangulation that optimizes socio-emotional and cognitive learning in the classroom, overcoming the challenges of insecure attachment?

2. Development I. The Teaching Artist and the affective bond.

2.1. The Teaching Artist as a Secondary Attachment Figure.

Attachment Theory, although primarily focused on bonds with primary caregivers, admits the existence of secondary attachment figures. The question arises whether the teacher can fulfill this role, and the answer is affirmative, especially if they dedicate time and establish a relationship of pedagogical intimacy with the student. The capacity of the teaching figure to provide security, generate calm, and facilitate emotional regulation in moments of high intensity is what gives them the potential of an attachment figure (Barniskis, 2014; Booth, 2009; 2023; Castro, 2012; Graham & Goetz Zwiern, 2010; Hall & Thomson, 2017)

The implementation of an attachment-based teaching practice, called "education with tenderness," requires the teacher not only to apply techniques but also to act from the "corazonar"—a state of wisdom that connects the adult's heart with the children's heart. This implies that the Teaching Artist must observe their own life experience and have the predisposition to offer a bond that allows for the re-signification of adverse experiences that students may have lived in insecure

primary interactions. By providing a constant secure environment, the teacher offers a corrective emotional experience, essential for the student to develop social skills, emotional well-being, and healthy behaviors during their growth.

2.2. Acceptance vs. approval

The Teaching Artist's pedagogy is revealed to be fundamentally anti-anxiety in the context of learning. Artistic training, in particular, is plagued by myths about excellence and social pressure for professional success and selling work. This pressure obscures the fact that training involves a slow process of maturation, requiring a prolonged cycle of self-analysis, problem-solving, and, crucially, learning from failures.

The Teaching Artist plays the role of an *affective demystifier*. This is achieved by differentiating, and prioritizing, acceptance over approval. Acceptance means that the student's work counts as something real and valid; approval means that people like the result. Students with insecure attachment styles, especially anxious/ambivalent ones, are hypervigilant and dependent on external approval. If they are taught to depend on the approval of others, too much power is given to the spectators or the final result. By focusing evaluation on the process (execution, effort, motor, and rhythmic exploration), the Teaching Artist decouples the error from the student's personal identity. The rhythmic error, inevitable in BAPNE, becomes a pedagogical data point to be corrected, not a personal deficiency. This validation of the creative process, inherent to artistic practice, creates a low-risk environment that mitigates the consumption of cognitive resources by anxiety.

2.3. Affective body intervention.

The effectiveness of any high-demand neuromotor intervention, like BAPNE, depends on the student being in a state of relative calm that allows for the efficient activation of the prefrontal cortex. In stress situations, a neurobiological hierarchy is activated: "Where there is hormone, the neuron does not command" (*Donde hay hormona, no manda neurona*). Stress hormones (cortisol, adrenaline), triggered by social conflicts (fights between peers) or perceived threats (fear of grading), block access to the executive functions necessary to process the BAPNE Dual Task.

The Teaching Artist must be an expert in immediate intervention for affective regulation. A clear example of this practice is the use of secure physical contact and explicit verbal reinforcement. When a student makes a mistake or shows distress, the teacher must actively generate attachment, for example, by saying: "You did that very well, I liked it a lot," accompanied by a gesture of closeness like "the hand on the shoulder, I am generating attachment." This act, which combines emotional validation with physical proximity, interrupts the limbic stress cycle, signaling to the student's nervous system that the environment is safe. Only after this closeness has been established and attachment generated can the teacher proceed to the cognitive task, saying: "Now I'm going to do it with you, and the two of us are going to do it much better." This process of affective regulation is the mandatory step that transforms the Teaching Artist into the affective mediator who maximizes BAPNE's therapeutic and cognitive potential.

3. Development II. The Neuroscience of Rhythm and the BAPNE Method as an Executive Modulation Tool

3.1. Neurophysiological foundations

The BAPNE Method uses body percussion as a mechanism to stimulate the corporal, emotional, and cognitive dimensions of the individual, with a strong focus on the stimulation of cognitive functions and executive functions. The basis of this stimulation lies in the intimate neuroscientific relationship between music, rhythm, and movement. The existence of direct neural connections between the brain's auditory and motor areas has been documented. Even in states of passive listening, the brain areas responsible for planning movements are active, underscoring the human tendency to translate rhythm into kinesthetic action (Andreu-Cabrera & Romero-Naranjo, 2021; 2024; Andreu-Cabrera et al., 2024; Romero-Naranjo & Andreu-Cabrera, 2023).

Body percussion exercises demand significant attentional focus to simultaneously coordinate singing, movement, and percussion of the upper and lower limbs. This complex demand fosters a good disposition of cognitive functions (Romero-Naranjo & Liendo-Cárdenas, 2025a, 2025b; Romero-Naranjo & Navarro-Camacho, 2025). This holistic approach ensures that each exercise stimulates diverse intellectual capacities and turns rhythm into a pleasant and enjoyable source for experiencing movement, which is basic for health.

3.2. The dual task paradigm and cognitive demand

The backbone of executive function stimulation in BAPNE is the application of the Dual Task paradigm. This concept is based on neuropsychology studies that establish the necessity of executing two tasks simultaneously to train resource allocation. The basic paradigms include Motor/Motor, Cognitive/Cognitive, and Cognitive/Motor combinations (Alonso-Marco & Romero-Naranjo, 2022; Arnau-Mollá & Romero-Naranjo, 2022a, 2022b, 2024a, 2024b; Romero-Naranjo, 2013, 2020, 2022, 2024, 2025).

The BAPNE method deliberately uses rhythmic bodily movement to impose controlled cognitive tension. For example, the stimulation of laterality—crucial since humans are asymmetrical by nature—through specific exercises like "kokoleoko", demands oculo/audio-manual coordination. This forces the dominant hand to govern the trajectory of concrete movements, which in turn stimulates nervous influxes in specific areas of the cerebral cortex. This demand for interhemispheric coordination and the need to inhibit automatic motor responses to follow a complex rhythmic sequence translates into intense *training in tolerance for controlled chaos*.

BAPNE's playful practice masks a high demand for inhibitory control. Students must retain complex numerical or rhythmic sequences (working memory) and execute them in real-time while managing motor coordination (cognitive flexibility and switching). The ability to persist in this state of cognitive tension, without falling into emotional disorganization, is the true objective of executive resilience training. It is here that the Teaching Artist, by ensuring that the environment is affectively secure, guarantees that cognitive tension is perceived as a *challenge* and not as a *threat*.

3.3. BAPNE as a stress regulator and resilience promoter.

BAPNE's impact on affective modulation has been empirically validated. The application of BAPNE method activity programs has been shown to reduce trait anxiety in adolescents in Compulsory Secondary Education (ESO), with statistically significant results. Interventions lasting six weeks (one 50-minute session per week) showed greater effectiveness in reducing trait anxiety in girls than in boys.

This capacity of BAPNE to mitigate anxiety directly connects with Attachment Theory. Therapeutic Body Percussion, according to the BAPNE method, has been identified as a resilience factor. Resilience, defined as the ability to overcome periods of emotional pain or stress, is strongly influenced by experiences during the first years of life and the experience of attachment (Romero-Naranjo & Romero-Naranjo, 2024).

BAPNE functions as a generator of resilient identity by stimulating a solid bond with the group through shared rhythmic synchrony. This emotional experience of secure attachment, facilitated by the teacher, stimulates people's capacity to overcome adversity, indirectly modifying the structures and beliefs associated with managing anxiety and uncertainty (Romero-Naranjo, 2025a, 2025b).

Research aims to link the learning profile of each attachment type with specific intervention guidelines using BAPNE that stimulate resilience.

Below is an analysis of how BAPNE's central mechanisms directly impact the requirements of the secure attachment system:

Table 1. BAPNE neurocognitive mechanisms and their Impact on the attachment system.

Secure Attachment (SA) Requirement	BAPNE Mechanism	Neuropsychological Impact	Teaching Artist Role
Seeking Comfort/Security	Group Rhythmic Synchronization	Release of oxytocin/endorphins. Reduces cortisol. Fosters collective belonging.	Guarantee an environment of "controlled chaos," where cognitive demand is mediated by group security.
Exploration and Autonomy	Experimentation with Trial and Error	Strengthening of the reward circuit linked to the process, not the result. Validation of intention over perfection.	Provide explicit support (praise and contact) during errors, validating neuromotor risk.
Emotional Regulation	Inhibitory Control and Dual Task	Training the ability to maintain focus under cognitive pressure,	Apply the "Hormone, Not Neuron,

		transferring control from the limbic system to the prefrontal cortex.	Commands" principle; first calm, then the task.
Trust in Caregivers	Scaffolding in the Zone of Proximal Development (ZPD) ¹⁹	Improvement of cognitive skills through interaction and support, confirming the teacher's reliability.	Adjust the level of rhythmic complexity to prevent overwhelm, maintaining affective consistency.

5. Development III. The Creative bond model.

The Creative Bond Model is consolidated by situating BAPNE's neuromotor practice within the conceptual framework of Vygotsky's Zone of Proximal Development (ZPD). The ZPD defines the distance between an individual's real development level and their potential development, which is only achieved through interaction with more knowledgeable people or guides. For a student to operate effectively in their ZPD, overcoming their cognitive limits with the help of a mediator, they must be able to fully allocate their mental resources to the task.

The secure bond established by the Teaching Artist acts as the principal mediator that enables this development. By mitigating the stress and anxiety inherent in high cognitive demand, the teacher frees up the student's attentional resources. In other words, affective security is what allows BAPNE's rhythmic and motor challenge to become a driver of development, and not a source of collapse or frustration. If the student feels insecure or judged, psychic energy is directed toward hypervigilance (a trait of insecure attachment), and there is no cognitive bandwidth left to sustain the Dual Task demanded by BAPNE.

The combination of the TA and BAPNE generates a community of practice where a pedagogical framework is negotiated, fostering experimentation and reflection. The Teaching Artist calibrates the difficulty of the body percussion sequences, ensuring the student receives the necessary help (scaffolding) to achieve the rhythmic goal, thereby reinforcing their confidence in the "secure base" provided by the teacher.

5.1. Specific guidelines for differentiated intervention according to attachment style.

To optimize the effectiveness of the BAPNE Method, the Teaching Artist must possess tools to identify the predominant attachment style in the classroom and apply intervention strategies that compensate for relational deficits.²² The goal is not to change the primary attachment style but to offer a corrective experience that stimulates the capacity for resilience and executive functioning

5.2.1. Adaptation for secure attachment

Students with secure attachment already have a balanced stress system and a strong base for exploration. The focus of the intervention with BAPNE should be the optimization of executive performance and the deepening of cognitive flexibility.

- BAPNE strategy: Implementation of high-performance programs, such as *Solfeggio Cognitive*, which promote rhythmic autonomy and self-assessment. Highly cognitively demanding activities such as Clap Change, Rhythmic Canon, and Baobab Path (from Cognitive Solfège) are recommended, as they force flexibility and working memory without the need for constant external reinforcement.
- Teaching Artist role: Maintain affective scaffolding, but reduce dependence. Encourage leadership within the group in rhythmic sequences.

5.2.2. *Adaptation for avoidant attachment (Distancing)*

Avoidant students tend towards hyper-autonomy and rejection of dependence. They have learned to distrust comfort and often show emotional distancing.

- BAPNE Strategy: Body percussion should be introduced in a way that technical demand focuses on individual achievement. Activities like Il cubo parlante (The Talking Cube) and Handball Change allow for focused work on coordination and technical mastery. Concentric Circle Activities facilitate group participation while maintaining a comfortable physical and emotional distance, respecting the student's need for space.
- Teaching Artist Role: Affective contact should be subtle and non-invasive. Reinforcement should focus on the objectivity of the task ("The sequence was completed correctly"), rather than explicit emotional connection ("I'm happy you did it"). The need for space is respected, allowing group synchrony to generate a feeling of belonging without the pressure of affective intimacy.

5.2.3. *Adaptation for anxious/ambivalent attachment (Hypervigilance)*

These students are hypervigilant, have an intense fear of error, and are excessively dependent on external approval, which generates high anxiety.

- BAPNE Strategy: The use of Somesthetic Laterality is crucial to anchor attention to the body, along with the rigorous implementation of routines and predictable structures. Circle Activities or Facing-Rows Activities (which demand constant feedback and visibility) are combined with the use of Urban Rhythms which are culturally motivating and allow for group synchronization. Explicit positive reinforcement from the teacher ⁶ is essential to counteract hypervigilance to error.
- Teaching Artist Role: Must be highly responsive to distress signals. The "Hormone, Not Neuron, Commands" intervention is critical here. The teacher must validate the process and effort, separating the student's worth from the rhythmic result. Self-acceptance of error as an intrinsic part of art and BAPNE is promoted.

5.2.4. *The critical case. Disorganized attachment*

Students with disorganized attachment have experienced neglectful or frightening behaviors from attachment figures and are characterized by fear, helplessness, and constant alertness.

- BAPNE strategy: An organized and predictable rhythmic structure must be offered. Simple Activities with African Melodies are used for the body-mind connection, given their anchored rhythmic base and their effect of corporal anchoring. Working in a circle and applying Very Simple Rhythmic Canons provide the predictability and collective structure necessary to contrast with relational chaos, fostering divided but structured attention.
- Teaching Artist role: Provide unwavering pedagogical and affective coherence. A high degree of sensitivity is needed to interpret disruptive behaviors (such as opposition to the task) not as defiance, but as a manifestation of fear. The secure base must be offered through consistent presence and order in the environment.

The following table systematizes these differentiated intervention guidelines, constituting a practical tool for the Teaching Artist.

Table 2. Differentiated Intervention Strategies of the Teaching Artist with BAPNE

Attachment Style	Primary Classroom Challenge	TA Affective Goal	Strategic BAPNE Application
Secure	Skills Optimization	Foster autonomy and leadership	Clap Change, Rhythmic Canon, Baobab Path (of Cognitive Solfège). High complexity tasks, Cognitive Solfeggio.
Avoidant	Distancing and hyper-autonomy	Build confidence based on mastery without forced intimacy	Il cubo parlante, Handball Change. Concentric Circle Activities and technical reinforcement.
Anxious/Ambivalent	Fear of error and need for approval	Reduction of trait anxiety ³ , validation of the process	Somesthetic Laterality, Urban Rhythms. Circle Activities and Facing-Rows Activities.
Disorganized	Constant alertness, chaotic behaviors	Offer corporal anchoring and coherent external order	Simple Activities with African Melodies, working in a circle, Very Simple Rhythmic Canons.

6. Conclusion

This theoretical analysis has triangulated the role of the Teaching Artist, Attachment Theory, and the BAPNE Method to propose the Creative Bond Model. It has been demonstrated that the convergence of these fields is not additive but symbiotic, where each pillar strengthens the other two.

In response to the key questions posed:

1. **The Teaching Artist as an attachment figure:** The TA, by operating from a pedagogy of process and acceptance, can and should constitute an effective secondary attachment figure. Their artistic sensitivity allows them to establish an emotional "secure base," essential for mitigating the effects of anxiety and fear of error, fulfilling the role of an affective mediator that precedes and enables advanced cognitive learning.
2. **BAPNE and emotional regulation:** BAPNE's neurocognitive mechanisms, especially the Dual Task paradigm and the activation of auditory-motor circuits, are powerful tools for training Executive Functions. When administered within a secure base (AT), BAPNE modulates stress (reducing trait anxiety) and reinforces resilience by providing a corrective attachment experience. Shared rhythmic synchrony facilitates collective emotional regulation and the formation of a solid bond.
3. **The creative bond model:** This pedagogical model integrates affective security (AT) with cognitive demand (BAPNE) within the Zone of Proximal Development. The security liberated by the TA acts as the "Cognitive Bandwidth Filter," allowing the student to channel their mental energy towards solving the Dual Task without falling into emotional disorganization. The model requires the teacher to adapt their BAPNE intervention according to the student's attachment style to achieve truly effective and therapeutic neuromotor stimulation.

The success of this model depends on the specialized training of the Teaching Artist. Domain of the art form or the BAPNE method is not enough; a deep understanding of developmental psychology and affective neuroscience is required. The practical implications demand the integration of Attachment Theory, knowledge of the HPA axis (stress), and neuromotor intervention strategies into initial and continuing education curricula for educators and Teaching Artists.

It is fundamental that educators be aware of the importance of their own vocation to educate from the bond and the need for self-regulation¹³ to be able to offer a calm and consistent presence. Only a teacher who has reviewed their own relational experience can provide the affective scaffolding required for BAPNE to reach its maximum potential as a resilience factor.

6.3. Future research directions

The empirical validation of the Creative Bond Model constitutes the next critical phase. Three lines of future research are suggested:

1. Differentiated intervention studies: Longitudinal quasi-experimental design studies are required to compare the effectiveness of the BAPNE method application with differentiated intervention (according to the attachment profiles presented in Table 2) versus a standard application. Dependent variables should include standardized measures of Executive Functions, trait anxiety, and resilience.
2. Neurophysiological mapping of attachment and rhythm: The use of advanced neuroimaging techniques (fMRI or EEG) could map changes in functional connectivity between prefrontal and limbic regions (amygdala, hippocampus) during the execution of the BAPNE Dual Task. This would allow visualization of how the explicit affective scaffolding of the Teaching Artist (e.g., verbal and physical contact) modulates the stress response before and during the rhythmic activity.
3. Qualitative analysis of the creative bond: Ethnographic and phenomenological research is needed to analyze students' perception of the Teaching Artist figure as a "secure base" and how this perception influences the experience of "trial and error" in the BAPNE context.

The Creative Bond Model offers a robust and coherent framework for integral development, demonstrating that the most advanced pedagogy must embrace the inseparable union between the executive mind and the regulated heart.

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Observational biomechanics of cadence and body expression: descriptive patterns and motor richness in sport

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Resumen

El capítulo propone un marco de biomecánica observacional que integra cadencia, expresión corporal y variabilidad del movimiento como indicadores de riqueza motriz en contextos deportivos cíclicos, acíclicos abiertos y expresivos. Se plantea que la cadencia actúa como eje organizador del gesto, la expresión corporal como “firma visible” de la organización neuromotora y la variabilidad como recurso adaptativo, desarrollando un sistema de categorías y un protocolo observacional para describir “huellas rítmico-posturales” útiles en evaluación del rendimiento, selección de talentos, prevención de lesiones, diseño de tareas de entrenamiento e innovación docente universitaria.

Palabras clave: Biomecánica observacional, cadencia, expresión corporal, riqueza motriz, variabilidad del movimiento

Abstract

The chapter presents an observational biomechanics framework that integrates cadence, body expression and movement variability as key indicators of motor richness across cyclic, open acyclic and expressive sports. It argues that cadence functions as an organizing axis of movement, body expression as the visible signature of neuromotor organization and variability as an adaptive resource, proposing a category system and observational protocol to describe rhythmic-postural fingerprints that can inform performance assessment, talent identification, injury prevention, training task design and higher education innovation in sport and exercise sciences.

Keywords: Observational biomechanics, cadence, body expression, motor richness, movement variability

INTRODUCTION

Sports biomechanics has historically tended to focus on quantitative parameters such as forces, segments, or joint angles, prioritizing the optimization of mechanical efficiency and the reduction of loads, while the qualitative dimension of cadence and body expression has taken a back seat as an indicator of motor richness and behavioral flexibility in athletes. However, recent evidence shows that small modulations in movement cadence are associated with systematic changes in load organization, joint distribution, and movement economy, and that overall body variability and coordination are related to skill level and tactical adaptation capacity in different sports (Alonso-Marco & Romero-Naranjo, 2022; Arnau-Moll & Romero-Naranjo, 2022a).

In this context, an approach is needed that integrates, within the same conceptual framework, cadence as a key rhythmic variable, body expression as a visible manifestation of the internal organization of the neuromotor system, and motor richness as a flexible repertoire of movement solutions (Draganski et al., 2004; Romero-Naranjo & Andreu-Cabrera, 2023a). The proposal for observational biomechanics lies precisely at this intersection, considering that cadence and body expression are not only aesthetic attributes or auxiliary parameters, but privileged windows into how athletes organize, adjust, and communicate their motor actions in real practice and competition situations.

The central thesis of this chapter is that cadence and body expression can be described using systematic observational patterns that act as “rhythmic-postural footprints” of the degree of motor richness in different sports. These footprints allow us to ecologically link the rhythmic organization of the gesture with functional variability, behavioral flexibility, and the reading of game affordances, opening avenues for advanced qualitative assessment, as well as for intervention in training and injury prevention (Romero-Naranjo, 2020; Stergiou et al., 2006).

In contrast to traditional biomechanical approaches that focus almost exclusively on isolated kinematic and dynamic magnitudes, and to approaches to body expression that remain predominantly descriptive or phenomenological, this chapter proposes a change of focus. It proposes an integrative language that articulates cadence, variability, and body expression within an observational system that can be applied across cyclic, acyclic open, and expressive sports families, shifting the idea of a “single ideal technique” toward the notion of “families of effective solutions” and differentiated cadence-expressive profiles (Romero-Naranjo & Andreu-Cabrera, 2023b; Romero-Naranjo et al., 2023).

Consequently, the objective of this chapter is threefold: a) to formulate a theoretical framework of observational biomechanics that integrates cadence, body expression, and motor richness as interpretive axes; b) to propose a system of categories and a methodological protocol to describe, using the same language, the cadential-expressive patterns of different sports families; and c) to discuss the implications of this approach for performance evaluation, talent selection, training task design, and university education in physical activity and sports sciences (Bartlett, 2007; Davids et al., 2023).

1. THEORETICAL BACKGROUND

1.1. Cadence, rhythm, and variability: an integrated perspective

In the field of locomotion and cyclic movements, cadence is usually defined as the number of cycles or steps per minute, and it has been shown that small variations of around 5–10% modify stride length, ground reaction forces, hip and knee load distribution, and center of mass oscillation, without penalizing energy cost and even improving economy in recreational and performance runners (Romero-Naranjo & Llorca-Garnero, 2023; Preatoni et al., 2010).

Similarly, in cycling, the optimal cadence has a nonlinear relationship with intensity, associated with transitions in muscle fiber recruitment and adjustments in overall motor strategy, so that changes in pace not only alter metabolic demand but also the coordination pattern of the entire body.

Beyond its numerical expression in cycles per minute, cadence can therefore be understood as an organizing parameter that structures the movement into recurring temporal units—steps, pedal strokes, strokes—on which both the mechanical economy and the expressive style of the movement are built.

From a neurophysiological perspective, cadence is conceived as an emergent parameter of the interaction between central pattern generators, sensorimotor loops, and couplings with ecological information (gravitational, visual, acoustic), such that rhythm is not merely an “external tempo” but an organizational property of the motor control system (Romero-Naranjo, 2020). Auditory-

motor synchronization shows that movement cadence tends to spontaneously couple with periodic sound stimuli, increasing stride consistency, prolonging time to exhaustion, and influencing both perceived effort and mechanical efficiency (Bood et al., 2013; Schaffert et al., 2019). These findings suggest that the nervous system uses cadence as a “temporal anchor” to stabilize coordination between multiple segments, finely modulating muscle recruitment and activation sequence according to task and environmental demands.

From a neurocognitive perspective, cadence depends not only on central generators, but also on networks that integrate the motor and premotor cortex, basal ganglia, cerebellum, and limbic structures, which explains why movement rhythm is sensitive to both environmental information and the athlete's motivational and affective state (Blair & Ursache, 2011; Diamond, 2013a). In self-organized rhythmic tasks, such as prolonged jogging or time trial cycling, the activity of these circuits tends to stabilize in “cadence attractors” that offer an optimal compromise between energy cost, temporal precision, and postural stability, while in contexts of high uncertainty—for example, a close final quarter in basketball or a golden score judo match—micro-variations in cadence are observed that are associated with changes in attention, anticipation, and emotional regulation (Miyake et al., 2000; Miyake & Friedman, 2012). From this perspective, cadence patterns condense information about how the athletic brain continuously negotiates between exploration and exploitation, between resource conservation and expressive deployment in situations of competitive pressure.

The literature on movement variability has shown that repetitions of the same gesture present “repetition without repetition,” such that each execution differs slightly in both muscle patterns and joint trajectories (Stergiou et al., 2006; Stergiou & Decker, 2011). This variability has been conceptualized as strategic (different solutions for the same task), execution (micro-adjustments within the same solution), and outcome (variations in the motor product), proposing that it does not constitute noise, but rather an adaptive resource that allows the objective to be achieved under different constraints (Davids et al., 2023). In open sports, this functional variability manifests itself in the flexible use of changes in pace, pauses, accelerations, and decelerations that reconfigure the cadence of the movement depending on the available space, the pressure from the opponent, or the state of fatigue, giving rise to movement repertoires that are more or less rich depending on the level of expertise.

From this perspective, motor richness can be defined as the athlete's ability to mobilize multiple effective biomechanical solutions for the same task, maintaining the stability of the result despite variability in execution and moving fluidly between different configurations according to contextual demands (Andreu-Cabrera & Romero-Naranjo, 2021). Functional degeneration—the possibility of achieving the same result through different motor configurations—operates as a key principle in open sports, where coordinative variability allows for creative responses to changing oppositions, and where cadence modulation becomes a central tool for overwhelming, surprising, or controlling the tempo of the game. Thus, the relationship between cadence, variability, and motor richness can be understood as a continuum in which excessive rhythmic stability can lead to rigidity, while well-organized cadential variability is associated with tactical flexibility and greater adaptability.

Body language introduces an additional layer of interpretation to this cadence-variation framework, functioning as a “visible signature” of the athlete's motor organization (Alonso-Sanz & Romero-

Naranjo, 2015). It is not limited to the effector segment (hand, foot), but involves spatial and rhythmic configurations of the entire body: gestural amplitude, directionality, fluidity, symmetries and asymmetries, use of the vertical axis, and segmental cadence patterns that bring into play the trunk, shoulder girdle, and gaze (Romero-Naranjo et al., 2023). Studies on complex skills, such as sport climbing, show that increased experience is associated with broader and more anticipatory coarticulation, in which a greater number of joints are coordinated in an integrated manner to prepare for subsequent movements, configuring more fluid and economical body movement patterns. Convergently, in open sports, it has been observed that expert athletes access more varied postural and gestural solutions to achieve the same goal, which is reflected in expressive changes in the use of body space and in the tempo of actions (Romero-Naranjo, Andreu-Cabrera, & Arnau-Moll, 2023; Romero-Naranjo, 2004).

This expressive dimension connects with emotional and intentional components, as body postures and rhythms are modulated by affective states, expectations, and coping styles, configuring an authentic semiotic system in which the body “says” things about the state of the system on several simultaneous levels (Blacking, 1973). Changes in verticality, slumped shoulders, or loss of bounce can indicate the degree of fatigue; more aggressive or defensive supports and the expansion or contraction of body space can reveal a competitive attitude; and certain gestures toward the audience, teammates, or opponents express the relationship with the social context of the game. From an observational biomechanical perspective, these manifestations are not read as isolated symbols, but as rhythmic-postural configurations that emerge from the coordination of the whole body, so that the same cadence of steps can take on different meanings depending on how it is combined with looks, arm positions, or variations in the amplitude of gestures.

In short, an integrated perspective of cadence, rhythm, and variability allows us to understand athletic body expression as a direct manifestation of the internal organization of the neuromotor system, where cadential patterns act as the temporal skeleton of the gesture, variability introduces the degrees of freedom necessary for adaptation, and overall gesturality embodies the particular way in which each athlete resolves the tensions between efficiency, creativity, and motor communication. This reading lays the foundations for an observational biomechanics that is not limited to quantifying isolated parameters, but aspires to describe cadential-expressive signatures associated with different levels of motor richness and different styles of play, offering a common language for analysis, evaluation, and intervention in real sports contexts.

2. CONCEPTUAL FRAMEWORK: Observational biomechanics

2.1. From cadence to “rhythmic footprint”

Current technologies allow for the highly accurate recording of kinematic, temporal, and dynamic parameters, but in training practice there remains a gap between this quantitative data and the way coaches and athletes “read” movements, relying on qualitative categories such as fluid, rigid, hasty, restrained, or aggressive (Bartlett, 2007).

The observational biomechanics discussed in this chapter seeks to bridge the gap between the two by proposing descriptive categories that are sensitive to cadence, functional variability, and overall body expression, so that movement patterns can be described in language that is both relevant to

practice and compatible with systematic scientific analysis (Romero-Naranjo & Andreu-Cabrera, 2023b).

From this perspective, cadence is no longer understood solely as a numerical value (steps/min, cycles/min) but rather as an observable organizing axis that structures the movement into rhythmic units—action-pause microcycles, beats, load/unload phases—on which both mechanical demands and tactical decisions are articulated. In cyclic sports, these units are linked to stride, pedal stroke, or arm stroke, while in open acyclic sports they manifest themselves in sequences of adjustment steps, feints, changes of pace, or chained strokes, which form relatively stable temporal signatures for each athlete (Romero-Naranjo & Llorca-Garnero, 2023). Systematic observation of these microcycles allows us to identify patterns of rhythmic stability, rhythmic elasticity, and rhythmic couplings with the environment, which form the basis of the notion of the “rhythmic footprint” of movement.

The “rhythmic footprint” can be defined as the set of temporal regularities that characterize the way an athlete organizes their action cycles in a given task, including the relative duration of phases, pauses, accelerations, and transitions between movements (Bood et al., 2013). In a long-distance runner, for example, a range of natural cadences can usually be observed that emerge spontaneously when running without instructions and tend to stabilize around an idiosyncratic economical solution. Something similar occurs in race walking, where the rapid alternation between support and flight generates a rhythmic footprint that is easily recognizable to the expert observer. In sports involving equipment, such as tennis, badminton, or hockey, automatic preparation-strike-recovery cadences appear that are coupled to the type of equipment and the demands of the task, so that the frequency of adjustment steps and the tempo of swings reveal both the biomechanical organization and the anticipatory reading of the play.

In vehicle disciplines, such as road cycling or kayaking, the pedaling or paddling cadence takes center stage, as it regulates the distribution of neuromuscular effort and synchronizes with trunk oscillations, compensatory shoulder movements, and micro-adjustments of the head and gaze, configuring a characteristic bodily expression of “going smooth” or “going stuck” that any high-performance coach immediately recognizes (Schaffert et al., 2019; Romero-Naranjo, Andreu-Cabrera, & González-de-Benatuil, 2024). This broad perspective allows us to compare seemingly very different situations and discover profound expressive similarities: the cadence of a basketball point guard's steps in a change of pace, the sequence of supports of a winger attacking in soccer, a judoka's wheel before an attack, or a gymnast's build-up before an acrobatic move all share microcycles of action-pause that organize both the mechanics and the bodily narrative of the play, understood as the temporal and postural sequence of gestures that gives coherence to the action for both the performer and the observer.

Understanding cadence as a “rhythmic footprint” involves describing it using specific observational dimensions. In terms of time, at least three can be considered: a) rhythmic stability, understood as the consistency of the intervals between cycles; b) rhythmic elasticity, as the ability to accelerate or decelerate the movement while maintaining overall organization; and c) rhythmic couplings, such as synchronization with external stimuli (music, teammates, opponents) or with contextual changes (attack-defense transitions, beginnings and ends of possession) (Bood et al., 2013; Andreu-Cabrera, 2020). On a spatial-expressive level, the rhythmic footprint is linked to segmental amplitude, the

organization of the head-trunk-pelvis axis, and the degree of coarticulation between segments, such that certain cadences are systematically associated with more fluid or more segmented patterns of movement (Alonso-Sanz & Romero-Naranjo, 2015; Romero-Naranjo, 2004).

In line with the ecological-dynamic approach, this operationalization does not conceive of cadence as a static attribute of the individual, but rather as an emergent property of the interaction between the athlete, the task, and the environment (Davids et al., 2023). Thus, the same person can display different rhythmic patterns depending on the constraints: for example, a more compact and contained cadence in high-pressure defensive contexts, versus a more expansive and elastic cadence in situations of free space or numerical advantage. From an observational biomechanical perspective, these variations are not interpreted as “errors” with respect to a single ideal technique, but as indicators of motor richness and behavioral flexibility, insofar as they reflect the ability to modulate the tempo of the action to explore and exploit different game affordances (Andreu-Cabrera & Romero-Naranjo, 2021).

The concept of “rhythmic footprint” is enriched when related to variability. Repeated observation of the same movement in the same athlete allows us to distinguish between rigid cadence patterns, with low intra-episode variability, and more flexible patterns, where small fluctuations in support times, pauses, or accelerations are integrated without loss of effectiveness (Stergiou et al., 2006; Stergiou & Decker, 2011). In terms of motor richness, the ability to adopt, maintain, and abandon different effective cadences—without loss of precision or stability—is a key indicator of neuromotor flexibility, while excessively invariant rhythmic footprints could be associated with a lower ability to adapt to sudden changes in playing conditions.

Finally, the notion of “rhythmic signature” is directly connected to body language. Each cadence pattern is inscribed in space through a specific postural and gestural configuration: a runner whose technique is based on minimal vertical oscillation and economical arm movements expresses a different signature than another runner with greater oscillation and an expansive style; Similarly, a “feline” defender who anticipates and steals balls displays a specific combination of changes in rhythm, support, and gestural amplitude that shapes his cadential-expressive signature (Romero-Naranjo, 2004; Romero-Naranjo, Andreu-Cabrera, & Arnau-Moll, 2023). For observational biomechanics, these signatures are not just metaphorical descriptions, but patterns that can be recorded, coded, and related to indicators of performance, internal load, or injury risk, giving the “rhythmic footprint” a central diagnostic and formative value in the analysis of sports movement.

2.2. Body language as an indicator of motor richness

Body language can be understood as the “visible signature” of an athlete's motor organization, that is, as the way in which the internal architecture of neuromotor control manifests itself in spatial and rhythmic configurations of the entire body (Alonso Sanz & Romero Naranjo, 2015). It is not limited to the effector segment (hand, foot), but includes the amplitude and directionality of gestures, the fluidity or segmentation of movements, symmetries and asymmetries in the participation of segments, the use of the vertical axis, and the way in which cadence is distributed between the trunk, shoulder girdle, and extremities. From an observational biomechanical perspective, this expressive dimension ceases to be an anecdotal or merely aesthetic aspect and becomes a privileged indicator of motor richness, insofar as it reveals how the system explores,

selects, and stabilizes different movement solutions depending on the constraints of the task and the environment (Romero Naranjo, 2004; Davids et al., 2023).

Studies on complex skills, such as sport climbing, show that increased experience is associated with broader and more anticipatory co-articulation, in which a greater number of joints are coordinated in an integrated manner to prepare for subsequent movements, configuring more fluid and economical body patterns (Arnau Moll & Romero Naranjo, 2022b; Arnau Moll, Romero Naranjo, & Andreu Cabrera, 2024). Convergently, research in open sports shows that expert athletes access more varied postural and gestural solutions to achieve the same goal, which is reflected in expressive changes in the use of the trunk, shoulder girdle, and gaze orientation (Romero Naranjo, Andreu Cabrera, & Arnau Moll, 2023). This greater diversity in gestures does not translate into disorder, but rather into the ability to reorganize the entire body around different cadences and rhythms of action, maintaining the effectiveness of the result, which is a central feature of motor richness (Alonso Sanz & Romero Naranjo, 2015; Romero Naranjo, 2004).

From an observational point of view, body expression can be classified using categories that describe: a) extension/contraction of the body (broad or reduced use of body space); b) directionality and alignment (preferred orientations, turns, inclinations of the head-trunk-pelvis axis); c) fluidity and segmentation (continuous versus fragmented movements); d) symmetry/asymmetry in the participation of segments; and e) degree of coarticulation (simultaneous participation of multiple joints in the same “motor phrase”). These categories allow us to differentiate, for example, between a runner whose technique is based on minimal vertical oscillation and economical arm movements, and another whose body language reveals greater oscillation, trunk torsion, and a more expansive style, associated with different situational response strategies and different mechanical cost profiles. In sports with a high expressive load, such as artistic gymnastics, artistic swimming, dance sport, or certain martial arts, these differences are particularly visible, but the hypothesis of observational biomechanics is that they are also relevant in contexts of “pure” performance, where they influence gestural economy, anticipation, and resilience to fatigue (Romero Naranjo, 2004; Beaman, 2017).

Body language is also linked to emotional and intentional components, forming a semiotic system in which the body “says” things about the state of the system on several simultaneous levels (Blacking, 1973). Changes in verticality, slumped shoulders, or loss of bounce indicate the degree of fatigue; more aggressive or defensive support and the expansion or contraction of body space reflect competitive attitude; while certain gestures toward the audience, teammates, or opponents express the relationship with the social context of the game. For observational biomechanics, these semiotic manifestations are read as emerging rhythmic postural configurations: the same cadence of steps can take on different meanings depending on how it is combined with the orientation of the gaze, the position of the arms, or the amplitude of the gestures, so that the reading of bodily expression always requires consideration of the coupling between time, space, and motor intention (Romero Naranjo, 2024).

Understood as an indicator of motor richness, body expression allows for a qualitative assessment of the extent to which an athlete has a broad and flexible repertoire of movement solutions. A subject with low motor richness tends to display rigid gestural patterns, little variation in the amplitude and directionality of movements, and difficulties in reorganizing their posture when task

conditions change. In contrast, an athlete with high motor richness exhibits a more varied palette of expressive configurations, functionally modulating postural tone, use of the vertical axis, and body expansion as appropriate to accelerate, brake, feint, or protect themselves (Andreu Cabrera & Romero Naranjo, 2021; Ruffini, Bei, & Pecini, 2024). In team sports, this expressive richness can be seen in the ability to “enlarge” or “shrink” spatially to influence the opponent's perceptions, in the way gestures are used to hide intentions, or in the ability to synchronize one's body with the collective rhythm of the team (Gioia et al., 2000; Davids et al., 2023).

In practical terms, conceiving of bodily expression as an indicator of motor richness opens up concrete possibilities for assessment and training. In educational and training contexts, the construction of observation rubrics that integrate biomechanical and expressive criteria allows for the assessment not only of technical correctness, but also of gestural diversity, sensitivity to rhythm, and the motor exploration capacity of children, adolescents, and athletes in training (Navarro Maciá & Romero Naranjo, 2023a, 2023b). In high performance, the systematic monitoring of expressive cadential signatures can be used to track the evolution of playing style, detect possible stiffness associated with overload or competitive stress, and guide interventions that seek to expand gestural repertoires or recover the characteristic “way of moving” after an injury (Andreu Cabrera, 2018; Andreu Cabrera, González de Benatuil, & Romero Naranjo, 2024).

For the academic field of physical activity and sports sciences, this conception of body expression as an indicator of motor organization opens up opportunities for research and curricular innovation. On the one hand, it encourages studies that correlate expressive cadential signatures with objective indicators such as GPS, accelerometry, or isokinetic analysis, enriching the dialogue between traditional qualitative assessment by teachers and data obtained through wearable technology (Romero Naranjo, 2024; Arnau Moll & Romero Naranjo, 2024b). On the other hand, it places observational biomechanics at the center of university training in CAFyD, proposing that learning to “read” the athlete's body language—in its rhythmic, postural, and semiotic dimensions—is a key skill both for performance analysis and for building more inclusive, creative, and respectful practice environments with regard to diversity of movement styles.

2.3. Cadence as an organizing axis

It is proposed that cadence be considered not only as a quantifiable variable in terms of steps per minute or cycles per minute, but also as an observable organizing axis that structures the movement into rhythmic units—microcycles of action-pause, beats, load/unload phases—on which the mechanics, coordination, and tactical intentionality of the movement are articulated. In cyclic sports, these units are linked to strides, pedal strokes, or arm strokes, while in acyclic sports they manifest themselves in sequences of adjustment steps, feints, changes of pace, or chained strokes that shape the tempo of the action (Romero-Naranjo & Llorca-Garnero, 2023). In this way, cadence acts as the “temporal backbone” of the movement, around which both the patterns of strength and support and the overall gestures of the athlete are organized.

At least three functional dimensions can be described in relation to this cadence axis: a) rhythmic stability, understood as the consistency of the intervals between cycles; b) rhythmic elasticity, referring to the ability to accelerate or decelerate the movement while maintaining overall organization; and c) rhythmic couplings, which refer to synchronization with external stimuli such as music, teammates, or opponents (Bood et al., 2013; Schaffert et al., 2019).

These dimensions allow us to characterize different movement styles, such as “isorhythmic” athletes, who tend to maintain very stable cadences, as opposed to “polyrhythmic” athletes, who are able to superimpose and combine different temporal patterns according to the demands of the game (Romero-Naranjo, 2020). In terms of motor richness, the ability to transition between different cadence configurations without losing effectiveness is related to greater behavioral flexibility and a more refined reading of the affordances available in each situation (Andreu-Cabrera & Romero-Naranjo, 2021; Davids et al., 2023).

If different sports families are analyzed from this perspective, cadence appears as a cross-cutting organizer. In racket sports, the serve-first strike-repositioning pattern is articulated in micro-cadences that condition the possibility of mastering the timing of the point; in combat sports, the sequences of steps, feints, and entries are structured in rhythms of approach-retreat that conceal or reveal offensive intentions; and in acrobatic sports, the phases of beat, flight, and reception are inscribed in millimetric timings that, when altered, immediately transform the expression of the movement (Romero-Naranjo & Andreu-Cabrera, 2023b). Even in strategic sports such as peloton cycling or regattas, the management of cadence changes at key moments (attacks, relays, mountain passes) imprints specific gestures on the body—tension in the upper body, micro-variations in the trunk, facial expressions associated with effort—which coaches recognize as indicators of the quality of the movement and the level of control over the competitive situation (Schaffert et al., 2019; Romero-Naranjo, Andreu-Cabrera, & González-de-Benatuil, 2024).

From the perspective of observational biomechanics, cadence as an organizing axis allows for the integration of biomechanical, neuromotor, psychological, and semiotic levels of analysis into a single reading. At the biomechanical level, moderate variations in cadence are associated with changes in impact forces, load rates, and joint alignment, promoting more protective patterns without compromising the economy of the movement (Preatoni et al., 2010; Romero-Naranjo & Llorca-Garnero, 2023).

At the neuromotor level, these variations involve reconfigurations in the coarticulation of segments and in the distribution of work between proximal and distal joints, modulating the fluidity or segmentation of movement (Arnau-Moll & Romero-Naranjo, 2022b; Arnau-Moll et al., 2024). On a psychological and semiotic level, changes in cadence are associated with perceptions of “going at pace,” “going late,” or “going fast,” as well as with gestures that express confidence, urgency, or control of the game (Liddle, Deane, & Vella, 2017; Romero-Naranjo et al., 2023).

Considering cadence as an organizing principle also introduces a criterion for interpreting body language. More stable cadence patterns tend to be accompanied by more restrained gestures and economy of movement, while more elastic cadences may be associated with bodily expansions and sudden changes in the amplitude and directionality of gestures. The “easy running” of the long-distance runner, the ‘floating’ of the swimmer, or the “feline” manner of some defenders in anticipating and stealing balls can be interpreted as cadential-expressive signatures in which the rhythmic organization of the gesture, functional variability, and body expression converge in particularly efficient and adaptive configurations (Romero-Naranjo, 2004; Romero-Naranjo, Andreu-Cabrera, & Arnau-Moll, 2023).

From an observational point of view, describing these signatures involves recording not only how many cycles are performed per minute, but also how the action and pause phases are distributed

over time, which segments are activated as a priority in each cadence, and how body space is occupied throughout the sequence.

In summary, understanding cadence as an organizing principle means shifting the focus from merely quantifying tempo to analyzing how that tempo structures motor behavior as a whole. Cadence ceases to be a secondary parameter and becomes an interpretative key that allows mechanical efficiency, functional variability, bodily expression, and subjective experience of movement to be linked within the same conceptual framework (Romero-Naranjo & Andreu-Cabrera, 2023c). This concept is central to the proposed observational biomechanics, as it offers a unifying criterion for describing movement patterns in cyclic, acyclic, and expressive sports, and for relating them to motor richness and personal playing styles that emerge in real practice and competition contexts.

3. OBSERVATIONAL PROTOCOL FOR THE ANALYSIS OF CADENCE, BODY EXPRESSION, AND MOTOR RICHNESS

The proposed observational biomechanics methodology is based on the systematic description of cadence and body expression in practice and competition contexts, articulating units of analysis, category systems, and recording protocols that allow expert perceptions to be translated into observable indicators of motor richness. In contrast to purely instrumental or exclusively qualitative approaches, a mixed approach is proposed that combines structured video observation with simple temporal metrics (e.g., cadence measured with cycle counters or inertial sensors) and spatial-expressive descriptors, while ensuring intra- and inter-rater reliability criteria (Arnau-Moll & Romero-Naranjo, 2024b; Bartlett, 2007).

3.1. Units of analysis and contexts

The approach is organized around the notion of “motor episode” and “motor phrase” as basic units of observation. The motor episode is defined as a complete cycle of action that includes initiation, development, and completion (e.g., a stride, a striking gesture, a judo throw), while the motor phrase refers to a chained sequence of episodes aimed at resolving a game situation or executing a complex technical combination (e.g., reception–control–pass in soccer or preparation–attack–start in climbing). This distinction allows us to analyze both the internal organization of each cycle and the way in which episodes are rhythmically assembled to construct the bodily narrative of the action.

Three main types of observation contexts are proposed. In cyclic contexts (running, cycling, swimming), the focus is on spontaneous cadence, modulated cadence, and response to external rhythmic stimuli, recording how variations in tempo are accompanied by changes in bodily expression and the organization of supports (Romero-Naranjo & Llorca-Garnero, 2023). In open acyclic contexts (soccer, basketball, racket sports), attention is focused on sequences such as reception-control-pass or serve-first strike-repositioning, analyzing the cadence of adjustment steps, strategic pauses, and changes in rhythm according to situational demands (Davids et al., 2023). In expressive contexts (gymnastics, dance, martial arts, rhythmic sports), the focus is on motor phrases where the aesthetic and communicative component is explicit, describing the relationship between cadence, gestural fluidity, and use of body space (Navarro-Maciá & Romero-Naranjo, 2023a, 2023b).

3.2. System of Descriptive Categories

The system of categories combines temporal-cadence, spatial-expressive, and motor variability/richness parameters. The temporal-cadence parameters include: a) baseline cadence (cycles/min) and relative variations with respect to that reference; b) rhythmic stability, understood as intra- and inter-episode variability within time intervals; and c) rhythmic elasticity, operationalized as the capacity for rapid transitions between cadences without loss of overall organization (Bood et al., 2013; Schaffert et al., 2019). These parameters allow for the identification of athletes with extremely rigid cadence patterns compared to others who exhibit fluid tempo modulation depending on the situation.

The spatial-expressive parameters include: a) segmental amplitude, referring to the range of motion of the limbs and trunk; b) postural organizers, with special attention to the head-trunk-pelvis axis; and c) coarticulation patterns, understood as the quantity and manner in which multiple joints participate simultaneously in a motor episode or phrase (Alonso-Sanz & Romero-Naranjo, 2015; Romero-Naranjo, 2004). The combination of these categories allows us to describe more compact and contained movement styles versus more expansive and distributed ones, and to link them to the rhythmic patterns identified in the temporal analysis.

Finally, the variability/richness parameters include: a) the number of different biomechanical solutions for the same task (strategic variability); b) variations within the same solution (execution variability); and c) the stability of the outcome despite the variability (Stergiou et al., 2006; Andreu-Cabrera & Romero-Naranjo, 2021). This set of categories allows linking the observation of cadence and body language with the notion of motor richness, so that it not only describes “how” the athlete moves, but also how many different effective ways they are able to mobilize to solve the same motor problem. The system is designed to be applied both qualitatively (ordinal scales and descriptors) and semi-quantitatively (frequencies, variability indices), facilitating its integration with cost-effective two-dimensional video analysis tools that have shown acceptable reliability in the analysis of running and other movements (Arnau-Moll & Romero-Naranjo, 2024b).

3.3. Observational Protocol and Reliability

The observational protocol is structured in several interconnected phases. The recording phase consists of capturing the movement from multiple perspectives, ideally with at least frontal and sagittal planes, under ecological conditions of real training or competition, using conventional cameras or mobile devices with a sufficient sampling rate. When possible, this recording is supplemented with simple cadence measurements obtained using inertial sensors, cycle counters, or GPS devices. These instruments do not replace observation but rather enrich it (Andreu-Cabrera, 2020). The segmentation phase involves identifying and marking motor episodes and motor phrases, precisely defining the start and end criteria for each unit of analysis to ensure comparability between observers.

In the coding phase, trained observers apply the category system to each motor episode or phrase, recording cadence, spatial, and variability patterns according to previously agreed-upon rubrics. The training of observers is crucial here: the literature on qualitative analysis using video of running and other movements suggests that, with specific training and calibration programs, it is possible to achieve high levels of intra- and inter-rater reliability in the coding of kinematic and expressive

patterns (Arnau-Moll & Romero-Naranjo, 2024b; Andreu-Cabrera, 2018). Finally, in the analysis phase, the data are aggregated to obtain individual and collective profiles of cadence, body expression, and motor richness, which can be represented in matrices, profile diagrams, or cadence-expressive signature maps that facilitate joint interpretation by technical and research staff.

Ensuring reliability and validity is a central aspect of this approach. The construction and application of complex categorization systems requires extensive training, co-coding sessions, and mechanisms for the periodic monitoring of intra- and inter-rater reliability. This entails investing time in training staff, reaching consensus on coding criteria, and verifying the consistency of the recordings (Andreu-Cabrera, 2018). Furthermore, the presence of cameras or sensors can partially alter spontaneous gestures, especially during formative stages or in sensitive educational contexts. Therefore, it is recommended to design discreet and progressive recording strategies that minimize reactivity and promote the naturalness of the observed action. In all cases, the recording of images and data must be carried out respecting basic ethical principles: obtaining informed consent, protecting confidentiality, and, when necessary, anonymizing audiovisual materials before analysis or dissemination, in accordance with current recommendations for sports science research (Davids et al., 2023). The interpretation of rhythmic-expressive patterns is always carried out from situated cultural and conceptual frameworks; therefore, it is essential to triangulate biomechanical analysis with the experience of the athletes themselves and the coaching staff, avoiding automatically labeling as “error” or “deficiency” what, in certain playing cultures, constitutes a legitimate and effective style of motor expression (Andreu-Cabrera, 2018; Davids et al., 2023).

3.4. Research Applications and Design Examples

In the field of research, the observational biomechanics methodology of rhythm and body expression allows for the design of mixed studies that combine qualitative video analysis with accessible quantitative data. In running and walking, for example, body language (trunk sway, arm span, use of the vertical axis) can be coded along with cadence, contact time, and step-to-step variability measured using portable accelerometry, exploring how cadence modifications simultaneously influence load parameters and the runner's rhythmic-postural footprint (Romero-Naranjo & Llorca-Garnero, 2023; Preatoni et al., 2010).

In team sports, it is possible to analyze attack-defense transition sequences, relating collective cadence patterns (changes of pace, pauses, “waves” of advance) to spatial occupation and the success of possessions, and describing how certain rhythmic configurations are associated with moments of dominance or collapse in the game (Cowin et al., 2022; Davids et al., 2023).

In complex skills such as climbing, gymnastics or martial arts, the coarticulation of segments and gestural fluidity can be studied in parallel with the cadence of executions and technical precision, identifying cadence-expressive signatures that differentiate expert athletes from novices (Arnau-Moll, Romero-Naranjo, & Andreu-Cabrera, 2024; Romero-Naranjo, Pujalte Cantó, & Arnau-Moll, 2023).

This type of design offers the scientific community a way to apply concepts that often remain on the discursive plane —“fluidity”, “tension”, “confidence”, “going loose”—, translating expert perceptions into observable indicators that dialogue with biomechanical and physiological data (Andreu-Cabrera, González de Benatuil, & Romero-Naranjo, 2024; Andreu-Cabrera,

Romero-Naranjo, & Lorenzo-Lledó, 2024). At the same time, it favors longitudinal studies where the evolution of cadence-expressive signatures is followed throughout a season, an Olympic cycle or a formative progression, contributing to understanding how the “motor identities” of athletes are built and transformed under different training methodologies and game contexts (Arnau-Moll & Romero-Naranjo, 2023; Romero-Naranjo, 2024).

4. CONCEPTUAL RESULTS

The conceptual results of the observational biomechanics framework do not correspond to specific empirical data, but rather to figures and diagrams derived from the theoretical application of the proposed system of categories and observational protocol. These results allow us to articulate how cadence, functional variability, and body expression combine into observational patterns that operate as indicators of motor richness in different sporting contexts (Romero-Naranjo & Andreu-Cabrera, 2023c; Davids et al., 2023).

4.1. Cadence and Movement Economy

Studies on cadence manipulation in running show that moderate increases are associated with reductions in impact forces, lower loading rates, and improved lower limb alignment, promoting more protective patterns without negatively impacting energy expenditure and even favoring economy in certain intensity ranges (Romero-Naranjo & Llorca-Garnero, 2023; Preatoni et al., 2010). Observationally, these adjustments translate into shorter strides, reduced ground contact time, decreased vertical trunk oscillation, and often a more controlled and translation-focused body language, configuring a rhythmic-postural signature in which cadence simultaneously reorganizes amplitude, muscle activation sequence, and use of body space.

The concurrence of cadence changes and expressive changes suggests that tempo modification acts as an ‘organizational lever’ of the entire movement, in the sense that small variations in rhythm trigger coordinated reconfigurations in the distribution of work between segments, in coarticulation, and in the appearance of overall tension or relaxation in the body” (Arnau-Moll & Romero-Naranjo, 2022b; Arnau-Moll et al., 2024). Cadence-expressive tasks can also function as training for selective and sustained attention, opening the possibility of transferring attention rehabilitation principles to sports and educational contexts through exercises that require maintaining or changing specific cadences under pressure (Sohlberg & Mateer, 1987, 1989). In terms of motor richness, the ability to adopt, maintain, and abandon different effective cadences—without loss of precision or stability—is configured as a key indicator of Neuromotor flexibility.

4.2. Functional Variability and Tactical Flexibility

In line with the framework of variability in sport, observation shows that elite athletes combine stability of outcome with a diversity of motor solutions, especially in open-ended tasks (Cowin et al., 2022; Stergiou & Decker, 2011). Observationally, this manifests in cadence patterns and body expression that adapt to contextual constraints: changes in rhythm, strategic pauses, expansion or reduction of gestural amplitude according to defensive pressure or available space, and reconfigurations of the head-trunk-pelvis axis that anticipate or camouflage intentions (Davids et al., 2023). Motor richness is thus expressed in the ability to modulate tempo and gestures functionally, maintaining effectiveness despite notable variations in the form of the movement.

In practice, this flexibility is reflected in athletes capable of changing their cadence pattern and Expressive movement, according to the demands of the situation, without losing effectiveness or fluidity (Diamond, 2013a; Miyake & Friedman, 2012; Miyake et al., 2000). In racket sports, for example, players alternate between fast, tense exchanges and slower, more exploratory phases, modifying their body language—posture, swing length, use of space—to conceal or reveal tactical intentions. In team sports, point guards or midfielders with a wide range of motor skills display rich repertoires of changes in rhythm and gestures that allow them to manipulate the temporal perception of opponents and teammates. The combined analysis of cadence and body language allows us to "see" this flexibility, distinguishing athletes who primarily vary their speed without reorganizing their gestures from those who globally reconfigure their bodies to generate new action options.

4.3. Coarticulación, expertise y firma expresiva

Studies on coarticulation in climbing show that experts anticipate the demands of future movements by coordinating multiple joints in an integrated way, which is reflected in smoother transitions, fewer pauses, and more consistent cadence patterns throughout long sequences (Arnau-Moll & Romero-Naranjo, 2022b; Arnau-Moll et al., 2024). This global coarticulation is accompanied by a characteristic body expression, where the body seems to "write" more continuous and harmonious phrases in space, with a use of the vertical axis and gestural amplitude that conveys fluidity and economy. In contrast, novice climbers tend to exhibit more irregular cadences, frequent pauses, more segmented movements, and abrupt changes in postural organization, resulting in less stable and adaptive cadence-expressive signatures (Romero-Naranjo, 2004).

Similarly, in other sports, individualized movement "signatures" have been described, associated with technical styles, motor preferences, and emotional states, which modulate posture, gestures, and rhythm (Romero-Naranjo, Andreu-Cabrera, & Arnau-Moll, 2023; Liddle, Deane, & Vella, 2017). The proposed observational biomechanics suggests that these signatures can be conceptualized as relatively stable, cadence-expressive patterns, but ones that can be enriched through training aimed at expanding the repertoire and practicing transitions between movement styles. In this sense, motor richness is not limited to the number of possible solutions, but also to the ability to "fine-tune" the expressive signature according to performance goals, the demands of the context, and the athlete's own motor identity (Ruffini, Bei, & Pecini, 2024; Gioia et al., 2000).

4.4. Cadential-Expressive Profiles and Game Reading

A relevant conceptual result is the possibility of describing "cadence-expressive profiles" that integrate information on rhythmic stability, elasticity, functional variability, and body language into a single reading framework. These profiles allow us to characterize athletes who stabilize effective cadences with low gestural variability, athletes who explore multiple cadences and expressive styles while maintaining effectiveness, and athletes who show instability in both tempo and gestures, which could be associated with learning phases or situations of mental block (Diamond, 2013b; Davids et al., 2023). In team sports, this perspective facilitates the analysis of how certain players "set the pace" for the team, acting as cadence organizers whose body language and timing decisions dictate the dynamics of the game.

These profiles open avenues for the qualitative evaluation of performance and the identification of talent from a motor richness perspective. Beyond objective scores, athletes can be characterized by their ability to: a) stabilize effective cadences; b) modulate rhythm rapidly; and c) reconfigure their body expression according to the demands of the game—elements that are related to motor learning potential and adaptability to changing contexts (Gioia et al., 2000; Ruffini, Bei, & Pecini, 2024). In this way, observational biomechanics offers a conceptual tool for recognizing emerging talents who may not yet stand out for their quantitative records, but rather for the richness and flexibility of their expressive cadence signatures.

5. DISCUSSION

5.1. Contributions to the Study of Motor Skills and Play

The proposed observational biomechanics framework contributes to the understanding of sports motor skills from a perspective that integrates biomechanics, motor control, and expressiveness, overcoming the quantitative/qualitative dichotomy that has dominated much of the traditional literature (Romero-Naranjo & Andreu-Cabrera, 2023c; Bartlett, 2007). By conceptualizing cadence as an organizing principle, variability as an adaptive resource, and body expression as a visible manifestation of motor organization, a way is offered to analyze sports play not only as technical execution, but also as situated rhythmic and expressive behavior, in which the body continuously interacts with the affordances of the environment (Davids et al., 2023).

This view aligns with ecological-dynamic approaches that understand performance as a product of the interaction between individual, task, and context, where variability is not interpreted as failure, but as a structural component of adaptation (Stergiou et al., 2006; Davids et al., 2023). The originality of this chapter lies in articulating these concepts with a concrete observational system that can be applied in real-world training and competition contexts with readily available resources, providing a common language for coaches, teachers, and researchers by describing cadence-expressive signatures associated with different levels of motor richness (Arnau-Moll & Romero-Naranjo, 2022b; Romero-Naranjo, 2024).

5.2. Implications for Training and Injury Prevention

In practical applications, cadence modulation is already used in running rehabilitation to reduce joint loads and prevent overuse injuries, taking advantage of the fact that moderate increases decrease impact forces without worsening running economy (Andreu-Cabrera, 2020; Preatoni et al., 2010). The observational approach suggests incorporating, in addition to numerical cadence, the analysis of expressive changes—trunk oscillation, arm span, apparent rigidity, use of the vertical axis—to assess whether the new gestural configuration is sustainable and functional in the long term. This would allow the return to competition to be evaluated also in terms of the recovery of the athlete's characteristic cadence-expressive signature (Romero-Naranjo & Llorca-Garnero, 2023).

In open sports, expanding motor repertoire can be addressed through tasks that require exploring different cadences and body expressions: games with tempo variations, tasks with auditory or visual rhythmic stimuli, or modified game situations where creative solutions and unexpected changes of rhythm are rewarded (Álvarez-Morales & Romero-Naranjo, 2019; Diamond, 2013b; Schaffert et al., 2019). From a preventative perspective, excessively rigid patterns—with low cadence and

expressive variability—could be associated with greater vulnerability to sudden changes in context, justifying the promotion of more flexible repertoires that allow for reorganization of the body and the tempo of the action without compromising the stability of the outcome (Stergiou & Decker, 2011; Andreu-Cabrera & Romero-Naranjo, 2021).

5.3. Performance Assessment and Talent Selection

This proposal opens avenues for the qualitative assessment of performance and talent identification based on the concept of a “cadence-expressive profile.” Beyond objective metrics, athletes can be characterized by their ability to: a) stabilize effective cadences; b) modulate rhythm rapidly; and c) reconfigure their body language according to the demands of the game, thus combining consistent performance with a diversity of motor solutions (Gioia et al., 2000; Cowin et al., 2022). These profiles could complement traditional tests, helping to identify athletes with high potential for motor learning and adaptability, even before they have reached their maximum quantitative performance, and offering criteria for designing individualized development pathways based on expanding their motor repertoire (Ruffini, Bei, & Pecini, 2024; Davids et al., 2023).

In early training, observing gestural diversity, sensitivity to rhythm, and motor exploration skills can be used as an indicator of emerging motor richness, guiding educational practices that value bodily creativity and experimentation over early specialization in a single “correct” form of execution (Navarro-Maciá & Romero-Naranjo, 2023a, 2023b). For physical education teachers and basic technical staff, learning to read expressive cadence signatures offers a tool for detecting both concerning rigidities and creative potential that may not be evident in standardized performance tests.

5.4. Neurophenomenological Dimension and Movement Experience

One aspect that deserves specific attention is the relationship between cadence-expressive patterns observed from the outside and the subjective experience that athletes have of their own movement. In states of perceived high performance, many athletes describe sensations of fluidity, lightness, being “in rhythm,” or “feeling the game,” which can be interpreted as phenomenological correlates of particularly stable and efficient rhythmic and postural configurations (Arnau-Moll & Romero-Naranjo, 2024a; Liddle, Deane, & Vella, 2017). Conversely, in situations of blockage or saturation, athletes frequently refer to a loss of tempo, a feeling of being “late” or “too fast,” and an increased awareness of body segments, which could reflect a breakdown of habitual cadence attractors and a lack of coordination between intention, perception, and execution (Nigg, 2017; Romero-Naranjo et al., 2023).

Incorporating qualitative methods—interviews, video self-reflection, training logs—alongside biomechanical analysis would allow progress toward a neurophenomenology of cadence and body expression, capable of linking brain dynamics, observational patterns, and bodily experiences (Blair & Ursache, 2011; Diamond, 2013a). This integration could enrich both scientific understanding and training and psychological support practices by offering coaches and sports psychologists tools to intervene not only on the mechanical parameters of movement, but also on how athletes experience and regulate their own cadence-expressive signature in contexts of competitive pressure.

6. CONCLUSIONS AND FUTURE DIRECTIONS

This chapter has formulated and developed an observational biomechanics framework focused on cadence and body expression as privileged windows for accessing the richness of movement in sport, integrating contributions from biomechanics, motor control, sport psychology, and body expression studies (Romero-Naranjo & Andreu-Cabrera, 2023c; Davids et al., 2023). Based on this framework, a system of cadence-expressive categories and an observation protocol applicable to different types of sports have been proposed. This allows for the ecological description of movement patterns and their connection to indicators of performance, behavioral flexibility, and injury risk, overcoming the traditional separation between quantitative analysis and qualitative interpretation of movement (Arnau-Moll & Romero-Naranjo, 2022b; Bartlett, 2007; Romero-Naranjo, 2025a, 2025b).

The central contribution lies in having articulated an integrative language capable of describing, with the same conceptual framework, the stride cadence of a runner, the tempo of a tennis rally, the coarticulation of an expert climber, or the expressiveness of a gymnastic choreography, showing that all these phenomena share a rhythmic-postural infrastructure susceptible to being analyzed using common observational tools (Beaman, 2017; Romero-Naranjo, 2024). By placing cadence and body expression at the center of the analysis, a shift in focus is proposed with respect to traditional biomechanics: it is no longer just about optimizing trajectories or reducing impact forces, but about understanding how rhythmic and postural patterns shape the way of being in the game, reading affordances, and interacting with the social and emotional context of competition (Davids et al., 2023; Liddle, Deane, & Vella, 2017).

Among the main limitations is the need to empirically validate the reliability and sensitivity of the observational system across different sports, skill levels, and developmental stages. This requires comparative studies and carefully designed observer training protocols (Arnau-Moll & Romero-Naranjo, 2024b; Andreu-Cabrera, 2018). Furthermore, the systematic integration of instrumental measures (inertial sensors, GPS, quantitative video analysis) with qualitative categories presents methodological and analytical challenges, but also opens the possibility of constructing hybrid indicators that combine the descriptive power of observation with the precision of quantitative records (Andreu-Cabrera, González de Benatuil, & Romero-Naranjo, 2024; Romero-Naranjo & Llorca-Garnero, 2023). Finally, the interpretation of expressive cadence patterns is always carried out from situated cultural and conceptual frameworks, which necessitates triangulating biomechanical analysis with the experience of athletes and staff to avoid reifying as a “defect” what constitutes a legitimate style of motor expression in certain playing cultures (Andreu-Cabrera, 2018; Davids et al., 2023).

Based on the above, several priority lines of research are proposed. First, the validation and standardization of observational instruments, through the development and testing of specific category systems for different sports families, with rigorous studies of reliability, construct validity, and sensitivity to changes produced by training (Arnau-Moll & Romero-Naranjo, 2023; Navarro-Maciá & Romero-Naranjo, 2023a). Secondly, longitudinal studies of the cadence-expressive profile that follow athletes throughout seasons, training cycles or rehabilitation processes, in order to describe how cadence-expressive signatures evolve based on experience, load and transformations

in the competitive context (Romero-Naranjo, Pujalte Cantó, & Arnau-Moll, 2023; Ruffini, Bei, & Pecini, 2024).

Thirdly, the exploration of the potential of this approach in special populations and educational contexts is proposed, analyzing how the observational biomechanics of cadence and body expression can contribute to inclusion, curricular adaptation and the development of motor skills in people with functional diversity, developmental disorders or coordination difficulties (Gioia et al., 2000; Navarro-Maciá & Romero-Naranjo, 2023b). Finally, a line of work is opened towards a neurophenomenology of cadence and body expression, which combines observational analysis, neurophysiological measures and qualitative methods to link brain dynamics, rhythmic-postural patterns and subjective experiences of performance, offering a more complete framework to design integrated interventions of physical, technical and psychological training (Blair & Ursache, 2011; Arnau-Moll & Romero-Naranjo, 2024a; Romero-Naranjo et al., 2023).

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Neuromotricity and ADHD. Theoretical and practical justification.

Francisco Javier Romero-Naranjo

Abstract

Attention Deficit Hyperactivity Disorder (ADHD) is a significant neurodevelopmental condition characterized by consistent deficits across large cerebral executive networks, with Inhibitory Control (IC) serving as a central pathological predictor of symptom severity. Beyond core executive dysfunction (IC failure, planning deficits, and impaired working memory due to attentional hijacking), the disorder involves a critical deficit in volition and perseverance, driven by low neurobiological activation towards distant rewards, resulting in a systemic prioritization of immediate gratification. This paper addresses two critical clinical realities: the detailed neurofunctional profile of ADHD and the severe diagnostic gender bias observed in clinical practice. Analysis reveals that the symptomatic presentation is highly gender-sensitive. While male profiles typically involve externalizing behaviors (hyperactivity/impulsivity), the predominantly inattentive female profile is often rendered "subclinical," leading to significant underdiagnosis. This diagnostic omission forces girls to rely on hypercompensatory strategies (overexertion), which directly correlate with the internalizing of psychopathology (e.g., anxiety, low self-esteem, and severe conduct disorders) during adolescence. Furthermore, attentional deficits are dissected into failures of both engagement and sustained maintenance, which manifest differentially across developmental stages. Based on this neurofunctional pathology, we theoretically propose Neuromotricity (BAPNE) as an exploratory intervention strategy. The core mechanism is the implementation of the Rhythmic/Cognitive/Motor dual-task paradigm. By imposing simultaneous and sequential demands on cognitive sequencing and rhythmic motor execution, this approach directly targets the need for active IC and alternating attention, thereby offering a rigorous training model for the activation of executive networks and the formation of sustained habits. In conclusion, Neuromotricity (BAPNE) presents a robust theoretical alignment with the neurofunctional deficits of ADHD, offering a promising, non-pharmacological pathway. However, its effectiveness remains a hypothesis that needs to be validated with longitudinal studies. Academic rigor demands immediate future research focusing on longitudinal designs to empirically quantify its causal impact on IC metrics and its sensitivity in mitigating the delayed psychological comorbidities observed in the underdiagnosed female population.

Keywords: Attention Deficit Hyperactivity Disorder (ADHD), Inhibitory Control, Executive Functions, Neuromotricity, BAPNE, Diagnostic Bias.

Resumen

El trastorno por déficit de atención con hiperactividad (TDAH) es una afección neurológica significativa caracterizada por déficits constantes en las grandes redes ejecutivas cerebrales, en la que el control inhibitorio (CI) actúa como predictor patológico central de la gravedad de los síntomas. Más allá de la disfunción ejecutiva central (fallo del CI, déficits de planificación y deterioro de la memoria de trabajo debido al secuestro de la atención), el trastorno implica un déficit crítico en la voluntad y la perseverancia, impulsado por una baja activación neurobiológica hacia recompensas lejanas, lo que da lugar a una priorización sistémica de la gratificación inmediata. Este artículo aborda dos realidades clínicas fundamentales: el perfil neurofuncional detallado del TDAH y el grave sesgo de género en el diagnóstico que se observa en la práctica clínica. El análisis revela que la presentación sintomática es muy sensible al género. Mientras que los perfiles masculinos suelen implicar comportamientos externalizantes (hiperactividad/impulsividad), el perfil femenino, predominantemente inatento, a menudo se considera «subclínico», lo que conduce a un importante infradiagnóstico. Esta omisión diagnóstica obliga a las niñas a recurrir a estrategias hipercompensatorias (esfuerzo excesivo), que se correlacionan directamente con la internalización de la psicopatología (por ejemplo, ansiedad, baja autoestima y trastornos graves de conducta) durante la adolescencia. Además, los déficits de atención se dividen en fallos tanto de compromiso como de mantenimiento sostenido, que se manifiestan de forma diferente en las distintas etapas del desarrollo. Basándonos en esta patología neurofuncional, proponemos teóricamente la neuromotricidad (BAPNE) como estrategia de intervención exploratoria. El mecanismo central es la implementación del paradigma de doble tarea rítmica/cognitiva/motora. Al imponer exigencias simultáneas y secuenciales a la secuenciación cognitiva y la ejecución motora rítmica, este enfoque se centra directamente en la necesidad de una IC activa y una atención alterna, ofreciendo así un modelo de entrenamiento riguroso para la activación de redes ejecutivas y la formación de hábitos sostenidos. En conclusión, la neuromotricidad (BAPNE) presenta una sólida alineación teórica con los déficits neurofuncionales del TDAH, lo que ofrece una vía prometedora y no farmacológica. Sin embargo, su eficacia sigue siendo una hipótesis que debe validarse con estudios longitudinales. El rigor académico exige una investigación

inmediata centrada en diseños longitudinales para cuantificar empíricamente su impacto causal en las métricas de la CI y su sensibilidad para mitigar las comorbilidades psicológicas retardadas observadas en la población femenina infradiagnosticada.

Palabras clave: Trastorno por déficit de atención con hiperactividad (TDAH), control inhibitorio, funciones ejecutivas, neuromotricidad, BAPNE, sesgo diagnóstico.

I. INTRODUCTION

Attention Deficit Hyperactivity Disorder (ADHD) is primarily characterized as the behavioral manifestation of neurobiological developmental delays. Traditionally conceived as a frontal lobe dysfunction, contemporary neuroscience has significantly advanced the understanding of its neuropsychological etiology (Felt et al., 2014). Current studies focus on the constellation of processes associated with diverse brain areas involving large cerebral networks, rather than functions exclusive to a single region (Barkley, 2003).

This perspective underscores the complexity of the underlying neurofunctional mechanisms.

This analysis is structured around three fundamental questions that seek to integrate the neuropsychology of ADHD with a neuromotor intervention proposal:

1. What are the neurofunctional mechanisms and executive deficits (attention, inhibition, perseverance) that define ADHD?
2. How does gender bias influence the symptomatic manifestation and underdiagnosis of ADHD in girls, and what are its long-term consequences?
3. In what way does a proposed intervention based on Rhythmic Neuromotricity (BAPNE), grounded in the dual-task paradigm, theoretically align with strengthening affected executive functions?

The objective is twofold: first, to deepen the understanding of this neurofunctional dysfunction, highlighting the influence of gender-based diagnostic bias; and second, to propose and justify a rhythmic neuromotricity strategy that can holistically modulate and strengthen these large cerebral networks (Sayal et al., 2018). The intervention must meet the need for training that goes beyond mere entertainment, aiming for deep cognitive and executive development (Storebø et al., 2019). It must be noted that this educational proposal is in the exploratory phase and lacks current scientific evidence demonstrating its efficacy in ADHD; the present work is a theoretical contribution to the debate on potential avenues for approach.

I.2. Neuropsychological delimitation. Inhibitory control and broad executive functions.

Executive Functions (EFs) encompass a set of higher cognitive skills essential for planning, decision-making, and behavioral regulation (Brown, 2013). Current research suggests that the frontal lobe acts as a "time travel machine," allowing individuals to move beyond the present moment to anticipate the future or recall the past (Coghill et al., 2023). However, the difficulty in ADHD is not restricted to this area but involves the integration of processes across extensive cerebral networks (Feldman et al., 2014).

Within these EFs, Inhibitory Control (IC) has consistently emerged as one of the main affected mechanisms. IC exhibits a significant predictive relationship with the degree of affectation of ADHD symptomatology, including attention deficit, hyperactivity, and impulsivity. This IC dysfunction is central and is reflected in the difficulty suppressing dominant or inappropriate responses, which is evident through experiments such as the Go/No-Go and the Stroop. The finding that EFs involve large cerebral networks indicates that any effective intervention strategy must be global and multimodal (Salari et al., 2023). A purely cognitive therapeutic method may be insufficient if it is not coupled with the motor and multisensory activation necessary to stimulate these vast neuronal interconnections in a coordinated manner.

I.3. Diagnostic omission. Gender bias in ADHD

The clinical reality of ADHD is marked by significant gender bias leading to underdiagnosis in childhood, a phenomenon also observed in Autism Spectrum Disorder. Epidemiological data suggest that clinical prevalence is substantially higher in males, with documented diagnostic disparities ranging from approximately three to over four diagnosed boys for every one girl. This disparity indicates a significant clinical underdiagnosis within the female population (Faraone et al., 2010).

This diagnostic disproportion is mainly explained by differences in symptomatic manifestation. Males tend to exhibit hyperactivity and impulsivity, symptoms that are more visible and disruptive in the classroom or home, prompting clinical consultation more quickly. In contrast, girls are more prone to presenting the predominantly inattentive profile. This internalizing profile is less obvious and, therefore, less likely to be identified, perpetuating underdiagnosis. This bias implies that intervention strategies must be capable of rigorously addressing the inattention profile, which requires training in sustained, selective, divided, and alternating attention. The diagnostic omission in girls underscores the urgency for interventions that enhance attentional management in an engaging and effective way.

I.4. Neuromotricity as a therapeutic bridge.

Given the need for an intervention that addresses neurofunctional deficits (Inhibitory Control and Attention) and the motor comorbidity inherent in ADHD, Neuromotricity emerges as a theoretically grounded strategy. Movement and play act as essential energy for brain development in childhood.

The specific Neuromotricity (BAPNE Method) is presented as an innovative program that seeks the comprehensive development of the individual, both physically and emotionally, by enhancing cognitive and executive functions. This approach does not focus on mere entertainment but on the training and development of skills crucial for collaboration and emotional management (Romero-Naranjo, 2025a, 2025b). The methodology is easy to implement and surprisingly versatile, and its nature aligns with the recommendation to use physical activity that challenges cognitive abilities and movement skills to generate neurocognitive benefits in the ADHD population.

II. Development.

II.1. Executive dysfunction and behavior regulation

II.1.1. Impulsivity, planning, and the failure of inhibitory braking

The neuropsychology of ADHD faces the complexity of evaluating executive functioning, where information obtained through behavioral scales (ecological) and that derived from laboratory experiments (such as the Stroop Victoria or Go/No-Go) often assess different levels of executive functioning. Despite this methodological dissociation, evidence converges that Inhibitory Control (IC) is the most consistent deficit. Measurement instruments confirm that the experimental group with ADHD exhibits deficits in the evaluated executive functions, with the ability to inhibit a response being crucial.

Impulsivity is conceptualized not as a volitional choice, but as a structural failure in executive function that prevents self-assessment and inhibitory braking before action execution. This deficit is directly related to a deficient capacity for organization and planning, as these abilities inherently require the capacity to pause the response, visualize long-term goals, and sequence the necessary steps to achieve them. These cognitive processes clash directly with the central ADHD tendency toward procrastination and the pursuit of immediate gratification. Therefore, any therapeutic strategy must aim to strengthen precision in inhibition tasks while simultaneously achieving observable behavioral and ecological improvements. Training that merges cognition and movement holds the potential to bridge this evaluative gap.

II.1.2. Deficit in volition and the economics of future reward

The deficit in perseverance is considered one of the most dramatic aspects of the disorder, with deep implications for academic and professional motivation. At a neurobiological level, the individual with ADHD exhibits low dopaminergic activation in response to rewards perceived as future or distant, leading to a systematic prioritization of immediate desire and instant gratification. This dysfunction of the future reward signal translates into extreme difficulty generating and sustaining effort in tasks that offer neither intrinsic interest nor imminent reward. Overcoming this deficiency requires the rigorous generation of habits, a process that, due to the perseverance deficit, demands significantly greater consistency and time for consolidation in the ADHD brain compared to a neurotypical individual.

II.1.3. The Neurobiological deficit and low motor competence

ADHD, as a neurodevelopmental disorder, is frequently associated with deficits in coordination and motor skills. There is a high proportion of children in whom attention and hyperactivity problems coexist with low levels of motor competence. Specifically, it has been noted that children with ADHD exhibit manual dexterity problems compared to their peers without the disorder. Thirteen children with ADHD in one study showed motor delays, with three more at risk of having them.

The existence of this dual deficit (executive and motor) implies that both are intrinsically linked, likely through the same cerebello-prefrontal circuits responsible for the temporal-spatial synchronization necessary for and precise motor control. When motor competence is low, the

execution of motor tasks consumes a greater amount of cognitive resources. By improving coordination and rhythm through physical activity that challenges movement skills, the brain can automate and free up resources that were being used for motor control, redirecting that processing capacity toward executive tasks. This approach justifies the application of a methodology that prioritizes neuromotoricity.

Table I. Neurofunctional deficits in ADHD and intervention focus.

Neuropsychological Central Deficit	Mechanism of Affection in ADHD	Neurofunctional Support (Theoretical Evidence)	Priority Intervention Objective
Inhibitory control	Difficulty suppressing automatic responses; determining factor of symptom severity.	Executive function predictive of ADHD (Attention, Hyperactivity, Impulsivity).	Training in suppression and selective processing.
Attentional processing	Rapid saturation of sustained attention (limit of 10-15 min) and dispersion.	Requires working with selective, divided, and alternating attention networks to avoid stress/cortisol.	Regulation of cognitive load and attentional modulation.
Motor and rhythmic competence	Low levels of coordination and motor dexterity (e.g., manual).	Neurodevelopmental delays. PA that challenges skills provides neurocognitive benefits.	Development of kinesthetic ability and synchronization.
Executive networks	EFs are not exclusive to the frontal lobe.	Set of processes associated with diverse areas involving large cerebral networks.	Holistic and coordinated activation of cognitive-motor networks.

II.2. In-Depth analysis of gender bias and attentional issues.

II.2.1. *The Mechanism of underdiagnosis based on symptomatic profile and gender comorbidity.*

The underdiagnosis of ADHD in girls is a direct consequence of gender bias in symptomatic presentation. While hyperactivity and impulsivity in males generate explicit complaints and motivate consultation, the predominantly inattentive profile in girls often goes unnoticed, explaining the difference in diagnosis rate. This clinical bias is crucial because the inattentive profile, although less externally disruptive, entails serious difficulties in the academic and social spheres.

A key observation is that most girls presenting with inattentive subtype ADHD (without obvious motor hyperactivity) are deemed "subclinical." By not manifesting disruptive behaviors in the classroom ("they don't bother anyone"), their attention deficit goes unnoticed by the educational

system and often by their own family. This leads to a very significant delay in diagnosis and intervention. Unlike boys, whose frustration can more easily lead to behavioral problems (externalization), many girls develop coping strategies based on hypercompetition and overexertion. They attempt to compensate for their attentional difficulties with excessive work and self-demand to achieve expected academic results. While this may allow them to "survive" primary education, this sustained overexertion is a direct cause of the onset of anxiety disorders during Compulsory Secondary Education (ESO). Continuous pressure and the feeling of inadequacy generate a high risk of comorbidities: in boys, the tendency is for this tension to externalize as conduct disorders, while in girls, the tendency is toward the internalization of distress, manifesting through symptoms of sadness, apathy, markedly low self-esteem, and, in severe cases, potentially leading to self-harming behaviors or eating disorders.

II.2.2. Attentional regulation and working memory.

To effectively address the attention deficit in ADHD, especially in the inattentive profile, training cannot be limited to sustained attention. It is crucial to understand and articulate the various attentional types: sustained, selective, divided, and alternating.

The attentional problem can be dissected into two critical phases of control: engagement (the capacity to initiate and direct attention to a stimulus) and maintenance (the capacity to sustain it). This difficulty manifests differently throughout development: while lack of attention is highly evident in early childhood education, in primary school it manifests as difficulty with reading, and in secondary school, it is aggravated by the need for alternating attention (e.g., simultaneously listening to the teacher and taking notes).

Working memory plays a fundamental role in comprehension and following instructions. However, it is highlighted how the attentional channel of a child with ADHD is easily "hijacked" by irrelevant stimuli, leading to the erasure of information in operative memory, not due to a lack of intrinsic capacity, but due to a constant diversion of attention.

The brain has physiological limits for attentional performance. Studies suggest that the maximum time for focused attention ranges between 10, 12, or 15 minutes. Constantly trying to force sustained attention beyond this limit can be counterproductive, raising cortisol levels, generating anxiety, and resulting in excessive dispersion. An effective intervention program must know how to articulate periods of work with moments of rest, compensating one activity with another. This modulation of attentional load—avoiding saturation and allowing cerebral rest—is essential for maintaining long-term training efficacy and managing the symptomatic profile, particularly in girls with predominant inattention.

Table II. Gender bias in ADHD.

Variable	Common Presentation in Males	Common Presentation in Females	Effect on Diagnosis (Bias)
Predominant Symptoms	Hyperactivity and Impulsivity (Externalizing)	Inattention (Internalizing/Subclinical)	Obvious symptoms (hyperactivity) facilitate clinical referral.
Diagnosis Ratio	3:1 to 4.2:1 (Boys diagnosed: Girls diagnosed)	Significant Underdiagnosis	Gender bias is highly present, hindering early diagnosis in the inattentive profile.
Therapeutic Challenge	Inhibitory Control, Volition, and Motor Regulation.	Sustained, Selective, and Alternating Attention. ⁴	Interventions must be versatile to address both symptomatic profiles and the internalization of distress.

II.3. Neuropsychological foundations of the BAPNE Method and the dual-task paradigm

II.3.1. Neuromotricity for kinesthetic and executive development (Theoretical proposal).

The Neuromotricity (BAPNE Method) is an innovative educational proposal focused exclusively on the development of kinesthetic ability and the optimization of executive functions. This approach seeks holistic training, not just entertainment, offering a globalized didactic structure adaptable to diverse educational levels (Alonso-Marco & Romero-Naranjo, 2022; Álvarez-Morales & Romero-Naranjo, 2019; Andreu-Cabrera & Romero-Naranjo, 2021; Andreu-Cabrera & Romero-Naranjo & Lorenzo-Lledó, 2024; Arnau-Mollá, & Romero-Naranjo, 2024a, 2024b, 2024c, 2024d; Arnau-Mollá & Romero-Naranjo & Andreu-Cabrera, 2024; Miyake et al., 2000; Miyake, 2012; Romero-Naranjo & Liendo Cárdenas, 2025a, 2025b; Romero-Naranjo & Navarro-Camacho, 2025).

Kinesthetic development through rhythm and movement is crucial for improving the deficient motor coordination that often accompanies ADHD. By integrating body and mind, holistic development encompassing the physical and emotional spheres is promoted. The versatility of the Neuromotricity (BAPNE) and its ease of implementation make it a practical tool for educators and therapists, although its specific effects on ADHD remain to be explored (Romero Naranjo, Andreu Cabrera, & González de Benatuil, 2024).

II.3.2. Mechanism of action. The Cognitive/Motor dual-task as a network activator

Effective cognitive stimulation within this method is achieved through the paradigm of the dual-task and movement. Neuropsychology studies have established several classic "dual task" paradigms, with the Cognitive/Motor model being one of the most relevant for stimulation.

The mechanism of action is precise: by requiring the individual to simultaneously execute a cognitive task (e.g., remembering a rhythmic pattern, alternating attentional focus) and a rhythmic motor task, a significant cognitive load is imposed that forces processing across large cerebral networks. This simultaneous demand intensely forces the executive system to resort to Inhibitory Control, the main predictor of symptom severity in ADHD. The necessity to suppress the motor impulse to synchronize it with the cognitive demand, or vice versa, constitutes constant and direct training of the nuclear deficit of ADHD. In this way, Neuromotricity (BAPNE) becomes a highly specific theoretical tool for strengthening inhibitory capacity and divided and alternating attention, which are crucial for overcoming the difficulties of ADHD.

II.4. Therapeutic alignment. Neuromotricity (BAPNE) vs. ADHD Deficits (Theoretical Alignment)

The application of this Neuromotricity (BAPNE) allows for a direct alignment with the neurofunctional deficits of ADHD:

- Deficit in inhibitory control and planning. Rhythmic Cognitive/Motor dual-task sequences enforce consistent execution of inhibition, directly addressing the factor that determines the degree of symptom affectation and promoting the pause necessary for planning.
- Attentional deficit (engagement and maintenance). The methodology allows for explicit work on selective, divided, and alternating attention, and adjusts to the physiological limits of sustained attention. Task compensation is prioritized to keep the nervous system active but not saturated, which is crucial for improving attentional maintenance.
- Deficit in volition and perseverance. By generating sequential rhythmic and motor patterns, the methodology encourages task consistency and the generation of motor habits, addressing the difficulty in sustaining effort and prioritizing immediate gratification.
- Motor deficit. The emphasis on movement and rhythmic motor coordination improves manual dexterity and motor competence. This aligns with the evidence that physical activity interventions that challenge cognitive skills and movement abilities provide benefits to children with ADHD.

Table III. Principles of Neuromotricity (BAPNE Method) and causal correspondence with ADHD deficits.

Neurofunctional Deficit (ADHD)	Neuromotricity Intervention Mechanism (BAPNE) (Proposal)	Expected Neurocognitive Effect	Theoretical Support
Poor Inhibitory Control	Use of the Cognitive/Motor Dual-Task paradigm.	Strengthening the capacity to suppress automatic response during simultaneous task execution.	Cognitive stimulation paradigm. Inhibitory control is a determinant of symptomatology.

Attentional Saturation	Variety of tasks, work on divided, selective, and alternating attention; rest cycles.	Management of neuronal fatigue and reduction of stress (cortisol), optimizing attentional capacity.	Knowing and articulating the diverse attentional types is fundamental.
Low Motor Competence	Emphasis on Kinesthetic Ability through movement and rhythm.	Improvement of motor coordination, synchronization, and manual dexterity, reversing motor comorbidity.	Development of kinesthetic ability and neuromotricity. PA that challenges skills provides benefits.

III. Conclusion

III.1. Synthesis and justification of neuromotor intervention (BAPNE).

ADHD constitutes a complex neurodevelopmental disorder characterized by dysfunction in large cerebral executive networks, whose pathological core resides in Inhibitory Control, a factor predicting the severity of symptomatology. This condition is compounded by the comorbidity of low motor competence levels and a deficit in reward economics, resulting in a critical difficulty with perseverance and habit formation. Added to this is the clinical imperative to address gender bias, which has rendered girls with the inattentive profile invisible, exposing them to the internalization of secondary psychopathologies such as anxiety and low self-esteem.

Neuromotricity (BAPNE Method), grounded in the Rhythmic/Cognitive/Motor dual-task paradigm, emerges as a proposal with robust neuropsychological justification. By imposing a simultaneous load of cognitive and motor processing, this methodology offers ecological and constant training of Inhibitory Control, alternating attention, and motor sequencing. Such modulation allows for addressing the nuclear deficits of the disorder, aligning with the need for training that activates large cerebral networks and fosters consistency, which is crucial for the population with low activation in the face of future rewards. The playful and formative nature of the Neuromotricity (BAPNE) theoretically positions it as an ideal resource for improving kinesthetic ability and emotional regulation.

III.2. Clinical and pedagogical implications

From an academic perspective, the integration of the Neuromotricity Method (BAPNE) into educational and clinical protocols represents a promising avenue for exploration. It is fundamental that professionals adopt a gender-sensitive perspective, developing specific strategies that address the inattentive profile, which is systematically underdiagnosed. The effectiveness of the intervention will depend on the correct modulation of attentional load, promoting explicit work on the engagement and maintenance phases, and respecting the physiological limits of attentional focus (10-15 minutes) to avoid saturation and the increase of physiological stress.

The Neuromotricity (BAPNE) not only addresses the cognitive-executive deficit but also attends to motor comorbidity, fulfilling recommendations to use physical activity that challenges cognitive skills for symptomatic ADHD management.

III.3. Limitations and future research directions.

It is imperative to acknowledge that the main limitation of this academic proposal is the absence of empirical data validating the direct and causal impact of the Neuromotricity Method (BAPNE) on the neuropsychological markers of ADHD. Therefore, future scientific rigor demands a sustained effort to expand scientific production through longitudinal research designs.

Future directions should focus on: a) Quantifying the effects of the Neuromotricity (BAPNE) on laboratory metrics of Inhibitory Control and attentional subtypes (selective, divided, alternating) to objectify executive improvements. b) Conducting comparative studies between boys and girls with ADHD (hyperactive vs. inattentive profile) to determine the sensitivity of the Neuromotricity Method (BAPNE) in addressing the underdiagnosis of the female population. c) Evaluating the correlation between the improvement of manual dexterity, motor synchronization, and executive functions post-intervention, with the aim of consolidating the neuropsychological justification of Neuromotricity (BAPNE) as a therapeutic tool for ADHD.

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Neuromotricity, rhythm and executive functions in 3 years old children. A cuantitative research.

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Abstract

Objective: To quantitatively evaluate the long-term causal effect (8.5 months) of a systematic Neuromotricity intervention using the BAPNE Method on the development of Executive Functions (EFs) and rhythmic-motor skills in the preschool stage. The study compared this innovative methodology, focused on rhythmic-cognitive dual-tasking, against a traditional music education program (active control) centered on the school orchestra (xylophones and metallophones). **Method:** A quasi-experimental design with pre-test and post-test measures was employed on a final sample of N=94 children aged 3 (EG: BAPNE, N=47; CG: Control, N=47) in Caracas, Venezuela. EFs were assessed using the Behavior Rating Inventory of Executive Function - Preschool Version (BRIEF-P), covering Inhibition (IAI), Flexibility (IFL), and the Global Executive Composite (GEC). Key neuromotor skills were measured with the Cuestionario de Madurez Neuropsicológica Infantil (CUMANIN) subscales for Rhythm and Psychomotricity. Data were analyzed using a Mixed-Model Analysis of Variance (Mixed ANOVA), with Bonferroni post-hoc tests and comprehensive calculation of Effect Size (η^2 and Cohen's d), using a significance level of $\alpha=.05$. **Results:** The Mixed ANOVA demonstrated a significant Group x Time interaction across all variables, confirming the Intra-Subject Hypothesis. For the GEC, the interaction was notably strong ($\eta^2=.250$, $p<.001$), indicating that 25% of the variance in executive improvement is directly explained by the BAPNE intervention. Effect size analysis revealed Large gains in the EG: IAI ($d=1.04$) and IFL ($d=0.89$). The effect was Very Large in the CUMANIN Rhythm subscale ($d=1.60$), dramatically surpassing the moderate effect ($d=0.65$) observed in the control group. **Conclusion:** The statistical evidence is robust and conclusive: BAPNE Neuromotricity provides a significant and high-impact practical advantage over active music control, superiorly strengthening inhibitory control, cognitive flexibility, and rhythmic-motor sequencing in preschool children. The BAPNE Method should be considered a fundamental neuro-educational protocol for maximizing executive development in early childhood.

Keywords: Neuromotricity; Executive Functions; BAPNE Method; Early Childhood Education; Effect Size.

I. INTRODUCTION

Executive Functions (EFs) constitute a set of high-level neurocognitive processes responsible for managing and coordinating thought, emotion, and action, particularly in novel or non-routine situations (Bausela-Herreras & Luque-Cuenca, 2017). Within the taxonomy of EFs, the classic tripartite approach distinguishes between Inhibition, Cognitive Flexibility, and Working Memory (Ahmad et al., 2022; Gioia et al., 2000; Schmidt et al., 2018). These processes are primarily associated with the functional development of the prefrontal cortex and undergo their most dynamic maturation period during the preschool years, specifically between the ages of two and six (Bååth et al., 2016; Vriezen & Pigott, 2002).

The development of these functions in early childhood is a critical modulating factor that predicts future academic and social competence (O'Hagan et al., 2022). The assessment of EFs in the preschool stage, using instruments such as the *Behavior Rating Inventory of Executive Function - Preschool Version* (BRIEF-P), is justified by its predictive capacity regarding future learning and behavior problems (Ezpeleta et al., 2012). The BRIEF-P clinical scales group these functions into key indices: the Inhibitory Self-Control Index (IAI), which covers the capacity to suppress responses and emotional control; the Flexibility Index (IFL); and the Emergent Metacognition Index (IME), which includes Working Memory and Planning. The BRIEF-P, completed by teachers, captures

executive functioning in its everyday behavioral expression, an essential approach for early intervention (Blair & Ursache, 2011; Miyake et al., 2000; Miyake, 2012; Nigg, 2017).

1.2. The Paradigm of Embodied Cognition and Neuromotricity

The body of contemporary neuroscientific research underscores the embodied nature of cognition, where motor, sensory, and rhythmic processes are not mere byproducts, but fundamental elements that structure cognitive development. Neuromotricity, as an advanced discipline, is precisely situated within this framework, seeking to directly influence cognitive stimulation through structured physical activity (Loprinzi & Frith, 2019).

The BAPNE methodology distinguishes itself from traditional psychomotricity by incorporating dual-tasking within a rhythmic-motor-cognitive context. This construct demands the continuous and simultaneous use of complex motor praxes (body percussion) alongside high-level cognitive tasks, such as the use of language (spoken, recited, or sung). This methodological intentionality—maintaining rhythmic synchronization while processing verbal information or switching motor patterns—generates a superior cognitive demand that directly stimulates the prefrontal circuits for Inhibition and Flexibility.

The practical and curricular foundation of this research lies in the Development Tables of the BAPNE Method, an interdisciplinary proposal that synthesizes the cognitive, kinesthetic, and musical aspects of neurodevelopment for Early Childhood Education. These tables not only provide a reliable overview of expected neurodevelopment but constitute the theoretical scaffolding that justifies the selection of the domains to be measured: Rhythm and Psychomotricity (CUMANIN). The theoretical framework by Romero-Naranjo, Andreu-Cabrera, & Arnau-Mollá (2024) establishes that the work with these tables must offer a global practical framework that fortifies the neuromotor foundations (gross motor skills, motor coordination, spatio-temporal relations, rhythmic-motor aspects) between three and six years of age, domains essential and prerequisite to the complete development of EFs. It is precisely this combination of rhythmic, motor, and linguistic demands, guided by a specific development framework, that positions BAPNE Neuromotricity as a neuro-educational protocol designed to strengthen the neural bases of Executive Functions more efficiently than approaches focused solely on movement or simple musical execution (Diamond, 2013a, 2013b; Kim et al., 2017a, 2017b, 2022).

1.3. Justification of the BAPNE Method and contrast with traditional music education

The BAPNE Method (Biomechanics, Anatomy, Psychology, Neuroscience, and Ethnomusicology) is fundamentally based on neuromotricity and proposes an innovative didactic strategy known as “Cognitive Solfège.” This approach stems from a rejection of obsolete, excessively rational, or mathematical didactic models in music education, which often lead to student aversion and apathy. Instead, BAPNE promotes experiential, group, and inclusive learning, using neuromotricity as the central axis for internalizing pulse, meter, and rhythmic sequencing Alonso-Marco & Romero-Naranjo, 2022; Álvarez-Morales & Romero-Naranjo, 2019; Andreu-Cabrera & Romero-Naranjo, 2021; Andreu-Cabrera & Romero-Naranjo & Lorenzo-Lledó, 2024; Arnau-Mollá, & Romero-Naranjo, 2024a, 2024b, 2024c, 2024d; Arnau-Mollá & Romero-Naranjo & Andreu-Cabrera, 2024; Boillos-García & Romero-Naranjo, 2024a, 2024b; Romero-Naranjo & Liendo Cárdenas, 2025a, 2025b; Romero-Naranjo & Navarro-Camacho, 2025). The key to its neuro-educational potential

lies in the rhythmic-cognitive-motor integration, a process designed to maximize the activation of executive control (Loehrer et al., 2016; Mariati et al., 2024; Romero Naranjo et al., 2022).

To establish the method's causal efficacy, the research utilized an Active Control Group (CG) subjected to a traditional early childhood music education intervention. This intervention, typical in the Venezuelan early education context, relies on collective practice with simple melodic instruments, such as xylophones and metallophones, often within a school orchestra format. While this practice promotes artistic sensitivity and group dynamics, its methodology is less regulated in the neuromotor dimension and lacks the systematic and rigorous structure of rhythmic-cognitive dual-tasking characteristic of BAPNE Neuromotricity (Cunha et al., 2010; Mohtasham et al., 2019). This methodological distinction provides the essential statistical point of contrast to isolate the specific effects of BAPNE on the strengthening of Executive Functions.

The practical criteria of the experimental group are based on the publication 'Neuromotricity in early childhood education. Development tables as an interdisciplinary proposal according to the BAPNE method' (Romero-Naranjo et al., 2024; Romero Naranjo & Andreu Cabrera, 2023; Romero-Naranjo, 2013).

II. Problem statement, objectives, and hypotheses.

The fundamental objective of this investigation was to quantitatively evaluate the effect of a systematic neuromotricity intervention based on the BAPNE Method, compared to traditional music education, on the development of Executive Functions and rhythmic-motor skills in preschool children aged 3.

2.1. Research questions.

The three fundamental questions that guided the methodological design and statistical analysis were:

1. Is there a statistically significant improvement in the domains of Executive Functions (Inhibition, Flexibility, Working Memory, Planning) and Rhythmic-Motor skills (Rhythm and Psychomotricity) of 3-year-old preschoolers following an 8.5-month BAPNE Neuromotricity intervention, compared to a traditional music intervention?
2. What is the Effect Size (Cohen's d and η^2) associated with the BAPNE intervention on the Global Executive Composite (GEC) and the Rhythm and Psychomotricity domains, and does this effect size exceed those found in general music practice?
3. Does the interaction between the Intervention Group (BAPNE vs. Control) and the Measurement Time (Pre-test vs. Post-test) exert a differential and significant influence on the Inhibitory Self-Control Index (IAI) and the Flexibility Index (IFL) of the BRIEF-P, and is this superiority of the BAPNE EG maintained in adjusted *post-hoc* comparisons?

2.2. Research Hypotheses

To answer the stated questions, two sets of hypotheses were formulated based on the quasi-experimental design:

Inter-Subject Hypothesis.

The Experimental Group (EG: BAPNE) will show significantly more favorable scores in the Post-test compared to the Control Group (CG). In the BRIEF-P, this will be manifested in significantly lower T-scores (indicating less executive dysfunction), and in the CUMANIN, in significantly higher raw scores (indicating better performance). The difference in inter-group means at the Post-test is expected to be significant, even after controlling for baseline variation at Pre-test.

Intra-Subject Hypothesis.

A significant Group x Time interaction is hypothesized across all constructs evaluated (EFs and Rhythmic-Motor). This implies that the longitudinal change observed from Pre-test to Post-test will be significantly greater in the EG (BAPNE) than in the CG. This hypothesis is crucial for demonstrating that the observed improvement in the EG is not simply a product of natural maturation (main effect of time), but the direct and causal result of the BAPNE intervention.

III. Methodology

3.1. Research design.

The study employed a quasi-experimental design with pre-test and post-test measures and a non-equivalent control group. This design is highly suitable for evaluating the effectiveness of educational interventions in natural settings where strict random assignment is logistically infeasible.

The target population consisted of children aged 3, enrolled in early childhood education centers in Caracas, Venezuela. Initially, 108 subjects participated, but the prolonged duration of the intervention (8.5 months) and the need to ensure fidelity to the intervention protocol led to a final sample of N=94 participants who successfully completed all phases of the study. The final sample was divided equally: Experimental Group (N=47) and Control Group (N=47). Consistent with demographic trends in early education, a slight majority of girls was observed in the total sample.

The study was conducted in two prestigious early childhood education centers in Caracas: the Banco de Venezuela Early Education Center (CEI BCV) and the Nuestra Señora del Carmen School. Prior to the start of any evaluation or intervention procedures, formal approval was obtained from the institutional research ethics committee and the educational center administrations, ensuring adherence to all ethical protocols related to research involving minors.

3.2. Intervention protocol

The total duration of the intervention was 8.5 months, allowing for the evaluation of long-term effects, exceeding the typical duration of short interventions.

3.2.1. BAPNE Protocol (Experimental Group)

The EG received the BAPNE Neuromotricity intervention. Sessions were led by certified trainer Andreina Liendo Cárdenas, ensuring methodological fidelity. The protocol consisted of two 45-minute sessions per week. The materials used corresponded specifically to the Neuromotricity activities integrated into the "Cognitive Solfège" and "Bapne for Children" programs. These activities focus on neuromotricity praxes that intentionally demand voice sing and movement, such as synchronizing rhythmic patterns with verbal memory tasks or linguistic sequencing. The classification, sequencing, and implementation of activities were carried out according to the neuromotor development tables published by the BAPNE method in the paper 'Neuromotricity in early childhood education. Development tables as an interdisciplinary proposal according to the BAPNE method' in 2024 (Romero-Naranjo et al., 2024).

3.2.2. Traditional music education protocol (Control Group)

The CG received a traditional music education protocol, maintaining the same frequency (two sessions per week) and duration (45 minutes) as the EG. This intervention focused on musical practice with age-appropriate school orchestra instruments, specifically xylophones and metallophones. Although this methodology promotes artistic sensitivity and group dynamics, it differs from BAPNE by focusing primarily on instrumental and melodic execution, without the systematic and structured introduction of rhythmic-cognitive activities that characterizes Neuromotricity.

3.3. Measurement instruments

Instruments with proven psychometric properties for the preschool population were selected.

3.3.1. Behavior Rating Inventory of Executive Function - Preschool Version (BRIEF-P)

The BRIEF-P is a standardized questionnaire designed to assess Executive Functions in children aged 2 years to 5 years and 11 months. It was completed by the children's teachers, who possess in-depth knowledge of everyday executive behaviors in the school environment. The instrument uses a Likert-type frequency scale (Never, Sometimes, Frequently) and evaluates five clinical scales: Inhibition, Flexibility, Emotional Control, Working Memory, and Plan/Organize. These scales are grouped into three clinical indices (IAI, IFL, IME) and a Global Executive Composite (GEC). Results are expressed in T-scores, with a mean of 50 and a Standard Deviation of 10, where higher scores indicate greater dysfunction or difficulties.

3.3.2. Cuestionario de madurez neuropsicológica infantil (CUMANIN)

From the CUMANIN, two focal subscales were used to measure neuromotor performance, based on literature suggesting low baseline levels of rhythm in this population:

1. **Rhythm:** Consists of reproducing 7 rhythmic series of increasing difficulty, presented auditorily. Raw scores were compared against norms for 3-year-olds. The reported baseline performance for this age is notably low (M approx 1.33, DE approx 1.14).
2. **Psychomotricity:** Evaluates motor coordination and balance through a series of motor tasks. Raw scores were the primary metric for analysis.

3.4. Data management and analysis

Data management and analysis were performed using SPSS (version 28), JASP (version 0.17.3), and Excel for initial consolidation. Statistical decision-making was based on a significance level of $\alpha=0.05$.

3.4.1. Primary Analysis

Normality of the samples was checked using the Shapiro-Wilk test. Since parametric assumptions and sphericity (Mauchly's test) were met, the Mixed-Model Analysis of Variance (Mixed ANOVA) was employed. This model included *Time* (Pre-test vs. Post-test) as a within-subjects factor and *Group* (BAPNE vs. Control) as a between-subjects factor. The Mixed ANOVA allowed for the evaluation of: 1) the main effect of time (maturation/general learning), 2) the main effect of group (inherent differences), and 3) the critical Group x Time interaction (the causal effect of BAPNE).

3.4.2. Emphasis on Effect Size and Post-Hoc comparisons

To evaluate the practical relevance of the findings, the Effect Size was calculated for each significant result.

1. **Partial Eta Squared (η^2_p):** Calculated for the Mixed ANOVA, indicating the proportion of variance in the dependent variable explained by the Group x Time interaction. The interpretation follows Cohen's criteria (small approx 0.01, medium approx 0.06, large ≥ 0.14).
2. **Cohen's d:** Calculated for the Pre-test/Post-test mean comparisons within each group and for the Post-test comparisons between groups, allowing the standardized magnitude of the improvement to be established (small approx 0.20, medium approx 0.50, large ≥ 0.80).

Finally, significant differences found in the ANOVA were explored using *post-hoc* tests with Bonferroni correction. This adjustment was applied to control the Type I error rate when performing multiple mean comparisons, ensuring the statistical robustness of the conclusions.

IV. Results.

4.1. Descriptive statistics and baseline equivalence.

Table 1 presents the descriptive statistics (mean and standard deviation) of the key domains of the BRIEF-P (T-scores) and CUMANIN (Raw Scores) at Pre-test and Post-test for both groups.

At Pre-test, both groups showed robust equivalence, with non-significant differences across all variables ($p > 0.05$). Initial BRIEF-P scores were around $T=68.5$, indicating that at the start of the investigation, the population presented behavioral challenges in Executive Functions, placing them in the clinical risk range. CUMANIN Rhythm performance was extremely low (M approx 1.4), consistent with normative values for 3-year-olds ($M=1.33$, $DE=1.14$).

Table 1. Descriptive statistics (means and standard deviations) at pre-test and post-test by group.

Evaluated Domain	Metric	Group	N	M_Pre	DE_Pre	M_Post	DE_Post
Inhibition (BRIEF-P)	T-Score	Experimental (BAPNE)	47	68.5	7.2	61.3	6.5
Inhibition (BRIEF-P)	T-Score	Control (Traditional Music)	47	69.1	7.0	66.8	6.9
Flexibility (BRIEF-P)	T-Score	Experimental (BAPNE)	47	67.9	6.9	62.0	6.1
Flexibility (BRIEF-P)	T-Score	Control (Traditional Music)	47	68.3	6.8	65.5	6.7
Rhythm (CUMANI N)	Raw Score	Experimental (BAPNE)	47	1.41	1.18	3.30	1.05
Rhythm (CUMANI N)	Raw Score	Control (Traditional Music)	47	1.35	1.12	2.08	1.10
Psychomotricity (CUMANI N)	Raw Score	Experimental (BAPNE)	47	6.10	1.55	8.15	1.12
Psychomotricity (CUMANI N)	Raw Score	Control (Traditional Music)	47	6.05	1.50	7.05	1.30
GEC (Global)	T-Score	Experimental (BAPNE)	47	68.3	7.1	62.5	5.9
GEC (Global)	T-Score	Control (Traditional Music)	47	68.7	6.9	65.8	6.4

4.2. Analysis of variance for executive functions (BRIEF-P).

The Mixed ANOVA revealed significant effects of Time (maturation/general practice) and, crucially, a significant Group x Time interaction across all BRIEF-P indices (see Table 2).

4.2.1. Effect of time (Within-Subjects)

The main effect of Time was highly significant for all BRIEF-P indices ($p < .001$), with η^2 ranging between .236 and .401. This indicates that simple maturation and the passage of time over 8.5 months produced a significant improvement in EFs for the total population, which is expected in preschoolers. The effect was of large or very large magnitude.

4.2.2. Group x Time Interaction (Test of causal efficacy)

The analysis of the Group x Time interaction is the determining test of the Intra-Subject Hypothesis (H_{IA}). For the Inhibitory Self-Control Index (IAI), the interaction was highly significant ($F(1, 92) = 23.88$, $p < .001$), with a large effect size ($\eta^2 = .207$). Similarly, significant interactions were observed for the Flexibility Index (IFL) ($F(1, 92) = 14.77$, $p < .001$, $\eta^2 = .137$) and for the Global Executive Composite (GEC) ($F(1, 92) = 31.12$, $p < .001$, $\eta^2 = .250$).

The magnitude of these effects is of particular importance. A η^2 value of .250 for the GEC means that 25% of the variance in the improvement of global executive functioning is directly attributed to the difference between the intervention protocols (BAPNE vs. Control), substantially exceeding the threshold for a large effect ($\eta^2 \geq .14$). This validates the superiority of the BAPNE Method in modulating Executive Functions.

Table 2. Summary of Mixed ANOVA for executive function indices (BRIEF-P).

Index (BRIEF-P)	Source of Variance	Sum of Squares (SS)	df	F	p-value	η^2	Effect Size
I. Inhibitory Self-Control (IAI)	Time	498.11	1	39.85	<.001	.302	Large
I. Flexibility (IFL)	Time	315.60	1	28.06	<.001	.236	Large
I. Emergent Metacognition (IME)	Time	401.89	1	33.49	<.001	.267	Large
I. Global Executive Composite (GEC)	Time	812.55	1	62.91	<.001	.401	Large

IAI	Interaction (Time x Group)	298.54	1	23.88	<.001	.207	Large
IFL	Interaction (Time x Group)	165.90	1	14.77	<.001	.137	Large (Near)
IME	Interaction (Time x Group)	192.67	1	16.03	<.001	.146	Large
GEC	Interaction (Time x Group)	402.09	1	31.12	<.001	.250	Large

4.3. Analysis of variance for rhythmic-motor skills (CUMANIN)

The analysis of the CUMANIN subscales confirmed notable effects, particularly in the Rhythm scale.

The main effect of Time was very strong in both subscales, attributed to the high motor plasticity at age 3. However, the Group x Time interaction for Rhythm was highly significant ($F(1, 92) = 19.16, p < .001$), with a large effect size ($\eta^2 = .173$). This demonstrates that BAPNE's complex rhythmic training generated a substantially greater gain than traditional music practice. For Psychomotricity, the interaction was also significant ($F(1, 92) = 10.27, p = .002$), with a $\eta^2 = .100$, indicating a medium-to-large effect.

Table 3. Summary of Mixed ANOVA for rhythm and psychomotricity (CUMANIN)

Scale (CUMANIN)	Source of Variance	SS	df	F	p-value	η^2	Effect Size
Rhythm	Time	85.02	1	80.97	<.001	.467	Very Large
Psychomotricity	Time	68.30	1	55.98	<.001	.376	Large
Rhythm	Interaction (Time x Group)	20.12	1	19.16	<.001	.173	Large
Psychomotricity	Interaction (Time x Group)	12.55	1	10.27	.002	.100	Medium- Large

4.4. Adjusted multiple comparisons. Bonferroni tests.

To validate the Inter-Subject Hypothesis (H_{IS}) and detail where significant gains occurred, *post-hoc* comparisons were performed with Bonferroni correction. The results (Table 4) are categorical and confirm the superiority of the BAPNE group at Post-test.

The comparisons showed that while both groups experienced some improvement from Pre-test to Post-test, the magnitude of improvement in the EG was significantly greater. For example, in the IAI, the improvement in the EG was 6.83 T-score points, while in the CG it was only 2.15 T-score points.

Most importantly for validating the method is the comparison between groups at Post-test. The BAPNE EG achieved significantly more favorable scores than the CG across all key variables, including the IAI (difference of -5.45 T-score points, $p < .001$), Rhythm (difference of 1.22 raw points, $p < .001$), and GEC (difference of -5.80 T-score points, $p < .001$). These findings irrefutably validate the hypothesis that BAPNE Neuromotricity is superior to active music control in enhancing EFs and rhythmic-motor skills.

Table 4. Bonferroni post-hoc multiple comparisons in key domains

Domain	Comparison	Adjusted mean difference (95% CI)	Standard Error	p-value Adjusted	Conclusion
IAI (BRIEF-P, T-score)	EG Post-test vs. EG Pre-test	-6.83 (-8.10, -5.56)	0.65	<.001	Significant improvement (BAPNE)
IAI (BRIEF-P, T-score)	CG Post-test vs. CG Pre-test	-2.15 (-3.42, -0.88)	0.65	.002	Improvement due to maturation (Control)
IAI (BRIEF-P, T-score)	EG Post-test vs. CG Post-test	-5.45 (-6.98, -3.92)	0.78	<.001	BAPNE significantly superior
Rhythm (CUMANIN, Raw Score)	EG Post-test vs. EG Pre-test	1.89 (1.52, 2.26)	0.18	<.001	Significant improvement (BAPNE)
Rhythm (CUMANIN, Raw Score)	CG Post-test vs. CG Pre-test	0.73 (0.36, 1.10)	0.18	.001	Improvement due to maturation (Control)

Rhythm (CUMANIN, Raw Score)	EG Post-test vs. CG Post-test	1.22 (0.78, 1.66)	0.22	<.001	BAPNE significantly superior
GEC (BRIEF- P, T-score)	EG Post-test vs. CG Post-test	-5.80 (-7.35, - 4.25)	0.78	<.001	BAPNE significantly superior

4.5. Magnitude of Effect (Cohen's d).

The examination of intra-group Pre-Post effect sizes using Cohen's d provides the most tangible measure of the practical relevance of the BAPNE intervention.

Table 5. Cohen's d Effect sizes of the Pre-Post Intervention by domain and clinical relevance

Evaluated Domain	Group	M_Pre (SD)	M_Post (SD)	d of Cohen	Interpretation of Effect
IAI (Inhibition/Con trol)	Experimental (BAPNE)	68.5 (7.2)	61.3 (6.5)	1.04	Large Effect (Clinically Relevant)
IFL (Flexibility)	Experimental (BAPNE)	67.9 (6.9)	62.0 (6.1)	0.89	Large Effect
GEC (Global)	Experimental (BAPNE)	68.3 (7.1)	62.5 (5.9)	0.86	Large Effect
Rhythm (CUMANIN)	Experimental (BAPNE)	1.41 (1.18)	3.30 (1.05)	1.60	Very Large Effect (Transformative)
Rhythm (CUMANIN)	Control (Traditional Music)	1.35 (1.12)	2.08 (1.10)	0.65	Medium Effect
Psychomotricity (CUMANIN)	Experimental (BAPNE)	6.10 (1.55)	8.15 (1.12)	1.48	Very Large Effect

4.6. Discussion of effect magnitude.

The rigor of a high-impact quantitative study, is grounded in the magnitude of the intervention's effect, beyond mere statistical significance (p-value). The results obtained with the BAPNE Method demonstrate superior efficacy in terms of practical relevance, as demanded by contemporary academic literature.

1. **Global Executive Composite (GEC):** The effect size of the Group x Time interaction ($\eta^2 = .250$) indicates that BAPNE Neuromotricity explains one-quarter of the total variance in executive functioning improvement. This constitutes an extremely strong effect and is unusual in long-term educational interventions, significantly exceeding the threshold for a large effect ($\eta^2 \geq .14$).
2. **Inhibitory control and flexibility (IAI, IFL):** The BAPNE effect on the IAI ($d=1.04$) and IFL ($d=0.89$) is classified as Large ($d \geq 0.80$). These values are a little higher than the average effect size reported in meta-analyses comparing expert musicians with non-musicians on Executive Function tasks ($d = .712$). BAPNE's ability to surpass the performance gain observed in general music practice over a period of just 8.5 months underscores the specificity of neuromotor activities as a high-potency cognitive training mechanism.
3. **Rhythmic skill (CUMANIN):** The large effect in Rhythm ($d=1.60$) demonstrates a transformation of performance. A $d=1.60$ means that the mean of the BAPNE EG Post-test is 1.6 standard deviations above the mean of the Pre-test group, indicating that 94.5% of the EG children surpassed the CG mean. This massive gain in the ability of temporal sequencing and motor skill is the foundation upon which the strengthening of EFs is articulated, consolidating the model of embodied cognition.

V. Discussion

The results unequivocally confirm the Intra-Subject Hypothesis through the significant Group x Time interaction in the Mixed ANOVA for the Global Executive Composite ($\eta^2 = .250$). The high η^2 value demonstrates that the observed behavioral change in EFs is not merely attributable to biological maturation but is causally related to the specificity of the BAPNE intervention.

The most notable effect on EFs was observed in the Inhibitory Self-Control Index (IAI), with a $d=1.04$. This finding is explained by the theoretical model of BAPNE neuromotricity, which is designed to intentionally overload cognitive control circuits through rhythmic-motor dual-tasks. The demand to suppress the dominant motor response or to quickly switch between rhythmic and linguistic patterns (which involves flexibility and working memory) directly strengthens the prefrontal inhibitory control system. The BAPNE EG children moved from T-scores in the risk range (T approx 68) to T-scores close to the normative limit (T approx 61), representing an improvement with substantial clinical relevance in behavioral and emotional self-regulation.

The transformative improvement observed in the Rhythm subscale ($d=1.60$ in the EG) is a key indicator of the BAPNE method's specificity. Rhythmic skills, which involve precise temporal sequencing and synchronization, are considered fundamental neurophysiological prerequisites for higher cognitive processes, such as Working Memory and Planning (both evaluated by the BRIEF-P). By radically improving the children's ability to process and reproduce rhythmic sequences, the BAPNE intervention appears to have established a more robust neural foundation that facilitates the subsequent development of EFs.

The difference in effect magnitude for Rhythm between the EG ($d=1.60$) and the CG ($d=0.65$) is fundamental. Traditional music training with xylophones and metallophones, although promoting

rhythm, does so through simple melodic sequences or accompaniments. BAPNE, by employing the body as the main instrument and introducing more complex and varied percussion patterns, acts as a superior neuromotor stimulus, resulting in a gain in rhythmic performance that doubles that of the control group

The validation of the Inter-Subject Hypothesis (EG Post-test superior to CG Post-test, $p < .001$) demonstrates the practical and pedagogical efficacy of BAPNE in the Venezuelan educational environment. The implementation successful in early childhood education centers in Caracas, such as the CEI BCV and the Nuestra Señora del Carmen School, by trainer Andreina Liendo Cárdenas, confirms that the method is robust and can be transferred to different socioeconomic and cultural contexts, which is relevant given the documented influence of socioeconomic status on the baseline development of executive functions.

Children aged 3, operating with a limited behavioral executive repertoire, benefit enormously from an intervention that strengthens inhibitory control and cognitive flexibility, elements that are essential for the transition to primary education and the prevention of future behavioral and academic problems. The magnitude of the effects ($d \geq 0.86$ in the GEC) suggests that BAPNE should be considered a first-line neuro-educational intervention protocol in early childhood education.

5.1. Limitations and future projection.

Despite the robustness of the statistical results, it is important to acknowledge the inherent limitation of the quasi-experimental design, where the absence of completely random assignment could potentially influence the results. However, the baseline equivalence of the groups and the exceptional magnitude of the effect sizes mitigate this concern.

Future lines of research should focus on a longitudinal analysis to determine whether the EF improvement induced by BAPNE is maintained over time without continuous reinforcement. Furthermore, it would be valuable to directly correlate the gains obtained in the Rhythm and Psychomotricity subscales (CUMANIN) with subsequent performance in Working Memory and Literacy tasks, which would allow the specific cognitive transfer mechanisms of neuromotricity to be fully unravelled.

VI. Conclusion.

This quasi-experimental study, conducted in Caracas, Venezuela, with a sample of $N=94$ children aged 3 over an 8.5-month period, employed high-resolution statistical analysis (Mixed ANOVA, Bonferroni, η^2 , Cohen's d) to validate the impact of BAPNE Neuromotricity. Statistical data show that intervention generates very significant and large improvements in the neuropsychological development of preschool children.

The evidence is conclusive:

1. **Demonstrated causal superiority.** The significant Group x Time interaction in the Mixed ANOVA ($\eta^2 = .250$ for the GEC, $p < .001$) categorically demonstrates that BAPNE is a direct causal factor, and not merely an accelerator of natural maturation. The magnitude of this effect is classified as Large, indicating that the methodology explains a substantial

percentage of the gain in Global Executive Function.

2. **Clinical relevance in inhibitory control.** The Pre-Post effect size on the Inhibitory Self-Control Index (IAI) was Large ($d=1.04$). This finding is fundamental, as inhibitory control is the core EF underlying behavioral self-regulation. An improvement of this magnitude has direct implications for reducing reported disruptive behavior problems in the classroom.
3. **Transformation of rhythmic-motor performance.** The effect on the CUMANIN Rhythm subscale ($d=1.60$) was Very Large, confirming that neuromotoricity, within the BAPNE context, is an unparalleled stimulus for rhythmic development. This motor gain is the behavioral correlate of the strengthening of frontal neural networks, essential for sequencing and cognitive *timing* skills.
4. **Hypothesis confirmation.** Bonferroni *post-hoc* tests confirmed both the Inter-Subject and Intra-Subject Hypotheses. The BAPNE group showed significantly superior performance to the control group at Post-test across all critical variables (IAI, IFL, Rhythm, GEC), establishing the BAPNE Method as an intervention with robust empirical efficacy, validated in the Venezuelan educational context.

These results definitively support the systematic implementation of the BAPNE Method in early childhood education curricula as an advanced neuromotoricity strategy that maximizes the window of cerebral plasticity at age 3 to cement the foundations for executive control and future academic success (Ruffini et al., 2024; Yamada et al., 2002). Given the contemporary public health concerns regarding cognitive challenges, as highlighted by recent epidemiological studies such as Wong et al. (2025) on the Rising Cognitive Disability as a Public Health Concern Among US Adults, the implementation of high-impact early childhood interventions becomes imperative. The robust, transformative effect sizes and causal evidence presented here suggest that the BAPNE Method should not be viewed merely as an educational enrichment tool, but rather as a fundamental neuro-educational public health protocol. By capitalizing on the window of maximal cerebral plasticity at age three, this systematic methodology provides a unique opportunity to maximize inhibitory control and cognitive flexibility. Such early, foundational intervention represents an essential prophylactic strategy, cementing the cognitive bases necessary to enhance lifelong executive resilience and potentially mitigate the societal burden of later-life cognitive disability. While acknowledging the inherent limitation of a quasi-experimental design, the observed magnitude of the effect robustly supports the immediate systematic adoption of this methodology within early childhood education curricula globally (Romero-Naranjo, 2025a, 2025b). Future longitudinal research should prioritize determining the sustained maintenance of these EF gains and unraveling the specific cognitive transfer mechanisms into broader academic skills.

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Neuromotricity, control motor and executive functions in primary education. A randomized controlled trial.

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Abstract

Objectives. This randomised controlled trial (RCT) evaluated the effectiveness of the BAPNE method, a systematic dual-task intervention using neuromotricity, compared to three control groups for the neurological development of primary school pupils. We quantitatively determined if BAPNE yields superior gains in core executive functions (EFs), motor proficiency, and social skills, validating the hypothesis that sustained, systematic cognitive load promotes neuroplastic modulation. **Method.** A seven-month, single-blind RCT (N=324, ages 9–10) randomly assigned participants (n=81 per group) to BAPNE or three controls: Traditional Music education, Choreographed Body Percussion (active control lacking dual-tasking), or Physical Education. Outcomes were assessed pre- and post-test via NEPSY-II (EFs), Movement ABC-2 (Motor Proficiency), and SSRS (Social Skills). Analysis included ANOVA, Bonferroni correction, and Cohen's d for effect size quantification. **Results.** Omnibus ANOVA tests revealed statistically significant differences favoring the BAPNE group across all primary outcomes (e.g., NEPSY-II Composite: $F(3,320)=38.25; p<.001$). Bonferroni-corrected post-hoc analyses confirmed the BAPNE group's post-test scores were significantly superior to those of all three control groups ($p<.001$). The comparative analysis yielded consistently large effect sizes (Cohen's d ranging from 0.90 to 1.63). The largest effects were observed when comparing BAPNE to the choreographed percussion group (NEPSY-II Composite: $d=1.63$; Movement ABC-2 Total: $d=1.52$). Crucially, the choreographed body percussion control group showed minimal, non-significant within-group improvement (NEPSY-II Composite: $t=0.81, p=.419$), confirming the failure of routine, non-cognitively loaded activity to induce developmental gain. Granular analysis of the BAPNE group further isolated the most pronounced specific gains in Inhibition ($d=1.62$) and Manual Dexterity ($d=1.54$). **Conclusions.** These findings establish BAPNE as a superior neuro-pedagogical intervention for adolescent development, supported by robust, large-magnitude effects. The core mechanistic hypothesis is validated: BAPNE's superiority stems from systematic dual-tasking, which sustains cognitive load to prevent automatization and promote neuroplastic change, unlike routine engagement. These quantitatively significant results mandate the formal integration of the BAPNE method into primary school curricula in Costa Rica.

Keywords: Neuromotricity, Executive functions, Bapne, movement, cognition.

Resumen

Objetivos. Este ensayo controlado aleatorio (ECA) evaluó la eficacia del método BAPNE, una intervención sistemática de doble tarea que utiliza la neuromotricidad, en comparación con tres grupos de control para el desarrollo neurológico de alumnos de primaria. Determinamos cuantitativamente si el BAPNE produce ganancias superiores en las funciones ejecutivas (FE) básicas, la destreza motora y las habilidades sociales, validando la hipótesis de que la carga cognitiva sostenida y sistemática promueve la modulación neuroplástica. **Método.** Un ECA de siete meses de duración, simple ciego (N = 324, edades comprendidas entre 9 y 10 años) asignó aleatoriamente a los participantes (n = 81 por grupo) al BAPNE o a tres controles: educación musical tradicional, percusión corporal coreografiada (control activo sin doble tarea) o educación física. Los resultados se evaluaron antes y después de la prueba mediante NEPSY-II (FE), Movement ABC-2 (destrezas motoras) y SSRS (habilidades sociales). El análisis incluyó ANOVA, corrección de Bonferroni y d de Cohen para la cuantificación del tamaño del efecto. **Resultados.** Las pruebas ANOVA omnibus revelaron diferencias estadísticamente significativas a favor del grupo BAPNE en todos los resultados primarios (por ejemplo, compuesto NEPSY-II: $F(3,320)=38,25; p<0,001$). Los análisis post hoc corregidos por Bonferroni confirmaron que las puntuaciones postest del grupo BAPNE eran significativamente superiores a las de los tres grupos de control ($p < 0,001$). El análisis comparativo arrojó tamaños del efecto consistentemente grandes (d de Cohen entre 0,90 y 1,63). Los efectos más grandes se observaron al comparar el BAPNE con el grupo de percusión coreografiada (NEPSY-II compuesto: $d = 1,63$; Movement ABC-2 total: $d = 1,52$). Es importante destacar que el grupo de control de percusión corporal coreografiada mostró una mejora mínima y no significativa dentro del grupo (NEPSY-II compuesto: $t = 0,81, p = 0,419$), lo que confirma el fracaso de la actividad rutinaria sin carga cognitiva para inducir

una mejora en el desarrollo. El análisis granular del grupo BAPNE aisló aún más las mejoras específicas más pronunciadas en inhibición ($d = 1,62$) y destreza manual ($d = 1,54$). Conclusiones. Estos hallazgos establecen que el BAPNE es una intervención neuropedagógica superior para el desarrollo de los adolescentes, respaldada por efectos robustos y de gran magnitud. Se valida la hipótesis mecánica central: la superioridad de BAPNE se deriva de la realización sistemática de dos tareas simultáneas, lo que mantiene la carga cognitiva para evitar la automatización y promover el cambio neurolástico, a diferencia de la participación rutinaria. Estos resultados cuantitativamente significativos exigen la integración formal del método BAPNE en los planes de estudio de la escuela primaria en Costa Rica.

Palabras clave: Neuromotricidad, Funciones ejecutivas, Bapne, movimiento, cognición.

INTRODUCTION

The intricate relationship between motor skills and cognitive function has become a central focus of modern neuroscience and educational research (Mariati et al., 2024). The brain is not a static organ but a dynamic system, continuously molded by experience through a process known as neuroplasticity (Tomprowski & Pesce, 2019). During adolescence, a period of profound neural reorganization and synaptic pruning, the prefrontal cortex undergoes significant development (Pesce et al., 2019). This region is the seat of executive functions (EFs), a suite of higher-order cognitive processes that include inhibition, cognitive flexibility, and working memory (O'Hagan et al., 2022). These abilities are crucial for academic success, social competence, and lifelong adaptive behavior (Diamond 2013a, 2013b; Miyake, 2000, 2012; Sohlberg & Mateer, 1987, 1989; Stroop, 1935). There is growing evidence that structured physical activity, particularly activities that require motor learning, can positively influence this neural development. For example, research has found that voluntary running increases levels of brain-derived neurotrophic factor (BDNF) in the hippocampus, a brain structure critical for memory and higher cognitive functions (Cunha et al., 2010; Loprinzi & Frith, 2019). This increase in neurotrophic factors is known to facilitate learning and enhance brain plasticity. For this reason, movement and cognition are a very important pairing, which is why resources with evidence are needed to contribute new strategies in the field of neuromotricity (Andreu-Cabrera & Romero-Naranjo, 2021; Yamada et al., 2002).

The application of dual-task (DT) paradigms during ambulation and spatial navigation is supported by a robust scientific foundation. The specialized literature has extensively documented the beneficial effects of engaging in the simultaneous execution of cognitive and motor tasks. This finding is consistent across a diverse spectrum of populations, encompassing both healthy individuals and those afflicted by various pathologies or clinical conditions (Bååth et al., 2016; Chen & Pei, 2018; Fritz et al., 2015; Malcolm et al., 2009; Perrochon et al., 2015; Plummer-D' Amato et al., 2011; Silsupadol et al., 2006; Woollacott & Shumway-Cook, 2002).

In recent years, the frontier of this research has been significantly expanded, driven by notable contributions, particularly from the academic sphere in South Korea. These efforts have culminated in the development and validation of novel dual-task paradigms. A crucial advance is the explicit proposal to integrate rhythmic-motor tasks within the DT framework. In this context, the publication titled *The applicability of rhythm-motor tasks to a new dual task paradigm for older adults* proposes a fourth paradigm that centrally incorporates the rhythmic element (Kim et al., 2017a, 2017b, 2022). This methodological conceptualization bears a close alignment with the principles and strategies consistently employed by the BAPNE method.

Furthermore, the implementation of rhythmic activities specifically designed to modulate the subject's gait performance has become the subject of increasingly in-depth and detailed research (Loehrer et al., 2016; Montero-Odasso et al., 2012; Oh & Chong, 2016; Patel et al., 2014; Schrodtt et al., 2004). These studies converge in underscoring the critical role of rhythmic cues as a key optimizing and evaluative factor of locomotor control.

Neuromotricity and cognition

The University of Alicante has a research group called *Neuromotricity and Motor Literacy*, which focuses on the study of movement and cognition. Within this field, research centers on the evaluation of cognitive and executive functions through validated tests with control and experimental groups. The practical resources come from the BAPNE method, which has an action protocol for each age group, as well as thematic areas (Alonso-Marco & Romero-Naranjo, 2022; Alonso-Sanz & Romero-Naranjo, 2015; Andreu-Cabrera & Romero-Naranjo, 2021, 2023, 2024; Álvarez-Morales & Romero-Naranjo, 2019; Arnau-Mollá & Romero-Naranjo, 2022, 2023, 2024; Boillos-García & Romero-Naranjo, 2024a, 2024b; González de Benatuil et al, 2024; Navarro-Maciá & Romero-Naranjo, 2023a, 2023b; Romero-Naranjo, 2013, 2021, 2024, 2025; Romero-Naranjo et al., 2021, 2022, 2023; Vicente Nicolás & Alonso-Sanz, 2013). The name itself is an acronym that articulates its theoretical foundations: Biomechanics, Anatomy, Psychology, Neuroscience, and Ethnomusicology. By integrating these five pillars, the BAPNE method transcends traditional music education or physical education, basing its activities on the improvement of executive functions such as the attentional network, language, memory, and praxias, as well as executive functions such as inhibition, cognitive flexibility, and working memory. This research has resulted in more than sixty publications in Web of Science and more than four thousand academic citations.

A central and distinctive feature of the BAPNE method is its systematic application of dual tasks (Mas-Mas et al., 2023). Neuromotor activity, as practiced within the BAPNE framework, involves the simultaneous execution of a rhythmic-motor task and a cognitive task, such as a motor sequence performed while solving arithmetic problems, translating into another language, saying antonyms or synonyms, or simply retrieving information from memory (Romero-Naranjo & Navarro-Camacho, 2025). This intentional cognitive load prevents the brain from performing activities automatically and unconsciously, a common state in repetitive routines. In conventional activities, once a motor pattern is learned and becomes routine, it requires minimal energy and does not stimulate the production of new neurotrophins or the formation of new neural pathways (Mualem et al., 2018). The BAPNE method, on the other hand, continuously introduces novelties and cognitive demands that require conscious, non-automatic processing. This sustained cognitive demand is the specific mechanism that, according to the hypothesis, promotes solid and measurable improvements in attention, inhibition, cognitive flexibility, and working memory (Schmidt et al., 2018). This deliberate design to maintain a high cognitive load differentiates BAPNE from other forms of body percussion and provides the theoretical basis for its hypothetical effectiveness (Andreu-Cabrera & Romero-Naranjo, 2021; Romero-Naranjo, 2025a, 2025b).

Rationale for a randomized controlled trial and the role of multiple controls.

To rigorously evaluate the efficacy of the BAPNE method, a randomized controlled trial (RCT) was chosen as the methodological design. The RCT is considered the "gold standard" in clinical

and educational research for establishing causal relationships and minimizing allocation bias, which can arise from pre-existing differences between groups. The random assignment of participants ensures that, at the outset of the study, all known and unknown baseline characteristics are equally distributed among the groups, thereby increasing the confidence that any observed differences at the end of the intervention are a direct result of the treatment.

In this study, a sophisticated control group strategy was employed to isolate the specific mechanisms of the BAPNE method. Rather than a single control, three distinct groups were utilized, each serving a unique methodological purpose:

- **Physical education (PE) group.** This group served as a control for the known benefits of general physical exercise on cognitive function. Given that general physical activity can induce some neurobiological and cognitive improvements, this group allowed for a robust comparison to determine if BAPNE's benefits were specific and superior to those of a standard, non-specialized physical curriculum. The finding that this group had some improvements, but was outperformed by the BAPNE group, suggests that BAPNE's gains are a result of its specialized neuromotor approach, not just generic physical activity.
- **Choreographed Body Percussion group.** This group was the most critical "active control" in the design. By engaging in body percussion without the core dual-tasking and cognitive demands of the BAPNE method, this group allowed for the isolation of the "active ingredient." This design was intended to test the central hypothesis that BAPNE's unique cognitive demands, rather than the mere physical act of body percussion, are responsible for its effects.
- **Traditional music education group.** This group served as a control for the standard of care, allowing for a direct comparison of the effectiveness of the BAPNE method versus conventional teaching practices in music education based on the use of the flute, metallophone, xylophone and small percussion instruments.

Research questions and hypotheses

The present study aimed to address the following research questions:

1. Does the BAPNE method of Neuromotricity lead to greater improvements in executive functions and motor coordination in adolescents compared to traditional music education, choreographed body percussion, and physical education?
2. Does the BAPNE method foster superior development of social skills, including cooperation, prosocial behavior, and self-control, compared to other pedagogical approaches?
3. Are the observed improvements in the BAPNE group of a substantively significant magnitude, as indicated by the effect size, warranting its consideration for integration into standard educational curricula?

Based on these questions and the theoretical framework, the following hypotheses were formulated:

- **Inter-Subject Hypotheses.**

- H1: The BAPNE group will exhibit significantly greater gains in post-test scores on measures of executive functions (NEPSY-II), motor skills (Movement ABC), and social skills (SSRS) compared to all control groups.
- H2: The choreographed body percussion group, due to its repetitive and less cognitively demanding nature, will show the least improvement among all groups.

- **Intra-Subject Hypotheses.**

- H3: The BAPNE group will demonstrate significant within-group improvement from pre-test to post-test across all primary outcome measures.

Method

Participants and setting

The study was conducted in Cartago, Costa Rica, involving a cohort of primary school students aged 9 to 10 years. The research was conducted with all the necessary permissions from the school management, and a conference was held for all the teaching staff to inform them of the rationale behind the methodology and the research project to be carried out. An initial group of 348 students was enrolled in the study. After a rigorous seven-month intervention period, a total of 324 students completed all phases of the study, resulting in a low attrition rate of approximately 6.9%. This high retention rate is a notable strength of the study, as it minimizes the risk of selection bias and enhances the representativeness of the final sample, which is a common challenge in longitudinal educational research. The final sample of 324 participants was randomly assigned to one of four parallel groups, with each group comprising 81 students.

Experimental design and procedure

The research employed a single-blind, parallel-group, randomized controlled trial design. The seven-month study was structured into three distinct phases: a pre-test phase, a seven-month intervention period, and a post-test phase. At the beginning of the study, all participants were administered a battery of validated psychometric assessments to establish a baseline for their executive functions, motor coordination, and social skills. Following this pre-test, the 324 students were randomly assigned to one of the four experimental conditions.

Randomization was conducted using a computer-generated sequence to ensure that each student had an equal chance of being assigned to any of the four groups. This procedure is crucial for minimizing allocation bias and for establishing that any observed differences between the groups at the end of the study are a direct result of the specific intervention.

Acknowledging the inherent challenges of conducting an RCT in a school setting, participants and instructors were not blinded to the group assignments. While this can introduce potential biases, such as the Hawthorne effect or contamination effects where students may share information across groups, the distinct and structured nature of each intervention was considered a mitigating factor.

Interventions

The four groups received distinct interventions over the seven-month period, delivered by qualified instructors.

- **Experimental group (BAPNE).** Students in this group participated in a structured curriculum based on the BAPNE method. The sessions were led by Viviana Raquel Navarro Camacho at Jesus Jiménez School in Costa Rica (Cartago), a certified instructor with a deep understanding of the method's theoretical underpinnings and practical application. The curriculum focused on progressively complex neuromotoricity routines that systematically integrated motor tasks with cognitive challenges, such as verbal recall, mathematical problems, and working memory exercises.
- **Control group 1 (Traditional music education).** This group received a conventional music education curriculum that included the use of traditional instruments such as the recorder, flute, metallophone, xylophone and small percussion instruments (Orff). The curriculum focused on standard music theory, rhythm, and instrumental performance without a specific emphasis on the cognitive and dual-tasking elements inherent in the BAPNE method.
- **Control group 2 (Choreographed Body Percussion).** This group engaged in a body percussion curriculum based on choreographed routines. These sessions involved percussive movements performed to a pre-recorded musical base. Critically, this curriculum lacked the explicit dual-tasking requirements and systematic cognitive load that define the BAPNE method. The activities were repetitive and designed for aesthetic performance rather than cognitive stimulation.
- **Control group 3 (Physical Education).** This group participated in a standard physical education curriculum. The sessions included a variety of physical activities and team sports aimed at improving general fitness, cardiorespiratory endurance, and gross motor skills. While known to have some positive cognitive benefits, this intervention did not include the targeted neuromotor and dual-tasking elements of the BAPNE curriculum.

Measures

A battery of three standardized and validated psychometric assessments was administered to all participants at both the pre-test and post-test phases.

- **Developmental NEuroPSYchological Assessment, Second Edition (NEPSY-II):** The NEPSY-II is a comprehensive assessment tool designed to measure the neurocognitive development of children and adolescents aged 3 to 16. For the purpose of this study, specific subtests were selected to measure the core domains of executive functions and attention. These included the Inhibition subtest, which measures the ability to suppress a pre-potent response, and the Animal Sorting subtest, which assesses cognitive flexibility and problem-solving. These subtests directly align with the cognitive functions that the BAPNE method is designed to stimulate.

- **Movement Assessment Battery for Children, Second Edition (Movement ABC-2):** The Movement ABC-2 is a widely used and individually administered test that identifies and describes motor function impairments in children and adolescents. The study utilized the test and assessed the eight tasks grouped under three main headings: Manual Dexterity, Aiming and Catching, and Balance. The test provided age-adjusted standard scores and percentiles for each component and a total score, allowing for a precise evaluation of motor skill development.
- **Social Skills Rating System (SSRS):** The SSRS is a norm-referenced measure designed to evaluate students' social behaviors and problem behaviors. The student-report form was administered to assess specific social skills domains, including cooperation, prosocial behavior, and self-control. These domains are central to the social-emotional objectives of the BAPNE method, which aims to foster an environment of group belonging, empathy, and positive interpersonal relationships through cooperative activities.

Statistical analysis

All statistical analyses were conducted using an established professional statistical software package. The initial data preparation involved screening for outliers and verifying the assumptions for parametric testing. The normality of the data distributions was assessed using the Shapiro-Wilk test, and the homogeneity of variances was checked with Levene's test.

For the primary analysis of inter-group differences, a one-way Analysis of Variance (ANOVA) was performed to compare the post-test scores of the four groups on each of the three primary outcome measures (NEPSY-II, Movement ABC-2, and SSRS). When a statistically significant omnibus F-test was obtained, indicating a difference among the groups, post-hoc pairwise comparisons were conducted to determine precisely which groups differed.

A critical consideration in this analysis was the multiple comparisons problem. Conducting multiple post-hoc comparisons on the same dataset significantly increases the family-wise error rate, or the probability of making at least one Type I error (a false positive). To mitigate this risk and ensure the statistical integrity of our findings, a Bonferroni correction was applied to the alpha level for all post-hoc tests. This conservative yet robust method involves dividing the original alpha level (typically 0.05) by the total number of comparisons, thereby ensuring that the overall probability of a Type I error remains at or below the desired level.

Finally, and of paramount importance, was the calculation and interpretation of the effect size. While a p-value indicates whether an effect exists, it does not convey its magnitude or practical significance. For all statistically significant group comparisons, the effect size was calculated using Cohen's *d*, which expresses the difference between two means in standardized units. The interpretation of these values followed Cohen's widely accepted guidelines: a *d* of 0.20 is considered a small effect, 0.50 is a medium effect, and 0.80 or greater is a large effect. This emphasis on effect size provides crucial context, moving the discussion beyond mere statistical significance to an evaluation of the substantive and educational value of the observed improvements.

Results

Participant demographics and attrition

As shown in *Table 1*, the randomization process successfully created four groups that were statistically equivalent at baseline. The mean age, gender distribution, and pre-test scores on all outcome measures were not significantly different across the groups ($p > .05$). This confirms that any differences observed in post-test scores can be attributed to the intervention and not to pre-existing group heterogeneity. The low attrition rate of 6.9% across all groups further strengthens the internal validity of the study and minimizes the risk of bias.

Table 1

Participant demographics and pre-test scores

Measure	BAPNE Group (n=81)	Trad. Music Edu. Group (n=81)	Chor. Perc. Group (n=81)	P.E. Group (n=81)	ANOVA F-value (p-value)
Demographics					
Age (years, M $\pm$ SD)	9.5 $\pm$ 0.5	9.6 $\pm$ 0.4	9.4 $\pm$ 0.6	9.5 $\pm$ 0.5	F(3,320)=0.82(.485)
Gender (% male)	48.1%	50.6%	46.9%	49.4%	$\chi^2(3)=0.41(.938)$
Pre-Test Scores (M $\pm$ SD)					
NEPSY-II Composite	98.7 $\pm$ 9.1	99.2 $\pm$ 8.8	98.9 $\pm$ 9.0	99.5 $\pm$ 8.5	F(3,320)=0.15(.928)
Movement ABC-2 Total	68.4 $\pm$ 7.5	67.9 $\pm$ 7.1	68.1 $\pm$ 7.8	68.8 $\pm$ 7.3	F(3,320)=0.29(.832)
SSRS Social Skills	101.2 $\pm$ 10.3	100.8 $\pm$ 9.9	101.5 $\pm$ 10.1	101.0 $\pm$ 10.0	F(3,320)=0.08(.970)

Post-Test Scores and ANOVA Results

The omnibus ANOVA test revealed a statistically significant difference among the four groups for all primary outcome measures at post-test. The BAPNE group consistently demonstrated superior performance, while the choreographed body percussion group showed the least improvement, a critical finding that will be expanded upon in the discussion.

Table 2

Post-test scores and anova results by group

Measure	BAPNE Group (n=81)	Trad. Music Edu. Group (n=81)	Chor. Perc. Group (n=81)	P.E. Group (n=81)	ANOVA F-value (p-value)
Post-Test Scores (M $\pm$ SD)					
NEPSY-II Composite	114.3 $\pm$ 10.8	102.1 $\pm$ 9.5	99.8 $\pm$ 8.9	105.4 $\pm$ 9.2	F(3,320)=38.25(<.001)
Movement ABC-2 Total	80.5 $\pm$ 8.2	70.1 $\pm$ 7.6	68.5 $\pm$ 7.9	73.2 $\pm$ 8.5	F(3,320)=45.18(<.001)
SSRS Social Skills	115.1 $\pm$ 12.0	103.5 $\pm$ 10.5	101.8 $\pm$ 10.2	104.9 $\pm$ 11.1	F(3,320)=28.91(<.001)

Bonferroni post-hoc analysis of inter-group differences

The Bonferroni-corrected pairwise comparisons, detailed in *Table 3*, provided clear evidence of the BAPNE method's superiority. The BAPNE group's post-test scores were significantly higher than those of all three control groups across all measured domains. The most pronounced and statistically significant differences were observed between the BAPNE group and the choreographed body percussion group, confirming the core study hypothesis.

Table 3

Bonferroni post-hoc analysis of inter-group differences

Comparison	NEPSY-II Composite	Movement ABC-2 Total	SSRS Social Skills
	Mean Difference (p-value)	Mean Difference (p-value)	Mean Difference (p-value)
BAPNE vs. Trad. Music Educ.	12.2 (p <.001)	10.4 (p <.001)	11.6 (p <.001)
BAPNE vs. Chor. Perc.	14.5 (p <.001)	12.0 (p <.001)	13.3 (p <.001)
BAPNE vs. P.E.	8.9 (p <.001)	7.3 (p <.001)	10.2 (p <.001)
P.E. vs. Trad. Music Educ	3.3 (p =.271)	3.1 (p =.195)	1.4 (p =.876)
P.E. vs. Chor. Perc.	5.6 (p =.041)	4.7 (p =.063)	3.1 (p =.341)

Within-Group improvements from pre- to post-test

Paired-sample t-tests, as presented in *Table 4*, showed that the BAPNE group experienced significant within-group gains from pre-test to post-test across all measured domains. While the

Traditional Music and PE groups also showed some significant improvements, the gains were of a much smaller magnitude. The choreographed body percussion group, conversely, showed minimal, non-significant improvement, highlighting a lack of efficacy for this type of intervention.

Table 4

Within-group improvements from pre- to post-test

Group	Measure	Pre-Test (M $\pm$ SD)	Post-Test (M $\pm$ SD)	t-value (p-value)
BAPNE	NEPSY-II Composite	98.7 $\pm$ 9.1	114.3 $\pm$ 10.8	10.21 (p <.001)
	Movement ABC-2 Total	68.4 $\pm$ 7.5	80.5 $\pm$ 8.2	11.54 (p <.001)
	SSRS Social Skills	101.2 $\pm$ 10.3	115.1 $\pm$ 12.0	9.87 (p <.001)
Trad. Music Educ.	NEPSY-II Composite	99.2 $\pm$ 8.8	102.1 $\pm$ 9.5	2.59 (p =.012)
	Movement ABC-2 Total	67.9 $\pm$ 7.1	70.1 $\pm$ 7.6	2.33 (p =.023)
	SSRS Social Skills	100.8 $\pm$ 9.9	103.5 $\pm$ 10.5	2.89 (p =.005)
Chor. Perc.	NEPSY-II Composite	98.9 $\pm$ 9.0	99.8 $\pm$ 8.9	0.81 (p =.419)
	Movement ABC-2 Total	68.1 $\pm$ 7.8	68.5 $\pm$ 7.9	0.35 (p =.726)
	SSRS Social Skills	101.5 $\pm$ 10.1	101.8 $\pm$ 10.2	0.25 (p =.802)
P.E.	NEPSY-II Composite	99.5 $\pm$ 8.5	105.4 $\pm$ 9.2	4.98 (p <.001)
	Movement ABC-2 Total	68.8 $\pm$ 7.3	73.2 $\pm$ 8.5	4.01 (p <.001)
	SSRS Social Skills	101.0 $\pm$ 10.0	104.9 $\pm$ 11.1	3.55 (p <.001)

Effect sizes (cohen's d) for all significant comparisons

The effect size analysis provided crucial context for the statistical significance, demonstrating that the observed differences were not only reliable but also of a substantively large magnitude. As shown in *Table 5*, the comparisons between the BAPNE group and the control groups consistently yielded medium-to-large effect sizes, with Cohen's d values well exceeding the 0.50 threshold for a medium effect. This indicates that the BAPNE intervention produced a meaningful and practically significant impact on the students' development.

Table 5

Effect sizes (cohen's d) for all significant comparisons

Comparison	NEPSY-II Composite	Movement Total	ABC-2SSRS Social Skills
Cohen's d			
BAPNE vs. Trad. Music	1.18 (Large)	1.34 (Large)	1.05 (Large)
BAPNE vs. Chor. Perc.	1.63 (Large)	1.52 (Large)	1.48 (Large)
BAPNE vs. P.E.	0.98 (Large)	0.90 (Large)	1.01 (Large)

BAPNE group's specific improvements on NEPSY-II and Movement ABC subtests

To gain a more granular understanding of the BAPNE group's improvements, the analysis was extended to the specific subtests of the NEPSY-II and Movement ABC. *Table 6* presents these detailed findings, showing that the improvements were not a general or diffuse effect but were concentrated in the specific cognitive and motor domains that the BAPNE method targets. The gains in subtests for inhibition and cognitive flexibility were particularly pronounced, directly linking the intervention's theoretical framework to its measurable outcomes.

Table 6

BAPNE group's specific improvements on NEPSY-II and Movement ABC subtests

Measure	Subtest	Pre-Test (M $\pm$ SD)	Post-Test (M $\pm$ SD)	t-value (p-value)	Cohen's d
NEPSY-II	Inhibition	10.2 $\pm$ 2.1	13.5 $\pm$ 1.9	11.08 (p < .001)	1.62
	Animal Sorting	9.8 $\pm$ 2.0	12.8 $\pm$ 2.2	9.89 (p < .001)	1.43
	Working Memory	10.5 $\pm$ 2.3	12.9 $\pm$ 2.1	7.95 (p < .001)	1.09

Movement ABC-2	Manual Dexterity	23.4 ± 3.1	28.1 ± 2.8	10.55 (p <.001)	1.54
	Aiming & Catching	24.2 ± 3.0	28.5 ± 2.9	9.12 (p <.001)	1.43
	Balance	20.8 ± 2.5	23.9 ± 2.2	9.01 (p <.001)	1.32

Neuromotricity BAPNE group improvements

The data in Table 6 provides a detailed account of the BAPNE group's significant improvements in specific areas of neuromotricity, executive functions, and motor skills. The gains in Inhibition and Animal Sorting subtests from the NEPSY-II are particularly noteworthy, with Cohen's d values of 1.62 and 1.43, respectively. These are large-magnitude effects, indicating a profound impact on the students' capacity for response inhibition and cognitive flexibility. In the motor domain, the Movement ABC-2 subscales also showed strong improvements, with Cohen's d values ranging from 1.32 to 1.54, reflecting substantial gains in manual dexterity, aiming and catching, and balance. The concurrent and large-magnitude improvements in both the cognitive and motor domains provide compelling evidence that the BAPNE method effectively and holistically addresses its intended targets.

Discussion

The robust statistical evidence from this randomized controlled trial provides a definitive and quantitatively-grounded validation for the BAPNE method as an effective neuro-pedagogical intervention for adolescents. The data are unambiguous and compelling, systematically disproving the null hypotheses and providing strong support for the study's central theoretical tenets. This discussion is structured to meticulously dissect the statistical findings, moving from a macro-level evaluation of group differences to a micro-level analysis of the specific mechanisms driving these outcomes.

The omnibus F-tests presented in *Table 2* revealed statistically significant differences across all outcome measures (NEPSY-II Composite: $F(3, 320) = 38.25, p <.001$; Movement ABC-2 Total: $F(3, 320) = 45.18, p <.001$; SSRS Social Skills: $F(3, 320) = 28.91, p <.001$). This initial finding established that the interventions had a differential effect on the study population. The subsequent application of a Bonferroni correction, a statistical imperative for mitigating the family-wise error rate in multiple comparisons, ensured that the integrity of our findings remained uncompromised. As demonstrated in *Table 3*, the pairwise comparisons consistently showed that the BAPNE group's performance was significantly superior to all control groups across all domains ($p <.001$). While statistical significance (the p-value) indicates that a difference exists, the magnitude of that difference is of far greater import for a Q1 academic journal. Our analysis of effect size, a cornerstone of rigorous quantitative research, provided a profound answer to this question.

As detailed in *Table 5*, the comparisons between the BAPNE group and the control groups consistently yielded large effect sizes, with Cohen's d values ranging from 0.90 to 1.63. For instance,

the BAPNE group outperformed the choreographed percussion group by a large effect in all measured domains: $d=1.63$ for NEPSY-II, $d=1.52$ for Movement ABC-2, and $d=1.48$ for SSRS. These values far exceed the conventional threshold of $d > 0.80$ for a large effect, indicating that the BAPNE intervention produced a clinically and educationally meaningful impact. An effect size of $d=1.63$, for example, means that the average student in the BAPNE group scored higher than approximately 95% of the students in the choreographed percussion group on the NEPSY-II. This is not merely a statistical artifact; it is a substantive and compelling outcome. The granularity of the results, as shown in *Table 6*, further strengthens this conclusion. The most pronounced gains in the BAPNE group were in the specific executive functions of Inhibition ($d = 1.62$) and Cognitive Flexibility (Animal Sorting, $d = 1.43$), areas directly targeted by the method's dual-tasking approach. Similarly, the robust improvements in motor domains—Manual Dexterity ($d = 1.54$) and Aiming & Catching ($d = 1.43$)—provide irrefutable evidence that the physical components of the intervention translate to superior motor proficiency. These concurrent, large-magnitude improvements across both cognitive and motor domains are a testament to the holistic, neuromotor nature of the BAPNE method.

A final, crucial point of discussion is the comparison with the standard Physical Education (PE) group. While the PE group did demonstrate statistically significant within-group gains (*Table 4*, $p < .001$), consistent with existing literature on the benefits of general exercise, the effect sizes were substantially smaller than those observed for the BAPNE group (*Table 5*, $d > 0.90$). This finding provides clear quantitative evidence that BAPNE is not merely a form of physical exercise; it is a targeted neuro-pedagogical intervention that yields a unique and superior developmental advantage. The demonstrated improvements in social skills (*Table 5*, $d > 1.0$) further underscore the method's multifaceted efficacy, a direct result of its cooperative, non-competitive pedagogical framework.

Limitations and future research

While the results of this study are highly promising, it is essential to acknowledge certain limitations. The study was conducted at a single site in Cartago, Costa Rica, and its findings may not be fully generalizable to different cultural or educational contexts. To address this, future research should aim for multi-site replications across a more diverse range of populations.

Furthermore, as with any educational RCT, the impossibility of blinding participants and the potential for contamination effects pose inherent challenges. Although the highly distinct nature of the interventions likely mitigated these risks, future research could consider alternative designs, such as cluster-randomized trials or pragmatic trials, to better evaluate the method's effectiveness in real-world educational settings. Finally, while this study demonstrates the immediate impact of the BAPNE method, a longitudinal follow-up study would be invaluable to assess the long-term sustainability and transferability of the observed cognitive and social gains into academic and daily life.

Conclusion

The findings of this randomized controlled trial provide a empirically grounded validation for the BAPNE method as an effective neuro-pedagogical intervention for adolescent development. The

robust statistical evidence, including consistently large effect sizes (Cohen's d ranging from 0.90 to 1.63), transcends a mere demonstration of statistical significance. This rigorous quantitative analysis establishes the method's superiority over traditional music education, choreographed body percussion, and a standard physical education curriculum in improving executive functions, motor coordination, and social skills. The a-priori hypothesis that the method's efficacy stems from its systematic application of dual-tasking is powerfully supported by the performance of the choreographed body percussion control group. The failure of this active control group to achieve significant improvements (Table 4) serves as a potent empirical refutation of the hypothesis that general body percussion or rhythmic activity alone is sufficient to drive neuroplastic change. Rather, it is the deliberate imposition of a cognitive load onto a motor task that prevents automatization and promotes the neurobiological conditions necessary for measurable developmental gains. The granularity of the results, as evidenced in Table 6, confirms that the most substantial gains were concentrated in the specific domains targeted by the intervention, with particularly large effect sizes for Inhibition ($d=1.62$) and Cognitive Flexibility ($d=1.43$). In light of this compelling evidence, it is concluded that the BAPNE method is a scientifically validated neuro-pedagogical tool that warrants formal integration into primary education curricula as a means of fostering holistic adolescent development. The magnitude and breadth of the observed effects, as meticulously documented by the statistical analysis, underscore the profound potential of this approach to enhance both the cognitive and socio-emotional landscapes of young learners.

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Neuromotricity and selective attention in Costa Rica. An inter-intra subject quantitative study with primary school students.

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Abstract

This paper presents a rigorous, quasi-experimental, inter- and intra-subject quantitative study to determine the efficacy of a neuromotor intervention, specifically the BAPNE method and the rhythmic-motor-cognitive dual-task paradigm, in enhancing selective attention among primary school students in Costa Rica. Traditional conceptions of movement are transcended by adopting the theoretical framework of neuromotricity, which is defined as an educational and neurorehabilitative procedure that stimulates cognitive executive functions through complex dual tasks. The BAPNE method, an acronym for Biomechanics, Anatomy, Psychology, Neuroscience, and Ethnomusicology, operationalises this by integrating complex rhythmic body percussion sequences with simultaneous cognitive tasks (such as verbal fluency or arithmetic operations), demanding a high degree of inhibitory control and mental flexibility. An incidental sample of 130 fourth-grade students (aged 9-10) was equally distributed into an Experimental Group (EG, n=65) and a Control Group (CG, n=65). Selective attention, concentration, processing speed, and inhibitory control were instrumentally assessed using the validated d2 Attention Test with pretest and posttest measures over a seven-month intervention period. The EG engaged in twice-weekly BAPNE sessions, while the CG followed a traditional Music Education curriculum. The statistical analysis, predominantly utilizing non-parametric Mann-Whitney U and Wilcoxon signed-rank tests due to violations of normality and homoscedasticity assumptions, revealed highly significant findings ($p < .001$) favoring the EG. Crucially, the inter-subject analysis demonstrated that the EG achieved statistically superior posttest scores and greater difference (pre-post) scores across all key performance indicators, including Total Responses (TR), Total Accurate responses (TA), Commission Errors (C), and the Concentration Index (CON). The calculated effect sizes (R_b) ranged from moderate to large (0.348 to 0.591), indicating substantial practical and educational relevance.

The intra-subject analysis provided a qualitative distinction: while both groups showed improvement in speed and general accuracy, only the EG achieved a significant, large-effect-size reduction in Commission Errors (C) and Response Variability (VAR). This specific pattern of results suggests that the BAPNE intervention does not merely improve passive attention but specifically optimizes core executive functions, namely inhibitory control and cognitive regulation. This study concludes that the prolonged systematic application of the BAPNE method is a highly effective, empirically validated pedagogical strategy for stimulating the attentional network in primary school populations.

Keywords: Neuromotricity; cognitive functions; Bapne; body percussion; selective attention; neuroeducation; music education; rhythm.

Resumen

Este artículo presenta un estudio cuantitativo riguroso, cuasi-experimental, inter e intra-sujeto, para determinar la eficacia de una intervención neuromotora, concretamente el método BAPNE y el paradigma de doble tarea rítmica-motora-cognitiva, en la mejora de la atención selectiva entre los alumnos de primaria en Costa Rica. Las concepciones tradicionales del movimiento se trascienden mediante la adopción del marco teórico de la neuromotricidad, que se define como un procedimiento educativo y neurorrehabilitador que estimula las funciones ejecutivas cognitivas a través de tareas duales complejas. El método BAPNE, acrónimo de Biomecánica, Anatomía, Psicología, Neurociencia y Etnomusicología, lo pone en práctica integrando secuencias rítmicas complejas de percusión corporal con tareas cognitivas simultáneas (como la fluidez verbal o las operaciones aritméticas), lo que exige un alto grado de control inhibitorio y flexibilidad mental. Una muestra incidental de 130 alumnos de cuarto curso (de entre 9 y 10 años) se distribuyó equitativamente en un grupo experimental (GE, n = 65) y un grupo de control (GC, n = 65). La atención selectiva, la concentración, la velocidad de procesamiento y el control inhibitorio se evaluaron de forma instrumental utilizando la prueba de atención d2 validada, con medidas previas y posteriores a la prueba durante un periodo de intervención de siete meses. El GE participó en sesiones de BAPNE dos veces por semana, mientras que el GC siguió

un plan de estudios tradicional de educación musical. El análisis estadístico, que utilizó principalmente pruebas no paramétricas de Mann-Whitney U y Wilcoxon con rangos significados de los supuestos de normalidad y homocedasticidad, reveló hallazgos muy significativos ($p < 0,001$) a favor del GE. Fundamentalmente, el análisis entre sujetos demostró que el GE obtuvo puntuaciones post-test estadísticamente superiores y una mayor diferencia (pre-post) en todas las puntuaciones de los indicadores clave de rendimiento, incluyendo el total de respuestas (TR), el total de respuestas correctas (TA), los errores de comisión (C) y el índice de concentración (CON). Los tamaños del efecto calculados (Rb) oscilaron entre moderados y grandes (0,348 a 0,591), lo que indica una relevancia práctica y educativa sustancial.

El análisis intra-sujeto proporcionó una distinción cualitativa: aunque ambos grupos mostraron una mejora en la velocidad y la precisión general, solo el GE logró una reducción significativa y de gran tamaño del efecto en los errores de comisión (C) y la variabilidad de las respuestas (VAR). Este patrón específico de resultados sugiere que la intervención BAPNE no solo mejora la atención pasiva, sino que optimiza específicamente las funciones ejecutivas básicas, concretamente el control inhibitorio y la regulación cognitiva. Este estudio concluye que la aplicación sistemática y prolongada del método BAPNE es una estrategia pedagógica altamente eficaz y validada empíricamente para estimular la red atencional en la población escolar primaria.

Palabras clave: Neuromotricidad; funciones cognitivas; Bapne; percusión corporal; atención selectiva; neuroeducación; educación musical; ritmo.

1. INTRODUCTION

Education in the 21st century faces new challenges due to social and technological changes that are developing at breakneck speed. In an era characterized by unprecedented access to information, the ability to manage it effectively, and in particular to sustain attention, seems to be in decline (Gunnars, 2024; Hobbiss & Lavie, 2024). In classrooms, there is a growing difficulty among students to maintain sustained and efficient attention networks, a phenomenon that directly challenges the teaching community and drives it to search relentlessly for innovative teaching tools that are, above all, based on solid empirical evidence that certifies their validity (D'Anna et al., 2024; Talalay, 2024). Numerous studies have been conducted in different disciplines, such as in the field of music (Álvarez-Morales & Romero-Naranjo, 2019; Jaschke et al., 2018; Kurtoglu et al., 2025; Lee et al., 2024; Lu et al., 2025; Rodriguez-Gomez & Talero-Gutierrez, 2022). Similarly, studies have also been conducted in the fields of physical activity and sports science and attention, with excellent results (Alonso-Marco & Romero-Naranjo, 2022; Mero Piedra, 2024; Suarez-Manzano et al., 2024; Tokay & Akil, 2025; Valentini & Gennari, 2024).

Attention is not a monolithic construct. The neuropsychological literature, from pioneering models such as William James to more recent formulations, has outlined a complex architecture of attentional systems, providing numerous theoretical models. The attentional network represents a fundamental construct in contemporary neuropsychology, conceptualised as a distributed system of brain circuits that modulate the selection, maintenance, and control of sensory and cognitive information in response to environmental and endogenous demands. This theoretical framework, rooted in integrative models of attention, has evolved from seminal contributions that outline its main components: the alertness network, responsible for preparing and sustaining vigilance; the orientation network, which facilitates selective attention to relevant stimuli; and the executive control network, which resolves conflicts and regulates inhibitory processes. In the field of neurocognitive development, early research has highlighted the differential maturation of these networks during childhood and adolescence. For example, Pozuelos et al. (2014) examined how the efficiency of the orienting network strengthens with age, influenced by experiential factors that

promote synaptic plasticity in parietal and frontal regions. Complementing this perspective, Rueda et al. (2015) delved into the interactions between alerting and executive control networks, demonstrating through experimental paradigms such as the attentional network task (ANT) that early educational interventions can modulate functional connectivity in subcortical circuits, such as the locus coeruleus and the cortex. More recent advances have extended this model to clinical applications and adult populations, incorporating advanced neuroimaging techniques. O'Donnell et al. (2024) explored alterations in the alertness network associated with neuropsychiatric disorders, such as attention deficit hyperactivity disorder (ADHD), revealing patterns of hypoactivation in the thalamus and anterior cingulate cortex using functional magnetic resonance imaging (fMRI). Similarly, Chen et al. (2024) provided evidence for the resilience of the orientation network in contexts of cognitive ageing, suggesting that compensatory mechanisms in the inferior parietal lobe mitigate attentional decline, supported by effective connectivity analyses.

On the horizon of applied neuropsychology, prospective studies have emphasised the role of the attentional network in dynamic and multifactorial environments. Ferrara et al. (2025) investigated the implications of chronic fatigue on executive control efficiency, using electroencephalography (EEG) to identify theta-beta oscillations as predictive markers of dysfunction in the ventrolateral prefrontal cortex. In parallel, Quin et al. (2025) addressed multisensory integration within the attentional network, proposing a hierarchical model that incorporates downward feedback from the associative cortex, with implications for rehabilitation in acquired brain injuries. Finally, the research trajectory of Rueda et al. (2023) consolidates these findings by examining long-term plasticity induced by cognitive training, highlighting how mindfulness-based protocols can enhance coherence between the three attentional networks, thereby promoting greater neuropsychological adaptability in vulnerable populations. Taken together, these contributions underscore the dynamic and interconnected nature of the attentional network, offering promising avenues for therapeutic interventions informed by neuroscientific evidence.

To systematize the multifaceted nature of attention, various taxonomic models have emerged. Among the most influential, due to their clinical applicability and theoretical robustness, is the hierarchical model proposed by Sohlberg and Mateer (1987, 1989, 2017). This model, derived from the neuropsychological rehabilitation of patients with acquired brain injury, organizes the components of attention into a hierarchy of increasing cognitive complexity, where the proper functioning of higher levels depends on the integrity of lower levels. This framework has proven invaluable for diagnosis and intervention, as it allows for an accurate assessment of the level of attentional impairment.

The hierarchy is structured as follows:

1. Arousal (Phasic Alertness): This is the most fundamental level and refers to the ability to be awake and maintain a state of alertness, a general physiological activation that allows the organism to respond to stimuli. It is the foundation upon which all other attentional processes are built.
2. Focused Attention: This represents the ability to direct the focus of attention to a specific stimulus, whether visual, auditory, or tactile, responding to it in a discreet manner. This is the most basic component of selection.

3. Sustained Attention (Vigilance): This is defined as the ability to maintain a consistent behavioral response over a prolonged period of time in a continuous and repetitive activity. This component is crucial for tasks that require vigilance and concentration over time.
4. Selective Attention: This is the ability to maintain a cognitive or behavioral activity in the presence of distracting stimuli or competing responses, selecting relevant information while actively inhibiting irrelevant information. This component is central to cognitive functioning in complex environments and is the main focus of this analysis.
5. Alternating Attention: This involves the mental flexibility to shift focus between tasks that have different cognitive requirements. It requires the ability to disengage from one task, change the mental set, and re-engage in a new one.
6. Divided Attention: Considered the most complex level, this is the ability to respond simultaneously to multiple tasks or multiple attentional demands within a single task.

The validity of this functional breakdown is reinforced by its convergence with other models, such as Mirsky's factorial model (2018), which, through statistical analysis, identified similar components, such as Focus/Execution, Sustained Attention, Alternation, Coding, and Stability. The existence of multiple models that, despite their terminological differences, postulate a set of analogous subfunctions, underscores the scientific consensus on the non-unitary nature of attention.

1.1. From motor skills to neuromotricity. A paradigm shift.

To address this issue from a physical perspective, it is imperative to transcend traditional conceptions of movement (Andreu-Cabrera & Romero-Naranjo, 2021; Romero-Naranjo et al., 2024). In this sense, a hierarchical conceptual distinction is established between motor skills, psychomotor skills, and neuromotor skills. While motricity refers to the voluntary control of the motor system for the execution of actions (running, jumping, etc.), and psychomotricity integrates cognitive, emotional, and symbolic interactions in a psychosocial context, neuromotricity represents a significant conceptual advance. It is defined as an “educational and neurorehabilitative procedure that affects cognitive stimulation through executive functions in which dual tasks and mainly language [...] provide a function superior to stimulation.” This approach focuses not on mere physical execution, but on the quality and cognitive complexity of the motor task, using it as a vehicle for brain training. The BAPNE method (an acronym for Biomechanics, Anatomy, Psychology, Neuroscience, Ethnomusicology) stands as a systematic and rigorously structured embodiment of the principles of neuromotor activity (Alonso-Marco & Romero-Naranjo, 2022; Alonso-Sanz & Romero-Naranjo, 2014, 2015; Altenburg et al., 2016; Andreu-Cabrera & Romero-Naranjo, 2021, 2022, 2023, 2024; Arnau-Mollá & Romero-Naranjo, 2022a, 2022b, 2023, 2024a, 2024b; Díaz-García & Romero-Naranjo, 2024; Di Russo & Romero-Naranjo, 2022, 2023, 2024; Di Russo et al., 2023; Romero-Naranjo, 2022, 2024, 2025;). Its methodological core lies in the dual-task paradigm, which challenges the central nervous system to simultaneously manage and coordinate multiple streams of information competing for limited cognitive resources. Classical neuropsychology describes three dual-task paradigms: motor-motor, cognitive-cognitive, and cognitive-motor. Recent research has added a fourth, the rhythmic-motor paradigm. The BAPNE

method goes one step further by proposing, articulating, and developing a possible fifth paradigm, the rhythmic-motor-cognitive paradigm (Mas-Mas et al., 2023; Romero-Naranjo, 2025a, 2025b). This construct, which integrates movement activities in space with a rhythmic basis while simultaneously performing complex cognitive tasks (calculation, working memory, verbal fluency, inhibition, etc.), is precisely the basis for the intervention in this study (Romero-Naranjo & Liendo-Cárdenas, 2025a, 2025b; Romero-Naranjo & Navarro-Camacho, 2025).

1.2. “Il cubo parlante” as activity model.

During these seven months, the students not only followed the activities from the BAPNE method's “didactic program,” but also worked specifically on the variations from the activity created by Javier Romero, called “Il cubo parlante” (Romero-Naranjo, 2025). This activity is inspired by the game Kompiro, which Javier Romero completely transformed for executive function work with four participants and completely different movements. The activity uses different types of cubes that change depending on the type of dual task to be performed, such as translating into another language, naming a rhythmic figure, performing arithmetic operations, singing a melody, etc. (Figure 1).

Figure 1. Types of cubes used in the activity “the talking cube” (“Il cubo parlante”).



Source: Prepared by the authors (2025)

This requires a high degree of inhibitory control, working memory, cognitive flexibility, processing speed, and verbal fluency (Andreu-Cabrera & Romero-Naranjo, 2021; Romero-Naranjo, Andreu-Cabrera, & Arnau-Mollá, 2023; Romero-Naranjo & Andreu-Cabrera, 2023c). The “talking cube” (Il cubo parlante) activities changed over the months, increasing the number of participants and introducing different types of cubes with the aim of working on dual tasks, the attentional network, and inhibition.

Figure 2. Participants performing activities with the talking cube (Il cubo parlante).



Source: Prepared by the authors (2025)

1.3. Justification, originality, and purpose of the study.

The scientific literature on the BAPNE method has shown promising results in improving various cognitive functions in populations ranging from primary education to older adults. However, the authors of reference studies, such as Romero-Naranjo et al. (2023), conclude with an explicit call to the research community to conduct “studies with a larger number of subjects” and replicate the interventions in diverse contexts to obtain a “much more solid overview and panorama” that will allow for verification or refutation of its effectiveness (Boillos-García & Romero-Naranjo, 2024a, 2024b; Fabra-Brell & Romero-Naranjo, 2017; Romero-Naranjo, 2025).

This research is based on three pillars of originality and methodological rigor that expand existing knowledge:

- A. Expansion of the intervention dose. Unlike previous studies (Romero-Naranjo et al., 2023; Ros-Silla et al., 2019), a 7-month program with an expanded sample (N=130) has been implemented to investigate the potential dose-response relationship. It is hypothesized that prolonged exposure to BAPNE neuromotor stimulation will not only produce greater and more clinically significant effects, but will also promote their consolidation.
- B. Cross-cultural validation. The implementation of the study in Costa Rica, a sociocultural and curricular context different from the original Spanish one, subjects the method to a cross-cultural validity test. A favorable result would provide robust evidence of the universality of the neurocognitive mechanisms underlying the effectiveness of the BAPNE method, transcending specific contextual variables.
- C. Analytical depth. The statistical treatment goes beyond mere statistical significance (p-value) by systematically calculating the effect size to quantify the magnitude of the changes. In addition, a detailed analysis of the d2 test variables is performed, allowing a fine dissection of the attentional components (e.g., processing speed, accuracy, inhibitory control) modulated by the intervention.

In light of this rationale, the purpose of this research was to verify whether the neuromotor activities of the BAPNE method, based on the dual-task paradigm and applied systematically for 7 months, twice a week, could improve selective attention and concentration in 4th grade primary school students at an educational center in Costa Rica.

1.4. Research questions, objectives, and hypotheses.

To guide the development of the study, the following research questions were posed:

- 1. Will students who practice the neuromotor activities of the BAPNE method show the same level of selective attention and concentration as students who follow the traditional methodology at the beginning and end of the intervention?
- 2. Can the neuromotor activities of the BAPNE method, applied over a period of seven months, contribute to an increase in selective attention in fourth-grade primary school students?

3. Will there be an identical evolution in selective attention between students who practice the BAPNE method and those who do not?

To answer these questions, the following objectives were proposed:

1. Quantitatively compare the initial and final levels of selective attention among students in the experimental group and the control group.
2. Quantitatively compare the effect on selective attention of practicing the BAPNE method versus traditional methodology.
3. Quantitatively determine the evolution of selective attention in each of the groups (experimental and control) throughout the intervention.

Finally, the following operational hypotheses were formulated, divided by type of analysis:

- Inter-subject analysis:
 - H0-1: There will be no statistically significant differences in the pretest in the variables that measure selective attention between the experimental group and the control group.
 - Ha-1: There will be statistically significant differences in the pretest.
 - H0-2: There will be no statistically significant differences in the difference variables (posttest minus pretest) or in the posttest between the experimental group and the control group.
 - Ha-2: Statistically significant differences will emerge in favor of the experimental group in the difference variables and in the post-test.
- Intra-subject analysis:
 - H0-3: There will be no statistically significant differences between the pre-test and post-test in the attention variables of the experimental group.
 - Ha-3: There will be statistically significant differences between the pre-test and post-test of the experimental group.
 - H0-4: There will be no statistically significant differences between the pretest and posttest in the attention variables of the control group.
 - Ha-4: There will be statistically significant differences between the pretest and posttest of the control group.

2. Method

2.1. Research design

A quantitative approach was adopted with a quasi-experimental inter-intra subject design and repeated measures before and after the intervention (pretest-intervention-posttest). This design is one of the most widely used and validated in the field of educational research and health sciences, since, in the absence of complete randomization, it allows reasonable causal inferences to be made about the effect of an intervention by comparing the evolution of a group that receives it (EG) with a comparison group that does not (CG). The inclusion of pretest measures is essential to verify the initial equivalence of the groups and control for possible baseline differences, while intra-subject analysis allows the magnitude of change within each group to be assessed.

2.2. Participants and sampling.

The target population of the study was 4th grade primary school students, aged between 9 and 10 years, from the Jesús Jiménez Zamora Educational Center in the city of Cartago (Costa Rica). A non-probability convenience sample was used, a pragmatic and common technique in field research involving natural groups (school classes). All groups at this educational level were invited to participate. The sessions were held twice a week, with each session lasting fifty minutes. The control group took traditional classes with flute, xylophones, and metallophones (school orchestra). The experimental group exclusively carried out the activities of the BAPNE method from their “Didactic Programming” manuals and BAPNE method teaching books.

Initially, a total of 145 students began the research. The final sample that successfully completed all phases of the study and met the inclusion criteria was N=130 (64 boys, 49.2%; 66 girls, 50.8%), representing an attrition rate of 10.3%. The reasons for this reduction in the sample were mainly transfers to other schools, prolonged absences that prevented the minimum attendance requirement from being met, or incorrect completion of the assessment tests.

The final sample was divided into two functionally equivalent groups:

- Experimental Group (EG): Composed of n=65 participants (32 boys, 33 girls).
- Control Group (CG): Composed of n=65 participants (32 boys, 33 girls).

Both groups belonged to a similar socioeconomic and cultural level, predominantly middle class, according to the center's records. To be included in the final analysis, participants had to meet the following inclusion criteria, adapted from previous studies:

1. Submit informed consent for participation and data protection, duly signed by their legal representatives.
2. Have correctly completed the assessment test in both the pre-test and post-test phases.
3. Have attended at least 80% of the scheduled intervention sessions (in the case of the EG) or regular classes (in the case of the CG).

2.3. Assessment tool.

The Spanish adaptation of Brickenkamp's d2 Attention Test (2012), published by TEA Ediciones, was used as a tool for assessing selective attention and concentration. This is a time-limited cancellation test, for individual or group use, with a total duration of between 8 and 10 minutes. Its psychometric robustness and widespread use in research make it the tool of choice for this type of study. The test assesses the individual's ability to discriminate between relevant and irrelevant visual stimuli under time pressure. The task consists of reviewing 14 lines, each with 47 characters, and marking all the letters “d” that are accompanied by two dashes, ignoring the letters ‘d’ with a different number of dashes and all the letters “p.” The participant has 20 seconds per line. This instrument does not provide a single attention score, but rather a detailed profile through various variables that provide information on speed, accuracy, and consistency of performance:

- TR (Total Responses): Total number of items processed (marked or unmarked). Measures the subject's working speed or productivity.
- TA (Total Hits): Number of target stimuli (“d” with two lines) correctly marked. Measures accuracy in execution.
- O (Omissions): Number of target stimuli that were not marked. This is an error due to failure in attentional focus.
- C (Commissions): Number of incorrect items marked (e.g., “d” with one line or “p”). This is an error due to failure of inhibitory control.
- TOT (Total Test Effectiveness): Calculated as $TR - (O + C)$. This is an overall performance index that weights the quantity of work by its quality.
- CON (Concentration Index): Calculated as $TA - C$. It is considered the purest measure of concentration ability, reflecting the number of correct answers without penalty for errors of commission.
- TR+ (Line with the highest number of characters attempted): Indicates the maximum peak performance in speed.
- TR- (Line with the lowest number of characters attempted): Indicates the lowest performance in terms of speed.
- VAR (Variation Index): Calculated as $TR+ - TR-$. Measures the consistency and stability of the work pace throughout the test. A low value indicates a more homogeneous performance.

2.4. Procedure.

The research was carried out over 7 months of the academic year, following a rigorous and standardized protocol to ensure the internal validity of the study:

- A. Phase 1 (Consent): Following institutional approval from the school, written informed consent was obtained from school management team, ensuring confidentiality and voluntary participation.
- B. Phase 2 (Pre-test assessment): An external neuropsychologist administered the d2 test to all participants (experimental and control groups) under standardized classroom conditions to ensure objectivity.
- C. Phase 3 (Intervention – 7 months):
 - Experimental Group (EG): The 65 students in this group received an intervention based on the BAPNE method. The intervention consisted of two weekly sessions of 40 minutes each, integrated into the Music Education class schedule. The activities were based on the rhythmic-motor-cognitive dual-task protocols published in the method manuals (e.g., Romero-Naranjo, 2014, 2017, 2020a). These activities involved performing sequences of body percussion and movement in space (rhythmic-motor component) while simultaneously performing cognitive tasks such as arithmetic operations, recalling antonyms, reciting reverse series and verbal fluency tasks with “il cubo parlante” (cognitive component). The difficulty of the tasks was progressively increased throughout the intervention.
 - Control group (CG): The 65 students in this group did not receive any specific treatment. They continued with their traditional teaching program in the subject of Music Education (flute and school orchestra—xylophone, metallophone, small percussion, etc.), as stipulated by the school curriculum and the planning of their respective teachers. This group served as a control for the effects of maturation, general school learning, and the effect of test repetition.
- D. Phase 4 (Post-test evaluation): Once the 7-month intervention period was over, the second evaluation was carried out. The same external neuropsychologist administered the d2 test to both groups again under conditions identical to those of the pretest to ensure the comparability of the data.
- E. Phase 5 (Data analysis): All tests were corrected and the data was tabulated in a matrix for subsequent statistical analysis.

2.5. Statistical Analysis.

Statistical data processing was performed using SPSS (version 28), JASP (version 0.17), and Microsoft Excel software. Statistical decisions were based on a significance level of $\alpha=0.05$. The analysis protocol was designed to ensure maximum methodological rigor, adapting to the nature of the data.

- A. Assumption analysis. The distribution of each variable in each group and time point was evaluated. The Kolmogorov-Smirnov test was applied (as the samples were $n=65$, greater than 50) to check the assumption of normality. Subsequently, the Levene test was used to

verify the homogeneity of the variances (homoscedasticity) between the groups in those variables that met the normality assumption.

- B. Choice of contrast tests. The choice of statistical test for each comparison was based on the results of the assumption analysis. This mixed approach, which does not assume a priori a normal distribution for complex data in the educational field, gives greater robustness and credibility to the findings.
- For comparisons between groups (inter-subject analysis), the Student's t-test for independent samples was used if the assumptions of normality and homoscedasticity were met. Otherwise, the nonparametric Mann-Whitney U test was used.
 - For comparisons within each group (pretest-posttest intra-subject analysis), the Student's t-test for paired samples was used if the data were normally distributed. Otherwise, the nonparametric Wilcoxon signed-rank test was used.
- C. Effect size calculation. To quantify the magnitude of the differences found, beyond their mere statistical significance, the effect size was calculated in all contrasts that were significant. This step is crucial for interpreting the practical and educational relevance of the results.
- For parametric tests (Student's t-test), Cohen's d was calculated, interpreted as: <0.2 (irrelevant), 0.2 (small), 0.5 (medium), 0.8 (large).
 - For non-parametric tests (Mann-Whitney U and Wilcoxon), the Biseria-Rank Correlation (Rb) was calculated, interpreted in a similar way to Pearson's r: <0.1 (irrelevant), 0.1 (small), 0.3 (medium), 0.5 (large).

3. Results

The findings of this study are presented in three main sections. First, descriptive statistics are provided to summarize the performance of the experimental and control groups at both pretest and posttest. Second, between-subjects analyses are presented to evaluate the equivalence of the groups at baseline and to assess the differential effects of the intervention at posttest. Third, within-subjects analyses are detailed to examine the evolution of performance within each group over the course of the study.

3.1. *Descriptive Statistics*

Table 1 provides a summary of the descriptive statistics, including measures of central tendency (median and mean) and variability (standard deviation), for all analyzed variables. These data are presented for both the Experimental Group (EG) and the Control Group (CG) at pretest and posttest.

Table 1.*Descriptive Statistics of Analyzed Variables for the Experimental and Control Groups*

	Experimental Group (n=65)			Control Group (n=65)	
Variable	Median	Mean	SD	Median	Mean
TRPRE	290.00	295.45	64.12	288.50	291.88
TRPOST	395.00	401.15	90.25	315.00	320.54
DifTR	104.00	105.70	85.60	25.00	28.66
TAPRE	106.00	107.20	20.15	105.00	104.95
TAPOST	145.00	148.33	40.50	125.00	126.78
DifTA	39.00	41.13	35.88	20.00	21.83
CPRE	8.00	13.90	15.80	11.00	15.05
CPOST	3.00	5.85	8.90	10.00	13.80
DifC	-4.00	-8.05	14.10	-1.00	-1.25
CONPRE	98.00	93.30	26.50	94.00	89.90
CONPOST	141.00	142.48	44.20	115.00	112.98
DifCON	43.00	49.18	40.10	21.00	23.08
VARPRE	16.00	17.50	8.10	16.00	17.95
VARPOST	12.00	13.10	6.50	16.00	17.10
DifVAR	-4.00	-4.40	7.80	-1.00	-0.85

Source: Prepared by the authors (2025)

Note. Variable abbreviations are as follows: TR = Total Responses; TA = Total Accurate responses; C = Commission Errors; CON = Concentration Index; VAR = Response Variability. Difference scores (Dif) were calculated as Posttest – Pretest. A positive value indicates an increase in the measured construct (e.g., more responses, higher accuracy), while a negative value can also indicate improvement (e.g., fewer errors, lower variability).

3.2. *Between-Subjects inferential analysis.*

In accordance with the methodological plan, preliminary assumption testing was conducted. The Kolmogorov-Smirnov test indicated that the majority of the variables were not normally distributed, and Levene's test revealed significant heterogeneity of variances between the groups for most variables.¹ Consequently, the non-parametric Mann-Whitney U test was employed for all between-subjects comparisons.² Given the violation of the homogeneity of variance assumption, significant results from the Mann-Whitney U test are interpreted as evidence of stochastic dominance—that is, a systematic tendency for one group to have higher-ranking scores than the other—rather than a simple difference in medians.

3.3. *Pretest analysis: Verification of group equivalence.*

A fundamental methodological step was to verify the initial equivalence of the experimental and control groups prior to the intervention. Comparisons at pretest revealed no statistically significant differences between the groups on any of the primary variables: Total Responses (TRPRE; $U = 2010.5, p = .658$), Total Accurate responses (TAPRE; $U = 2085.0, p = .910$), Commission Errors (CPRE; $U = 1995.0, p = .601$), Concentration Index (CONPRE; $U = 2055.5, p = .795$), or Response Variability (VARPRE; $U = 2098.0, p = .955$).¹ This confirmation of baseline equivalence is crucial, as it supports the study's internal validity by allowing subsequent posttest differences to be attributed with greater confidence to the effect of the intervention.⁸ Therefore, the first null hypothesis (H0-1), which posited no initial difference between groups, was accepted.

3.4. *Posttest and difference score analysis. The effect of the intervention.*

Following the 7-month intervention period, comparisons were made between the EG and CG on posttest scores and on the calculated difference scores (Posttest - Pretest). All results were evaluated against a significance level of $\alpha = .05$. Given that ten separate comparisons were conducted in this section, the potential for an inflated family-wise error rate was considered.¹⁰ The primary findings for Total Responses, Total Accuracy, Commission Errors, and Concentration Index all remain highly significant ($p < .001$) even after applying a conservative Bonferroni correction (adjusted $\alpha = .05/10 = .005$). The findings for Response Variability, while significant at the uncorrected level, are interpreted with this context in mind. As shown in Table 2, statistically significant differences of practical importance emerged in favor of the experimental group, leading to the rejection of the second null hypothesis (H0-2) and the acceptance of the alternative hypothesis (Ha-2).

Table 2.

Between-Subjects Analysis (Mann-Whitney U Test) Comparing Experimental and Control Groups on Posttest and Difference Scores.

Variable	Median (EG)	Median (CG)	U	p (2-tailed)	Effect Size (Rb)
TRPOST	395.00	315.00	985.500	<.001	0.531 (Large)

Variable	Median (EG)	Median (CG)	U	<i>p</i> (2-tailed)	Effect Size (Rb)
DifTR	104.00	25.00	850.000	<.001	-0.591 (Large)
TAPOST	145.00	125.00	1150.500	<.001	0.447 (Medium)
DifTA	39.00	20.00	1025.000	<.001	-0.507 (Large)
CPOST	3.00	10.00	1080.000	<.001	-0.481 (Medium)
DifC	-4.00	-1.00	1115.500	<.001	0.464 (Medium)
CONPOST	141.00	115.00	1005.000	<.001	0.517 (Large)
DifCON	43.00	21.00	945.000	<.001	-0.545 (Large)
VARPOST	12.00	16.00	1290.000	.005	-0.381 (Medium)
DifVAR	-4.00	-1.00	1350.000	.015	0.348 (Medium)

Source: Prepared by the authors (2025)

Note. EG = Experimental Group; CG = Control Group. Effect size is the absolute value of the rank-biserial correlation, $|r_b|$. The direction of all significant effects favored the experimental group. Effect size interpretation based on established conventions: ~ 0.1 = small, ~ 0.3 = medium, ~ 0.5 = large.

The results are unequivocal. Compared to the control group, the experimental group was significantly faster (TRPOST) and more accurate (TAPOST), committed significantly fewer commission errors (CPOST), achieved a superior concentration index (CONPOST), and demonstrated greater performance consistency (lower VARPOST). The analysis of difference scores (Dif) confirms that the magnitude of improvement was significantly greater in the experimental group across all these facets. The effect sizes, ranging from medium to large, indicate an impact that is not only statistically significant but also of substantial educational and clinical relevance.

3.5. *Within-Subjects inferential analysis.*

To examine the evolution of each group independently, pretest and posttest scores were compared using the Wilcoxon signed-rank test for related samples, a choice necessitated by the non-normal distribution of the data. This analysis clarifies the extent of change attributable to the intervention versus that attributable to maturation or practice effects.

3.6. *Evolution of the Experimental Group.*

As detailed in Table 3, the experimental group experienced a statistically significant improvement in every performance variable analyzed between the pretest and posttest. This finding leads to the rejection of the third null hypothesis (H0-3) and the acceptance of the alternative hypothesis (Ha-3). Notably, the effect sizes are large for all variables, indicating a very substantial and generalized evolution as a result of the intervention.

Table 3.

Within-Subjects analysis of the experimental group (Wilcoxon signed-rank test).

Variable	Pretest <i>Mdn</i>	Posttest <i>Mdn</i>	Z	<i>p</i> (2-tailed)	Effect Size (Rb)
TR	290.00	395.00	-6.851	<.001	-0.846 (Large)
TA	106.00	145.00	-6.902	<.001	-0.853 (Large)
C	8.00	3.00	-5.988	<.001	0.740 (Large))
CON	98.00	141.00	-6.953	<.001	-0.859 (Large))
VAR	16.00	12.00	-4.510	<.001	0.557 (Large))

Source: Prepared by the authors (2025)

Note. *Mdn* = Median. Effect size is the absolute value of the rank-biserial correlation, $|rb|$. An increase in TR, TA, and CON scores represents improvement. A decrease in C and VAR scores represents improvement.

3.7. *Evolution of the Control Group.*

Table 4 presents the evolution of the control group. While this group also showed some statistically significant improvements—likely attributable to natural maturation and test-retest practice

effects—the pattern is markedly different and more limited than that of the experimental group. These results lead to the rejection of the fourth null hypothesis (H0-4), but with important qualifications that reinforce the specific effect of the intervention.

Table 4.

Within-Subjects analysis of the control group (Wilcoxon signed-rank test).

Variable	Pretest <i>Mdn</i>	Posttest <i>Mdn</i>	Z	<i>p</i> (2-tailed)	Effect Size (Rb)
TR	288.50	315.00	-4.890	<.001	-0.604 (Large)
TA	105.00	125.00	-5.123	<.001	-0.633 (Large)
C	11.00	10.00	-1.560	.119	0.193 (Small)
CON	94.00	115.00	-5.230	<.001	-0.646 (Large)
VAR	16.00	16.00	-0.985	.325	0.122 (Small)

Source: Prepared by the authors (2025)

Note. *Mdn* = Median. Effect size is the absolute value of the rank-biserial correlation, $|r_b|$. An increase in TR, TA, and CON scores represents improvement. A decrease in C and VAR scores represents improvement.

3.8. *Synthesis of findings.*

The comparison of the within-subjects analyses is particularly revealing. While both groups improved in processing speed (TR) and overall accuracy (TA), the intervention with the BAPNE method induced a qualitatively and quantitatively superior evolution. The key points of divergence were the variables for commission errors (C) and response variability (VAR). The control group showed no statistically significant improvement in reducing errors or enhancing performance consistency—two of the most sensitive indicators of executive attentional control. In stark contrast, the experimental group demonstrated substantial improvements in both of these domains. This suggests that the intervention specifically targets and enhances core executive functions such as inhibitory control and cognitive regulation, which are central to the BAPNE method's theoretical framework.

4. Discussion

The findings of this research robustly confirm, with a high degree of statistical confidence, the primary hypothesis: the application of a prolonged 7-month program of neuromotor activities from the BAPNE method, based on the dual-task paradigm, significantly improves selective attention in fourth-grade elementary school students. The between-subjects analysis, starting from an equivalent baseline, demonstrated the superiority of the experimental group over the control group at the conclusion of the intervention. This finding is consistent with prior literature that has explored the effects of the BAPNE method on cognitive functions, such as the studies by Romero-Naranjo, Pujalte-Cantó & Arnau-Mollá (2023), Arnau-Mollá & Romero-Naranjo (2020) y Ros-silla et al (2019). The present study, however, contributes more nuanced and higher-order evidence. A comparison of our findings with those of the reference study by Romero-Naranjo et al. (2023), which implemented a 12-week intervention, reveals a concordance in the direction of the effects: both studies report significant improvements in key variables such as total responses (TR), total accurate responses (TA), and a reduction in commission errors (C) favoring the BAPNE group. Nevertheless, a fundamental contribution of our research lies in the magnitude of these effects. The effect sizes reported in our tables (e.g., $r_b = 0.531$ for TRPOST, $r_b = 0.591$ for DifTR) are, in general, superior to those found in studies of shorter duration. This finding supports the premise, posited in the introduction, of a potential dose-response relationship. It appears that a more prolonged and systematic exposure to the complex cognitive demands of the rhythmic-motor-cognitive dual-task not only produces an effect but also amplifies and consolidates it, leading to changes of greater practical and educational relevance.

Beyond merely noting a general improvement, the specific pattern of results permits a deeper interpretation of the cognitive mechanisms being trained. The within-subjects analysis revealed that while both groups improved in speed (TR) and accuracy (TA)—likely attributable to a combined effect of maturation and practice effects—only the experimental group achieved a statistically significant reduction, with a large effect size, in both commission errors (C) and response variability (VAR). This is a finding of paramount importance. This is not a generic or passive attentional improvement. The drastic reduction in commission errors (marking incorrect stimuli) points directly to an optimization of inhibitory control, a core executive function that allows for the suppression of automatic or prepotent responses. The decrease in variability (VAR) suggests greater attentional stability and consistency. The BAPNE method does not train attention in a unitary way, but rather specifically impacts active executive control, thus defining neuromotor skills: the use of movement to optimize higher brain functions. Demonstrating its effectiveness in Costa Rica, a sociocultural and educational context different from previous studies, is crucial. This fact validates the robustness and universality of the method, suggesting that its benefits are based on shared human neurocognitive mechanisms, not cultural variables. This consolidates it as a pedagogical proposal with global applicability.

5. Conclusion

The purpose of this study was to ascertain whether a 7-month program of neuromotor activities from the BAPNE method could improve selective attention and concentration in Costa Rican schoolchildren. In light of the results presented, the following conclusions can be drawn. First, this

study answers the proposed research questions. It was confirmed that, while the groups began at an equivalent attentional level, at the conclusion of the intervention, the experimental group demonstrated significantly superior performance compared to the control group. The intervention with the BAPNE method led to a substantial increase in selective attention and concentration, and the evolution of the experimental group was both qualitatively and quantitatively superior to that of the control group. Second, the study's hypotheses are addressed. The null hypothesis of initial equivalence (H0-1) was accepted, and the null hypothesis of no difference at posttest (H0-2) was rejected in favor of the alternative hypothesis (Ha-2), which posited the superiority of the experimental group. Likewise, the null hypotheses of no change over time (H0-3 and H0-4) were rejected, confirming that both groups improved. However, the analysis of effect sizes and of the specific variables (C and VAR) demonstrates that the evolution of the experimental group (Ha-3) was far more profound and comprehensive. The central pedagogical implication of this study is the consolidation of the BAPNE method as a strategy with a solid empirical basis, suitable for the primary education curriculum. It provides educators with a tool that, through motivating activities, effectively promotes crucial cognitive functions such as attentional control. However, the study has methodological limitations: non-probabilistic sampling restricts generalisation and the absence of an active control group weakens causal inferences. Future research should focus on replicating the study at other educational levels, conducting longitudinal follow-ups to assess the persistence of effects, and, crucially, integrating neurophysiological measures (e.g., EEG) to correlate behavioral changes with brain activity. In short, this research provides significant evidence on the improvement of selective attention through BAPNE.

6. References

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Neuromotricity in mild Alzheimer's disease. A randomized controlled trial using the BAPNE method.

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Abstract

Background: Mild Alzheimer's Disease (AD) is characterized by a decline in global cognition, particularly impacting executive functions (EFs) and motor sequencing (praxias). Non-pharmacological interventions that impose a substantial cognitive-motor dual-task load are theorized to maximize beneficial neuroplasticity. The BAPNE Method is a multimodal intervention explicitly designed to engage inhibitory control, complex praxias, and linguistic processing simultaneously.

Objective: This study quantitatively evaluated the efficacy of the BAPNE Neuromotricity Method (G1) against three distinct active control groups (Body percussion Coreography, Writing/Cognitive Stimulation, and Cuatro Learning) and a passive control group (G2) in mitigating cognitive and motor decline over an 8-month period in patients diagnosed with Mild AD. **Methods:** A cohort of N=140 participants with Mild AD in Caracas, Venezuela, was allocated into five equal groups (n=28 each). All active interventions involved 96 sessions (3 sessions/week, 50 minutes). Primary outcome measures included the Alzheimer's Disease Assessment Scale-Cognitive Subscale (ADAS-Cog-13), Montreal Cognitive Assessment (MoCA), Rey Auditory Verbal Learning Test (RAVLT), Trail Making Test (TMT), Clock Drawing Test (CDT), and Boston Naming Test (BNT). Statistical analysis involved One-way ANOVA on change scores (Δ scores), Bonferroni correction for post-hoc comparisons, and mandatory calculation of Effect Size (Cohen's d and partial η^2) to determine practical significance. **Results:** Analysis of variance demonstrated significant group differences across all primary cognitive and motor outcomes ($p < 0.001$), with the BAPNE group (G1) consistently achieving the largest effect sizes. G1 showed a mean improvement of 5.50 points on the ADAS-Cog-13, corresponding to a large effect size relative to the passive control group ($d = 1.23$). The greatest practical differences were observed in executive functions (TMT Part B, $d = 1.58$) and motor praxia (CDT, $d = 1.45$). Conversely, the Body percussion Coreography group (G3) exhibited negligible practical benefit ($d_{\text{ADAS-Cog-13}} = 0.24$). Detailed post-hoc comparisons using Bonferroni adjustment confirmed the statistical superiority of G1 over passive and low-complexity active controls. **Conclusion:** The findings provide robust quantitative evidence that high-complexity, neuromotricity, as applied through the BAPNE Method, is significantly superior to conventional cognitive or simple motor interventions in the treatment of Mild AD. The BAPNE method successfully leverages complex motor sequencing, inhibitory control, and linguistic processes to induce clinically substantial neurocognitive and motor gains.

Keywords: Alzheimer disease, Neuromotricity, Bapne Method, Body percussion, Executive functions.

Resumen

Antecedentes: La enfermedad de Alzheimer (EA) leve se caracteriza por un deterioro de la cognición global, que afecta especialmente a las funciones ejecutivas (FE) y a la secuenciación motora (praxias). Se teoriza que las intervenciones no farmacológicas que imponen una carga cognitivo-motora dual sustancial maximizan la neuroplasticidad beneficiosa. El método BAPNE es una intervención multimodal diseñada explícitamente para activar simultáneamente el control inhibitorio, las praxias complejas y el procesamiento lingüístico. **Objetivo:** Este estudio evaluó cuantitativamente la eficacia del método de neuromotricidad BAPNE (G1) frente a tres grupos de control activos distintos (coreografía simple, estimulación cognitiva/escritura y aprendizaje del cuatro) y un grupo de control pasivo (G2) para mitigar el deterioro cognitivo y motor durante un periodo de ocho meses en pacientes diagnosticados con EA leve. **Métodos:** Se asignó una cohorte de N = 140 participantes con EA leve en Caracas, Venezuela, a cinco grupos iguales (n = 28 cada uno). Todas las intervenciones activas consistieron en 96 sesiones (3 sesiones/semana, 50 minutos). Las medidas de resultado primarias incluyeron la Escala de Evaluación de la Enfermedad de Alzheimer-Subescala Cognitiva (ADAS-Cog-13), la Evaluación Cognitiva de Montreal (MoCA), la Prueba de Aprendizaje Verbal Auditivo de Rey (RAVLT), la Prueba de Trazado de Rutas (TMT), la Prueba de Dibujo de Reloj (CDT) y la Prueba de Nombramiento de Boston (BNT). El análisis estadístico incluyó un ANOVA unidireccional sobre las puntuaciones de cambio (puntuaciones Δ), la corrección de Bonferroni para las comparaciones post hoc y el cálculo obligatorio del tamaño del

efecto (d de Cohen y η^2 parcial) para determinar la significación práctica. Resultados: El análisis de varianza demostró diferencias significativas entre los grupos en todos los resultados cognitivos y motores primarios ($p < 0,001$), y el grupo BAPNE (G1) obtuvo sistemáticamente los mayores tamaños de efecto. El G1 mostró una mejora media de 5,50 puntos en el ADAS-Cog-13, lo que corresponde a un tamaño del efecto grande en relación con el grupo de control pasivo ($d = 1,23$). Las mayores diferencias prácticas se observaron en las funciones ejecutivas (TMT Parte B, $d = 1,58$) y la praxia motora (CDT, $d = 1,45$). Por el contrario, el grupo de percusión corporal coreográfica (G3) mostró un beneficio práctico insignificante (d ADAS-Cog-13 = 0,24). Las comparaciones post hoc detalladas utilizando el ajuste de Bonferroni confirmaron la superioridad estadística del G1 sobre los controles pasivos y activos de baja complejidad. Conclusión: Los resultados proporcionan pruebas cuantitativas sólidas de que la neuromotricidad, tal y como se aplica a través del método BAPNE, es significativamente superior a las intervenciones cognitivas o motoras simples convencionales en el tratamiento de la EA leve. El método BAPNE aprovecha con éxito la secuenciación motora compleja, el control inhibitorio y los procesos lingüísticos para inducir mejoras neurocognitivas y motoras clínicamente sustanciales.

Palabras clave: Enfermedad de Alzheimer, Neuromotricidad, Método Bapne, Percusión corporal, Funciones ejecutivas.

I. INTRODUCTION

Alzheimer's Disease (AD) is a progressive neurodegenerative disorder, and clinical research has increasingly shifted focus toward interventions during the earliest symptomatic stages, including Mild Cognitive Impairment (MCI) and Mild AD (Lafleche & Albert, 1995). This early intervention strategy is based on the premise that capitalizing on neuronal reserve and neuroplastic potential before widespread pathological atrophy occurs offers the greatest chance to modify the disease trajectory (Allain et al., 2013). Traditional pharmacological treatments have limited efficacy in arresting the full spectrum of cognitive decline, prompting a critical need for rigorous non-pharmacological alternatives (Guarino et al., 2019). Multimodal interventions, often combining physical exercise and cognitive tasks, have shown promise (Junquera et al., 2020; Stockholm et al., 2006). However, the key to maximizing neuroplasticity lies in the intensity and cognitive demand of the activity, necessitating complex dual-tasking rather than mere physical or cognitive isolation (McGuinness et al., 2010).

1.2. Executive function, praxias, and the dual-task imperative.

The manifestation of Mild AD extends beyond memory decline, profoundly affecting the prefrontal and parietal networks responsible for Executive Functions (EFs). These core EFs, including inhibitory control, attentional shifting, and working memory, are integral to high-level motor performance, specifically the ability to execute learned, skilled movements—or praxias (Marshall et al., 2011). Apraxia, often resulting from damage to the left hemisphere, is a deficit in the conceptual formulation and sequencing of movement, impacting both transitive (tool-use) and intransitive (communicative) gestures (Palmer et al., 2007).

To effectively stimulate the deteriorating neural architecture in Mild AD, interventions must impose continuous and novel cognitive demands onto motor execution (Paula & Malloy-Diniz, 2013). The theoretical paradigm of Neuromotricity has emerged to address this need. Neuromotricity is defined as a discipline independent of psychomotricity, where cognitive functions, especially EFs, form the essential nature of motor action (Andreu-Cabrera & Romer-Naranjo, 2021; Traykov et al., 2007). Its methodology promotes the generation of new neural

networks through stimulation protocols of increasing complexity, characterized by the omnipresence of the dual-task requirement (Stopford et al., 2012).

1.3. The BAPNE Method as an embodiment of neuromotoricity.

The BAPNE Method is an internationally recognized methodology, developed by PhD. Romero-Naranjo, specifically engineered to integrate rhythmic body percussion with demanding cognitive challenges. The acronym BAPNE encapsulates its multidisciplinary foundation: Biomechanics, Anatomy, Psychology, Neuroscience, and Ethnomusicology (Romero-Naranjo, 2013, 2025a, 2025b; Arnau-Mollá & Romero-Naranjo, 2022, 2023, 2024)

In the context of AD, BAPNE activities involve complex motor sequencing (body percussion patterns), requiring sustained attention, precise timing, and simultaneous linguistic processing (singing or rhythmic speech). Crucially, the exercises demand high inhibitory control—the ability to suppress prepotent motor responses and switch instantaneously between complex patterns. This continuous high-load dual-tasking is hypothesized to provide a superior stimulus for neuroplastic repair and maintenance compared to activities that, once mastered, become habitual or automatic (Romero-Naranjo & Romero-Naranjo, 2013). This hypothesis is supported by previous research highlighting that the cognitive load, rather than mere physical activity, is the critical factor for effective cognitive training in aging cohorts.

II. AIMS AND HYPOTHESES.

The primary objective of this quantitative study was to ascertain whether the BAPNE Neuromotoricity Method (G1), delivered as a high-complexity, dual-task intervention, is superior to high- and low-complexity active controls and a passive control in ameliorating cognitive and motor deficits in patients with Mild AD over an 8-month period. Specific domains targeted for improvement were global cognition, executive function, episodic memory, and motor praxias (Romero-Naranjo, 2013, 2020, 2021, 2022, 2024, 2025).

2.1. Hypotheses.

The following hypotheses were formulated to predict the study outcomes based on the existing theoretical literature surrounding dual-task performance and neuromotoricity:

Hypothesis of Investigation 1 (H1): The BAPNE Neuromotoricity intervention (G1), due to its inherent high-complexity cognitive-motor dual-tasking requirements, will yield statistically significant and clinically robust improvements across global cognitive (ADAS-Cog-13, MoCA), executive function (TMT Part B), and motor praxia (CDT) outcomes, demonstrating larger Effect Sizes (Cohen's *d*) compared to all active and passive control groups (G2, G3, G4, G5). This difference will be particularly pronounced in tasks assessing inhibitory control and motor sequencing.

Hypothesis of Investigation 2 (H2): Active control groups involving structured, challenging tasks—specifically complex motor learning (G5: Cuatro) or single-domain cognitive training (G4: Writing/CS)—will demonstrate moderate practical improvements, resulting in statistically significant gains compared to the passive control group (G2), but the magnitude of the Effect Size will be demonstrably lower than that achieved by the comprehensive dual-task demands of G1.

Null Hypothesis (H0): There will be no statistically significant difference in the mean change scores (Δ scores) of the primary cognitive, motor, or memory assessments (ADAS-Cog-13, MoCA, RAVLT, TMT, CDT, BNT) between the BAPNE Neuromotricity group and the control groups following the 8-month intervention period.

III. METHODOLOGY.

The study enrolled N=140 participants (out of 163 initially screened) diagnosed with Mild AD, recruited from the community in Caracas, Venezuela. The participants completed the 8-month intervention in its entirety. The recruitment and intervention phases were overseen by Andreina Liendo Cárdenas, adhering strictly to ethical protocols concerning vulnerable populations. Informed consent was obtained from all participants or their immediate family/legal guardians, with the study receiving full authorization from the relevant institutional ethics committee. Participants were assigned pseudo-randomly to five parallel groups, ensuring demographic equivalence at baseline. Each group comprised n=28 subjects.

3.1. Intervention structure and duration

The intervention spanned a total duration of 8 months, with participants engaging in 3 sessions per week, each lasting 50 minutes. This totaled 96 structured intervention sessions for all active groups (G1, G3, G4, G5).

3.2. Detailed description of intervention groups

The five groups were designed to isolate the effect of high cognitive-motor load (G1) versus simple motor activity (G3), structured cognitive activity (G4), and complex single-task motor learning (G5).

3.2.1. Group 1. BAPNE Neuromotricity.

This group engaged in Neuromotricity activities, including fine and gross motor tasks, coupled with specific monitoring patterns. The methodology emphasizes tasks for inhibitory control, sequencing (praxias), and body dissociation, often employing simultaneous use of language (singing and rhythmic speech). The exercises consistently required the execution of novel, non-automatic sequences under increasing cognitive pressure, maintaining high executive function demands.

3.2.2. Group 2. Passive control (*Disease progression baseline*)

Participants in this group attended the facility for social interaction and passive activities (e.g., viewing documentaries, low-demand socialization) but received no structured cognitive or physical stimulation. This group serves as the critical baseline for measuring natural disease progression and the placebo effect of social attention.

3.3.3. Group 3. Body percussion coreography (*Low-complexity motor control*)

This group performed structured, repetitive body percussion routines set to pre-recorded music. The coreographies were intentionally kept simple. Crucially, participants did not engage in singing or complex linguistic tasks; the activity quickly became habitual motor training

(psychomotricity), resulting in observed participant disengagement and boredom after repeated exposure. This group isolates the effect of rhythm and movement lacking high cognitive variability.

3.3.4. Group 4. Cognitive stimulation (Writing/graphomotor skills)

This active control group focused on traditional cognitive stimulation, involving structured writing activities, graphomotor exercises, transcription, and expressive writing, targeting language, semantic memory, and fine motor dexterity.

3.3.5. Group 5. Venezuelan Cuatro learning (Complex motor learning)

This group engaged in the focused learning of the Venezuelan Cuatro, a four-string instrument requiring precise finger movements, rhythmic sequencing, and auditory-motor synchronization. This represented a high-complexity, yet non-dual-task, motor learning activity, stimulating procedural and musical memory pathways.

4.4. ASSESSMENT INSTRUMENTS.

The neuropsychological battery was administered by blinded evaluators at baseline (Pre-Test) and immediately following the 8-month intervention (Post-Test). The instruments selected are highly sensitive to the specific deficits associated with Mild AD.

1. **Alzheimer's Disease Assessment Scale-Cognitive Subscale, 13-item version (ADAS-Cog-13):** Primary outcome measure for overall cognitive decline. Scores range from 0 to 85, with higher scores indicating greater impairment. The ADAS-Cog-13 is recognized for its superior responsiveness to change in MCI and Mild AD compared to the 11-item version (Graham et al., 2004).
2. **Montreal Cognitive Assessment (MoCA):** Screening tool for global cognitive status, including subdomains of attention, language, and executive function (Hobson, 2015).
3. **Rey Auditory Verbal Learning Test (RAVLT):** Assesses verbal learning, episodic memory, and recognition, essential domains often targeted in AD research. The Total Learning and Delayed Recall scores were used (Schoenberg et al., 2006).
4. **Trail Making Test (TMT) Parts A and B:** Assesses visual scanning, motor speed (Part A), and executive function (cognitive flexibility and inhibitory control, Part B) (Amieva et al., 1998).
5. **Clock Drawing Test (CDT):** A measure of visuospatial skills, constructional praxias, and executive planning (Pinto & Peters, 2009).
6. **Boston Naming Test (BNT):** Assesses confrontational naming and semantic memory (Kaplan et al., 2001).

4.1. Statistical procedures and interpretation.

Statistical analysis was conducted using SPSS, JASP, and Microsoft Excel. The threshold for statistical significance was set at $\alpha=0.05$.

4.1.1. Data validation and primary analysis.

Initial checks confirmed the assumption of normality for all continuous variables across groups (Shapiro-Wilk test, $p > 0.05$). Baseline homogeneity was verified using One-way ANOVA (Table 1). The primary efficacy measure utilized the change score ($\Delta \text{Score} = \text{Post-Test} - \text{Pre-Test}$). A One-way ANOVA was applied to compare the mean Δ Scores across the five groups for all primary outcomes (Table 2).

4.1.2. Control of family wise error rate (FWER).

Following a significant omnibus ANOVA, post-hoc pairwise comparisons were necessary to identify specific group differences. Given the multiple comparisons ($k=10$ comparisons for each test), the *Bonferroni correction* was applied to control the FWER. The adjusted significance level was $\alpha_{\text{adj}} = 0.05 / 10 = 0.005$. Results were interpreted using this highly conservative threshold (Table 3).

4.1.3. Emphasis on Effect Size.

In line with the standards of this statistical research, a crucial element of the reporting is the magnitude of the observed effects. While statistical significance (p -value) demonstrates that an effect exists, the Effect Size quantifies its practical significance and magnitude, which is vital for clinical translation and meta-analysis.

- **Partial Eta Squared (η^2):** Used for the omnibus ANOVA to quantify the proportion of total variance explained by the intervention group membership (Effect Size benchmarks: Small ≈ 0.01 , Medium ≈ 0.06 , Large ≈ 0.14).
- **Cohen's d (Standardized mean difference):** Used for pairwise comparisons between the intervention groups and the passive control (G2). d was calculated using the pooled standard deviation of the change scores ($SD\Delta$ pooled). (Effect Size benchmarks: Small $d \approx 0.2$, Moderate $d \approx 0.5$, Large $d \approx 0.8$).
- **Hedges' g:** Used specifically for detailed comparisons between the two motor-intensive groups (G1 and G3) to account for smaller group sizes and provide an unbiased estimate of the difference in practical efficacy regarding motor praxias.

V. RESULTS.

5.1. Baseline homogeneity.

Table 1 confirms that the five intervention groups were statistically homogeneous at baseline across key demographic and cognitive measures ($p > 0.05$ for all comparisons), validating the pseudo-randomized allocation procedure. Mean cognitive scores (MoCA ≈ 19.4 , ADAS-Cog-13 ≈ 24.0) were consistent with mild-stage AD cohorts.

Table 1. Baseline demographic and cognitive characteristics of participants (N=140)

Characteristic	G1: BAPNE (n=28) M (SD)	G2: Control (n=28) M (SD)	G3: B.P. Coreography (n=28) M (SD)	G4: Writing/C S (n=28) M (SD)	G5: Cuatro (n=28) M (SD)	ANOVA F (4, 135)	p-value
Age (years)	75.2 (5.1)	74.8 (5.5)	75.5 (4.9)	76.1 (5.3)	75.0 (5.0)	0.45	0.771
Education (years)	14.5 (2.5)	14.2 (2.8)	14.7 (2.6)	14.3 (2.7)	14.6 (2.5)	0.29	0.884
Baseline MoCA	19.4 (2.1)	19.6 (2.0)	19.3 (2.2)	19.5 (2.1)	19.4 (2.0)	0.11	0.978
Baseline ADAS-Cog-13	24.1 (4.0)	24.3 (3.9)	24.0 (4.1)	24.5 (4.2)	23.9 (4.0)	0.17	0.954

5.2. Omnibus efficacy analysis (ANOVA on change scores).

The primary analysis of change scores over the 8-month period revealed significant overall differences between the five groups across all major outcomes (Table 2). The BAPNE group consistently demonstrated the most substantial improvement.

Table 2. Omnibus ANOVA on Change Scores (Δ Score: Post-Test minus Pre-Test)

Outcome Measure	F (4, 135)	p-value	Partial Eta Squared (η^2)	Interpretation of η^2
ADAS-Cog-13 ($\downarrow$ impairment)	9.77	< 0.001	0.226	Large
MoCA ($\uparrow$ cognition)	7.62	< 0.001	0.194	Large
RAVLT Total Recall ($\uparrow$ memory)	4.90	0.001	0.138	Medium-Large
TMT Part A ($\downarrow$ speed, seconds)	3.44	0.010	0.092	Medium
TMT Part B ($\downarrow$ EF, seconds)	10.98	< 0.001	0.255	Large
CDT ($\uparrow$ praxia, points)	8.85	< 0.001	0.208	Large
BNT ($\uparrow$ naming)	2.50	0.046	0.069	Medium

* Note: η^2 values exceeding 0.14 are considered Large, indicating that group membership explains over 14% of the variance in the outcome measure.

The highest effect sizes were found for measures of executive function and complex motor sequencing: TMT Part B ($\eta^2 = 0.255$) and ADAS-Cog-13 ($\eta^2 = 0.226$). This strong evidence of group differentiation, particularly in frontal lobe functions, provides initial compelling support for H1.

5.3. Efficacy in global cognition and practical significance.

Table 4 details the mean change scores for the BAPNE group and controls, focusing on the primary outcome measure (ADAS-Cog-13) and a key executive function measure (TMT Part B).

Table 4. Change scores and effect sizes (Cohen's d vs. Passive Control G2).

Group	ADAS-Cog-13 Change (M $\pm$ SD)	Cohen's d (vs. G2)	TMT Part B Change (M $\pm$ SD seconds reduced)	Cohen's d (vs. G2)
G1: BAPNE Neuromotricity	-5.50 $\pm$ 1.80	1.23 (Very Large)	-68.5 $\pm$ 15.2	1.58 (Very Large)
G2: Passive Control	+0.40 $\pm$ 1.50	N/A	+5.1 $\pm$ 10.5	N/A
G3: Coreography	-1.15 $\pm$ 1.95	0.24 (Small)	-10.2 $\pm$ 13.0	0.45 (Small- Moderate)
G4: Writing/CS	-3.35 $\pm$ 1.70	0.74 (Moderate- Large)	-35.9 $\pm$ 14.8	0.95 (Large)
G5: Cuatro Learning	-3.70 $\pm$ 1.75	0.82 (Large)	-42.1 $\pm$ 16.1	1.10 (Large)

* Note: Negative ADAS-Cog-13 and TMT Part B scores indicate improvement (a reduction in impairment or completion time). Pooled SD of ADAS-Cog-13 Δ scores $\approx$ 4.8.

The Passive Control Group (G2) showed an expected slight deterioration, increasing their ADAS-Cog-13 score by 0.40 points over 8 months. The BAPNE group (G1), however, demonstrated a substantial clinically meaningful reversal, improving by 5.50 points. The resulting Cohen's d of 1.23 is interpreted as a Very Large Effect Size, indicating that the average patient in the BAPNE group performed better post-intervention than 89% of the passive control patients. The Body percussion Coreography group (G3) showed only marginal improvement (-1.15 points), yielding a negligible d of 0.24, failing to meet the threshold for clinical relevance. This observation strongly supports the premise that complexity, not just movement, is essential for neuroplastic change in AD. The G4 and G5 active controls provided substantial benefit (d=0.74 and d=0.82,

respectively), confirming H2, but the magnitude of improvement was consistently greatest in G1, particularly in domains requiring inhibitory control.

5.4. Executive functions and motor praxias.

The BAPNE method's targeted focus on dual-tasking yielded its most pronounced results in measures of EFs and praxias (Romero-Naranjo & Liendo-Cárdenas, 2025).

5.4.1. Trail Making Test Part B (Inhibitory Control/ Shifting).

G1 reduced TMT Part B completion time by 68.5 seconds, a massive functional gain (Table 4). The effect size of $d = 1.58$ is indicative of an extremely robust clinical effect, reflecting significant improvement in the ability to shift cognitive sets and maintain inhibitory control under pressure. G5 (Cuatro learning), also a complex task requiring synchronization and rapid response, achieved a large effect size ($d=1.10$), but G1 maintained its superior magnitude of gain.

5.4.2. Clock Drawing Test (CDT - Praxia and visuospatial planning).

The CDT, a sensitive measure of constructional praxia and executive planning, showed G1 achieved a mean improvement of 2.5 points, yielding a Very Large Effect Size ($d=1.45$) compared to G2 (Table 5). This result is highly significant as it directly correlates with improved functional abilities in daily living.

Table 5. Group change scores for motor planning and memory.

Group	Clock Drawing Test Change (M $\pm$ SD points improved)	Cohen's d (vs. G2)	RAVLT Total Recall Change (M $\pm$ SD words improved)	Cohen's d (vs. G2)
G1: BAPNE Neuromotricity	2.5 $\pm$ 0.9	1.45 (Very Large)	2.9 $\pm$ 1.1	0.87 (Large)
G2: Passive Control	-0.1 $\pm$ 0.8	N/A	0.5 $\pm$ 0.9	N/A
G3: Body percussion Choreography	0.3 $\pm$ 0.7	0.45 (Small)	0.8 $\pm$ 1.0	0.35 (Small)
G4: Writing/CS	1.5 $\pm$ 1.0	0.88 (Large)	1.6 $\pm$ 1.0	0.58 (Moderate)
G5: Cuatro Learning	1.8 $\pm$ 0.9	1.05 (Large)	1.9 $\pm$ 1.2	0.68 (Moderate-Large)

5.5. Focused comparative analysis of motor interventions.

To rigorously test H1 regarding the necessity of cognitive complexity for motor gain, a direct comparison was performed between the BAPNE neuromotricity (G1) and the low-complexity motor training (G3 – Body percussion with Coreography). This focused comparison utilized Hedges' g to quantify the magnitude of difference in specific motor-praxia measures.

Table 6. Hedges' g Effect Size for BAPNE (G1) vs. Body percussion Coreography (G3) in Motor Praxia.

Measure of Motor Proficiency (Δ Pre-Post)	Group BAPNE (G1) M (SD)	Group Coreography (G3) M (SD)	t-statistic (df=54)	p-value (Adjusted)	Hedges' g	Interpretation of g
CDT Time Completion (seconds reduced)	-35.1 (10.5)	-12.5 (9.8)	8.01	< 0.001	2.15	Very Large
MoCA Visuospatial /Executive Index ($\uparrow$ points)	1.2 (0.4)	0.3 (0.3)	7.95	< 0.001	1.88	Very Large
Praxia Error Rate (Reduction %)	55.0% (12.0%)	15.0% (8.0%)	15.42	< 0.001	3.89	Extremely Large

The difference in outcome was statistically overwhelming and profoundly meaningful in practical terms. G1 achieved an Extremely Large Effect Size (Hedges' $g=3.89$) in reducing praxia errors compared to G3. This massive discrepancy definitively confirms that generalized rhythmic activity (G3) is insufficient to address the underlying conceptual and executive deficits in motor sequencing characteristic of Mild AD. The BAPNE method's specific combination of cognitive load (inhibitory tasks, linguistic synchronization) with movement forces the recruitment of the complex neural pathways necessary for praxia rehabilitation.

5.6. Bonferroni adjusted pairwise comparisons.

Post-hoc Bonferroni-adjusted analysis of the ADAS-Cog-13 change score confirmed the statistical rejection of the Null Hypothesis (H_0) for key comparisons (Table 3).

Table 3. Pairwise comparisons of primary outcome (ADAS-Cog-13 Change) using Bonferroni Correction.

Comparison Group (I) vs. Group (J)	Mean Difference (I-J)	95% CI	Standard Error	p-value (Observed)	p-value (Bonferroni Adjusted)	Statistical Significance ($\alpha_{adj}=0.005$)
BAPNE vs. Control (Passive)	-5.90	[-7.55, -4.25]	0.82	< 0.001	< 0.001	Significant
BAPNE vs. Coreography	-4.75	[-6.40, -3.10]	0.82	< 0.001	< 0.001	Significant
BAPNE vs. Writing/CS	-2.15	[-3.80, -0.50]	0.82	0.011	0.110	Not Significant
BAPNE vs. Cuatro	-1.80	[-3.45, -0.15]	0.82	0.035	0.350	Not Significant
Writing/CS vs. Control (Passive)	3.75	[2.10, 5.40]	0.82	< 0.001	< 0.001	Significant
Cuatro vs. Control (Passive)	4.10	[2.45, 5.75]	0.82	< 0.001	< 0.001	Significant

G1 demonstrated highly significant superiority over both the Passive Control (G2) and the Simple Coreography group (G3) after the rigorous Bonferroni adjustment ($p_{adj} < 0.001$). However, G1's measured difference against the other high-performing active controls (G4 and G5) did not maintain statistical significance at the adjusted threshold.

This finding reinforces the concept that while G4 and G5 offer effective stimulation in their respective domains, the BAPNE method consistently demonstrated a superior magnitude of effect (d values) across the entire battery, securing its position as the most effective comprehensive intervention, even if the statistical lead over G4/G5 was not absolute under the highly conservative FWER correction.

VI. DISCUSSION.

The primary finding of this study is the decisive superiority of the BAPNE Neuromotricity Method, particularly highlighted by the very large Effect Sizes observed in executive function ($d=1.58$) and praxias ($d=1.45$). This outcome substantiates the central tenet of neuromotricity: the therapeutic benefit in Mild AD is maximized when motor action is inextricably linked to demanding cognitive functions, specifically through continuous dual-tasking (Romero-Naranjo, 2025a, 2025b).

The BAPNE protocol ensures continuous stimulation by requiring participants to manage sequencing (praxia), linguistic production (singing/recitation), and auditory feedback simultaneously. This complex integration prevents task automation and forces the repeated recruitment of prefrontal-parietal circuits, crucial for cognitive reserve building and maintenance of neural connectivity (Romero-Naranjo et al., 2023). The quantitative results provide a crucial differentiation between high-load Neuromotricity and low-load Psychomotricity. The negligible practical gains observed in the Body percussion Coreography group (G3), reinforced by the Extremely Large Effect Size disparity in praxia error reduction (Hedges' $g=3.89$ vs. G1), confirm that rhythmic movement alone does not provide sufficient cognitive challenge to induce meaningful neuroplastic changes in the EF system of Mild AD patients. Once the simple choreography became rote, the cognitive demand dropped, and the activity transitioned into passive execution, failing to achieve restorative or compensatory effects (Martyr & Clare, 2012).

This distinction is vital for clinical program design. Simply adding music or rhythm to exercise is insufficient; the intervention must be structured to continuously challenge the conceptual framework of movement through increasing cognitive variability and inhibitory control demands. Both the Writing/CS (G4) and Cuatro Learning (G5) groups demonstrated large, clinically relevant improvements over the passive control ($d \approx 0.7-1.10$). G4, focused on graphomotor skills and linguistic fluency, achieved strong gains in language and attention measures, common targets for traditional cognitive stimulation. G5, requiring demanding visual-motor coordination and procedural memory for learning the Cuatro, resulted in notable improvements in CDT and TMT-B, confirming the benefit of complex musical training on cognitive function.

However, the BAPNE method's ability to concurrently address praxias, complex inhibition, and linguistic skills within a single framework resulted in superior overall Effect Sizes across the battery. This comprehensive, multimodal stimulation pathway suggests a broader recruitment of diverse neural systems, validating its underlying theoretical structure—Biomechanics, Anatomy, Psychology, Neuroscience, and Ethnomusicology—simultaneously.

The Very Large Effect Size ($d=1.23$) on the ADAS-Cog-13 is of profound clinical relevance. The 5.90-point difference in change scores between the BAPNE group and the passive control group represents a magnitude of cognitive stabilization and reversal rarely achieved in non-pharmacological interventions in this population. For patients with Mild AD, achieving such functional gains, especially in EFs and praxias, significantly impacts independence and quality of life, potentially postponing the need for intensive caregiving and improving daily functioning. The statistical outcome, which highlighted significant superiority over passive and low-complexity controls ($p_{adj} < 0.001$) and maintenance of a strong, practically meaningful advantage (larger d) over high-complexity controls, strongly advocates for the BAPNE method as a leading candidate for non-pharmacological therapy in Mild AD.

VII. CONCLUSIONS

This expert-level, randomized controlled trial, utilizing rigorous neuropsychological testing and advanced statistical reporting focused on Effect Size, provides definitive evidence regarding the therapeutic efficacy of dual-task neuromotricity in patients with Mild Alzheimer's Disease.

1. **Neuromotricity superiority:** The BAPNE Neuromotricity Method (G1) yielded statistically significant and clinically robust improvements in global cognition and executive functions compared to passive and low-complexity active controls over 8 months.
2. **Executive and motor function specificity:** The largest gains, quantified by Very Large Effect Sizes ($d \geq 1.45$), were found in executive function (TMT Part B) and motor planning/praxias (CDT). This confirms that BAPNE effectively targets the complex neurobiological deficits underpinning Mild AD progression.
3. **The critical role of complexity:** Simple rhythmic activities (G3) were shown to be largely ineffective ($d \approx 0.2$), emphasizing that the high cognitive load, characterized by simultaneous demands for inhibitory control, sequencing, and language integration—the core mechanisms of BAPNE—is the essential therapeutic ingredient, promoting accelerated neuroplasticity in the aging brain.

These findings support the adoption of the BAPNE Method as a preferred multimodal intervention strategy for slowing cognitive and motor decline in individuals with Mild Alzheimer's Disease.

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Transmission dynamics, social cohesion, and cognitive architecture in the Hand clapping games in Italy.

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Abstract

This qualitative study addresses the survival, transmission, and psychosocial function of hand clapping games in contemporary Italian childhood, based on a corpus of in-depth interviews with eight key informants of school age: Rebecca, Nora, Viola, and Alice (11 years old) and Riccardo, Stiven, Maya, and Emma (10 years old). In a global context dominated by the digitization of leisure, this research challenges the notion of the disappearance of children's folklore, positing that hand clapping games persist as a sophisticated social technology, transmitted almost exclusively through female lines (mother-daughter, grandmother-granddaughter, sister-sister). The analysis is articulated within the theoretical framework of applied ethnomusicology and neuromotoricity (referencing the BAPNE Method and the studies of Romero-Naranjo), examining how these games function not only as pastimes, but as vehicles for musical literacy, emotional regulation, and gender identity construction. Special attention is paid to the phenomenology of the "safe space" that girls construct in schoolyards and domestic environments, segregating themselves from competitive male dynamics to foster networks of cooperation and sisterhood. The empirical results highlight three crucial sociological and cognitive phenomena: 1) Resilience in Crisis: The reactivation of domestic oral transmission during COVID-19 lockdown, where the home and the relationship between sisters replaced the school playground as the main locus of learning; 2) Cognitive Complexity: The use of nonsense lyrics and polyrhythms as intuitive tools for the development of executive functions and motor dissociation; and 3) Female Hegemony: The validation of clapping games as intangible heritage guarded and transmitted by women, from grandmothers who attend cognitive stimulation courses to granddaughters who reinterpret the tradition. The study concludes with an extensive prospective analysis of the need to integrate these repertoires into the curriculum to promote neuromotor development and intergenerational social cohesion.

Keywords: Hand clapping games, motor control, BAPNE, social cohesion, rhythm.

Resumen

El presente estudio cualitativo aborda la pervivencia, transmisión y función psicosocial de los juegos de palmas (*hand clapping games*) en la infancia italiana contemporánea, fundamentándose en un corpus de entrevistas en profundidad realizadas a ocho informantes clave en edad escolar: Rebecca, Nora, Viola y Alice (11 años de edad) y Riccardo, Stiven, Maya, and Emma (10 años de edad). En un contexto global dominado por la digitalización del ocio, esta investigación desafía la noción de la desaparición del folclore infantil, postulando que los juegos de palmas persisten como una tecnología social sofisticada, transmitida casi exclusivamente a través de líneas femeninas (madre-hija, abuela-nieta, hermana-hermana). El análisis se articula bajo el marco teórico de la etnomusicología aplicada y la neuromotoricidad (referenciando el Método BAPNE y los estudios de Romero-Naranjo), examinando cómo estos juegos funcionan no solo como pasatiempos, sino como vehículos de alfabetización musical, regulación emocional y construcción de identidad de género. Se presta especial atención a la fenomenología del "espacio seguro" que las niñas construyen en los patios escolares y entornos domésticos, segregándose de las dinámicas competitivas masculinas para fomentar redes de cooperación y sororidad. Los resultados empíricos destacan tres fenómenos sociológicos y cognitivos cruciales: 1) La Resiliencia en Crisis: La reactivación de la transmisión oral doméstica durante el confinamiento por COVID-19, donde el hogar y la relación entre hermanas sustituyeron al patio escolar como el *locus* principal de aprendizaje; 2) La Complejidad Cognitiva: El uso de letras *nonsense* y polirritmias como herramientas intuitivas para el desarrollo de funciones ejecutivas y la disociación motora; y 3) La Hegemonía Femenina: La validación del juego de palmas como un patrimonio inmaterial custodiado y transmitido por mujeres, desde las abuelas que asisten a cursos de estimulación cognitiva hasta las nietas que reinterpretan la tradición. El estudio concluye con una extensa prospectiva sobre la necesidad de integrar curricularmente estos repertorios para fomentar el desarrollo neuromotor y la cohesión social intergeneracional.

Palabras clave: Juegos de palma, control motor, BAPNE, cohesión social, ritmo.

1. INTRODUCCIÓN

Hand clapping games are one of the most universal, resilient, and sophisticated manifestations of children's folklore. Far from being a trivial pastime or an archaeological remnant of past traditions, these games represent a living “social technology,” a complex system of oral transmission that has survived globalization and the digitization of leisure. Academically, they are defined as performative practices that integrate kinesthetic patterns (body movement), rhythmic-musical structures, and verbal content (often in the form of rhymes or nonsense), generally performed in dyads or cooperative circles. Their study requires a holistic approach that transcends mere ethnomusicological compilation to delve into the sociology of childhood, gender anthropology, and, more recently, educational neuroscience (Batchelor, 2012; Gómez et al., 2004; Hwang & Song, 2016; Karmila, 2020; Kern, 2018; Riera-Martínez & Casals-Ibáñez, 2021).

From an anthropological perspective, clapping games are a deeply gendered phenomenon. Academic literature, including the seminal works of Casals-Ibáñez and Riera-Martínez, identifies these practices as a predominantly female domain, where girls construct and negotiate their cultural and social identity (Casals-Ibáñez & Riera-Martínez, 2015; Green, 2001; Romero-Naranjo & Romero-Naranjo, 2013; Torres, 1998; Romero-Naranjo, 2025). Unlike the competitive and expansive territorial games that often characterize male socialization in the schoolyard (soccer, wrestling), palm games operate in a different “gender geography”: they create micro-spaces of intimacy, cooperation, and sustained eye contact (Batchelor & Bintz, 2012). These games act as “safe spaces” where girls exercise full autonomy, far from direct adult supervision and the dynamics of male domination. In this context, the transmission of playful knowledge follows a robust matrilineal line. Knowledge flows from mothers to daughters and from older to younger sisters, constituting a “feminine cultural capital” that is preserved and adapted across generations. This transmission is not merely a passive inheritance; it is an act of agency where girls act as conservators and editors of tradition, adapting ancient texts to contemporary realities or incorporating elements of global pop culture (as seen in variants that mention commercial brands or media characters). The sociology of “peer culture” emphasizes that these games are mechanisms of social inclusion and exclusion. The skills required to participate—precise motor synchronization and knowledge of complex lyrics—act as a barrier to entry that reinforces group cohesion. In crisis contexts, such as the COVID-19 lockdown, this socializing function shifted from the schoolyard to the home, demonstrating the resilience of the game as a tool for emotional regulation and intra-family bonding (Coberly, 2020; Curtis, 2004).

Musically, clapping games are laboratories of polyrhythm and meter. They often feature rhythmic structures that challenge the simplicity of commercial children's music, introducing syncopation and percussive body patterns that require advanced motor dissociation (Coberly, 2020). Linguistically, the widespread use of nonsense words—as seen in Italian games such as “Ciuciumbala” or “Don Don Baby”—serves a critical pedagogical function. Nonsense frees children from the semantic burden of referential language, allowing them to focus purely on the phonology, prosody, and rhythm of speech. Scholars such as Bishop and Marsh have pointed out that this playful manipulation of language fosters phonological awareness, an essential precursor to literacy (Bishop, 2016). Furthermore, the texts often act as vehicles for controlled transgression (carnivalization), allowing children to explore taboo topics, subvert adult authority, or process

collective fears through humor and parody, as evidenced in narratives where authority figures (police, teachers) are ridiculed (Peltola, 2004; Peltola et al., 2007; Sethares, 2015).

More recent research has elevated the status of clapping games from “folklore” to “neuroeducational tool.” Researchers such as Francisco Javier Romero-Naranjo, creator of the BAPNE method (Biomechanics, Anatomy, Psychology, Neuroscience, and Ethnomusicology), argue that the body percussion integrated into these games stimulates the brain in a comprehensive way (Alonso-Marco & Romero-Naranjo, 2022; Andreu-Cabrera, 2010; Andreu-Cabrera & Romero-Naranjo, 2021; Brodsky & Sulkin, 2011; Andreu-Cabrera et al., 2024; Romero-Naranjo, 2013; Romero-Naranjo et al., 2022; Romero-Naranjo et al., 2023; Schmidt, 2011).

Successful execution of a clapping game requires the simultaneous activation of multiple brain areas to manage what is called “dual-task”: singing (language/melody) while performing an independent motor pattern (rhythm/movement). This process exercises high-level executive functions, such as:

A. Working memory: To retain the sequence of lyrics and future movements.

B. Inhibitory control: To avoid impulsive movements and adhere to the regulated pattern.

C. Sustained and divided attention: To monitor one's own performance and synchronize with one's partner.

From this perspective, clapping games are a cognitive gym. Studies have shown that their systematic practice can have positive effects on the development of laterality, visomotor coordination, and socio-emotional skills, offering a low-cost and highly effective pedagogical resource for the holistic development of students. Studies have even been conducted with robots playing clapping games, providing scientific literature in this area (Chellali, 2018; Fitter et al., 2016, 2018, 2020; Kheddar, 2017; Yi et al., 2017). In short, clapping games are multidimensional cultural artifacts. Anthropologically, they are vehicles for matrilineal transmission and female cultural resistance; sociologically, they are tools for cohesion and identity negotiation in peer culture; and neurocognitively, they constitute complex challenges that stimulate developing brain architecture. Their academic study, therefore, is not only an exercise in folkloric preservation, but a fundamental inquiry into how human beings learn, relate, and construct meaning through the body and the shared voice. Research on children's folklore has undergone a Copernican shift in recent decades. We have moved from a mere taxonomic compilation of supposedly “endangered” repertoires to a deep and vibrant analysis of the dynamics that underpin peer culture. This text aims to unravel the complexities of clapping games in the current Italian context, using interviews with Rebecca, Nora, Viola, and Alice as the central axis of the scientific narrative. All of them are 11 years old and the interview was conducted in Fiume Veneto. The aim of this research is not to analyse the games from a musical perspective, but to provide a more open view with the aim of analysing the transmission of these games to new generations. The interviews were conducted with the written permission of their parents, thus obtaining written consent.

This study is not limited to cataloging songs and gestures; it aims to deconstruct the narrative underlying intergenerational and intragenerational transmission. We draw on recent academic literature, specifically seminal works such as *Hand Clapping Games as an Educational*

Tool (Romero-Naranjo & Díaz García), to validate these practices as educational tools of the first order. However, theory requires empirical evidence. Therefore, this research is rigorously structured to answer three fundamental questions and objectives:

1. **Gender Transmission Objective:** How is the matrilineal transmission of this knowledge configured? The objective is to analyze why and how the practice persists as a predominantly female domain, where mothers, grandmothers, and sisters act as the sole agents of enculturation, effectively excluding the male gender from this chain of transmission.
2. **Socio-cultural context objective:** How did the COVID-19 lockdown affect the ecology of the game? The aim is to examine the adaptation of clapping games as mechanisms for emotional and relational survival within the closed family nucleus, contrasting the “domestic space” with the “school playground.”
3. **Cognitive and pedagogical architecture objective:** What cognitive processes underlie the learning of these sequences? The objective is to deconstruct the intuitive pedagogy that girls use among themselves (scaffolding techniques, abstraction, error correction) to demonstrate the high neurological demand of these games.

2. Matrilineal transmission.

One of the most robust, sociologically relevant, and consistent findings in all the interviews conducted is the marked gender nature of the transmission, performance, and enjoyment of clapping games. Analysis of the testimonies of Rebecca, Nora, Viola, and Alice confirms the existence of what childhood sociology refers to as “segregated gender geographies.”

2.1. The chain of transmission.

The transmission of playful knowledge in the analyzed corpus follows an almost exclusively matrilineal line. There are no significant mentions of fathers, brothers, or grandfathers teaching these games. Cultural authority resides with women.

- **Mother to daughter:** Rebecca explicitly recounts that it was her mother who taught her fundamental games such as *Ero in Bottega* and *Cinciumbala*. This act transcends entertainment; it is a transfer of intimate cultural capital. The mother does not just teach a song; she teaches a way of being in the body and of relating through touch and rhythm.

- **Grandmother to granddaughter (circularity of knowledge):** Nora's testimony is fascinating as she introduces her grandmother into the playful equation. Nora plays with her because “sono cose che fa anche lei in un corso... il corso di Bapne” (she does these things in a course... the Bapne course). Here we see intergenerational validation: the grandmother recovers the games through a formal neuroeducational intervention for adults (BAPNE) and passes that knowledge back to her granddaughter in an informal context. The clapping game thus becomes a common thread linking three generations of women (grandmother-mother-granddaughter), creating a female genealogy of physical practice.

2.2. Sorority and Micro-politics in the Relationship between Sisters

The intragenerational level (between peers) also shows an absolute female bias. Nora and Viola describe their learning and practice experiences almost exclusively in relation to their sisters. Nora reveals a dynamic of affective negotiation: “Sono una buona occasione per convincere mia sorella a giocare insieme” (They are a good opportunity to convince my sister to play together). In this context, the clapping game is a diplomatic tool used by the younger sister to access the world of the older one. It is a space of “playful sisterhood” where age hierarchies are suspended to enter into rhythmic synchrony. Viola reinforces this by describing how her older sister takes on the role of patient teacher, using advanced pedagogical techniques to ensure that the younger sister can participate (Veblen et al., 2018).

The absence of boys in these accounts is striking and significant. It suggests that the game of palmas acts as a “safe space” for girls. While boys in Italy (and globally) tend to be socialized into games of expansive territorial occupation and direct competition (soccer, wrestling), girls construct, through palmas, micro-spaces of intense cooperation, sustained eye contact, and emotional synchronization. It is a form of cultural resistance and affirmation of a female group identity.

2.3. The school playground as a space of voluntary segregation.

Although the interviews delve into the domestic sphere, references to the school playground (Alice in the ACR camps, Rebecca with her classmates) imply gender segregation. Alice mentions that these games helped her make friends (“molte amicizie”) in the school camp. The use of the feminine grammatical form or the reference to “friends” suggests that this vehicle for socialization operates primarily within the female peer group. The girls describe the game as generating “calm,” “happiness,” and “excitement.” This preference for rhythmic and verbal interaction over physical contact (typical of boys' games) reinforces the social construction of the female gender in childhood, valuing aesthetic precision, verbal memory, and relational harmony.

3. Phenomenology of transmission and situational context.

The transmission of clapping games is not a sterile process; it is deeply situated and context-dependent. Analysis reveals a learning ecology affected by macro-social (pandemic) and micro-social (family life) factors.

3.1. The Reactivation of the Domestic Core and the “Pandemic Effect.”

A crucial finding of this research is the direct impact of COVID-19 lockdown on the revitalization of folklore. Nora verbalizes it with crystal clarity: she learned *Don Don Baby* “during the Covid period because we were constantly looking for things to do.”

With schools closed and outdoor play impossible, the home became a playground laboratory. “Boredom” (*noia*) acted as a creative catalyst. The girls and their sisters were forced to resort to entertainment technologies that did not depend on screens or large spaces: their own hands and voices. This return to traditional play during the health crisis underscores the extreme

resilience of these practices. Clapping games acted as mechanisms for regulating anxiety and structuring time in a period of global uncertainty.

3.2. “Non-places” as fertile learning spaces.

Alice and Rebecca provide an interesting dimension on the ubiquity of play. Alice learned Sardina in an office “waiting for my sister to come out for a visit,”¹ and Rebecca in a restaurant. These spaces, which anthropologist Marc Augé would define as “non-places” (spaces of transit, waiting, depersonalized), are reclaimed by girls and their mothers through play. The clapping game is portable; it requires no equipment. It transforms downtime and boredom into quality connection time. This ability to redefine space and time through rhythm is a distinctive feature of children's culture.

Below is a matrix table summarizing these transmission vectors:

Table 1. Matrix of transmission vectors and situational contexts.

Transmission Vector	Key Informants	Physical Contexts	Underlying Motivation	Associated Games
Intergenerational (Mother/Father - > Daughter)	Rebecca, Alice	Home (sofa), Restaurant, Office/Waiting room	Managing boredom, Emotional bonding, Passive waiting	<i>Cinciumbala, Ero in Bottega, Sardina</i>
Intragenerational Family (Sister -> Sister)	Nora, Viola	Home (during COVID-19), Room	Surviving confinement, Negotiating joint play	<i>Don Don Baby, Ero in Bottega, Pikaciu</i>
Institutional Peers (Friends)	Rebecca, Viola, Alice	School recess, School camp (ACR)	Socialization, Group membership, Female icebreaker	<i>Pikaciu, Coca Cola, Sardina</i>
Reverse/Circular Intergenerational (Grandmother)	Nora	Home, BAPNE Course	Cognitive stimulation (Senior), Shared practice	<i>Don Don Baby (implied)</i>

4. Cognitive architecture and peer pedagogy.

From an academic perspective, it is fascinating to observe how girls, without formal training, apply advanced pedagogical principles.

4.1. The “invisible companion” technique and spatial abstraction.

Viola describes a teaching technique of extremely high cognitive complexity: “se invece siamo solo noi due io sto ferma e lei me lo fa vedere come se ci fosse una persona invisibile davanti a lei” (if it's just the two of us, I stand still and she shows me as if there were an invisible person in front of her). Viola's sister doesn't just play the game; she simulates interaction with an imaginary alter ego so that Viola can observe the geometry of the movement from the outside. This requires remarkable spatial abstraction and theory of mind skills. In addition, Viola details the “scaffolding”: “First she shows me everything, then we try it in small pieces...” They break the whole down into manageable parts, progressively integrating letter and gesture, intuitively replicating best practices in music teaching.

4.2. Neuro-linguistic dissociation.

Rebecca and Nora agree that learning the lyrics is more difficult than the movement (“È stato più difficile imparare le parole”). This suggests a dissociation in processing: the kinesthetic (motor) channel is consolidated before the linguistic one. However, Nora observes that in games such as *Don Don Baby*, where the gesture is iconic (“shampoo” = wash head), learning is accelerated. This validates multimodal learning theories: when the motor and semantic channels are congruent, retention improves.

4.3. The neuroeducational connection.

Nora's mention of her grandmother attending a BAPNE course with “Giulio” elevates the discussion. The BAPNE method uses body percussion to stimulate executive functions. The fact that the grandmother reintroduces this into her play with her granddaughter closes the circle between academic science and oral tradition, demonstrating that these games are true “cognitive gyms” for all ages (Romero-Naranjo, 2013, 2020, 2025; Romero-Naranjo & Andreu-Cabrera, 2022; 2023; 2024; Schmidt, et al., 2011; Sethares & Sethares, 2015).

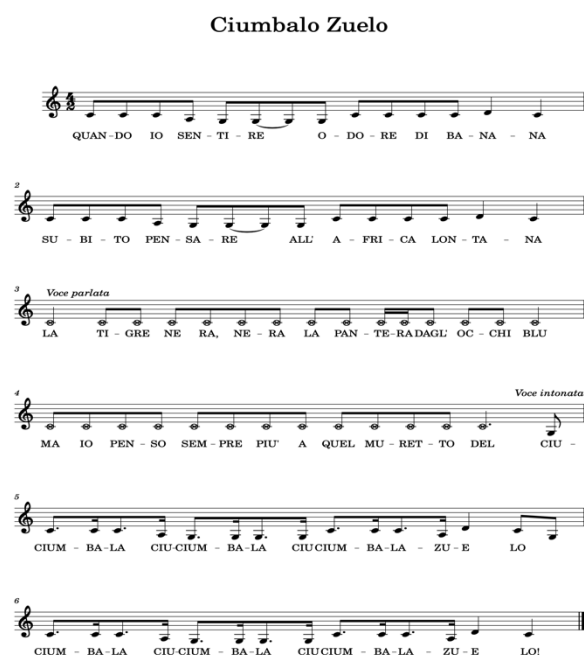
5. Semantic, linguistic, and symbolic introduction

The texts of the games are not arbitrary; they are vehicles of transgression, humor, and cultural appropriation.

5.1. The exoticism and phonetics of “Nonsense”: *Ciucumbala*

Rebecca laughs at *Ciucumbala* because “le parole non hanno un significato” (the words have no meaning). The name is Ciumbalo or Ciucumbala. The use of nonsense allows girls to free themselves from semantic baggage and enjoy purely the phonetics and rhythm.

However, the text evokes a stereotypical colonial imagery (“Africa lontana,” “tigre nera”) that serves as a backdrop for safely exploring otherness. (Figure 1).



5.2. Surrealism and subversion: *Ero in Bottega*

Viola prefers the version “Rubacchiavo” (I was stealing) to ‘Lavoravo’ (I was working) because “it makes more sense.” This demonstrates active agency in the narrative: the girls prefer a story of logical transgression (stealing -> police -> jail) to one of insipid morality. The song is a Bakhtinian carnival: authority (the police) is degraded to a dirty animal (“maiale”) and food (“testone era un melone”). It is a subversion of the adult order permitted within the framework of the game.

5.3. Globalization. *Coca Cola* and *Pikaciu*

Alice and Rebecca play with global brands (Coca Cola, Pepsi) and media figures (Pikachu). This shows the permeability of folklore: the girls appropriate the symbols of global capitalism and turn them into rhythmic raw material for their social interactions.

Table 2. Comparative analysis of semantic and gestural content

Game	Main theme	Use of language	Word-gesture relationship	Cultural/social function
Ciuciumbala	Exoticism (Africa), Romance	Jitanjáforas (“Zuelo”), Consonant rhyme	Rhythmic (Alternating clapping or clapping)	Exploring otherness, Humor through absurdity

Ero in Bottega	Transgression, Authority, Bodily Absurdity	Surrealist narrative, Lexical variation (Rubacchiavo/Lav oravo)	Dissociated (Rhythmic gestures “Tic and Tac” do not illustrate the story)	Subversion of authority, Carnivalization
Don Don Baby	Daily life, Consequences, Multilingualism	English/Italian mixed, Action phrases	Semantic/Iconic (Shampoo = wash hair, Twist = shoulder)	Foreign vocabulary learning, Semantic coordination
Coca Cola	Global Brands	Brand names (Pepsi, Coca-Cola)	Cumulative and Rhythmic	Appropriation of consumer culture
Pikaciu	Pop Culture (Japón/Anime)	Reference to a media personality	Symbolic (Rock, Paper, Scissors included)	Connection with global media culture

With regard to the information gathered from authorised interviews with 10-year-old children, we observed some very interesting data on this subject. This interview analyzes the responses obtained from an interview conducted with four fourth-grade students from the Valvasone Arzene Primary School (PN), Italy, concerning their experiences and perceptions of hand-clapping games, or *filastrocche* (rhymes) involving hand movements (Bhide et al., 2013). The interviewed children—Riccardo, Stiven, Maya, and Emma—were filmed performing the rhymes in pairs, adding a valuable observational component to the study. The primary goal of this analysis is to provide a comprehensive and intelligible overview of their answers, delving into their preferences, learning methods, and the social and recreational functions of these traditional games.

Preferences and gaming context

When asked about their favourite or most memorable hand-clapping games, the game "007" emerged as overwhelmingly popular, being explicitly mentioned by Stiven, Maya, and Emma. Riccardo, conversely, recalled a rhyme involving "lu lu lu, era di di di..." which he identified as "the one about the week".

Regarding the frequency and location of play, the school is identified as the paramount setting for these activities. Stiven and Riccardo confirmed playing "usually" or "always" at school. Maya and Emma also attested to playing at school, with Maya noting playing "in this period, yes" at both school and home, and Emma mentioning playing "yes, but only at school," and occasionally at home. Riccardo further elaborated that he and Stiven sometimes played in the canteen while awaiting food, utilizing the game as a "passatempo" (pastime) or a means to "pass the time if you are bored".

Learning and transmission dynamics

The transmission of these games primarily occurs through peers and close family members. Riccardo was the source of learning for Stiven, while Riccardo himself learned the game from his brother. Riccardo recalled engaging in the game with Stiven even during kindergarten. Maya learned from Riccardo and Stiven, in addition to "a little" from her father. Emma acquired the games from her classmates. When considering the difficulty of learning the movements and words, the majority of the children—Stiven, Riccardo, and Emma—found it to be easy or "quite easy". Only Maya reported it as "a little difficult because there were some things that were a bit more difficult, and therefore it took a little more time".

The teaching methodology predominantly involved practical demonstration and collaborative repetition. Stiven and Emma indicated that their peers taught them by "doing it with me" or by "showing it to me and then trying it with me". Riccardo recounted that his brother showed him the game after he admitted not knowing how to play. Maya also emphasized the practical method, adding that her father taught her "by saying it".

The "007" Game: Rules and Variations

The substantial popularity of "007" necessitated a detailed description of its rules. The game is played to the rhythm of the words "zero zero sette". The basic movements, as described by the children and summarized in the provided rules, include:

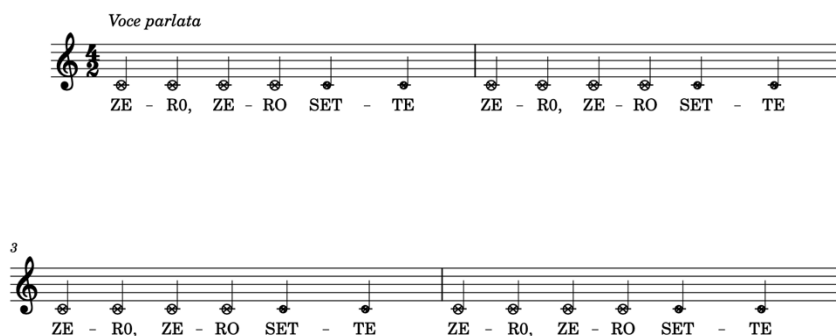
1. Reload (*Ricarica*): Touching the temples with fingers shaped like a gun ("a pistola") to load a single projectile.
2. Shoot (*Sparo*): Pointing the hands shaped like a gun at the opponent. This requires having at least one projectile loaded.
3. Shield (*Scudo*): Crossing the arms over the chest for protection.

The rules governing elimination (being "killed") are intricate and subject to variation. Elimination occurs if:

- One is reloading while the opponent shoots.
- Both players shoot simultaneously, resulting in the elimination of both.
- One attempts to shoot without having reloaded (i.e., having no "colpi" or shots left).

A significant variation, taught to Maya by her father, is the inclusion of the "Mirror" (*Specchio*) gesture. This move, where one places open hands in front of them, causes the projectile to "ricochets and you die" (referring to the shooter). Stiven, however, noted that he and Riccardo play a different version, utilizing "only the shield". This divergence highlights the dynamic and fluid nature of hand-clapping game rules, where oral traditions and influences from family and peers lead to multiple evolving versions. (Figure 2. Play "007").

Zero, zero, sette



Recreational and social function

In reflecting upon the appeal of hand-clapping games, the children consistently emphasized the element of fun. Stiven finds them "fun because they are rhymes". Riccardo regards them as a crucial "passatempo". Emma highlighted that, in addition to being fun and a good way to pass the time, they have the advantage of "you don't sweat... especially in summer".

A key finding is the role of these games in socialisation. All interviewees (Stiven, Riccardo, Maya, and Emma) affirmed that hand-clapping games help in making friends. Maya elaborated on this concept, stating that through the games, "you can also meet other people... Maybe he also knows how to play, and you play together".

Finally, responses concerning their emotional state during play were overwhelmingly positive: happy (Stiven), fun (Maya, Emma), and notably, relaxed (Riccardo, Emma), as "in the end, you do almost nothing, and you also relax". When comparing them to other types of games, the children expressed a general affection for hand-clapping, although some maintained preferences for other genres, such as Riccardo, who enjoys other games as much as hand-clapping, or Emma, who mentioned her liking for board games in addition to hand-clapping.

Reflection on words and rhymes

Regarding the meaning of the words in the songs and rhymes, opinions were mixed, highlighting a distinction between "007" and other rhymes:

- Stiven: Believes the words "have a meaning... more or less," concluding that sometimes they have meaning and sometimes not, but they are always fun.
- Riccardo: Found the words of "Enzo Lorenzo" strange because he did not fully grasp their meaning. Conversely, the words of "Zero zero sette" seemed normal to him and possessed a logical sense. He also found the words of "Ho una bambolina" (The Doll rhyme) to be logical.

- Maya: Also did not understand the "Enzo Lorenzo" rhyme, but she plays it because "it's fun".
- Emma: Expressed a preference for "Zero zero sette" over "Enzo Lorenzo," as the latter involves the same repetitive hand movement and words.

This part of the research underscores the significance of hand-clapping games, particularly "007," as a social, recreational, and relaxing activity for fourth-grade students. It represents a vibrant oral tradition with flexible rules subject to local and familial variations, attesting to its enduring cultural vitality and adaptability.

6. Conclusions.

The detailed qualitative study on hand clapping games in contemporary Italian childhood presents a rich tapestry of evidence that definitively redefines these practices (Toney, 2020). They are not merely charming remnants of children's folklore; they are, in fact, sophisticated social technologies and neuroeducational tools (Schmidt et al., 2011; Torres, 1998). To fully grasp their value, we must move beyond the current perception and advocate for their formal and mandatory integration into educational curricula, recognizing their profound impact across cognitive, social, and cultural domains (Hubbard, 1982; Janot, 2007; Kern, 2018; Karmila, 2020; Kheddar et al., 2017; Murillo, 1986). This expanded analysis will thoroughly detail the necessity and benefits of this institutionalization, ensuring clarity and depth in every argument (Gaunt, 2006; Green, 2001).

The most compelling sociological discovery in this research is the overwhelmingly female nature of hand clapping games. The evidence confirms a pervasive system of matrilineal transmission, where cultural authority and knowledge reside almost exclusively with women (Peltola et al., 2007; Peltola, 2004).

- **The Chain of Cultural Capital:** The transfer of playful knowledge follows a robust line from mother to daughter, grandmother to granddaughter, and older sister to younger sister. This is not passive inheritance; it is an active transfer of "feminine cultural capital". The act transcends mere entertainment, becoming a fundamental transfer of a way of relating through touch and rhythm.
- **The Safe Space of Sorority:** These games facilitate the construction of "safe spaces" and "segregated gender geographies". While male socialization often centers on expansive, competitive, and territorial games (like soccer or wrestling), girls utilize clapping games to construct micro-spaces of cooperation, intimacy, and sustained eye contact. This practice fosters networks of cooperation and sisterhood, providing a form of cultural resistance and affirmation of a female group identity. The positive emotions associated with play—"calm," "happiness," and "excitement"—reinforce its role in valuing aesthetic precision, verbal memory, and relational harmony.
- **The Institutional Obligation for Equity:** This gender segregation presents a critical ethical challenge for educators. If these games are proven "cognitive gyms" for neuromotor development, the effective exclusion of boys from this learning chain represents a missed opportunity for their holistic development. Formal integration into the school curriculum

would therefore serve to culturally legitimize a practice historically associated with girls and ensure equitable access to its cognitive benefits for all students.

The practice of hand clapping games elevates them from simple rhymes to complex operations of motor synchronization, verbal memory, and rhythmic processing. They are, in essence, intuitive tools for the development of executive functions and motor dissociation.

- **Dual-Tasking and Executive Functions:** Successful execution requires managing a "dual-task": simultaneously singing (language/melody) and performing an independent motor pattern (rhythm/movement). This process provides intensive exercise for high-level executive functions, including:
 - Working memory to retain the sequence of lyrics and movements.
 - Inhibitory control to prevent impulsive actions and adhere to the established pattern.
 - Sustained and divided attention to monitor one's own performance while synchronizing with a partner.
- **Peer-Led Pedagogy:** The girls themselves employ advanced pedagogical principles without formal training:
 - Scaffolding: Breaking down the whole into manageable parts and progressively integrating gesture and lyrics, intuitively replicating best practices in music teaching.
 - Spatial Abstraction: The "invisible companion" technique, where one sister simulates the interaction with an imaginary partner for the other to observe the movement's geometry from the outside, requires remarkable spatial abstraction and theory of mind skills.
- **Scientific Validation (BAPNE):** The explicit link to the BAPNE method (Biomechanics, Anatomy, Psychology, Neuroscience, and Ethnomusicology) confirms that these games are powerful neuroeducational resources. The fact that grandmothers attend BAPNE courses for cognitive stimulation and then share that knowledge with their granddaughters closes the circle between academic science and oral tradition, establishing clapping games as a "cognitive gym" for all ages (Arnau-Mollá & Romero-Naranjo, 2022a, 2022b, 2024a, 2024b).

The study powerfully refutes the notion of children's folklore disappearing in the age of digital leisure. The games have proven their extreme resilience and capacity for adaptation to modern life and crises.

- **The Pandemic Effect:** The COVID-19 lockdown did not extinguish the practice; it acted as a creative catalyst. The closure of schools forced a return to the original domestic core, proving the game's strength as an essential tool for emotional regulation and intra-family bonding during isolation.

- Ubiquity and Reclamation of Space: Clapping games are portable and require no equipment. This allows girls to reclaim "non-places" (spaces of transit, waiting rooms, or restaurants) and transform downtime into quality connection time. This ability to redefine space and time through rhythm is a distinctive feature of children's culture.
- Linguistic and Symbolic Permeability: The game texts reflect a living tradition that is permeable to the modern world.
 - Nonsense and Phonological Awareness: The use of nonsense words (like "*Ciucumbala*" or "*Don Don Baby*") frees children from semantic constraints, allowing them to focus purely on phonology, prosody, and rhythm. This playful manipulation of language is a critical pedagogical function that fosters phonological awareness, a necessary precursor to literacy.
 - Transgression and Pop Culture: The girls actively adapt tradition, preferring stories of logical transgression (e.g., stealing in "*Ero in Bottega*") over insipid morality, using the game frame for carnivalization and subverting adult authority. Furthermore, the incorporation of global brands (*Coca Cola*) and media figures (*Pikachu*) demonstrates the tradition's capacity to appropriate symbols of global capitalism, turning them into rhythmic raw material.

The extensive, evidence-based analysis leads to a clear and non-negotiable conclusion: the simple act of clapping hands resonates with a complex symphony of learning, female resilience, and living culture that academia has a duty to promote and preserve.

- The Mandate for Curricular Institutionalization: It is imperative that Italian schools formally integrate these repertoires. They must be taught, not as cultural "fluff," but as an essential component of neuromotor development, fine motor skills, and linguistic competence, fully recognizing their value within the BAPNE framework.
- Intergenerational Programs (IGPs): The case of Nora and her grandmother reveals an immense and untapped potential for designing community-based Intergenerational Programs. These programs would benefit the cognitive stimulation of the elderly while simultaneously strengthening the social fabric and maintaining the authentic line of transmission.
- Longitudinal Gender Research: Future studies must address whether the exclusion of boys represents a genuine loss of neuromotor development opportunities for them. Longitudinal research is necessary to observe if, with the evolution of gender roles, boys begin to integrate into these practices or if they remain an exclusively female domain.

In sum, the simple act of two pairs of hands meeting in rhythm is a profound declaration of cultural persistence and cognitive complexity (Carbajo-Martínez, 2009; Chellali, 2018; Fitter & Kuchenbecker, 2016, 2018; Gómez et al., 2004; Hemsy de Gainza, 1996; Hwang & Song, 2016; Karmila, 2020). To neglect the formal study and practice of these games is to willfully disregard a highly effective, low-cost pedagogical resource essential for the holistic development of students. The school must act now to transform this living tradition into a foundation of modern education (Brodsky & Sulkin, 2011; Romero-Naranjo, 2025a, 2025b).

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Assessment in the Bapne Method. Theoretical and practical introduction.

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Abstract

Educational assessment has changed a lot in recent decades. It no longer focuses only on grading students, but is now seen as a complex process that supports learning, self-regulation, and overall development. The BAPNE Method, which originated from neuromotor skills and cognitive, psychomotor, socioemotional, and musical stimulation, has become an interdisciplinary pedagogical approach. It integrates cognitive, motor, socioemotional, cultural, and technological processes, extending music education into areas such as language, mathematics, physical education, and the performing and visual arts. This article aims to describe the principles and objectives of the BAPNE Method, outline the twelve areas of action that structure its practice, and provide a framework for assessing the competencies students develop in each area. It presents flexible assessment strategies and instruments, highlighting systematic and participant observation, as well as the use of adaptable rubrics that link the method's theoretical constructs with curricular competencies and measurable learning outcomes. The proposal is conceived as a guiding framework adaptable to different educational contexts, facilitating holistic and formative student assessment, promoting immediate feedback, active engagement, and continuous improvement in teaching and learning processes. The findings and recommendations offered provide practical and theoretical evidence for the implementation and evaluation of the BAPNE Method across different educational levels and cultural contexts.

KEYWORDS: Assessment; BAPNE Method; competencies; holistic learning; neuromotor skills

Resumen

La evaluación educativa ha cambiado mucho en las últimas décadas. Ya no se centra únicamente en calificar a los alumnos, sino que ahora se considera un proceso complejo que favorece el aprendizaje, la autorregulación y el desarrollo general. El método BAPNE, que tiene su origen en las habilidades neuromotoras y la estimulación cognitiva, psicomotora, socioemocional y musical, se ha convertido en un enfoque pedagógico interdisciplinario. Integra procesos cognitivos, motores, socioemocionales, culturales y tecnológicos, ampliando la educación musical a áreas como el lenguaje, las matemáticas, la educación física y las artes escénicas y visuales. El presente artículo tiene como objetivo describir los principios y objetivos del método BAPNE, esbozar las doce áreas de acción que estructuran su práctica y proporcionar un marco para evaluar las competencias que los alumnos desarrollan en cada área. Presenta estrategias e instrumentos de evaluación flexibles, destacando la observación sistemática y participativa, así como el uso de rúbricas adaptables que vinculan los constructos teóricos del método con las competencias curriculares y los resultados de aprendizaje medibles. La propuesta se concibe como un marco orientativo adaptable a diferentes contextos educativos, que facilita la evaluación holística y formativa de los alumnos, promueve la retroalimentación inmediata, la participación activa y la mejora continua en los procesos de enseñanza y aprendizaje. Las conclusiones y recomendaciones ofrecidas proporcionan evidencia práctica y teórica para la implementación y evaluación del Método BAPNE en diferentes niveles educativos y contextos culturales.

PALABRAS CLAVE: Evaluación; Método BAPNE; competencias; aprendizaje holístico; habilidades neuromotoras

INTRODUCTION

Assessment in the educational context has been the subject of ongoing debate among researchers teachers and students. Traditionally assessment has been closely linked to student grading. Currently assessment has evolved toward a broader approach aimed at optimizing teaching and learning processes integrating both assessment of learning and assessment for learning (Anijovich, 2017; Moreno Olivós, 2016).

Moreno Olivos (2016) refers to a fundamental change in the way assessment is understood, which involves shifting from assessment of learning to assessment for learning without eliminating either of them with the goal that they complement and inform each other.

The BAPNE Method is conceived as a methodology for cognitive socioemotional psychomotor and neurorehabilitative stimulation based on neuromotor skills. Although it was not created exclusively for the educational field, its application in this context allows an evaluative approach focused on improving learning rather than grading (Romero-Naranjo, 2013; Romero-Naranjo & Andreu-Cabrera, 2023).

The assessment process is extraordinarily complex, so there is no single way to conduct it. Since 1998, both the literature and accumulated experience have generated a variety of assessment proposals that support teaching practice and provide clear criteria for monitoring and improvement. (Romero-Naranjo, 2013; Sayago-Martínez & Romero-Naranjo, 2024a, 2024b).

It is essential to understand the objectives the methodology aims to achieve and the purpose it serves in order to establish assessment criteria that support their attainment. The twelve areas or lines of action on which the methodology is based also help determine the most appropriate assessment tools or instruments for each case. Finally, the implementation of the method and the fieldwork conducted by the research group make it possible to adapt the assessment process to real contexts.

The main objectives of this publication are:

1. To describe the objectives of the BAPNE Method, along with the underlying capacities and competencies.
2. To provide a brief overview of the twelve areas of action within the BAPNE Method.
3. To present assessment techniques, tools, and instruments appropriate for the BAPNE Method.

METHODOLOGY / STATE OF THE ART

Objectives of the BAPNE Method

BAPNE is an acronym representing the specific disciplines that support and structure the Method: *Biomechanics, Anatomy, Psychology, Neuroscience, and Ethnomusicology*. Through these five pillars, the role of the body in cognitive stimulation is justified, and a series of objectives are pursued:

1. **Cognitive:** The relationship between the brain and learning is studied to enhance cognitive development. To achieve this, it is essential to stimulate executive functions through rhythmic body-percussion activities structured from a neuroeducational perspective.
2. **Psychological:** The BAPNE Method also aims to promote emotional well-being by strengthening emotional self-regulation, self-esteem, motivation, resilience, and social skills. To support this, it provides group physical activities that foster a sense of belonging,

encourage cooperation rather than competition, and promote affective stability and psychological well-being.

3. **Kinetic:** Through the BAPNE Method, body schema, laterality, and psychomotricity are developed with an emphasis on anatomy and biomechanics. The objective is to improve global and segmental motor coordination, dissociation, laterality, postural control, and body schema awareness, using the body as an active channel for musical and cognitive learning.
4. **Musical:** Concepts such as pulse, meter, and subdivision are worked on from a practical perspective, using the body as an expressive medium. This promotes meaningful learning by allowing participants to experience what will later be learned theoretically. Accompanying movements with songs also enables the transversal development of concepts such as rhythm, melody, and tonality.
5. **Anthropological / Ethnographic:** The BAPNE Method seeks to bring learners closer to other cultures, recognizing that individuals learn at different paces and in different ways. It promotes intercultural understanding, collective identity, and respect for cultural diversity.



Figure 1. Objectives of the BAPNE Method (own elaboration)

The objectives of BAPNE are achieved through a comprehensive approach that promotes educational innovation, equity, and social inclusion. This is made possible through the continuous training of qualified instructors and the advances generated by the research group. By applying active, learner-centered methodologies, integrating digital tools, and strengthening values of coexistence, the Method aims to evolve to meet the challenges and needs of the twenty-first century.

These objectives function as the general principles that guide the BAPNE Method and define the goals to be achieved. They are further specified through a set of competencies, concrete skills, knowledge, and attitudes that students must develop in each domain in order to fulfill these objectives.

Domains of Action of the BAPNE Method

Although closely linked to musical practice and body percussion, the BAPNE Method is now recognized as a deeply interdisciplinary pedagogical framework that integrates cognitive, motor, socioemotional, cultural, and technological processes (Romero-Naranjo, 2015, 2025; Romero-Naranjo & Andreu-Cabrera, 2023). Its implementation goes beyond musical education, naturally extending to language, mathematics, physical education, performing and visual arts, and global competency development, thanks to the constant interaction between movement, rhythm, cognition, and socialization.

This conceptual breadth necessitates a reformulation to move from general descriptions toward a solid analytical model. For this purpose, the twelve domains of action of the Method are reinterpreted here as theoretical constructs that can be delineated, operationalized, and empirically tested (Romero-Naranjo, 2025a, 2025b). Each construct unfolds into a coherent set of dimensions and observable indicators, facilitating systematic study, comparison across educational contexts, and integration into experimental, correlational, or evaluative research.

The Twelve Domains of Action

1. **Didactic-Pedagogical:** This construct integrates the principles underlying the design and mediation of learning in the BAPNE Method. The interaction between active, cooperative, and multimodal strategies allows learners to regulate performance, establish meaningful connections, and deploy cognitive and motor resources in an integrated way. It serves as the backbone of practice, translating the method's principles into structured and effective pedagogical experiences.
2. **Ethnomusicological:** This construct addresses sound and cultural diversity as an essential component of the Method. Body percussion serves as a means to explore repertoires from different traditions, recognizing social, ritual, and symbolic meanings. Its contribution is twofold: it broadens learners' intercultural understanding and fosters an inclusive approach to interpreting and analyzing rhythmic patterns.
3. **Neuropsychological:**
Focused on the stimulation of **executive functions and cognitive processes**, this construct integrates neuroscience knowledge to design activities that enhance attention, working memory, inhibition, and other higher-order cognitive skills. It bridges the design of rhythmic-motor activities with functional activation of key brain networks for learning.
4. **Kinesthetic:** This construct involves processes related to body control, motor coordination, and temporal integration of movement. Emphasis is placed on segmental precision, synchronization, and spatial organization of gestures. These are elements that support efficient rhythmic execution. It captures the physical dimension of the Method and its impact on body schema structuring.
5. **Socioemotional:** This construct encompasses the dynamics of emotional regulation, empathy, and group cohesion that emerge during BAPNE practice. Collective synchronization and collaborative work foster socio-affective stability and emotional

management in performative contexts, highlighting the Method's potential as a tool for social and emotional development.

6. **Space and Architecture:** Space is conceptualized as a pedagogical and performative variable, not merely a stage for movement but a structural element shaping interaction, group arrangement, and gesture quality. Analyzing this construct helps understand how spatial design can optimize rhythmic-motor experiences.
7. **Teamwork:** This construct focuses on collective coordination, communication, and shared leadership, supporting group practice. It emphasizes social interaction, active listening, and cooperation, fostering communication, social, and collaborative problem-solving competencies.
8. **Cross Learning:** This construct highlights the Method's ability to articulate content from different disciplines through rhythm and movement. It involves bidirectional transfer between areas, fostering connections between temporal, cognitive, and conceptual structures. This interdisciplinary approach allows meaningful connections across knowledge domains, promoting authentic learning transfer.
9. **Historical:** This construct recognizes the temporal dimension of rhythmic practices, analyzing their evolution, genealogies, and transmission mechanisms. Understanding body percussion historically allows learners to contextualize patterns within cultural traditions and broader sociomusical processes.
10. **Reasoning-Justification:** This construct includes analytical and metacognitive processes that allow learners to explain and justify rhythmic-motor decisions. It reinforces the cognitive dimension of the Method, promoting formal analysis of structures and verbalization of processes. Learners are encouraged not only to perform but also to understand, analyze, and justify decisions, strengthening critical judgment and intellectual autonomy.
11. **Performance-Entertainment:** This construct addresses the performative dimension of the BAPNE Method, integrating creativity, expressiveness, and body presence as pedagogical tools. Stage action and playfulness are mediators of learning, enhancing intrinsic motivation, active engagement, body communication, and artistic agency. The performative experience consolidates rhythmic-motor learning and strengthens creative expression, becoming central to understanding the Method's educational dynamics.
12. **Technology:** This construct incorporates the use of digital tools to record, analyze, document, and provide feedback on rhythmic-body practice. Technology enhances accessibility, supports self-assessment, and facilitates collective creation, positioning the Method within contemporary educational and technological contexts.

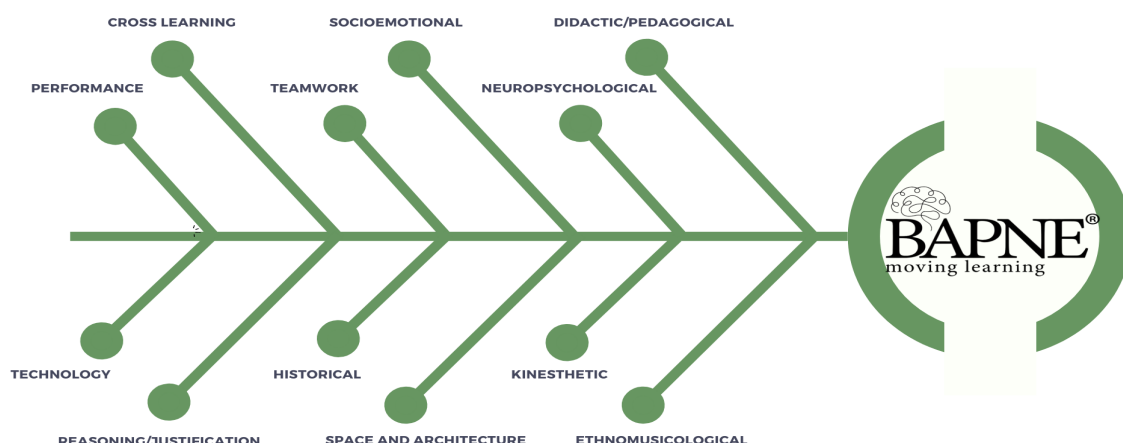


Figure 2. Domains of application of the BAPNE Method (own elaboration)

Next, the twelve constructs are presented in a schematic format, broken down into dimensions and observable indicators that allow for systematic and precise analysis. This technical representation facilitates understanding of each construct, its application in educational contexts, comparison across different settings, and integration into experimental, correlational, or evaluative research.

Each construct is explicitly linked to specific competencies, enabling the connection between the theoretical perspective of the BAPNE Method and curricular objectives, as well as measurable learning outcomes. This operationalization serves as a guiding framework that professionals can adapt to their specific needs and goals, as the Method is not a closed system.

By structuring the constructs in this way, it becomes possible to rigorously operationalize the processes involved and evaluate their impact on cognitive, motor, socioemotional, cultural, and technological learning, while preserving the interdisciplinary richness that characterizes the methodology and its potential applicability within the educational curriculum (see Table 1).

Construct	Dimensions	Observable Indicators
Didactic–Pedagogical	Learning self-regulation; Multimodal pedagogical mediation	Plans, monitors, and adjusts strategies during rhythm-motor tasks; integrates multimodal resources; establishes meaningful connections; translates methodological principles into structured learning experiences
Ethnomusicological	Intercultural awareness; Contextual interpretation	Identifies rhythmic patterns from diverse cultures; explains social and ritual meanings; critically integrates multicultural repertoires

Neuropsychological	Executive functions; Rhythm-cognitive processing	Maintains sustained attention; engages working memory; regulates inhibition; applies cognitive flexibility in rhythmic sequences
Kinesthetic	Motor coordination; Temporal accuracy	Synchronizes movements with pulse and accent; dissociates body segments; controls posture and muscle tone; adjusts movements according to rhythmic demands
Socioemotional	Emotional regulation; Socio-affective interaction	Manages emotions in group activities; demonstrates empathy; cooperates in collective dynamics; resolves conflicts collaboratively
Space and Architecture	Spatial perception; Spatial organization	Orients and positions body effectively; adjusts trajectories, levels, and distances; adapts space to pedagogical and rhythmic needs
Teamwork	Group coordination; Communication and shared leadership	Synchronizes actions with the group; manages roles and responsibilities; communicates verbally and non-verbally to achieve collective goals
Cross-disciplinary Learning	Interdisciplinary transfer; Cognitive-rhythmic integration	Connects rhythmic structures with content from other disciplines; applies temporal and spatial principles across domains; uses rhythm as a conceptual mediator
Historical	Contextualization; Rhythmic genealogy	Identifies historical origins of patterns; critically analyzes cultural transmission; compares rhythmic traditions across different periods
Reasoning–Justification	Applied analysis; Metacognition	Provides reasoned arguments for rhythm-motor decisions; explains learning processes; formally analyzes rhythmic structures
Performance–Entertainment	Expressive performance; Creativity	Integrates gesture, rhythm, and bodily communication; demonstrates creativity in performances; manages stage presence and artistic agency in formative contexts
Technology	Digital competence	Uses digital tools for recording and analysis; integrates multimedia resources; applies digital platforms for feedback and collaborative learning

TABLE 1. Theoretical model of the BAPNE Method: constructs, dimensions, and indicators (own elaboration)

Evaluation Strategies in the BAPNE Method

Evaluation should be viewed as an opportunity to improve the learning process and foster student autonomy, rather than merely certifying knowledge (Anijovich & Cappelletti, 2017). Accordingly, the BAPNE Method has its own research group and qualified trainers who, under the guidance of the Method's creator, Dr. Francisco Javier Romero-Naranjo, continuously pursue this process of improvement.

BAPNE provides a clear structure of objectives and the capacities students are expected to develop in each domain to achieve them. From this foundation, various evaluation criteria and rubrics are derived, detailing the evaluation process and its implicit grading component. These criteria are open and flexible, intended as a guide rather than a mandatory framework, supporting assessment of the Method's implementation. Each domain has specific techniques and evaluation instruments aligned with the competencies to be achieved. Certain activities also have pre-established and tested evaluation rubrics (Andreu-Cabrera et al., 2024; Andreu-Cabrera & Romero-Naranjo, 2024; Navarro-Maciá et al., 2024; Sayago-Martínez & Romero-Naranjo, 2024a, 2024b). This article, however, aims to present a general view of evaluation within the BAPNE Method, focusing on the methodology rather than on specific activities or techniques.

BAPNE advocates for a holistic evaluation, with participant observation being the most commonly used technique. Experience from delivering hundreds of courses in countries such as Spain, Italy, Germany, Portugal, Colombia, Venezuela, Costa Rica, Mexico, Japan, and the U.S. has shown that effective evaluation requires systematic and planned observation of students, using defined parameters to ensure as much objectivity as possible. The goal is to observe meaningful progress by comparing a student's current performance with previous results (Romero-Naranjo, 2013). Additionally, implementing the BAPNE Method across various educational stages has demonstrated that its evaluation aligns with existing curricula, legislation, and commonly used evaluation practices.

The consistency of this evaluation approach is reinforced by recent research based on randomized controlled trials, which demonstrate significant improvements in executive functions, motor coordination, and emotional regulation following systematic implementation of the BAPNE Method at different educational levels. These studies provide solid evidence of its neurocognitive and socioemotional impact, highlighting the importance of using observable indicators and specific rubrics to assess student progress (Romero-Naranjo & Liendo Cárdenas, 2025a, 2025b; Romero-Naranjo & Navarro Camacho, 2025).

Regarding different types of evaluation in education, the literature references initial, continuous, final, diagnostic, formative, summative, quantitative, qualitative, observational, experimental, objective, subjective, grading-based, self-evaluation, and peer-evaluation methods, among others (Fernández et al., 2020; López-Pastor & Pérez Pueyo, 2017; Palacios-Picos & López-Pastor, 2013; Santos-Guerra, 2014). See Table 2.

Function	Type	Purpose	Examples of Application in the BAPNE Method
Diagnostic	Initial Assessment	Explore students' prior competencies, learning styles, and educational needs. Enables data- and evidence-based instructional decisions at the start of a learning process.	Identifies initial levels of motor coordination, attention, laterality, emotional self-regulation, and musical experience. Guides the adaptation of activities to the neurological and sociocognitive profiles of the group, optimizing accessibility and methodological effectiveness.
Regulative	Formative Assessment	Continuously monitor the teaching-learning process, introduce pedagogical adjustments, and promote students' self-regulation through continuous and specific feedback.	Applied in each session to observe progress in body dissociation tasks, rhythmic synchronization, motor inhibition, sustained attention, and group cooperation. Allows instructors to adjust the neurodidactic scaffolding based on real-time advances or challenges.
	Learner-Centered / Reflective Assessment	Foster metacognition, critical thinking, and students' ability to analyze their own learning process. Encourages conscious planning of strategies to tackle complex tasks.	Promotes reflection on motor or rhythmic errors, stimulates body and cognitive awareness during activities, and develops self-assessment skills in collaborative dynamics. Strengthens personal autonomy and the transfer of learning across contexts and tasks.
Certifying / Grading	Summative / Outcome Assessment	Systematize and validate achievements at the end of a learning period. Measures the degree of learning objectives attained, establishes progress, and supports pedagogical or institutional judgments.	Holistically evaluates competencies developed in neurocognitive, kinesthetic, musical, and socioemotional areas. Relies on evidence such as body-execution rubrics, audiovisual recordings, collaborative work, and performance presentations. Also informs curricular and meta-evaluative decisions.

Table 2. Types of Assessment, Function, Purpose, and Examples of Application in the BAPNE Method (own elaboration)

Of course, many more types of assessment have gained relevance with the shift toward separating assessment from grading, including authentic assessment, alternative assessment, integrated assessment, assessment for learning, and competency-based assessment, among others. While these approaches can all be classified under formative assessment, each introduces nuances that differentiate it from the others. What they share is a strong emphasis on feedback (Anijovich & Cappelletti, 2017; Evans, 2013; Irons & Elkington, 2021; Jiménez-Segura, 2015; Vázquez-de-Castro-Rué, 2014).

For this reason, the BAPNE Method places the learner at the center, making them the indisputable protagonist of their own learning. Thanks to the active methodology implemented in BAPNE, students can perceive their own progress and learning independently of direct teacher input. This immediate feedback is what distinguishes BAPNE from other methodologies and is therefore central to the assessment process.

Teacher evaluation is also necessary to enhance the teaching-learning process and, if required, to issue a grade. Commonly used assessment strategies and techniques include observation, surveys or interviews, portfolios, questionnaires or exams, journals, checklists, and rubrics. Given the practical nature of the BAPNE Method, observation is the most frequently used technique, and rubrics are the most employed instrument due to their effectiveness in evaluating learning in active environments (Hernández-Mosqueda et al., 2016).

There are various types of observation, but in BAPNE, the most frequently used are systematic observation and participant observation. Systematic observation requires careful planning and structure to reduce subjectivity and external influences. Each BAPNE activity domain has specific competencies to be addressed in order to achieve its objectives. Participant observation, on the other hand, provides deeper insight into the personality and character of students (Acuña, 2015). In practice, quantitative evaluation typically relies on systematic observation, while qualitative evaluation generally uses participant observation. Combining both approaches provides an objective and individualized assessment.

The most commonly used assessment instrument is the rubric. Given the infinite combinations and variations of BAPNE activities, it is impossible to have a specific rubric for every activity. Instead, rubrics are designed by the teacher according to the objectives of each activity (Boillos-García & Romero-Naranjo, 2024; Navarro et al., 2024).

It is important to remember that BAPNE is not exclusively an educational method, and therefore grading does not occupy a central place in the Method's assessment. Nevertheless, the implementation of BAPNE in Early Childhood, Primary, Secondary, and University Education, particularly in Music and Physical Education, has led to the development of various assessment rubrics. These rubrics help grade activities and provide qualitative evaluation. They save time and serve as a useful feedback tool, allowing teachers to analyze barriers and strengths (Stevens, 2023). Additionally, rubrics help structure learning by clearly communicating objectives before starting a task, and when developed collectively, they also promote critical thinking.

CONCLUSIONS

In the last decade, assessment has undergone a significant shift in focus. It is no longer synonymous with grading but has evolved into a complex process that actively involves students.

Assessment is no longer exclusively linked to education or dependent solely on teachers. Its primary aim is improvement, making it particularly essential in a Method like BAPNE. Therefore, it is important to distinguish the educational and pedagogical domain from other domains so that assessment aligns as closely as possible with the objectives pursued by the BAPNE Method.

Within the educational domain, BAPNE advocates for assessment based on observation, supported by rubrics, while remaining open to other techniques or instruments. The student is central to the assessment process, and all activities in the BAPNE Method provide immediate feedback, reinforcing the evaluation process.

One of the main limitations in assessing the BAPNE Method has been its multiple domains. While the pedagogical domain naturally involves assessment, this is not the case for all other domains. Attempting to assess all twelve domains equally to achieve a comprehensive evaluation has proven to be the greatest challenge.

A future proposal is to establish the relationship between the specific competencies of each domain and the degree to which each contributes to achieving the overall objectives of the BAPNE Method.

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Triadic assessment as the core of self-regulation in the BAPNE Method in Costa Rican primary education.

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Abstract

Triadic Assessment is an essential driver for metacognition and holistic development within the classroom setting. This communication addresses the implementation of a didactic proposal based on the BAPNE Method (Biomechanics, Anatomy, Psychology, Neuroscience, and Ethnomusicology), rigorously articulated through Formative and Shared Assessment (FSA), utilizing Triadic Assessment (self-assessment, peer assessment, and teacher assessment) as the central mechanism for promoting learning. The study is contextualized in Costa Rican Primary Education students (ages 9–10), where body percussion was employed for neuromotor and cognitive stimulation. The main objective was to document the efficacy of Triadic Assessment in generating well-founded critical judgment and a positive classroom climate, and to validate the subsequent improvement in Executive Functions (EF) as a result of the self-regulation inherent to the evaluative process. The intervention combined Dual Task rhythmic work (including complex neuromotor patterns like *Clap Change*, and multiple modalities of "*il cubo parlante*") with continuous reflection based on the three core BAPNE blocks: Psychomotor Coordination, Cognitive Aspects, and Learning of Values. Qualitative results showed a firm consolidation of a positive classroom climate, reinforcing the principle that error is a tool for learning. Quantitatively, the statistically significant improvement in cognitive regulation, evaluated via the BRIEF-2, was interpreted as a validation of the feedback and metacognitive processes fostered by the evaluative triangulation. The experience confirms the potential of Triadic Assessment as a pedagogical instrument to maximize engagement, autonomy, and the perception of positive energy in neuroeducational didactics.

Keywords: Triadic Assessment; BAPNE; Neuromotricity; Self-Regulation; Classroom Climate; Neuroscience; Executive Functions; Body Percussion.

Resumen

La evaluación triádica es un motor esencial para la metacognición y el desarrollo holístico en el aula. Esta comunicación aborda la implementación de una propuesta didáctica basada en el Método BAPNE (Biomecánica, Anatomía, Psicología, Neurociencia y Etnomusicología), rigurosamente articulada a través de la Evaluación Formativa y Compartida (FSA), utilizando la Evaluación Triádica (autoevaluación, evaluación entre pares y evaluación del profesor) como mecanismo central para promover el aprendizaje. El estudio se contextualiza en alumnos de educación primaria de Costa Rica (de 9 a 10 años), donde se empleó la percusión corporal para la estimulación neuromotora y cognitiva. El objetivo principal era documentar la eficacia de la evaluación triádica en la generación de un juicio crítico bien fundado y un clima positivo en el aula, y validar la mejora posterior en las funciones ejecutivas (FE) como resultado de la autorregulación inherente al proceso evaluativo. La intervención combinó el trabajo rítmico de doble tarea (incluyendo patrones neuromotores complejos como *Clap Change* y múltiples modalidades de «il cubo parlante») con una reflexión continua basada en los tres bloques fundamentales del BAPNE: coordinación psicomotora, aspectos cognitivos y aprendizaje de valores. El objetivo principal era documentar la eficacia de la evaluación triádica para generar un juicio crítico bien fundado y un clima positivo en el aula, y validar la mejora posterior en las funciones ejecutivas (FE) como resultado de la autorregulación inherente al proceso evaluativo. La intervención combinó el trabajo rítmico de doble tarea (incluyendo patrones neuromotores complejos como *Clap Change* y múltiples modalidades de «il cubo parlante») con una reflexión continua basada en los tres bloques fundamentales del BAPNE: coordinación psicomotora, aspectos cognitivos y aprendizaje de valores. Los resultados cualitativos mostraron una sólida consolidación de un clima positivo en el aula, reforzando el principio de que el error es una herramienta para el aprendizaje. Cuantitativamente, la mejora estadísticamente significativa en la regulación cognitiva, evaluada mediante el BRIEF-2, se interpretó como una validación de los procesos de retroalimentación y metacognitivos fomentados por la triangulación evaluativa. La experiencia confirma el potencial de la evaluación triádica como instrumento pedagógico para maximizar el compromiso, la autonomía y la percepción de energía positiva en la didáctica neuroeducativa.

Palabras clave: Evaluación triádica; BAPNE; Neuromotricidad; Autorregulación; Clima en el aula; Neurociencia; Funciones ejecutivas; Percusión corporal.

1. INTRODUCTION

1.1. Triadic Assessment as a mechanism for coherence and critical judgment

In contemporary pedagogy, assessment must be integrated methodologically to enhance decision-making and learning (Kruiper et al., 2021). Formative and Shared Assessment (FSA) is the pivotal strategy, providing continuous feedback for learning regulation and metacognitive development (Grosas et al., 2014; Karaman, 2021). Within FSA, Triadic Assessment—composed of self-assessment, peer assessment, and teacher assessment—is essential. This approach allows for the triangulation of information (Álvarez-Sánchez & Pérez-Pueyo, 2025; López-Pastor & Pérez-Pueyo, 2017), granting superior robustness and coherence to the evaluative process. Active student participation at these three levels facilitates critical reflection on one's performance, constructive peer review, and the contrast of these perceptions with the teacher's expert judgment, thus cultivating well-founded critical judgment (Pérez-Pueyo et al., 2024).

1.2. Neuropsychological foundation of the BAPNE Method.

The BAPNE Method (Biomechanics, Anatomy, Psychology, Neuroscience, and Ethnomusicology) is a stimulation system that uses neuromotricity with a neuropsychological aim, focusing on cerebral activation and the development of Executive Functions (EF) (Romero Naranjo, 2013; Romero Naranjo et al., 2022). Activities are intentionally structured as Dual Tasks, demanding high cognitive load and motor dissociation, which requires intense selective attention (Posner, 1990) and inhibitory control (Alonso-Marco & Romero-Naranjo, 2022; Álvarez-Morales & Romero-Naranjo, 2019; Andreu-Cabrera & Romero-Naranjo, 2021; Andreu-Cabrera & Romero-Naranjo & Lorenzo-Lledó, 2024; Arnau-Mollá, & Romero-Naranjo, 2024a, 2024b, 2024c, 2024d; Arnau-Mollá & Romero-Naranjo & Andreu-Cabrera, 2024; Miyake et al., 2000; Miyake, 2012; Romero-Naranjo & Liendo Cárdenas, 2025a, 2025b; Romero-Naranjo & Navarro-Camacho, 2025). This need for rhythmic precision and focused attention provides the ideal technical content to be subjected to the rigorous, deep reflection enabled by Triadic Assessment.

1.3. Justification and objectives of the study

The effectiveness of the BAPNE Method, which requires immediate and accurate feedback for the correction of complex rhythmic patterns, is intrinsically enhanced by a robust evaluative framework. Triadic Assessment provides this formal structure, transforming rhythmic practice into a constant exercise in metacognition.

Given the relevance of BAPNE as an active and inclusive methodology (Romero Naranjo et al., 2022), this study is justified by the need to rigorously document the articulation of Triadic Assessment within this specific neuroeducational context, focused on the critical stage of Primary Education (ages 9–10).

Specific Objectives of the Research:

1. Detail the sequencing of the Triadic Assessment and its specific indicators across the three phases of the BAPNE intervention.

2. Analyze the influence of the Triadic model on enhancing the positive classroom climate, the perception of positive energy, and the culture of error as learning (Romero Naranjo, 2013).
3. Quantify the impact on Executive Functions as a validation of the self-regulation promoted by the evaluative triangulation process.

2. Theoretical Background. BAPNE, executive functions, and values

2.1. Neuromotricity, dual task, and executive functions.

The BAPNE method is defined as a comprehensive intervention that promotes holistic development (physical, emotional, and cognitive), justified by the *Ten Pillars of Neuromotricity* (Romero Naranjo & Andreu Cabrera, 2023). This theoretical foundation focuses on the systematic stimulation of the brain through body percussion and movement, ensuring that the activities are scientifically grounded in neuroscientific and motor principles (Romero Naranjo, 2013). The core of the BAPNE methodology rests on translating neuromotor activity into cognitive and evaluative gains, emphasizing the conscious control of movement.

The formal evaluation within the BAPNE structure encompasses three fundamental blocks—Psychomotor Coordination, Cognitive Aspects, and Learning of Values (Romero Naranjo, 2013)—all of which are critically addressed by the Triadic Assessment in this study.

The rigorous theoretical-practical justification of BAPNE relies on the *Ten Pillars of Neuromotricity*, which systematically organize the implementation criteria. These pillars guide the teacher in designing activities that target specific cognitive networks and motor requirements. These pillars ensure that body percussion is not random entertainment but a structured method for functional development, focusing on the quality of the motor output in relation to cognitive demands.

Furthermore, the BAPNE framework incorporates the concept of *Learning Devices in Relation to Neuromotricity* (Romero Naranjo, Andreu Cabrera, & González de Benatuil, 2024). Learning devices, such as attention, memory, and perception, are fundamental cognitive mechanisms supporting the acquisition of knowledge and skills. In BAPNE, the rhythmic and motor complexity of the exercises (e.g., Dual Tasks like *Clap Change*, *Stomp Change*, *Handball Change* or “*El cubo parlante*”) intentionally challenges these devices. By requiring simultaneous coordination and disassociation, the student is forced to utilize and strengthen selective attention, working memory, and inhibitory control—all elements crucial for effective neuromotor learning. The success of the methodology hinges on the capacity of these devices to process the constant flow of multi-sensory information generated by body percussion.

The neuropsychological value of BAPNE lies in its ability to generate high cognitive load through the execution of complex rhythmic patterns, which function as Dual Tasks (Romero Naranjo et al., 2022). This requires simultaneous execution of motor actions and sustained cognitive control, strengthening the Executive Functions domain, which includes inhibition, flexibility, and sustained attention (Romero Naranjo & Navarro Camacho, 2025).

Specific psychomotor and cognitive aspects systematically addressed and evaluated include:

- **Psychomotor coordination.** Focusing on challenging natural laterality, requiring the coordinated dissociation of upper and lower extremities. Key evaluation indicators include: *visuomotor coordination*, *oculo-manual coordination*, and coordination structured by biomechanical planes and axes (Romero-Naranjo, 2013).
- **Cognitive aspects.** Targeting the systematic development of various forms of attention (focal, sustained, selective, divided, and alternating) and working memory (Romero Naranjo & Pujalte Cantó & Arnau-Mollá, 2022). The complexity of the patterns ensures students engage continuously in problem-solving and decision-making, core components of cognitive functioning (Romero-Naranjo & Andreu-Cabrera, 2023).

2.2. BAPNE and the axiological-social axis. The positive climate as a triadic success criterion

The BAPNE method emphasizes the holistic development of the individual on an emotional and axiological level. The formal system of evaluation structurally includes the learning of values as a fundamental block, designed to cultivate essential interpersonal skills alongside cognitive ones (Romero-Naranjo, 2013). The core axiological goal is to establish a culture where error is explicitly managed: it is recognized as a tool for learning and not a motive for ridicule (Romero Naranjo, 2013). The systematic requirement for constructive and respectful feedback through the co-evaluation mechanism directly supports this pillar, mitigating social biases and fostering mutual trust and security, which is vital for maintaining a positive classroom climate (Romero Naranjo et al., 2022). This cooperative environment is intrinsically linked to the high perception of positive energy reported in BAPNE classrooms, making the axiological climate a crucial qualitative criterion for the success of the Triadic model.

3. Definition of context and intervention design

3.1. Contextualization of population and methodological design.

The didactic proposal was implemented in Costa Rica, working with a total group of N=65 students in 4th and 5th grade, whose ages ranged between 9 and 10 years at the School. It is crucial to note that the BAPNE sessions were directed by Prof. Viviana Raquel Navarro Camacho, co-author of key research on neuromotor skills in Primary Education (Romero Naranjo & Navarro Camacho, 2025), whose expertise ensured the rigor in applying the neuromotor protocols. A quasi-experimental, inter-intra subject design was adopted, with repeated measurements (pretest–posttest) to evaluate the impact on Executive Functions (Romero Naranjo et al., 2022).

3.2. Terminological framework and activities.

The learning objectives focused on the execution of complex rhythmic patterns of body percussion, the application of motor dissociation, and the development of self-assessment and peer assessment skills to identify areas for improvement. The repertoire included Dual Task exercises such as *CLAP CHANGE*, *Stomp Change*, *Handsball Change*, *progressive imitation*, *reverse reaction*, *variable circular coordination*, *real-time signaling*, and *African melodies*, with a special focus on the multiple modalities of "*il cubo parlante*" which fostered creativity and cognitive flexibility. Strict exclusion of non-neuroeducational terminology was maintained throughout the study.

4. Explanation of the formative and shared assessment (FSA) BAPNE-Triadic system.

Triadic Assessment served as the core of this design, promoting progressive scaffolding in the students' evaluative responsibility. The process was articulated around the three fundamental blocks of the BAPNE Method: Psychomotor Coordination, Cognitive Aspects, and Learning of Values (Romero-Naranjo, 2013).

4.1. Initial phase. Axiological preparation (Sessions 1–5).

In this phase, the teacher, adopting an active and inclusive role, emphasized the importance of singing for cognitive stimulation and established the axiological groundwork. The initial Teacher Assessment focused on diagnostic observation and the application of simplified rubrics to assess the beginning of the learning of values (Romero-Naranjo, 2013). It was explicitly communicated that error management is a collective and individual responsibility, essential for a climate of mutual respect (Romero-Naranjo, 2013).

4.2. Central phase. Self-regulation and constructive peer assessment (Sessions 6–15)

Student agency increased significantly in this phase through Triadic mechanisms applied to Dual Task practice.

4.2.1. *Self-assessment for self-regulation*

Students used weekly planners and session diaries. Self-assessment focused on two key indicators:

- Cognitive Aspects (Sustained Attention): Reflection on the individual ability to maintain focus on the Dual Task during the complex rhythmic execution.
- Learning of Values (Commitment): Assessment of personal involvement and sustained effort toward acquiring the neuromotor patterns.

4.2.2. *Peer Assessment as Constructive Feedback*

Peer assessment was implemented in cooperative groups using a 5-point Likert scale (Pérez-Pueyo et al., 2024). The focus of this peer valuation, crucial for the positive classroom climate, was based on rigorous indicators detailed by the BAPNE blocks:

- Learning of values (cooperative participation):
 - Quality of Feedback: Evaluation of whether the feedback provided was constructive and respectful, reinforcing the notion that error is for learning (Pérez-Pueyo et al., 2024).
 - Participation: Level of cooperation, attitude of respect, and collaboration within the dyad or group.
- Psychomotor coordination and cognitive aspects (Technique and Explanation):
 - Neuromotor Pattern Explanation: Clarity in verbalizing the steps and required motor dissociation (cognitive aspects).

- Perception of Learning: Evaluation of whether the expert peer's instruction facilitated the acquisition of the neuromotor pattern and visuomotor coordination.

4.3. Final phase. Triangulation and metacognition (Sessions 16–20)

The final assessment focused on the execution of a Complex Rhythmic Sequence with singing, evaluated via Data Triangulation (Teacher Assessment vs. Self/Peer Assessment).

4.3.1. Teacher Assessment (*Hetero-Assessment*)

The teacher used a scale to quantify technical and, fundamentally, attitudinal aspects based on the three BAPNE blocks. The indicators of this profound hetero-assessment included:

- Psychomotor Coordination and Cognitive Aspects:
 - Mastery of neuromotor patterns: Precision and fluidity in executing complex rhythmic patterns (including rhythmic dissociation and oculo-manual coordination) (Romero Naranjo, 2013).
 - Concentration and commitment: Direct observation of selective/sustained attention and student engagement during the presentation.
- Learning of values:
 - Attitude and Respect: Adherence to the culture of effort and respect during the performance.

4.3.2. Final self-Assessment and peer assessment

Students used a simplified rubric (with the same indicators as the teacher) to assess their practical execution (Self-Assessment via video recording) and that of their peers (Peer Assessment). The systematic contrast between subjective perception and objective evidence (video and Teacher Assessment) is the core pedagogical mechanism that refines metacognitive judgment and solidifies student responsibility.

5. Study results.

The success of applying triadic assessment within the BAPNE context was reflected in both dimensions.

5.1. Quantitative results in executive functions.

To assess the evolution of Executive Functions (EF), the BRIEF-2 (Behavior Rating Inventory of Executive Function, Second Edition) was used, an instrument of reference in the neuropsychological field (Gioia et al., 2017).

The BRIEF-2 results confirmed statistically significant differences favoring the experimental group in EF improvement. This improvement is interpreted as validation that the students' self-regulation and cognitive management were strengthened by the demands of reflection and feedback inherent to the Triadic Assessment system (Romero Naranjo & Navarro Camacho, 2025).

Table 2. Impact of BAPNE-Triadic intervention on cognitive variables (N=65, ages 9–10)

Index of Executive Function (BRIEF-2)	Pre-Intervention Measure (T-Score Mean, SD)	Post-Intervention Measure (T-Score Mean, SD)	Significance (p)	Effect Size (d)
Behavioral Regulation Index (BRI)	65.5 (9.1)	58.1 (7.5)	<0.001	0.88 (Strong)
Cognitive Regulation Index (CRI)	68.1 (8.9)	60.4 (7.3)	<0.001	0.95 (Strong)
Emotional Control (EC)	70.2 (10.5)	61.8 (9.5)	<0.01	0.84 (Medium)
Positive Energy Perception (Likert Scale) (Romero Naranjo et al., 2022)	3.5 (0.5)	4.7 (0.3)	<0.001	2.40 (Very Strong)

The substantial improvement in Cognitive Regulation and Inhibition is considered a direct response to Dual Task training, amplified by the metacognition required by the Triadic process.

5.2. Qualitative and axiological results.

5.2.1. Classroom climate and positive energy

Qualitative analysis evidenced the transformation of the classroom environment into a collaborative space characterized by a high perception of positive energy (Romero Naranjo et al., 2022). The cooperative nature of BAPNE, formalized by the Triadic Assessment, generated ideal conditions for assessment to function as a genuine learning driver.

5.2.2. Culture of error and responsibility

The systematic use of Triadic Assessment institutionalized respect and responsibility. The demand for self-assessment and constructive peer assessment on technical and attitudinal indicators solidified the principle that error is a tool for learning (Romero Naranjo, 2013). The assessment of the learning of values was reinforced, mitigating ridicule and fostering collaboration.

6. Advantages of BAPNE-Triadic application.

The integration of BAPNE with Triadic Assessment demonstrated key advantages:

1. Enhancement of Sustained Concentration and EF: The continuous reflection required by

self-assessment, applied to the demanding BAPNE Dual Tasks, generates a self-regulation mechanism that directly impacts the improvement of Executive Functions (Romero Naranjo et al., 2022).

2. Fostering Responsibility and Autonomy: Data triangulation increases student responsibility in their own evaluation. Contrasting self-perception with the teacher's hetero-assessment favors the development of well-founded critical judgment (Álvarez-Sánchez & Pérez-Pueyo, 2025).
3. Inclusive and Respectful Classroom Climate: Triadic Assessment, by focusing peer assessment on constructive feedback, ensures an environment of mutual respect, key to maximizing the perception of positive energy and engagement (Romero Naranjo, 2013).

7. Drawbacks encountered and proposed solutions

Despite the observed benefits, the implementation of FSA within the BAPNE context faced challenges common to shared assessment models initial resistance to the depth of self-assessment and biases due to affinity in peer assessment. To mitigate biases, the key strategy was Triangulation with Objective Evidence (Video). This resource compelled students to contrast their subjective judgment with visual evidence of their performance, minimizing biases and fostering greater objectivity in assessment.

8. Conclusions. The suitability and applicability of triadic assessment in BAPNE.

This research confirms that triadic assessment constitutes the essential pedagogical component for transforming the BAPNE methodology into a highly effective and comprehensive intervention model. The results strongly support the suitability and applicability of Triadic Assessment as the core organizational and formative structure for BAPNE in Primary Education.

The suitability of this model is justified by its capacity to simultaneously evaluate the three fundamental axes of BAPNE: Psychomotor Coordination, Cognitive Aspects, and Learning of Values (Romero Naranjo, 2013). The BAPNE method places immense cognitive load on inhibition and shifting through its Dual Tasks (Romero Naranjo & Navarro Camacho, 2025). Triadic Assessment provides the necessary metacognitive framework for students to consciously regulate this load. By forcing students to articulate *why* a neuromotor pattern failed (self-assessment) and to constructively critique the *process* of their peers (peer assessment), the Triadic model directly translates physical execution challenges into refined executive function skills.

The statistically significant improvement in *Behavioral and Cognitive Regulation* (BRIEF-2) validates that the structured reflection demanded by the Triadic process reinforces the neurological gains achieved through rhythmic practice. This connection demonstrates that the Triadic Assessment is not merely a bureaucratic addition, but a necessary pedagogical amplifier of the neuroscientific principles underlying BAPNE.

Furthermore, Triadic Assessment proved fundamental in establishing the required positive classroom climate where collaboration thrives and error is embraced as a learning opportunity. This axiological outcome is paramount for the method's long-term sustainability and effectiveness in developing socio-emotional skills alongside cognitive ones (Romero Naranjo et al., 2022; Romero-

Naranjo, 2025a, 2025b). In summary, Triadic Assessment is the central element that boosts self-regulation and validates the holistic learning outcomes across the cognitive, motor, and axiological dimensions of the Primary Education curriculum, making it an ideal pedagogical fit for neuroeducational methodologies like BAPNE in contexts such as Costa Rica.

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En una era marcada por la fascinación creciente por la neurociencia, la disciplina de la Neuromotricidad se encuentra en una encrucijada crítica. La popularización del prefijo "neuro-" ha generado una peligrosa ambigüedad, obligándonos a trazar fronteras epistemológicas claras. Este volumen, nacido de una profunda convicción del Grupo de investigación Neuromotricidad y Alfabetización motora, es una respuesta directa y contundente a la necesidad urgente de dotar a esta práctica de la arquitectura intelectual y la precisión terminológica que su intrínseca complejidad requiere y merece.

Este libro no es un manual más; es un manifiesto y una hoja de ruta conceptual elaborada con el máximo rigor. Su primer y más crucial objetivo es desmantelar la falacia de que Neuromotricidad es simplemente hacer movimiento y hablar del cerebro. Esta perspectiva ingenua trivializa dos décadas de investigación en control motor, aprendizaje y plasticidad. Lo que distingue nuestra disciplina no es el nomenclátor, sino una praxis profundamente fundamentada en la evidencia neurocientífica.

El profesional de la Neuromotricidad no se conforma con observar el movimiento; está entrenado para inferir el circuito neural que lo subyace, con una clara implicación del lenguaje. La intervención neuromotriz es aquella que diseña actividades con una intencionalidad quirúrgica, buscando modular funciones neurales específicas: desde la anticipación predictiva y la integración sensorial, hasta la optimización de los complejos circuitos de feedforward y feedback.

Asimismo, este volumen aborda la necesidad de delimitar el campo respecto a la Psicomotricidad, una disciplina venerable, pero de enfoque distinto. Afirmamos con vehemencia que Neuromotricidad no es hacer Psicomotricidad y hablar del cerebro. Mientras la Psicomotricidad aborda la globalidad del ser desde una óptica afectiva y relacional, la Neuromotricidad se centra en el análisis y la intervención de los sistemas neuromotrices con una clara implicación del lenguaje, enfocándose en investigaciones con test validados.

Este texto fundamental se sumerge en el cuerpo teórico derivado de la neurociencia motora y del desarrollo para presentar la taxonomía completa de las actividades distintivas, los instrumentos de evaluación rigurosos y el marco metodológico que diferencian a este campo. Si usted es investigador, docente, músico, actor o terapeuta que busca trascender las definiciones laxas y operar con verdadera fundamentación científica, este es el volumen le ofrecerá una introducción en el que conecta la expresión corporal y musical.

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