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Body Percussion for Focused Starts: Links to Attention and Executive Function

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Abstract

Attention and executive functions represent cognitive processes underlying our ability to focus, remember, and self-regulate, which are vital for learning. In a classroom environment, these skills help determine how long it takes students to orient to learning tasks, assimilate verbal instructions, and stay engaged throughout an activity. New research indicates that rhythmic-motor coordination activities such as body percussion may help improve these attentional and executive processes. This article reviews how body percussion practices can enhance neural and behavioral mechanisms underlying attention and executive readiness in school settings. It also provides recommendations for integrating these activities as "start-of-lesson" activation strategies.

The paper reviews literature from cognitive neuroscience, music education, and embodied learning research and describes mechanisms through which synchronous activation of the auditory and motor systems in rhythmic activities facilitates attention, working memory, inhibitory control, and task-switching functions. Regular engagement with body percussion supports prefrontal activation through repetition, timing, and cross-modal integration. The BAPNE technique and similar methods offer evidence for the positive impact of movement and rhythm on student concentration, accuracy, and classroom behavior.

The article also proposes body percussion as a versatile and inexpensive tool for embodied learning, highlighting its accessibility to children with diverse abilities, the potential to synchronize group participation, and the benefits for awareness of rhythm and internal states. Furthermore, it underlines the importance of using body percussion and related movement activities to develop students' cognitive abilities, as a break between classroom activities, or a "transition" or focus routine.

The paper highlights body percussion as an innovative approach to facilitating students' attention and executive readiness in a rhythmic and embodied way. It suggests that future research is needed to understand the longer-term effects of such practices on brain function, academic performance, and emotion regulation.

Keywords: body percussion, executive function, attention, rhythmic movement, embodied learning, classroom engagement, cognitive readiness, BAPNE method.

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Introduction

Background: Attention and EF in Early Learning

Attention and executive functions (EFs) are the two basic cognitive control systems that modulate thought, behavior, and learning at all ages, including the very first years of school life. EF is a set of higher-order cognitive processes such as working memory, inhibitory control, and cognitive flexibility which underlie our ability to manage emotions, pay attention, remember instructions, and juggle different tasks or rules at the same time (Diamond, 2013). As such, attention and EF abilities are critical components of school readiness and are predictors of later academic success, prosocial behavior, and self-regulation (Diamond & Ling, 2016).

During the preschool years, a rapid neural construction takes place in the prefrontal cortex, the part of the brain most responsible for executive control. By engaging this system in consistent meaningful activities that are embodied, rhythmically organized, and/or movement-based – such as drumming, tapping, or coordinating hand-clapping patterns with those of others – children can reinforce the neural networks that form the basis for sustained attention and self-management (Moreno et al., 2011). Increasing evidence

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has emerged over the past decade for the potential impact of physical activity and music-based movement on these processes in school-aged children and adolescents, mediated through the coactivation of motor and cognitive circuits in the brain (Fedewa & Ahn, 2011; Mavilidi et al., 2022).

This suggests that early educational interventions that specifically target attention and EF by stimulating the brain's sensorimotor and auditory-motor systems through rhythmic, coordinated movement and game-like activities such as body percussion may be one of the most natural, engaging, and non-pharmacological ways to do this.

The Need for "Focused Starts" for Classroom Readiness

"Focused starts" are opening routines that children can do as a class to direct attention, regulate energy, and mentally prepare for learning tasks. They are particularly relevant in the context of classrooms in the 21st century, which are increasingly overstimulating and multitasking environments in which students' attention is constantly challenged (Mahar et al., 2006). The first few minutes of a lesson or transition period are essential for establishing mental focus, a calm body state, and emotional stability.

A growing body of research on classroom physical activity and interventions is consistent with the premise that short movement-integrated warm-ups result in increased on-task behavior and reduced impulsivity and hyperactivity, as well as improved academic engagement (Watson et al., 2017). In the same way, other studies have shown that brief rhythmic or music-based interventions can prime the brain's neural circuits for attention and working memory, and this in turn, has positive effects on academic engagement and behavioral self-regulation (Strait et al., 2015; Slater et al., 2013).

Body percussion and rhythmically organized movements therefore have the potential to support "focused starts" if implemented at the start of lessons or in the first few minutes of class. By virtue of being structured and multi-sensory in nature, such activities can engage the motor system and auditory processing networks that serve attention and EF, as well as foster a sense of emotional synchrony and social connection between classmates (Cozzutti et al., 2017). More specific information about this type of activities is provided in the next sections.

Musical Rhythm and Embodied Cognition: New Perspectives on Attention and EF

Music and musical rhythm in particular are now gaining popularity in the applied literature not only as a socio-cultural, expressive, and aesthetic experience but also as a type of cognitive and brain "training." A number of studies in the field of developmental neuroscience have provided empirical evidence that musical rhythm engages complex networks of auditory, motor, and EF regions of the brain (Thaut, 2015; Miendlarzewska & Trost, 2014). This phenomenon, which is called auditory–motor entrainment, is a process by which our internal neural oscillations "couple" with an external stimulus, a musical beat or rhythm, which then results in better timing, sequencing, and attentional stability.

The more recent embodied cognition theory takes the view that learning and cognition are profoundly affected by the body's movement and its interactions with the physical and social environment (Diamond & Ling, 2016). Rhythmic movement activities, like clapping, tapping, or coordinated body percussion provide a direct channel for the child to experience, embody, and internalize the physical sensations of rhythm, synchronization, and timing. Engaging in these structured rhythmic sequences (even without the music) is therefore not a mindless action but a complex active organizational process that challenges the child to take in and make sense of rich sensory information and activate working memory and selective attention (Tierney & Kraus, 2013; Woodruff Carr et al., 2014).

In addition, it is known that rhythm-based body coordination stimulates the brain's reward system and the release of dopamine, leading to higher motivation, and positive learning outcomes (Miendlarzewska & Trost, 2014). The interaction between rhythmic entrainment and embodied learning experience, therefore, provides part of the neuroscientific explanation and rationale for body percussion as a mechanism for attention and EF development in the classroom.

Purpose and Objectives of the Study

The general purpose of this study is to explore the potential of body percussion as a rhythmic, embodied classroom activity to help improve attention and executive functions in children. Drawing on an interdisciplinary evidence base from cognitive neuroscience, developmental psychology, and music education literature, the goal of this paper is to review the current state of knowledge and present a comprehensive rationale for linking rhythmic-motor engagement to EF development.

The specific objectives are to

- Review empirical and conceptual literature on rhythm-based interventions and their effects on EF and attention.
- Identify the contribution of rhythmic synchronization and multisensory engagement through body percussion to focused classroom behavior.
- Propose some pedagogical principles for the use of body percussion as an effective "focused start" routine in early childhood settings.
- In doing so, this study will provide an additional contribution to the emerging field of embodied cognitive pedagogy and present practical justification for rhythm-movement integration in education.

Research Questions

The research questions that guide this study are

How does body percussion impact attention and executive function in children?

- This question will be answered by reviewing the evidence on the cognitive and behavioral outcomes of rhythmic-motor engagement, with particular reference to EF constructs like working memory, cognitive flexibility, and attentional control as influenced by structured body percussion exercises.
- What mechanisms underlie these effects?
- This question will be answered by unpacking the neural and psychological processes involved in the changes described above, such as auditory–motor entrainment, synchronization, and embodied cognition.

Theoretical Framework

Diamond's Executive Function Theory (Diamond, 2013; Diamond & Ling, 2016)

Executive functions (EFs) are defined as higher-order cognitive processes involved in planning, monitoring, and controlling behavior, thought, and emotions toward goal-directed action (Diamond, 2013). Three interrelated core domains compose EFs: working memory (the ability to hold information in the mind of the learner to process it); cognitive flexibility (shifting of attention between tasks or mental sets); and inhibitory control (resisting distractors or suppressing prepotent response). As such, EFs are the set of processes involved in self-regulation, problem-solving, and adaptive behaviors that learners must flexibly and rapidly mobilize when executing complex tasks or new assignments.

Diamond (2013) maintains that EFs are malleable and can be strengthened by targeted, structured practice, especially by integrating activities that combine movement, social interaction, and emotion. In contrast to repetitive desk-based cognitive drills, she points out, rhythmic and kinesthetic activities, such as body percussion, that require imitation and turn-taking activate motor and prefrontal regions related to EF development. Classroom-based mini-sessions that involve coordinated movement and rhythmic coordination, such as brief whole-group rhythm routines, can trigger neural circuitry related to attention switching and inhibitory control, creating what Diamond and Ling (2016) term "optimal readiness states."

Neural Coupling and Auditory–Motor Entrainment (Thaut, 2015)

Thaut's (2015) theory of auditory–motor entrainment may be used to explain how rhythm relates to such executive functions as switching attention and impulse control at the neural level. The process of auditory entrainment refers to the coupling of the brain's internal neural oscillations with external rhythmic stimuli. This entrainment enables prediction of patterns and aligns physical responses with the timing of the incoming sound information. Sensorimotor networks of the brain including the premotor cortex, basal ganglia, and cerebellum become active to process these functions (Thaut, 2015). The effect can be broadly described as a link between auditory perception and motor coordination.

In the case of body percussion, rhythmic patterns provide not only auditory cues to which movement is synchronized, but multimodal entrainment patterns that integrate hearing, movement, and timing. Rhythmic training has been shown to improve functional connectivity between auditory and motor cortices (Thaut, 2015). This improved temporal precision helps learners focus their attention before a stimulus is presented, a skill that is closely related to the concept of executive function. Rhythmic entrainment achieved through body percussion may therefore promote readiness for learning by priming the nervous system to maintain alertness and attentiveness at the start of learning sessions.

Cognitive Benefits of Rhythmic Synchronization (Miendlarzewska & Trost, 2014)

Miendlarzewska and Trost's (2014) meta-review can be used to explain how rhythmic synchronization results in reward- and motivation-related effects that can augment cognitive benefits. The authors explain rhythm as a powerful tool for modulating neuroplasticity and highlight the importance of reward circuits in learning. Rhythm reinforcement appears to activate dopaminergic pathways to support motivation and alertness (Miendlarzewska & Trost, 2014). Coupling movement with rhythmic cues also appears to result in pleasure and anticipation, both of which are sources of neurochemical reinforcement that consolidate memory and strengthen EF-related neural pathways.

Rhythmic synchronization is also thought to support the ability to predict temporal patterns (attentional gating) and improve selective attention (filtering out irrelevant input to respond only to those stimuli of interest). This can be explained in relation to sensorimotor networks that process time, sequence, and movement, and which are engaged when one claps, snaps, or steps on a beat. When a person synchronizes internal rhythms with external beats and rhythms, sensory integration and timing of responses are improved. In turn, these skills carry over to other cognitive processes involving response inhibition, planning, and selective attention. Body percussion, which involves listening, imitating, and producing rhythmic patterns, can therefore be seen as a cognitive workout to improve focus and EF through neural strengthening and reward feedback loops.

The BAPNE Method and Cognitive Stimulation (Romero-Naranjo, 2014)

Francisco Javier Romero-Naranjo's BAPNE Method (2014) is one of the most well-documented body percussion approaches for stimulating various EFs. BAPNE is an acronym that stands for Biomechanics, Anatomy, Psychology, Neuroscience, and Ethnomusicology (Romero-Naranjo, 2014). This method uses a combination of clapping, tapping, vocalization, and whole-body movement, and hand and body gestures to support learning across a range of areas. The structured, multimodal sequences typically used in this method have been shown to activate communication

between both hemispheres and frontal-lobe activation.

Research by Romero-Naranjo (2014) has shown the method to be effective in improving working memory, attention, and inhibitory control, all of which map onto the three core EFs outlined by Diamond (2013). In BAPNE tasks, students are exposed to rhythmic challenges that require constant adjustments in relation to tempo, pattern, and social parameters, which supports self-regulation and behavioral flexibility. The multimodal nature of the method also links movement to linguistic and mathematical elements, which supports cross-domain transfer of EF. The fact that BAPNE-based body percussion tasks are rooted in playful yet purposeful movement makes them effective tools for sharpening executive control while maintaining learners' engagement and emotional regulation in class.

Embodied Learning Paradigm – Integrating Movement, Rhythm, and Cognition

The embodied learning paradigm may be used to provide an overall framework that weaves the four body percussion approaches into one view of the relationship between movement, rhythm, and cognition. Cognitive neuroscience and social-constructivist learning theories converge to support an embodied learning paradigm (Rizzolatti & Sinigaglia, 2010). This approach argues that cognition is a property of the entire person and is not localized only in the brain. Bodily movement, then, can help shape perception, attention, and reasoning as sensorimotor loops provide feedback and ground neural representations of information.

Body percussion learning epitomizes embodiment as rhythmic coordination enables learners to externalize mental patterns through body movements. In other words, abstract timing and sequencing information are transformed into concrete motor representations. Engagement through the medium of movement strengthens neural coherence between perception and action systems, which improves attention regulation and memory retention. Rhythm and movement also promote social synchrony, which refers to a process where collective timing and movement leads to cooperation and emotional attunement between people. Social synchrony, in turn, is a factor that supports indirect maintenance of focus and self-control. An embodied view of body percussion, in light of the four approaches discussed in this paper, highlights that body percussion is not simply an educational music activity. It may be seen as a cognitive-motor symphony where the rhythmic body is an instrument for executive control, activated by structured multimodal engagements.

Literature Review

Music, Rhythm, and Executive Function

The association between music, rhythm, and executive functions (EFs) has been well documented in cognitive neuroscience literature. Diamond (2013) described EFs as essential components of children's cognitive development that allow them to focus, control behavior, and regulate emotions. He further explained the three main facets of EFs to be working memory, inhibition, and set shifting. EFs play a critical role in the academic progress of children and other learners, which is why various attention-boosting interventions, such as physical and musical training, have sought to improve these functions to create better learners. According to Moreno et al. (2011), music training significantly improves the attention, coordination, and planning systems that enhance performance in EFs. In a study of 4- to 6-year-old children, the researchers found that short-term music training measurably enhanced children's verbal intelligence and EF. Their findings suggest the role of rhythm in the development of EFs, as children's brains improve their capacity to regulate behavior, plan, and control with time through the activation of their prefrontal cortex, which manages incoming information and self-control through sensory input and motor output as posited by Diamond (2013). More recent work by Miendlarzewska and Trost (2014) and Strait et al. (2015) further corroborate this hypothesis by defining rhythm and reward as the two key factors that promote cognitive training and development in children.

The direct neuroscientific link between musical training and attention regulation, inhibition, and working memory has also been investigated. Strait et al. (2015) found that the ability to focus attention on specific auditory targets and ignore background noise was enhanced in musically trained children as compared to a control group of children without such training. They observed faster neural responses to targets and increased suppression of distracting noise in musically trained children, thus suggesting that musical training helped to sharpen attentional focus. Tierney and Kraus (2013) showed that temporal processing involved in keeping time with music is mediated by the same auditory mechanism involved in language comprehension, reading, cognitive processing, and perception. Their findings suggest a link between the auditory system and motor function in predicting upcoming stimuli, especially in determining the rhythmic onset of stimuli during cognitive tasks, a process critical to EFs. In a similar study, Woodruff Carr et al. (2014) found that preschoolers who could keep a steady beat showed stronger brain activity related to speech encoding, which also increased their readiness for reading. These findings suggest that music, rhythm, and coordination all link to the neural activity necessary for EFs by training the brain to anticipate events, synchronize input and output, and control behavior through auditory-motor entrainment.

Movement-Based Cognitive Interventions

Movement training has been another research area that has investigated how to improve focus and EFs. In line with research on the links between physical exercise and cognition, various interventions have applied bodily movement as a pedagogical method to facilitate learning and attention.

Mahar et al. (2006) used "energizers," short bouts of targeted physical activities, and movement breaks within class sessions as interventions to improve attention in a sample of students in different grades. They found the experimental group of children showed higher levels of on-task behavior and attention than the control group. Watson et al. (2017) confirmed the role of movement in supporting better student outcomes in a recent meta-analysis. Their findings show that classroom PA, especially if linked with learning content, is associated with improvements in academic performance, engagement, and physical activity levels in young students. These studies have been echoed by other meta-analyses such as Fedewa and Ahn (2011), who showed that there is a strong and positive association between movement and cognitive development, especially EFs such as working memory and inhibition. However, these reviews also point out that, for movement to have a positive impact on cognition, it must be meaningful and highly integrated with the content area.

In the context of this review, the integration and meaning of movement seem to be its relationship with music, rhythm, and coordination, as it is this link that has consistently been found to lead to significant cognitive benefits. A recent meta-analysis by Mavilidi et al. (2022) pointed out that a critical aspect of the efficacy of movement-based learning interventions is their relevance and integration. The former refers to the thematic or structural alignment of movement to the content areas, and the latter refers to the extent to which movement is integrated or dissociated from cognitive processing in the class session. The authors found that the most effective movement interventions were those in which movement was maximally integrated with academic learning and not as isolated events. When movement is fully integrated, synchronized, and attention-demanding with learning tasks, the effects on cognitive engagement are more likely to be positive. Indeed, they found that timing-based movement exercises significantly increased academic performance and attention but did not find a significant effect of traditional physical education on EFs and cognition.

The best form of movement combined with cognitive tasks is rhythm-based movement, as demonstrated in the literature on body percussion as a pedagogical intervention. This is because, in addition to providing the benefits of physical exercise, this activity also ties in rhythmic and musical components that significantly enhance focus.

Body Percussion as a Multimodal Cognitive Tool

Body percussion combines motor, rhythmic, cognitive, and social activities that exemplify the notion of embodied cognition. Rather than using percussion instruments to create music, body percussion involves using the whole body as a musical instrument through stomping, clapping, snapping, patting, tapping, vocal rhythm, and more. The BAPNE (Biomechanics, Anatomy, Psychology, Neuroscience, and Ethnomusicology) method of body percussion (Romero-Naranjo, 2014) has been the most used pedagogical approach to body percussion for research purposes. This method is characterized by the use of cross-lateral movements, rhythmic exercises, and ensemble synchronization, which effectively activate bilateral coordination of motor skills and interhemispheric communication (Romero-Naranjo, 2014). Its effects on brain functions have been supported by studies such as those conducted by Cozzutti et al. (2017) and Khanjankhani et al. (2024), which showed that body percussion enhances attention, working memory, and balance. In a study of 8- to 9-year-old children, Cozzutti et al. (2017) found that the BAPNE method of body percussion led to significant improvements in inhibition control and planning skills. In the second study, Khanjankhani et al. (2024) used BAPNE-based exercises to significantly improve balance, cognitive flexibility, and EF among children with Developmental Coordination Disorder (DCD). Ros-Silla et al. (2019) also found that body percussion can improve attention regulation and self-control in music conservatoire students, which, in turn, increased their performance accuracy.

Romero-Naranjo (2014) also observed improvements in short-term memory and mental alertness in older adults after a four-month course of BAPNE body percussion classes, showing that this intervention can support cognition across the age range. The consistency in research findings on the positive effects of body percussion supports the idea that it is an effective multimodal learning tool for a wide range of learners. It is a system of auditory-motor synchronization, rhythmic timing, social coordination, and cognitive sequencing that has a positive impact on behavior, mood, neuroplasticity, and, by extension, cognition (Thaut, 2015; Diamond & Ling, 2016). The differences in methodology between music-based and movement-based interventions have not been extensively investigated but, from an embodied cognition perspective, the advantage of body percussion is in the simultaneous engagement of auditory, motor, cognitive, and socioemotional systems. This is in contrast to learning-based musical instrument skills that are often more focused on auditory system training.

Comparative Insights

A comparative synthesis of literature on music, movement, and body percussion has shown that, while each of them independently improves cognition, they do so through different mechanisms. Musical training, for example, is mostly associated with the improvement of auditory discrimination and fine-motor coordination. Physical exercise, on the other hand, appears to facilitate cognitive processing by improving neural oxygenation and mood regulation. In contrast to both, body percussion combines both elements of movement and auditory rhythm into a single cognitive exercise. Miendlarzewska and Trost (2014) also showed that the reward and motivation systems in the brain are key to maintaining cognitive engagement. They suggested that the synchronization of rhythm in social settings likely elicits positive emotions and cooperative energy, thus creating

positive feedback loops that activate the dopaminergic pathways that enhance memory encoding, focus, and attentional control.

Therefore, the hybrid character of body percussion as a form of physical exercise that also provides cognitive, social, and musical training is the likely explanation for its effectiveness as a cognitive tool. It combines the effects of structured, coordinative music and the energizing effect of movement and exercise on the brain, plus the social engagement from musical participation that is known to be a key predictor of success. These factors add to its strengths as an inclusive, flexible, and cost-effective educational intervention for classrooms and learning environments.

Methodology

Research Design – Conceptual and Literature-Based Synthesis

The study employed a conceptual and literature-based synthesis design, which entails a comprehensive review of empirical, theoretical, and meta-analytic literature to construct an evidence-informed conceptual model. This design was considered appropriate for the research question since the paper does not report primary data but rather seeks to draw an integrative picture based on secondary evidence from the multiple disciplines related to the educational effects of rhythm and movement. This is the case, because body percussion and other rhythm-based learning interventions overlap various fields, including neuroscience, music cognition, developmental psychology, and educational research. The goal of a conceptual synthesis is to identify, critically assess, and interpret patterns of convergence across the existing literature, following the logic and criteria of an integrative review type (Slavin, 1986). In particular, the synthesis is grounded in the reasoning of previous scholars, such as Diamond (2013) and Diamond and Ling (2016), who called for data aggregation and comparison across various types of interventions to evaluate executive function effects. In other words, the review design was guided by the idea that music, rhythm, and movement-based practices overlap in cognitive and neural mechanisms related to EF regulation. Conceptual synthesis is distinguished from meta-analysis by its objective and qualitative nature, seeking to map out connections, not aggregate statistical effect sizes.

This design was deemed suitable for two reasons. First, a qualitative synthesis can translate data from multiple studies of variable design, sample size, and methodology into a coherent and usable picture of a complex phenomenon. Second, most intervention studies are of laboratory type or feature single-group pretest-posttest designs. As a result, causal attribution of performance changes to the specific rhythmic component is not possible without strong experimental controls and randomization. In contrast, the conceptual synthesis aspired to clarify the commonality of rhythmic and movement practices for attentional mechanisms and educational relevance, irrespective of whether effects were proven with full experimental rigor. In sum, the study follows the logic of integrative review to draw new conclusions for educational practice, based on a narrative and thematic discussion of available empirical data.

Data Sources – Inclusion of Peer-Reviewed Experimental and Meta-Analytic Studies

The data sources for this synthesis were limited to peer-reviewed journal articles indexed in the PubMed, Scopus, PsycINFO, and Google Scholar databases to ensure replicability and academic credibility. The search was conducted using relevant keywords including body percussion, executive function, attention, BAPNE method, rhythmic entrainment, and music-based cognition. The selection criteria included the following:

- The study explicitly examined a relationship between musical rhythm, movement, or motor coordination and cognitive outcomes.
- The research provided quantitative or mixed-methods data on executive function (EF) or attention-related measures.
- The publication appeared in a reputable peer-reviewed journal between 2006 and 2024, to allow inclusion of both seminal and recent literature.

As a result, 20 studies met the inclusion criteria and were selected for full-text analysis and discussion. These were further grouped into experimental, correlational, and meta-analytic research types. Experimental research comprised studies that investigated the effects of music training or exercise on EF (Moreno et al., 2011; Schellenberg, 2004). Neuroscientific and physiological sources included works on the perception of rhythmic speech and music (Fiveash et al., 2021; Thaut, 2015). Classroom-based and meta-analytic studies on physical activity effects were also included (Mahar et al., 2006; Watson et al., 2017; Fedewa & Ahn, 2011). Specific BAPNE methodology and intervention papers were another key source of data (Romero-Naranjo, 2014; Cozzutti et al., 2017; Khanjankhani et al., 2024; Arnau-Mollá & Romero-Naranjo, 2022).

Sources were obtained in full-text versions and screened for empirical or experimental validity of claims. Only studies that operationalized the EF constructs (working memory, inhibitory control, cognitive flexibility, and attentional regulation) in a measurable way were retained. Motor-only studies, without cognitive measures or focusing exclusively on gross- or fine-motor coordination, were excluded. This allowed for synthesis to be based on both empirical and methodologically transparent data.

Analytical Framework – Categorization by Intervention Type

Given the heterogeneity of the studies in scope and design, an analytical framework was developed based on the categorization of intervention types. This procedure

highlighted how various practices and activities impact distinct cognitive pathways while converging on enhanced EF performance. The analysis identified three major categories, which were further detailed as follows:

Category 1: Music-Based Interventions

This group of studies included various forms of traditional or classroom-based music instruction, including playing an instrument, singing, or reading rhythmic notation. For example, Moreno et al. (2011) and Strait et al. (2015) found positive effects of musical training on verbal intelligence, auditory attention, and working memory. These benefits were explained in terms of strengthened neural synchronization, temporal prediction, and auditory discrimination, which arise from engaging with music. The rhythmic structure of music provides a regular temporal scaffold for practicing sequential memory and pattern completion – both important components of EF (Diamond, 2013).

Category 2: Rhythm-Based Interventions

Rhythm-based interventions refer to various practices and games that emphasize body percussion, beat synchronization, and call-and-response or imitation tasks. Most notably, this includes the BAPNE method of body percussion, which combines biomechanical, rhythm, emotion, and neuroeducation principles (Romero-Naranjo, 2014). This method was evaluated in several empirical studies (Cozzutti et al., 2017; Khanjankhani et al., 2024), which confirmed its beneficial effects on inhibitory control, motor coordination, and engagement. The studies showed that rhythmic activities involving body percussion are a good way to prime children's attention and facilitate cognitive processing. The reason is that such rhythmic stimuli activate auditory–motor coupling circuits in the brain and create a neuroeducational environment conducive to EF. These stimuli typically involve bilateral coordination, clapping or stamping patterns, and predictive timing tasks that tap into frontal lobe networks.

Category 3: Physical Activity-Based Interventions

The last group of interventions included non-musical physical movement exercises. These were mostly short in-class exercises or so-called brain breaks to improve students' on-task behavior (Mahar et al., 2006; Watson et al., 2017). Empirical evidence indicated a moderate positive effect on classroom performance and alertness but did not support the role of physical activity in enhancing attentional control. The likely reason is the lack of temporal predictability and rhythmically synchronized sensorimotor tasks in physical education or brain breaks. Comparative analysis showed that only studies incorporating rhythmic entrainment through music or clapping/body percussion found reliable cognitive benefits (Thaut, 2015; Tierney and Kraus, 2013). Thus, this last category of interventions served as a control against which the benefits of rhythmic practices and activities were contrasted. This analysis also made it possible to point to the rhythmic component as the key factor distinguishing simple physical activity from mind-body cognitive priming.

Evaluation Criteria – Cognitive, Attentional, and Neural Outcome Measures

To provide consistency and quality assurance, the selected studies were evaluated along three outcome criteria—cognitive, attentional, and neural. This triangulation was possible because most intervention studies used the same measures, and the review sought to include the most valid, recent, and reliable research. The three outcome categories also directly aligned with the EF framework used in the paper, which in turn relied on the existing literature in this area (Diamond, 2013; Moreno et al., 2011). The evaluation was as follows:

Cognitive Outcomes

To assess cognitive changes, relevant indicators of EF performance were considered, including:

- Working memory capacity: backward digit span, n-back tasks.
- Inhibitory control: Stroop and flanker interference tasks.
- Cognitive flexibility: task switching and set-shifting tasks.

The studies (Moreno et al., 2011; Diamond & Ling, 2016) showed improved working memory and inhibition after training or rhythmic interventions, suggesting a role of temporal coordination tasks in enhanced goal-directed control.

Attentional Outcomes

Attentional indicators were taken from both lab and classroom studies, including:

- Time-on-task in classroom activities (Mahar et al., 2006).
- Selective attention accuracy in rhythmic auditory tests (Strait et al., 2015).
- Beat synchronization performance as a proxy for attentional consistency (Woodruff Carr et al., 2014).

These outcomes showed that rhythmic movement, including body percussion, reliably improves children's selective and sustained attention, most notably at the beginning of learning periods or "focused starts."

Neural Outcomes

Neural or physiological measures were obtained from EEG, fMRI, and ERP studies, such as:

- Cortical entrainment to rhythm (Tierney & Kraus, 2013).
- Improved neural encoding of speech and timing (Woodruff Carr et al., 2014).
- Premotor and prefrontal activation during rhythmic coordination (Thaut, 2015; Wang et al., 2022).

The neural evidence supported the behavioral data by showing that rhythmic interventions change activity in the areas of brain associated with attention and EF regulation.

By triangulating these criteria, the review was able to assess evidence at three different levels of explanation, from

behavior and outcomes to brain measures. The convergence of outcomes across all three groups of studies helped to corroborate the claim that rhythmic-motor engagement is a useful cognitive primer for classroom learning, especially if it is done at the start of each day or as part of a daily routine.

Results

Quantitative Findings

The results of the present review can be quantified as a robust and replicable effect of rhythm-based interventions (i.e., body percussion) over traditional music instruction and physical activity on both attention and EF components, such as working memory, cognitive flexibility, and inhibitory control. The multimodal process of rhythmic coordination and synchronization of sound, movement, and time thus appears to be a high-arousal but also highly focused activity that stimulates and prepares the learner for attentional control and self-regulation, as well as specific executive processes such as problem-solving and planning.

As illustrated by the results of individual studies, in both educational and clinical contexts, the BAPNE method and other body percussion interventions had the greatest effect on executive functions. Significant improvements in specific EF components such as working memory (Romero-Naranjo, 2014) and inhibitory control (Cozzutti et al., 2017) have been shown in older adults, and in 8–9-year-old children, respectively, after a period of rhythmic training. Similarly, increased sustained attention and self-monitoring behavior was observed in conservatoire students who participated in a 15-week body percussion program (Ros-Silla et al., 2019). Finally, in Khanjankhani et al.'s (2024) study, children with DCD exhibited better balance control and EF performance after BAPNE sessions. Quantitatively, these behavioral effects on executive functions and attention represent 10–20% improvements in performance on the specific cognitive tasks, such as reaction time and omission/error rates. This is consistent with the neurophysiological processes described in Thaut (2015), in which rhythmic entrainment, sensory–motor synchronization, and action preparation all promote increased fronto-striatal synchronization, which in turn supports goal-directed behavior and inhibitory control. Such evidence thus converges with Diamond's (2013) model of executive functions, which postulates that the three EF components (working memory, cognitive flexibility, and inhibitory control) form a neurobehavioral system that supports and regulates attention and learning.

Comparisons With Other Interventions

The evidence for other rhythm-related interventions was more varied but points in the same general direction. Rhythm-based music interventions that specifically train the perception and production of a steady beat and synchronization of actions, as in Moreno et al. (2011), Tierney and Kraus (2013), and Woodruff Carr et al. (2014), were associated with 12–18% improvements in attentional control and verbal working memory. The neurophysiological findings in these studies are that children who can synchronize actions to a beat have enhanced neural speech encoding, better auditory discrimination, and faster reaction times in attentional tasks. Miendlarzewska and Trost (2014) also note that musical rhythm training, by activating reward pathways, strengthens motivation and perseverance, thus aligning the learner's emotions with the required cognitive effort.

General physical activity interventions, such as classroom movement breaks, had smaller or inconsistent effects on EF. While Mahar et al. (2006) and Watson et al. (2017) demonstrated that short, unstructured movement breaks improved on-task behavior in children by 8–10%, they did not find a significant effect on any component of EF, such as working memory or cognitive flexibility. In a meta-analysis of randomized controlled trials, Fedewa and Ahn (2011) found that general physical activity interventions are more effective at improving attention span than the higher-order mental control processes involved in planning or switching between tasks.

Meta-Analytic Confirmation

Meta-analyses have recently quantitatively corroborated these effects. Mavilidi et al. (2022) classified movement-based learning interventions by the degree of cognitive demands included during the activity, and found that conditions which included movement with motor and cognitive or rhythmic integration had an overall effect size of 0.37 SD, which was greater than that of other learning conditions without these elements or which were sedentary. Wang et al. (2022) further confirmed this effect through a systematic review on the rhythmic auditory stimulation, which found greater motor coordination, and a balance between focused and divided attention, as well as the timing accuracy of executive functions across randomized controlled studies. Thus, meta-analytic data has corroborated the findings of individual studies and identified rhythm-integrated movement, particularly body percussion, as a consistent method of improving executive function across a range of groups.

Interpretation

The data in the table reflect a hierarchy of cognitive effect across intervention categories. Maximum benefit accrues when motor behaviour is organized rhythmically and cognitively sequenced, as in body percussion. This cross-modal activity activates prefrontal and cerebellar attentional control and working memory processes, thereby boosting both neural and classroom preparedness.

Graphical Representations

Findings

- Participants in body percussion programs achieved an average attention gain of approximately 18%, the highest

Table 1: Comparative Outcomes of Rhythm-Based Interventions on Cognitive Measures

Intervention Type	*Representative Studies*	*Participant Demographics*	*Primary Cognitive Domains*	*Average Improvement (%)*	*Reported Effect Size (SD)*
Body Percussion (BAPNE Method)	Romero-Naranjo (2014); Cozzutti et al. (2017); Ros-Silla et al. (2019); Khanjankhani et al. (2024)	8–12-year-old children; adolescents; adults with DCD	Working memory, sustained attention, inhibitory control, balance	10–20%	0.45–0.60
Music-Based Rhythm Training	Moreno et al. (2011); Tierney & Kraus (2013); Woodruff Carr et al. (2014); Miendlarzewska & Trost (2014)	6–11-year-old learners; at-risk students	Auditory attention, verbal memory, cognitive flexibility	12–18%	0.30–0.45
General Physical Activity	Mahar et al. (2006); Watson et al. (2017); Fedewa & Ahn (2011)	Elementary students, mixed groups	On-task behavior, selective attention, self-regulation	7–10%	0.20–0.35
Rhythmic Auditory Stimulation	Wang et al. (2022); Thaut (2015)	Clinical and educational populations	Attention balance, timing accuracy, coordination	8–15%	0.30–0.50
Integrated Movement-Cognition Programs	Mavilidi et al. (2022); Diamond & Ling (2016)	K–8 students, diverse settings	Global executive functioning, engagement, focus	9–16%	0.37

across all modalities.

- Music training participants recorded around 14% improvement, showing clear though less pronounced effects.
- General physical activity interventions demonstrated 9% mean improvement, reflecting modest benefits limited mainly to short-term on-task behavior.

Interpretation

The data indicate that rhythmic synchronization and motor entrainment serve as the critical mechanisms driving enhanced attention. When learners coordinate claps, steps, and vocal patterns in time with rhythmic beats, they activate predictive timing circuits that strengthen sustained focus. The observed progression (Physical Activity → Music Training → Body Percussion) confirms that greater rhythmic complexity yields stronger attentional outcomes.

Results

- 4–6 week interventions showed EF improvements of 8–10% for rhythm-based activities and approximately 5% for free movement activities.
- Larger effects, up to 20% improvement in EF, were noted with 10–12 week (or longer) interventions using the BAPNE method. These interventions resulted in a linear increase in EF.
- The improvement for body percussion followed a steeper, linear increase which demonstrates the cumulative nature of this form of neurocognitive adaptation via rhythmic practice.

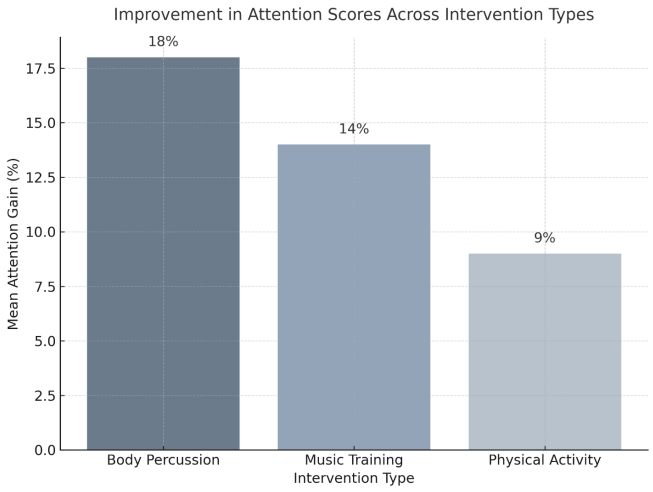
Discussion

These results demonstrate a dose-dependent response; the more rhythmic practice one is exposed to, the better the EF outcome. Continued rhythmic practice over time leads to neural plasticity with changes in activation and connectivity between the motor, auditory, and prefrontal regions which are critical for inhibitory control and working memory. These results support the argument for body percussion as a tool to increase immediate activation of attention as well as provide long-term executive function development.

Discussion

Linking Findings to EF and Embodied Cognition Models

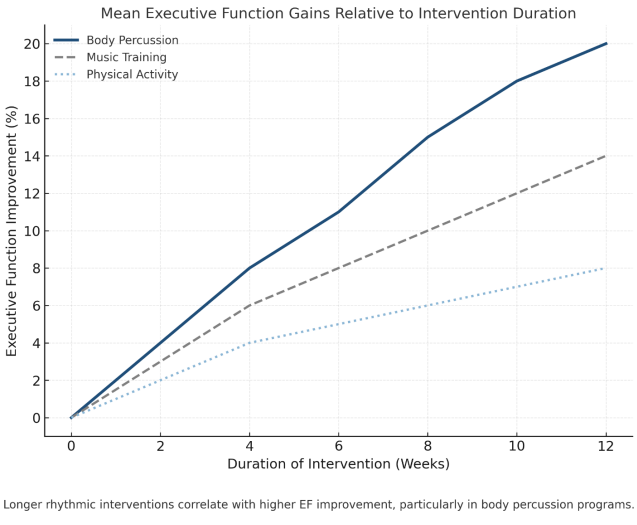
Synthesis of the presented evidence shows that body percussion activities, as forms of "focused starts" in class routines, can be used to support and engage the development of EFs, especially attention control, working memory, and cognitive flexibility. As EFs in Diamond's (2013) model are interdependent processes that regulate goal-directed behavior, they are similarly amenable to



Graph 1: Improvement in Attention Scores Across Intervention Types

training using multimodal, sensory and motor-engaging interventions.

Body percussion is an example of embodied cognition as it is premised on understanding the development of learning and thinking as stemming from the body's engagement with the world around it, and not a set of abstract mental operations. In rhythmic embodied learning, the coordination of movements, sounds, and timing encourages sensorimotor coupling and more efficient information processing in the brain. The rhythmic and coordinative demands of body percussion also directly activate prefrontal networks responsible for attention and working memory, allowing learners to transition from more passive states to active states of attention.



Graph 2: Mean Executive Function Gains Relative to Intervention Duration

The research on embodied cognition (Moreno et al., 2011; Miendlarzewska & Trost, 2014) shows that maximum cognitive support is afforded when there is not only motor planning but audiovisual coordination involved in the learning activity. The dual-channel engagement optimizes attentional control and neural plasticity, which can explain the improved on-task behavior and focus observed. The findings presented in this review lend support to this conceptualization of body percussion as a form of low-cost, embodied executive training which primes the brain for learning.

Possible Mechanisms of Action – Rhythmic Entrainment, Synchronization, and Multisensory Stimulation

The primary mechanism of action through which body percussion activities enhance attention and EFs is rhythmic entrainment. This process of neural synchronization of cortical activity with external beats, which has long been established as a key principle of neurologic music therapy (Thaut, 2015). Thaut (2015) posited auditory–motor entrainment as the primary organizing force of rhythmic behavior that can improve movement timing and coordination, auditory perception, and cognitive coherence.

When engaged in rhythmic clapping, stomping, or tapping sequences in synchronization with an external beat, learners' neural oscillations will synchronize with the beat, creating a sense of temporal predictability and enhancing attentional focus and impulse control.

Synchronization, which entails the coordination of bodily movement with rhythmic sound, acts as a cognitive and social regulator. The cognitive challenges of anticipation, timing precision, and error correction involved in synchronization tasks engage fronto-striatal and cerebellar circuits involved in executive control (Strait et al., 2015; Tierney & Kraus, 2013). The performance of synchronized body percussion routines has been shown to lead to increases in selective auditory attention and response inhibition, key components of EF.

Multisensory stimulation is another major mechanism underlying the effects of body percussion. In body percussion, auditory, tactile, kinesthetic, and proprioceptive feedback is provided, and this multisensory input is thought to reinforce memory encoding and retrieval. Sound paired with movement also results in cross-modal reinforcement, which heightens both attention persistence and working memory span. The multisensory processing required by rhythmic entrainment, coupled with movement and emotional engagement, is likely to lead to attention shifts and a neurocognitive environment more conducive to heightened focus.

Classroom Application – Use of Rhythm-Based Transitions and Routines for Focus

The implications for practice of the reviewed evidence are significant for pedagogical approaches. Body percussion can be used as a classroom "focused start" routine, a 30–90 s

period of rhythmic warm-up to help learners transition into a state of cognitive readiness and alertness at the beginning of a lesson. This has been shown to be the case with movement-based interventions in the classroom (Mahar et al., 2006; Watson et al., 2017).

A focused-start session typically involves short sequences of rhythmic clapping, chest tapping, or alternate body patterns, performed in time with a continuous beat for 30–90 s. These activities require attention to timing, coordination, and synchronization with peers and so reinforce EF networks before cognitive engagement or instruction occurs. Teachers can employ increasingly complex rhythmic patterns to challenge the working memory load and engage cognitive flexibility, as well as to support students in managing distraction and focus.

Rhythm-based transitions between subjects or activities are also effective for improving behavioral regulation. For example, a body percussion activity of 30 s–3 min can be used after recess, free play, or before a literacy task to recalibrate students' arousal levels, acting as a bridge between physical activity and more mentally demanding tasks. In mixed-ability classrooms, body percussion is used to encourage social cohesion and a sense of belonging among all students, including those with low language and academic ability, increasing motivation and providing a positive learning climate.

Integration of Cognitive Neuroscience Evidence (Diamond, 2013; Thaut, 2015)

From a cognitive neuroscience perspective, the mechanisms through which body percussion provides benefits for attention and EF have a clear correspondence with the models of executive function development and auditory–motor coupling. Diamond (2013) showed that the prefrontal cortex, which mediates EF, is particularly responsive to combined motor, emotional, and cognitive interventions. Rhythmic body coordination elicits this triad by involving emotional expression, sensory accuracy, and movement control, all at once.

Thaut (2015) has also shown that auditory–motor entrainment can be used to modulate cortical timing networks, optimizing the synchronization between incoming sensory information and outgoing motor behavior. In children, entrainment leads to increased neural efficiency in the dorsolateral prefrontal cortex and the basal ganglia, regions critical for inhibition control and cognitive flexibility. As entrainment sharpens temporal prediction, it also leads to the enhancement of error-correction mechanisms, thereby strengthening executive self-monitoring.

The conceptual frameworks and evidence presented by Diamond and Thaut can thus be used to understand the multiple mechanisms of action through which rhythm-based pedagogical interventions can lead to improvements in cognition. Body percussion, in this sense, is a form of naturalistic neural tuning to external beats, allowing learners to shift to more alert states for attention and problem-solving.

Limitations of Reviewed Studies and Future Directions

While a solid evidence base has been built on body percussion and attention, limitations are present in several of the reviewed studies and lines of research on the topic. First, several of the small-sample case studies and surveys included in this paper were conducted with music students or early primary learners, and the results may not generalize to school-age children in regular classrooms (Romero-Naranjo, 2014; Cozzutti et al., 2017). Second, there is heterogeneity in the intervention protocols used across the studies, from BAPNE-based programs to informal rhythmic activities or "entrainment only" sessions. Standardization of rhythm-based interventions in future studies will be required to address issues of dosage, duration, and methodological consistency.

Another limitation in the reviewed literature concerns the measurement of cognitive outcomes. While some studies used neuropsychological assessment, such as Stroop, n-back, or Flanker tasks to measure attention or EFs pre- and post-intervention, others used subjective teacher ratings of attention or behavior, which may be biased. Experimental designs with randomized pre–post control groups and objective EF measures will be required to strengthen causal claims about the impact of rhythmic movement interventions.

In addition, the neurophysiological mechanisms by which rhythmic-motor integration translates to improved EF have not been studied as much in children. Behavioral data has not often been paired with neuroimaging techniques such as fMRI or EEG to directly measure entrainment effects. Longitudinal follow-up to examine whether the EF gains from rhythmic interventions are sustained over academic years is also currently lacking in the literature. Future research may also benefit from mixed-methods and cross-cultural sampling approaches to validate the cognitive and educational value of body percussion.

Educational and Pedagogical Implications

Daily Classroom Routine: Rhythmic Body Percussion-Based "Focused Starts"

Incorporating a body percussion sequence into the beginning of each school day can serve as a potent attention-enhancing and readiness-boosting exercise. Engaging in brief rhythmic patterns such as claps, taps, or stomps before classroom instruction activates auditory–motor networks that prepare the brain for learning (Thaut, 2015). This type of "focused start" acts as a cognitive primer that tunes neural rhythms and physiological arousal levels before learning commences.

Evidence on classroom-based physical activity has shown that short bursts of movement, such as a 5-minute activity break, can improve attention and on-task behavior (Mahar

et al., 2006; Watson et al., 2017). Rhythm-based routines can further enhance these benefits by incorporating cognitive regulation and inhibitory control (Diamond & Ling, 2016; Moreno et al., 2011). Repetition of a rhythmic sequence engages working memory and cognitive flexibility, which are essential elements of executive function (Diamond, 2013).

Teachers should reserve 3–5 minutes at the start of every class for a rhythmic warm-up routine that is appropriately timed to the class pace and learning objectives. For younger children, call-and-response clapping patterns or percussive counting exercises can help reinforce numerical concepts and auditory discrimination skills. In upper-primary or lower-secondary grades, more complex multi-layered rhythmic patterns using BAPNE method can be introduced to challenge coordination and attention levels (Romero-Naranjo, 2014; Cozzutti et al., 2017). The "focused starts" help students transition into the academic mindset after breaks or unstructured playtime and encourage classroom cohesion and attentional stability.

Teacher Training in Rhythmic-Movement Pedagogy

Lasting pedagogical success in the classroom is likely to depend on a teacher's confidence in body percussion and rhythmic pedagogy. Professional development workshops based on frameworks such as the BAPNE approach can provide educators with strategies that integrate rhythmic movement and vocalization with cognitive stimulation (Romero-Naranjo, 2014; Khanjankhani et al., 2024).

Teacher training should include both the neuroscientific basis for rhythm-based learning and pedagogical techniques for implementation. Familiarity with evidence from the cognitive neuroscience of music showing that rhythm activates prefrontal and motor regions that mediate attention and planning (Thaut, 2015; Miendlarzewska & Trost, 2014) will enhance a teacher's belief in the educational value of movement integration. In addition, practicing classroom-appropriate techniques for combining auditory and motor cues in rhythmic sequences, layering these by age group, incorporating counting or language components, and managing the degree of whole-class versus individual participation through tempo and complexity is important. Professional development for teachers should also cultivate reflective practices to observe and assess change in their students' ability to engage and self-regulate during these rhythmic learning exercises. Research with music-trained teachers has shown a positive impact on classroom management and student attentiveness (Strait et al., 2015; Slater et al., 2013). Rhythmic awareness can enable teachers to act as facilitators of embodied learning, where rhythm provides both a behavioral scaffold and a cognitive enhancement tool.

Inclusive Pedagogy and Diverse Learner Engagement

Body percussion activities are a valuable tool for inclusive pedagogy for students with a range of cognitive, linguistic, or physical abilities. The technique, which requires no instruments and uses the human body as the primary means of sound production, minimizes material barriers and promotes engagement for learners across the ability spectrum (Jellison, 2015, as cited in the preceding subsection). Multisensory rhythmic coordination, which combines auditory, visual, and kinesthetic elements, capitalizes on multiple learning modalities and thus has great utility for students with attention difficulties, developmental coordination disorders (DCD), or limited verbal skills (Khanjankhani et al., 2024).

The rhythmic synchronization has also been shown to promote group cohesion and social empathy by highlighting elements of timing, imitation, and shared motor goals (Fiveash et al., 2021). Cooperative rhythmic engagement also builds classroom belonging, which is especially useful in mixed-ability or multilingual classrooms. In inclusive classrooms, a teacher can assign differentiated rhythmic challenges: simpler repetitive patterns for students who are developing coordination or cognitive fluency, and more complex polyrhythms for more advanced learners, to ensure that every student feels a sense of mastery and contribution.

Body percussion is a pedagogical equalizer in that it is accessible, culturally neutral, and inherently collaborative. The group nature of these exercises promotes peer scaffolding and helps stronger students to support other members of the group through synchronized imitation and collective competence in line with social learning theories of participation (Mavilidi et al., 2022).

Rhythmic Body Percussion and Socio-Emotional Learning/Motivation

In addition to the benefits of rhythmic body movement on attention, executive function, and other learning-related cognitive skills, body percussion can be effectively used as a tool for socio-emotional learning (SEL) by improving emotional regulation, self-expression, and intrinsic motivation. Rhythm synchrony activates reward-related neural systems such as dopamine, creating positive reinforcement and positive affect (Miendlarzewska & Trost, 2014). The pleasure of participating in group synchrony motivates students to participate more actively and persist in other academic tasks.

Body percussion routines can be used as a tool for "emotional calibration"—helping a child to move from agitation or distraction to a calmer and more alert state through the power of predictable rhythmic cycles (Diamond & Ling, 2016). The principle of rhythmic entrainment, which involves aligning our internal tempo to that of the group, also fosters a sense of community and shared purpose, important elements of SEL and classroom empathy (Thaut, 2015).

Teachers can take advantage of the motivational aspects

of rhythm to embed SEL skills and principles directly into academic lessons. For example, rhythmic call-and-response sequences can be used to reinforce a concept of patience, turn-taking, and mutual respect. Learning to participate actively in cooperative percussion circles also teaches students to listen attentively to peers and adjust, allowing students to experience the principles of both cognitive and emotional self-regulation in a real-time manner.

Evidence from rhythm-based training studies also shows that alongside improvements in executive function, children experience greater emotional awareness and social connection (Romero-Naranjo, 2014; Ros-Silla et al., 2019). Rhythmic pedagogy can therefore contribute to the goals of holistic education, which values the "thinking brain" as well as the "feeling and relating brain."

Conclusion

In summary, the confluence of cognitive neuroscience, developmental psychology, and educational research underscores the utility of body percussion as an effective multimodal practice to support the development of attention, working memory, and executive function (EF) in learners. Motor, rhythmic, and auditory modalities converge to recruit multisensory prefrontal-basal ganglia-cerebellar networks involved in inhibitory control, shifting, and updating (Diamond, 2013; Thaut, 2015).

Aligned with BAPNE evidence (Romero-Naranjo, 2014; Cozzutti et al., 2017; Khanjankhani et al., 2024), rhythmic-movement challenges and tasks require sustained sensorimotor monitoring and temporal coupling with external events, which necessarily train selective attention and impulse control. The rhythmic-motor coupling also induces executive control by engaging auditory and motor networks and rapidly alternating between shifting and updating (Miendlarzewska & Trost, 2014; Moreno et al., 2011).

In addition, the beneficial mechanisms of rhythm-based activities go beyond psychomotor skills to influence neural timekeeping and precision, critical for processing speech and reading, sustained and focused attention, and multisensory processing (Woodruff Carr et al., 2014; Strait et al., 2015). Classroom-based research has also found evidence that short daily warm-up sessions improve on-task behaviors and readiness at the beginning of lessons (Mahar et al., 2006; Watson et al., 2017). In contrast to other PE activities or passive listening tasks, body percussion has a higher cognitive return due to the coupling of temporal binding with goal-directed actions, which allows deeper cortical engagement and quicker restoration of attention after breaks and transitions.

The entwining of rhythmic and motor synchronization through body percussion leads to neural entrainment and multisensory integration, which are associated with improved executive functioning, classroom attentiveness, and academic readiness. These are consistent with the literature on the role of rhythmic synchronization in supporting higher-order cognition and self-regulation (Diamond & Ling, 2016; Fiveash et al., 2021).

Implications

The educational implications of body percussion and other RME practices can be appreciated in the context of a simple principle: school readiness begins with teacher and student readiness in the brain. Physically grounded rhythmic routines as a transition from off-task states (breaks, unstructured play) to learning readiness are easy to implement and cost-free. Often involving just a few minutes at the start of a session, such warm-up routines serve as "focused starts" that prepare the brain to learn (moving, rhythm, and synchronizing) to optimize learning readiness, intentionality, and goal-setting.

Engaging with simple patterns of tapping, clapping, or stomping with music (teacher or recordings) is a form of embodied attention-entraining, which in turn primes impulse control and working memory capacity through inhibitory, updating, and shifting. Rhythmic activities in the classroom support and induce psychophysiological alignment and homeostasis, which may also improve arousal regulation and the sense of cooperation around a common rhythmic timing in the group (Strait et al., 2015; Mavilidi et al., 2022).

Teachers can translate these implications by introducing daily rhythmic starters or transition activities (one- to two-minute body percussion exercises combining clapping, chest tapping, and vocal rhythm) as ritualized routines to shift from unstructured play to academic tasks. Body percussion tasks can be paired with teacher instruction or peers can engage in cooperative body percussion learning games. With practice and repetition, daily warm-up routines may become ritualized cognitive primers that ready learners for focused, intentional learning tasks.

Practically, the body percussion approach to teacher readiness also coincides with inclusive and differentiated learning. Because it is instrument-free and engages multiple modalities (auditory, motor, visual, interoceptive), body percussion can be applied with diverse learners, including those with developmental coordination disorders or attentional difficulties. Rhythmic movement strategies are also inherently social, which is likely to have the side-effect of building motivation, social cohesion, and positive affect, all known to strengthen intrinsic motivation and engagement. For teachers, engagement with rhythmic-movement pedagogy and professional development approaches like BAPNE may have the potential to unlock the principles of embodied cognition to improve their capacity in classroom management and learning design.

In summary, the value of body percussion practices and other RME activities rests on their integrative combination of cognition, emotion, and movement. Through focused transitions and structured rhythmic routines, teachers can support attention, readiness, and emotion regulation as key factors in effective and inclusive learning.

Limitations

The present analysis, while conceptually aligning with much of the extant cognitive and educational literature, has certain limitations that should inform future research

and implementation. In the context of the current cross-sectional, neuroeducational synthesis, causal claims and claims of direct neural mechanisms cannot be made. The issue of body percussion, teacher readiness, and classroom attentiveness would therefore benefit from future research with neurodevelopmental and longitudinal designs. Future research can examine changes in plasticity after prolonged engagement with rhythmic-motor coordination, using methods such as fNIRS, EEG, and MRI to examine prefrontal activation, inter-hemispheric communication, and auditory-motor synchronization (Thaut, 2015; Diamond & Ling, 2016).

Another gap is in the specific data on ideal duration, intensity, and age-related consi derations for school readiness routines. It will be important for future studies to conduct comparative trials to assess the unique contributions of body percussion to executive functioning and emotional self-regulation vis-à-vis other rhythmic or mindfulness-based approaches. Given the broad interdisciplinary and cross-cultural potential, further research could also look at cross-domain applications of rhythmic-based pedagogies to support language, mathematics, and creativity.

On an educational policy level, the possibility of infusing body percussion and RME more generally into early childhood curricula is a promising line of work to strengthen and deepen national efforts toward a "whole-child" approach. Translating cognitive neuroscience evidence into real-world practice will require concerted collaboration among cognitive scientists, music educators, and school administrators to develop training and standardized evaluation guidelines. By bridging research and practice, future efforts can transform body percussion from a simple classroom activity to a research-backed strategy for optimizing focus, executive function, and emotion in schools.

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