

# Moving to the Beat: Using Music, Rhythm, and Movement to Enhance Self-Regulation in Early Childhood Classrooms

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**Abstract** Differences in early self-regulation skills contribute to disparities in success in early learning and school transition, as well as in childhood well-being. Self-regulation refers to managing emotional, cognitive, and behavioral processes that are conducive to positive adjustment and social relationships. Researchers have identified that various domains of learning and development are enhanced by musical training, and understanding about the neurological processes responsible for such effects is increasing. This paper argues that coordinated rhythmic movement activities in preschool are an effective approach to support the neurological bases of self-regulation. Evidence and theory related to beat synchronization, cognitive benefits of formal music training, and music therapy for clinical populations are discussed to argue that musical activities could be better leveraged in early childhood education. The paper concludes that preschool activities designed to stimulate beat synchronization and motor coordination skills and embedded in group activities can enhance young children’s motor, auditory, and self-regulatory functioning.

**Keywords** Self-regulation · Music · Rhythm · Executive function · Movement · Early childhood

**Résumé** Des différences dans les compétences d’auto-régulation en bas âge contribuent aux disparités dans la réussite de l’apprentissage préscolaire, la transition vers l’école, ainsi que le bien-être de l’enfant. L’auto-régulation fait référence à la maîtrise des processus émotionnels, cognitifs et comportementaux qui conduisent à un ajustement et des relations sociales positifs. Des chercheurs ont indiqué que divers domaines d’apprentissage et de développement sont renforcés par la

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formation musicale, et la compréhension des processus neurologiques responsables de tels effets progresse. Cet article affirme que des activités de mouvement rythmique coordonné au préscolaire constituent une approche efficace pour appuyer les bases neurologiques de l'autorégulation. Les résultats et la théorie s'appliquant à la synchronisation rythmique, les bienfaits cognitifs d'une formation musicale formelle et la thérapie musicale appliquée aux populations cliniques sont discutés pour soutenir l'idée que les activités musicales pourraient être mieux exploitées en éducation de la petite enfance. L'article conclut que des activités préscolaires conçues pour stimuler les habiletés de synchronisation rythmique et de coordination motrice, et intégrées dans des activités de groupe, peuvent renforcer le fonctionnement moteur, auditif et de l'autorégulation chez les jeunes enfants.

**Resumen** Las diferencias en la habilidad de auto-regulación en la primera infancia contribuyen a la disparidad para alcanzar el éxito en el aprendizaje temprano y en la transición a la escuela, así como en el bienestar infantil. La auto-regulación se refiere al control de los procesos emocionales, cognitivos y de la conducta que favorecen los ajustes positivos y las relaciones sociales. Los investigadores han identificado que varias áreas del aprendizaje y del desarrollo mejoran con la formación musical, y está mejorando la comprensión de los procesos neurológicos responsables por dichos efectos. En este artículo se propone que las actividades de educación pre-escolar que incluyen movimientos rítmicos coordinados son un método efectivo para apoyar las bases neurológicas de la auto-regulación. Se examina la evidencia y la teoría relacionadas a la sincronización rítmica, a los beneficios cognitivos de una educación musical formal, y a la musicoterapia para poblaciones clínicas, y se argumenta que se podría hacer mejor uso de las actividades musicales en la educación de la primera infancia. Se llega a la conclusión de que las actividades pre-escolares diseñadas para estimular la sincronización rítmica y la coordinación motora, incorporadas a las actividades grupales, pueden mejorar las funciones motoras, auditivas y de auto-regulación en niños pequeños.

## Introduction

Recent research has emphasized the importance of a focus on self-regulation for young children in early childhood programs, as a means to prevent widening gaps in learning and achievement when children begin school, particularly for vulnerable children (Blair and Raver 2015; Diamond 2016). However, effective ways to support the development of young children's self-regulation skills remain an issue of debate. The aim of this paper is to review the research evidence about the value of rhythmic movement activities in early childhood classrooms to enhance self-regulatory skills. Such activities may deliver increased opportunities for young children to develop self-regulation skills in the context of enjoyable and fun activities.

Active engagement in music activities in early childhood is developmentally appropriate, and such activities are easily implemented within preschool classrooms. Many teachers already use music activities as a regular part of their early education programs. The evidence discussed in this paper suggests that music

activities could be more specifically designed to stimulate children's skills in beat synchronization and motor coordination and so build self-regulation through the early childhood years.

Children develop foundational skills for self-regulation in the first 5 years of life (Blair and Raver 2012), which is a critical period for brain development. Self-regulation is related to school success, academic achievement, and lifelong well-being (Blair and Raver 2015). Building these skills during early childhood is particularly important. Some children struggle to maintain attention in early learning environments, remain emotionally distressed after negative experiences, or display impulsive behaviors that are likely to bring them into conflict with teachers and peers. These children cannot manage competing and multiple sources of sensory information that compete for their attention in complex classroom environments. Early childhood teachers have a central role in helping young children to regulate their emotions, thinking, and behavior that are the bases of self-regulation.

## Self-Regulation and Executive Function in Early Childhood

The growth of self-regulation and executive functions during the period of age 3–6 years is paralleled by rapid brain development, especially in the prefrontal cortex. Self-regulation is used as an umbrella term to refer to a range of processes related to the regulation of attention, behavior, and emotions. These processes are functionally related to other areas of the brain that coordinate thinking and behavioral processes. These coordinating and higher-order skills are called executive functions. Multiple components of executive function include attention shifting, working memory, and inhibitory control (Blair and Raver 2015; Diamond 2016). Shifting refers to abilities to shift attention between different sorts of information or tasks. Working memory is about holding different sensory information in mind in completing a task, and inhibition is the ability to control reactions and resist distractions.

Self-regulation and executive function skills are reflected by the choices that children make and their observable actions. Most adults can easily identify preschool-aged children who have not developed the skills to resist distractions and follow directions that indicate difficulties in self-regulation. Children from less advantaged backgrounds are more likely to have poorer self-regulation skills, sometimes due to stressful home environments and subsequent stress-related, physiological responses (Blair and Raver 2012, 2015). Early differences in children's self-regulatory abilities are thought to be the primary contributor to socioeconomic gaps in school readiness and later achievement (Blair and Raver 2015). These neurological differences will underpin later learning and achievement gaps in school and if addressed prior to school, then vulnerability for poorer school and social outcomes is reduced. However, to date, there is limited evidence for the effectiveness of interventions to address difficulties in children's early self-regulation skills (Diamond 2016; Jacob and Parkinson 2015). Possibly, many approaches have failed to address the relevant underlying neurological pathways.

One known way to influence neurological development is through formal music training and informal music experiences with a rapidly growing body of research explicating the cognitive benefits of these activities (George and Coch 2011; Putkinen et al. 2015). This *musician advantage* refers to the non-musical cognitive benefits associated with formal music training, with musicians consistently showing enhanced skills in areas such as language, cognition, and motor control, along with enhanced neural plasticity and structural brain development, when compared to non-musicians (Hyde et al. 2009; Luo et al. 2012). However, this *musician advantage* has yet to be harnessed to specifically address early childhood self-regulation in preschool classrooms. While formal music education for all young children would be ideal, this is not likely to be feasible, or even necessary to accrue the benefits in self-regulation desired. This paper argues that coordinated rhythmic movement activities in preschool could be an effective and appropriate approach through which to address the neurological bases of self-regulation in early childhood. It is proposed that activities designed to improve beat synchronization skills, and stimulate the shared neural networks of auditory perception, motor control, and self-regulatory functioning, could, in effect, use the *musician advantage* for the purposes of supporting self-regulation development in young children. If effective, this would be an important tool for early childhood teachers in terms of preparing children for school transition and setting them on a pathway toward more positive academic and well-being trajectories.

## Sensorimotor or Beat Synchronization

A core skill in music making, at the foundation of the *musician advantage*, is the ability to adapt to and maintain a steady beat. Sensorimotor or beat synchronization refers to the “coordination of rhythmic movement with an external rhythm” (Repp and Sue 2013, p. 403). The external rhythm could be part of a piece of music with other musical elements, or provided as a simple tap or clap. Recent evidence from auditory neuroscience indicates that beat synchronization skills are an important neurodevelopmental marker (Thompson et al. 2015). Children as young as 5–24 months of age show tendencies to move rhythmically and spontaneously (though not “in time”) to music, when compared to listening to speech alone (Zentner and Eerola 2010). Beat synchronization skills improve with age, and children of 3–4 years are generally able to tap to their own preferred tempo with some consistency but are unable to adapt and synchronize to different tempos. Substantial improvements in synchronizing to any beat occur from 5 years of age (Repp and Sue 2013).

Beat synchronization skills have been linked with brain development in other developmental domains. Individual differences in beat synchronization skills have been consistently related to important skills for language development including auditory perception in preschool children (Woodruff Carr et al. 2014, 2016). That is, children with better beat synchronization skills at 3–4 years show more stable speech processing patterns in the brain than those with poorer beat synchronization (Woodruff Carr et al. 2016). Additionally, children with speech–

language impairments including dyslexia (Colling et al. 2017; Getchell et al. 2010) have significantly poorer beat synchronization skills than typically developing peers. The mechanism through which these synchronization and speech development links occur is considered to relate to shared neurological networks for auditory, motor, and speech processing (Woodruff Carr et al. 2016).

There is less research about beat synchronization and self-regulation skills in children, but studies suggest a similar neurological link may be apparent. In a small study with 24 children aged 7–8 years, Rubia et al. (2003) compared consistency of independent free finger tapping (reflecting internal beat stability) and sensorimotor synchronization skills of children with and without Attention Deficit Hyperactivity Disorder (ADHD). ADHD is characterized by executive function impairments, and this study provides insight into the links between executive functioning and beat synchronization skills. Synchronization was measured through tapping to a visual stimulus appearing at regular rates on a screen, rather than an auditory stimulus. There were no group differences in the independent free tapping task, but children with ADHD performed more poorly than their typically developing peers on the sensorimotor synchronization task, displaying more impulsive errors likely to be related to inhibition difficulties. Stronger inhibition skills (Rigoli et al. 2012) and sustained attention (Tierney and Kraus 2013) have also been linked with better sensorimotor synchronization in adolescence, with these executive function skills significantly improving with music training.

Children with poorer executive function skills also tend to have poorer rhythm perception skills (Lesiuk 2015). Lesiuk (2015) compared 29 children aged 9–11 years with identified executive function deficits with 42 children with no executive function deficits and measured various aspects of music perception. While this study did not include a measure of beat synchronization, there was a measure of pulse count (counting beats given within a piece of music) and rhythm discrimination (identifying whether two rhythmic phrases were the same or different). Children with executive function deficits performed significantly worse on the rhythm discrimination task, with working memory identified as contributing most variance to music perception performance. Poorer working memory has also been linked with poorer sensorimotor synchronization in young adults (Colley et al. 2017).

In summary, evidence about beat synchronization has at least two implications for the support of self-regulation in early childhood. First, children's ability to adapt to and synchronize to a given beat may provide a window to developing neurological processes that underpin self-regulation. Anecdotally, teachers report that children who struggle to find the beat in group music times are often the same children who also have trouble maintaining attention in other tasks of the program. This is supported by research showing that more consistent performance on simple rhythmic tasks is associated with better selective attention in adults (Slater et al. 2017). Second, practicing and developing beat synchronization through regular rhythmic movement could simultaneously support self-regulatory development, stimulating aspects of the *musician advantage* effect discussed in the following section.

## Formal Music Training: The Musician Advantage

A large body of research has documented the *musician advantage*, which refers to the non-musical cognitive benefits associated with formal music training. Formal music training here refers to structured and regular group or private instrumental or vocal lessons, or in early childhood general musicianship or music and movement classes with a curriculum that expose children to some music theory and concepts. When trained musicians are compared to non-musicians, they consistently show enhanced skills in a range of non-musical areas including language, cognition, and motor control, along with enhanced neural plasticity and structural brain development (Hyde et al. 2009; Luo et al. 2012). This advantage is thought to be the result of enhanced shared neural networks involved in auditory processing, motor control, and non-musical cognitive functions (George and Coch 2011; Slater et al. 2017).

There is growing evidence that the *musician advantage* extends to self-regulation skills including the executive functions for both adult (Moussard et al. 2016) and child musicians (Joret et al. 2017). Musically trained children (9–13 years) show enhanced selective attention (Dege et al. 2011; Putkinen et al. 2015), inhibitory control skills (Dege et al. 2011; Joret et al. 2017; Putkinen et al. 2015), and shifting skills (Zuk et al. 2014) when compared to children without music training. Evidence for enhanced working memory (George and Coch 2011; Pallesen et al. 2010) and sustained attention (Wang et al. 2015) has also been reported in adult musicians. An earlier start to music training, prior to 7 years (Bailey and Penhune 2010), and a longer duration of training (Dege et al. 2011) appear to yield stronger cognitive benefits. It has been suggested that enhancements in these domain-general areas of self-regulatory function provide the platform upon which all other cognitive advantages for musicians build (Wang et al. 2015). This is supported by evidence that early music training, in particular, results in substantial and sustained changes in brain white matter connectivity that provide the foundations upon which enhanced cognitive processing is built (Steele et al. 2013).

A fundamental aspect of the *musician advantage* is enhanced beat synchronization skills, discussed in the previous section. These skills are learnt and practiced through regular rhythmic movement to externally provided stimulus through the auditory system (e.g., playing along with other musicians), or to an internally driven pulse (e.g., when practicing alone). While all musicians interact with musical rhythm, arguably the population that *move* rhythmically and “in time” the most in daily life, and often in complex ways, are professional drummers and percussionists. An interesting body of research focusing on this group of musicians has demonstrated that percussionists outperform both non-percussionist musicians and non-musicians on beat synchronization, inhibitory control, and selective attention tasks (Krause et al. 2010; Repp and Sue 2013; Slater et al. 2017). This is likely due to significantly enhanced functional connectivity across motor coordination and self-regulatory neural networks developed through regular rhythmic practice.

These studies on the *musician advantage* in both child and adult musicians, and the particular role of coordinated rhythmic movement in stimulating these neural pathways, highlight the potential for rhythm-based activities to stimulate cognitive

development, including self-regulation in young children. This proposition is supported by the findings of a recent review of evidence on the impact of arts education on cognitive and non-cognitive outcomes for school-age children (See and Kokotsaki 2015) which concluded that of all the arts, music, and, in particular, instrumental training, held the most promise for improving student outcomes. While formal instrumental training for all young children would almost certainly yield positive cognitive benefits, this level of expense may not be necessary. A specific focus on regular practice of coordinated rhythmic movement and beat synchronization through activities that can be universally applied by early childhood teachers may be enough to stimulate some aspects of the *musician advantage*.

## Music Therapy and Rhythmic Entrainment

The field of music therapy offers additional evidence for the role of rhythm engagement in stimulating non-musical benefits including self-regulation skills (Thaut 2010; Thaut et al. 2009a, b). Music therapists are tertiary-trained allied health professionals who use music with a range of people to improve cognitive and social-emotional functioning, and quality of life. While all music therapists use rhythmic movement as a therapeutic tool when appropriate, a specialist strand of music therapy with a focus on the neurological benefits of rhythm and movement has developed over the last two decades. *Neurologic music therapy* is a standardized treatment model, which includes more than 20 techniques in motor, speech/language, and cognitive rehabilitation (Thaut et al. 2015).

At the core of neurologic music therapy mechanisms is rhythmic entrainment. Entrainment refers to the proclivity of the human body to match physical or physiological functions to an eternally provided rhythm or beat. Neurologic music therapists use rhythmic auditory cueing to capitalize on entrainment and improve motor functions in brain-injured patients (Thaut 2010; Thaut et al. 2009a, b). Provision of a steadily increasing externally provided beat stimulates the auditory-motor system, supporting more timely and coordinated movement than is possible without rhythmic support. While the evidence for rhythmic auditory cueing and motor rehabilitation is strong, there is less evidence for the effectiveness of music therapy for self-regulation skills, with neurologic music therapy leaders calling for further research in this area (Thaut et al. 2015).

Given what is known about entrainment, and overlapping neural systems for auditory processing, motor control, and self-regulation, it is likely that rhythm-supported movement could improve the sensorimotor synchronization skills of preschool children and in doing so support self-regulatory skill development. However, further research is required in this area to establish evidence for this hypothesis.



## Music, Emotion, Relaxation Activities and Emotional Regulation

Although the research discussed to this point has focused on the potential of leveraging rhythmic movement for primarily cognitive aspects of self-regulation, theory and evidence about the role of music in emotional states and the value of relaxation to music suggest potential for addressing emotional regulation. Listening to pleasant and familiar music and active music making stimulates desired neural activation patterns implicated in emotional regulation and may help support optimal levels of arousal (Moore 2013). Importantly, Zachariou and Whitebread (2015) have reported that group music play in preschool appears to motivate children with typically lower levels of emotional regulation to demonstrate and practice emotional regulation skills during structured music time.

A complementary body of research has recently emerged examining the effectiveness of yoga and mindfulness in relation to self-regulation. While not traditionally rhythmic in nature, these activities often involve simple movements or imagery accompanied by music and have a focus on active sensory-motor involvement which also supports brain-body neural connections (Diamond and Lee 2011). Daily yoga sessions have improved inhibition and behavioral self-regulation in 4-year-olds (Razza et al. 2015) and decreased levels of cortisol (a stress hormone) in second-grade students (Butzer et al. 2015). Weekly mindfulness sessions with children aged 9–11 years have yielded positive effects for executive function task performance and child-reported emotional control (Schonert-Reichl et al. 2015). These findings suggest that regular rhythmic movement sessions within early childhood settings that also incorporate elements of yoga or mindfulness and other relaxation-to-music techniques might support emotional regulation development.

## Early Childhood Music Participation

While there are clear cognitive benefits to early formal instrumental music instruction, less formal approaches to music participation in early childhood, and structured early childhood musicianship or music and movement classes, may also confer similar benefits. Informal music experiences include incidental or semi-structured musical play activities with parents in the home, or with educators and peers, where music is used as a tool for play and enjoyment, or for support of other developmental areas, rather than for a focus on learning music theory or concepts. Active music participation is considered particularly developmentally appropriate for preschool children given the typically prevalent role of music in their lives (Lamont 2008). Music activities such as singing (including action songs, counting songs, nursery rhymes, and children's songs), generating original songs to accompany routines, dancing, and listening to music (Barrett 2009, 2011, 2012) are common “cultural tools” (Vygotsky 1986/1934) used by parents and teachers to build children's understandings of cultural conventions.



Informal parent–child musical play in the home has been recently associated with enhanced self-regulation skills in young children. Children aged 2–3 years with higher levels of informal parent–child music engagement in the home have shown less auditory distractibility measured contemporaneously (Putkinen et al. 2013) and enhanced parent-reported attentional regulation skills at 4–5 years (Williams et al. 2015). These higher attentional abilities might translate into sustained attention to teacher instructions, and enhanced task persistence in early childhood education contexts.

Formal early childhood group music experiences outside of the home have also been linked with developmental benefits including aspects related to self-regulation development. For example, participation in weekly parent–infant active music classes has been associated with improved distress regulation in 12-month-old children (Gerry et al. 2012). Winsler et al. (2011) compared a group of 3–4-year-old children receiving weekly Kindermusik music and movement classes with a socio-demographically equivalent group who had not experienced any structured early childhood music classes. Children enrolled in Kindermusik showed better self-regulation skills when assessed on a range of tasks and were also more likely to use a range of positive self-regulatory strategies, including private speech during an attention task and singing/humming during a waiting task (Winsler et al. 2011).

Embedding music and movement experiences within the early education setting, in both formal and informal ways, also holds promise in supporting early self-regulatory development. An arts-enriched preschool program that included daily music sessions improved parent-rated emotional regulation skills in low-income children (Brown and Sax 2013) compared to children attending a regular program. Researchers have also documented the value of guided group musical play in 6–7-year-old children in providing opportunities for self-regulatory learning. Musical play observed included handclapping, circle games, movement, and instrumental play (Zachariou and Whitebread 2015), with each of these activities including an element of rhythmic movement. The researchers observed that musical play offered opportunities for self-regulatory behaviors to emerge including cognitive control, monitoring, and planning, with instrumental play offering the most opportunity. Importantly, in relation to emotional regulation, children who did not typically demonstrate high levels of emotional regulation in general classroom activities were able to demonstrate this during structured group musical play with peers, with the authors suggesting that it might be the motivating aspect of group music engagement that stimulates this behavior (Zachariou and Whitebread 2015).

## **Rhythm and Movement for Preschool Sensorimotor Synchronization and Self-Regulation**

Given the evidence and theory from various lines of research presented above, it is highly promising that activities that build beat synchronization and coordinated rhythmic movement skills in children, while simultaneously targeting specific self-regulation skills, would be effective in enhancing self-regulatory development. Further evidence from the field of human movement and exercise physiology

supports this notion suggesting that physical activities that embed cognitive challenge and social interaction are likely to support executive function development (Best 2010; Crova et al. 2014). This might include coordinative motor activities characterized by “complex motor movements ... and interaction with body parts for goal-directed behaviors” (Chang et al. 2013, p. 188). Coordinated movement activities both *require* employment of the self-regulatory systems of the brain and *build* the neural circuitry relevant to self-regulatory functions (Chang et al. 2013). This paper has argued that supporting such coordinated movement with rhythm as has been done with clinical populations by music therapists (Thaut 2010; Thaut et al. 2009a) is likely to further enhance these positive effects. Doing so will stimulate the same shared neural networks for auditory perception, motor coordination, and self-regulatory functioning that are enhanced in trained musicians, bringing *the musician advantage* to a wider group of children.

While no known rhythm- and movement-based interventions have been specifically designed to address beat synchronization and self-regulation in early childhood, existing intervention research provides some supporting evidence. Table 1 presents a brief summary of a selection of relevant studies. These studies were selected based on a rapid review of intervention or observational studies where music or rhythmic movement aspects were part of the program, and outcome measures included at least one of beat synchronization or a component of self-regulation or executive function. This was not a systematic, exhaustive search or review. The studies show that in early and middle childhood, it is feasible to provide interventions based on elements of rhythm, movement, and music training to stimulate steeper growth in beat synchronization and self-regulation skills than might otherwise occur.

There has been a range of theoretical ideas and research evidence from multiple lines of research reviewed in this paper to make the case from a neurological perspective of the potential value of sensorimotor and beat synchronization activities to improve young children’s self-regulation skills in early childhood classrooms through music, rhythm, and movement activities (see Fig. 1). Additional incorporation of elements of yoga or mindfulness and other relaxation-to-music techniques in regular music and movement activities might also support emotional regulation development. While early childhood teachers who incorporate a strong focus on music in their programs have believed in the value of such activities to children’s learning, more systematic research could test the ideas proposed in this paper. While formal instrumental instruction for children at risk of poorer self-regulation and school transition, such as that provided in New York’s *The Harmony Project* (Slater et al. 2013) (see Table 1), would be ideal in widening exposure to the *musician advantage*, costs of materials and instructors are likely out of reach for most jurisdictions. However, the core experience of practiced rhythmic movement, as is often applied to clinical populations by music therapists, could be used to simulate some of the effects of the *musician advantage* when embedded in regular preschool programs.

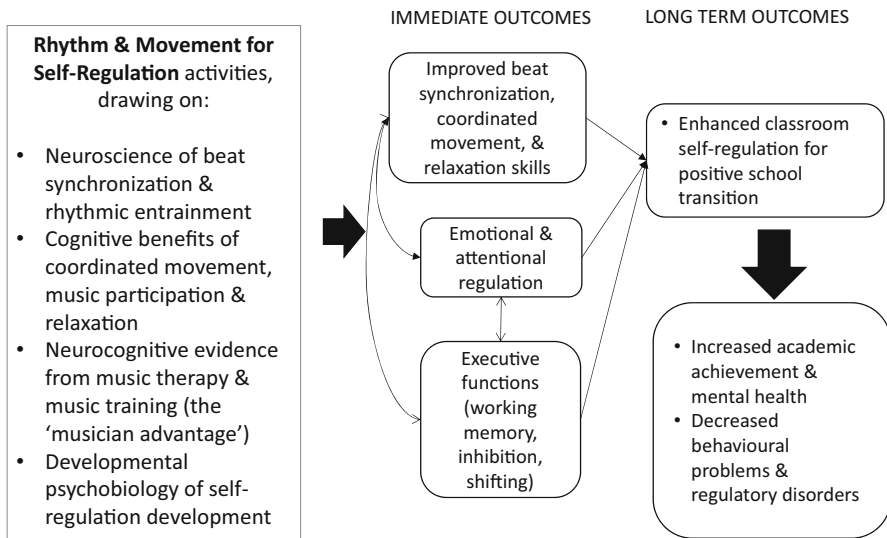
**Table 1** Summary of a selection of intervention studies focussed on beat synchronization and self-regulation skills in young children

Intervention	Population	Rhythm and movement focus	Dose and duration	Outcomes	Citations
Rhythmic support during mathematics (compared to maths lesson without rhythmic support)	N = 30 3–4 years	Teacher patting a beat on lap, children joining in, then beginning mathematics lesson by chanting or singing words created for the activity	Unknown	Improved observed <i>attention</i> and engagement in the rhythmic group. Children went on to use their own rhythmic support (tapping) when answering maths questions. Teacher reflective journals supported this	Geist et al. (2012)
Red light purple light circle games (compared to preschool as usual)	2011 study N = 65 3.8–5 years Post hoc subsample with poor self-regulation skills	Not specifically stated but a number of circle games involved movement to music/ rhythm, and instrumental play	Two 30 min sessions per week for 8 weeks	2011 study No treatment effect for the sample as a whole, but gains in <i>behavioral self-regulation</i> for children who began with low levels of these skills	Tominey and McClelland (2011) Schmitt et al. (2015)
Structured circle folk dancing (compared to no dance)	2015 study N = 265 3.2–5.6 years Subgroup of English language learners N = 60 3–6 years	Structured circle folk dancing to music	30-min session once per week for 6 months	2015 study Intervention group improvements in directly assessed <i>shifting</i> and <i>behavioral self-regulation</i> . English language learners in the intervention group also improved in mathematics	Walter and Sat (2013)

Table 1 continued

Intervention	Population	Rhythm and movement focus	Dose and duration	Outcomes	Citations
Computerized music training (compared to art training or no additional training)	<i>N</i> = 64 4–6 years	Nil Computer based: motor, perceptual, and cognitive tasks, training in rhythm, pitch, melody, voice, and basic musical concepts. A focus on listening	Daily for 2 h (in 2 × 1 h sessions), 5 days per week for 4 weeks (20 days)	Music group showed improvements in: verbal intelligence, <i>inhibition</i> accuracy, linked with enhanced neural plasticity	Moreno et al. (2011)
The Harmony Project instrumental training (compared to no music training)	<i>N</i> = 60 6–9 years Low income	Group musicianship classes focussed on rhythm, pitch, musical terms, followed by instrumental tuition	12 months: Musicianship classes twice per week for 1 h each until competency reached (at 5–12 months), then group instrumental music instruction for 4–5 h per week	Significantly better <i>beat synchronization</i> skills in music group compared to control group	Slater et al. (2013)
Music training (compared to art training or no training)	<i>N</i> = 48 8–11 years Dyslexia	Based on Kodaly and Orff pedagogies <sup>a</sup> A focus on rhythm and temporal processing Percussion instruments, rhythmic syllables, rhythmic body movements, sensorimotor synchronization	1 h twice per week for 30 weeks	Music group showed improvement in: <i>Working memory</i> , reading, <i>attention</i> , <i>rhythm perception</i> (which predicted phonological improvements)	Flaugnacco et al. (2015)

<sup>a</sup>Wheeler et al. (1985)



**Fig. 1** Conceptual model of applying rhythm and movement for preschool self-regulation

## Conclusion

Although leading researchers have advocated for a focus on early childhood self-regulatory development as a means to preventing later widening gaps in achievement, particularly for children from disadvantaged backgrounds, effective ways to stimulate these skills have been somewhat elusive. This paper has argued that rhythmic movement activities hold strong promise in this regard and should be increasingly leveraged in early childhood settings. Active music engagement in early childhood is easily implemented universally, with many teachers already using music activities as a regular part of programming. The evidence presented in this paper suggests that activities should be specifically designed to stimulate beat synchronization and motor coordination skills and embed challenging self-regulatory games, as well as established relaxation techniques.

### Compliance with Ethical Standards

**Conflict of interest** The author declares that she has no conflict of interest.

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