

# 児童の注意機能にもたらす音楽の影響

## The Influence of Music on Attention Function of Children

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注意はあらゆる認知機能の基盤となる重要な機能であり、社会的行動やコミュニケーション能力とも関連する機能である。注意が機能していなければ、我々は学習したり記憶したりすることもできないし、他者と意思疎通を図ることも難しい。この注意機能に問題を抱える臨床群には、たとえば自閉スペクトラム症児・者（ASD）などが挙げられ、ASDにみられる特徴としては注意の定位や制御、解放の困難が指摘されている。こういった注意の問題を扱う治療法はいくつかあるが、注意機能を促進する効果的なアプローチとして、音楽的訓練や音楽を用いた治療的介入の影響が報告されている。本稿は、音楽への関与が児童の注意機能にもたらす影響について検討された最近の研究、特に、(a) 定型発達児および自閉スペクトラム症児を対象とした研究と (b) 音楽療法分野における研究を概観し、今後の研究課題について検討することを目的とする。初期の研究では音楽への関与が児童の注意機能に良好な影響を与える可能性が示唆されたが、十分な証拠はまだ得られておらず、さらなる研究が必要であることが明らかとなった。

### Abstract

Attention is a complex cognitive domain that constitutes the foundational skill for good cognitive functioning. Without attention, we would be unable to learn, remember, or even communicate with others. There are certain clinical populations that show attentional difficulties, including individuals with autism spectrum disorders. There are several ways to treat the attentional problems of children, of which musical involvement and therapeutic intervention with music have been reported as an effective approach to enhancing attention function of children. This paper presents an overview of recent research on the effect of musical involvement on attention function of children, with a particular focus on (a) studies of typical children and children with autism spectrum disorders and (b) studies in the field of music therapy, and also considers issues for further research. While initial studies have suggested the possibility that musical involvement has a positive impact on attention function of children, it is apparent that sufficient evidence is lacking and more studies are needed to validate the effectiveness of musical involvement on attention function.

### 1. Motive and purpose

In order to interact with one's environment appropriately in a given cognitive, communicative, and social context, one's attention should function efficiently. With this ability, we can perform our daily activities by selecting and focusing on a mental or behavioral task for as long as necessary and shifting our attention between several tasks when needed<sup>[1]</sup>. Attention function generally comprises three distinct components: sustained, selective, and attention control/switching<sup>[1,2]</sup>. These attentional skills develop in a stepwise fashion from early childhood through engagement with one's environment. If the development of these basic skills that underlie higher brain functions, including cognition, is hindered or they function inappropriately, cognitive, social, and communication skills are adversely affected<sup>[2]</sup>. In other words, without attention, we would be unable to learn,

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remember, or even communicate with others<sup>[1]</sup>. In the case of children, attentional skills also affect their learning processes. One study by Muris<sup>[3]</sup> of 113 school children aged 9 to 12 years showed that attentional skills affect learning and cognitive functions, as their attention control correlated positively with school performance.

Turning to clinical populations, it has been found that children with autism spectrum disorders (ASD) who show attentional problems are likely to experience difficulties participating in group play and performing tasks and to suffer delays in learning and difficulties building relationships with their peers, which can lead to cognitive and social difficulties due to a wide range of attentional problems<sup>[4]</sup>. Cognitive deficits, including attentional difficulties in ASD, are generally regarded as secondary impairments or comorbidities; however, accumulating evidence from behavioral and neuroimaging studies shows that individuals with ASD display a wide range of attentional deficits across the various domains of attention function, such as disengaging, shifting or switching, and selective attention<sup>[5-10]</sup> (for a review, see<sup>[11, 12]</sup>). Mayes and Calhoun<sup>[13]</sup> found that 93% of 143 children with ASD with normal intelligence recruited for their study exhibited some form of attentional problems. A number of researchers have pointed out that the repetitive or obsessive behaviors, social interactive responses, and hypersensitivity observed in ASD may be caused by their attentional difficulties, and therefore it is considered that attentional dysfunctions in ASD may be one of their core symptoms<sup>[14, 15]</sup>. As is well known, significant attentional problems are also observed in individuals with attention deficit hyperactivity disorder and intellectual developmental disabilities.

There are several ways to treat the attentional problems of children, such as computerized training programs, environmental coordination, play therapy intervention, and music therapy intervention. In the past several decades, therapeutic intervention with music has been actively studied as having a positive impact on non-musical behaviors and functions across the cognitive, communication, social, motor, and emotional domains. In the clinical practice of music therapy, we often observe that music stimuli and activities designed for each child's needs and characteristics improve his or her attention function. This may be not only because music is motivational and fun for children but also because attributes of music influence our attention. Thaut et al.<sup>[16]</sup> states that "the perception of the rhythmic, melodic, harmonic, and dynamic patterns in music is very effective in consciously and subliminally focusing and organizing the flow of our attention" (p. 282). The purpose of this study is to present an overview of recent research on the effects of music on attention function of children and consider issues for further research.

## 2. Therapeutic mechanisms underlying the effects of music on attention function

Thaut and his colleagues<sup>[1, 17]</sup>, who have systematically investigated how music influences behaviors and brain functions, proposed the Rational Scientific Mediating Model (RSMM)<sup>[17]</sup> to investigate whether music could provide therapeutic stimulation to improve non-musical brain and behavior functions (Fig. 1). The RSMM serves to indicate ways of generating knowledge concerning the link between music and therapy. Considering it necessary to find the mechanisms in music that produce therapeutic effects and arrange them in a logical, systematic structure by linking appropriate bodies of knowledge to build a clinical foundation for the application of music to therapy, Thaut<sup>[17]</sup> investigated the findings of translational biomedical research in music based on this model (musical response models) and studied the overlaps between and processes common to musical and non-musical behavior and brain function (parallel non-musical response models). It was then found that music engages widely distributed neural networks that are shared with general non-musical cognitive function as well as motor and language functions (mediating models), and the mechanisms in music were determined that produce therapeutic effects by enhancing non-musical processes, including attention function.

Their results regarding the therapeutic mechanisms of music for attention are as follows<sup>[17]</sup>: (a) Rhythmic patterns in music "drive attention focus by interacting with attention oscillators via coupling mechanisms" (p.

260). The oscillation associated with the ability to shift attention can be enhanced by music. (b) As music provides multidimensional stimuli such as rhythm and melody, it can thus facilitate alternating and divided attention. (c) Timing, grouping, and organization that music brings in can sustain attention. (d) “Music recruits shared or parallel brain systems that assist the frontal lobes with alternating attention.” (p. 260) (e) Music stimulates additional dimensions of emotion and motivation that help to facilitate concentration and keep a person focused on a task. Attributes and motivational factors of music may contribute to improvements in attentional skills, including sustained, alternating, and divided attention.

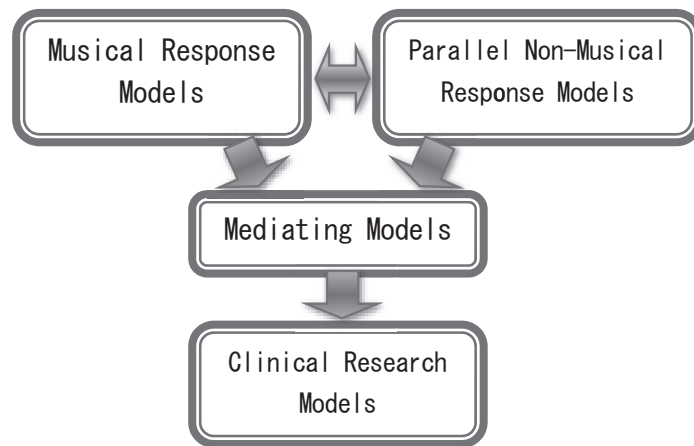


Fig. 1. The Rational Scientific Mediating Model <sup>[17]</sup>

### 3. Clinical research on the effects of music on attention function

Clinical studies of the attributes and motivational factors of music have been conducted that demonstrate their effectiveness in improving attentional skills in several clinical populations. Knox et al. <sup>[18]</sup> found that a musical attention training program improved alternating attention in brain-injured patients. Frassinetti et al. <sup>[19]</sup> demonstrated that auditory stimulation enhanced the visual perception of unilateral neglect patients. Gregory <sup>[20]</sup> examined elderly adults with cognitive impairments who participated in group music therapy sessions that involved active music listening and identification of the song titles. These results indicated positive influences on their sustained attention skills.

Although therapists often meet children with attentional difficulties in clinical settings, clinical studies investigating the effect of music on attention in children have been very limited. Robb <sup>[21]</sup> investigated attentive behavior among preschool children with visual impairments. They participated in two 30-min music-based and two 30-min play-based instructional sessions that were videotaped for data collection. Statistical analysis of the behavioral data revealed that the attentive behavior of participants was significantly higher during the music-based sessions than the play-based sessions. She suggests that music may have functioned to induce optimal levels of arousal in participants, thereby acting to increase performance on cognitive tasks.

Kim et al. <sup>[22]</sup> examined the effectiveness of improvisational music therapy sessions in ten autistic children aged 3 to 5 years. Music therapy sessions and play sessions were implemented 12 times each. The behavioral tests and observations found that participants demonstrated significantly more attention behaviors in the music therapy sessions than in the play sessions. They indicate that improvisational musical interaction may induce children’s attentive behaviors and nonverbal social communication by fostering stability (a predictable structure) and flexibility (spontaneity) within a structured framework for those children who cannot readily adjust to the unpredictability of daily life.

Lee <sup>[23]</sup> reported a case study of a 5-year-old child with ASD. As a result of 20 weekly 1-hour music therapy sessions, the child showed better attention span and language skills in behavioral observations.

Recently, Pasiali et al. <sup>[24]</sup> examined the effects of music therapy using a standardized test able to assess sustained, selective, and attentional control/switching attention skills. Nine adolescents aged 13 to 20 years with neurodevelopmental delays participated in this study. Results showed that they demonstrated significant improvements in selective and attention control/switching attention after eight music therapy group sessions.

This limited number of studies of attention function in children with ASD may be because improvements in social and communication skills often constitute the primary goals in music therapy intervention, as deficits in these skills are considered their main symptoms <sup>[25]</sup>. In light of such a small number of studies of children's attentional skills and the high rates of children with ASD who show the attentional problems cited earlier <sup>[13]</sup>, it may be suggested that therapists tend to overlook their fundamental needs to concentrate on first providing effective intervention. There is also the possibility that therapeutic music interventions that meet each child's needs in social and communication domains or music itself may contain elements to train attentional skills.

#### 4. Studies of typical children

There have also been a few studies investigating the influence of music on attentional skills of typical children. Wolfe and Noguchi <sup>[26]</sup> examined the use of music to increase sustained attention of 5-year-old children during conditions of auditory distractions as vigilance tasks. Children were randomly assigned to one of four conditions: musical story with and without distractions and spoken story with and without distractions, and the experimenter counted their appropriate responses as they listened. The results showed that children performed better under the musical story conditions regardless of the presence of distractions, and significant differences were found between the spoken story with distraction and the musical story with distraction.

Morton et al. <sup>[27]</sup> implemented a verbal dichotomous listening task preceded by both exposure to music and exposure to quiet to 10- to 12-year-old children. The results indicated increased memory capacity in the free-report task and reduced distractibility in the directed-report task after exposure to the music. They suggest that music may increase bilateral cerebral arousal levels.

In the past decade or so, a number of studies have examined musicians to reveal the influences of continuous active musical involvement on brain structures and functions compared to non-musicians. In this area of research with children, effects of long-term musical training have been reported. Trainor et al. <sup>[28]</sup> examined the effects of musical training on oscillatory brain activity and reported data indicating a gamma-band response to musical sounds relative to attention, memory, and comprehension induced in children after 1 year of musical training beginning at age 4 ½ years, but not in children of this age who were not engaged in musical lessons.

Fujioka et al. <sup>[29]</sup> measured the auditory evoked responses to a violin tone and a noise-burst stimulus in 4- to 6-year-old children receiving musical lessons using magnetoencephalography (MEG) repeatedly throughout 1 year. As the result, unlike the untrained children, an auditory evoked magnetic field related to auditory attention processing (sound classification and unconsciousness attention) was observed and the trained children showed significant improvement on behavioral tasks involving sustained attention and auditory short-term memory. There are several studies that have found that long-term musical training leads to deformations in the brain structures of children, such as in the corpus callosum, right precentral gyrus, right primary auditory area, and frontal area <sup>[30, 31]</sup>. It is now widely accepted that musicians' brains structurally differ from non-musicians, not congenitally but perhaps through neuroplasticity caused by training <sup>[30-32]</sup>.

Related literature suggests that musical involvement may enhance sustained attention skills of children and generate positive effects on brain function and structure related to attentional function. In clinical populations, people with neurodevelopmental delays, brain injuries, and dementia may benefit from music therapy for their attentional function. There are, however, very few studies showing a direct effect of musical involvement on children's attention function and few reports demonstrating that music has a functional enhancement effect using standardized behavioral tests. In addition, most of the studies reviewed above remained unclear about the

improvements in attention function under the direct influence of musical involvement on behavior.

## 5. Conclusion and future issues

This present study surveyed recent research on the effect of musical involvement on attention function of children with and without attentional difficulties. While initial studies suggested that activities and interventions using music might have a positive impact on attention function of children, it is apparent that sufficient evidence is lacking and more studies are needed to validate the effect of music on attention function.

Studies of healthy children are considered essential to examine the short-term effects and mechanisms of music activities, demonstrate the existence of such a phenomenon, and provide evidence to facilitate future clinical research<sup>[1]</sup>. Further studies, particularly those (a) examining the effects of music activities on the attentional skills of children, then, where this is found effective, (b) investigating the types of attention (sustained, selective, attentional control/switching, and divided attention) enhanced by music activities should be conducted that implement standardized behavioral measurements like those utilized in Pasiali's study<sup>[24]</sup> to capture behavioral changes in children. In addition, in order to investigate the neurological characteristics of the attentional processes active during the performance of attentional tasks, studies using apparatus for measuring brain functions can also contribute to understanding how these children's brain function during sustained, selective, and shifting attention. Through such studies, we would be able to figure out more effective interventions with music for individuals who have attentional difficulties.

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