



## Drum rhythm therapy: An intervention to stimulate the cognitive abilities of children with Autism Spectrum Disorder (ASD)

Nailul Fauziah,<sup>1\*</sup> Anggun Resdasari Prasetyo,<sup>1</sup> Erin Ratna Kustanti,<sup>1</sup> Pietro Crescenzo,<sup>2</sup> Suryanto Suryanto<sup>3</sup>

<sup>1</sup>Department of Psychology, Faculty of Psychology, Universitas Diponegoro, Semarang – Indonesia; <sup>2</sup>Faculty of Psychology, eCampus University, Novedrate – Italy; <sup>3</sup>Psychology Doctoral Programs, Faculty of Psychology, Universitas Airlangga, Surabaya – Indonesia

**Abstract:** Children with Autism Spectrum Disorder (ASD) face obstacles in their cognitive development. This study aims to determine the effectiveness of the drum rhythm therapy model in stimulating cognitive abilities (attention, concentration, and short-term memory) in children with ASD. The experiment method was used with a one-group pretest-posttest design. Attention and concentration levels were measured both before and after therapy through a series of observations. A total of 14 children with ASD aged 4–12 participated in the study. All the participants were new students at Gilang Ramadhan Studio Band (GRSB), Surakarta, Indonesia. The drum rhythm therapy was employed with the participants for three months. Data analysis was conducted using Wilcoxon test analysis in SPSS Version 23. Results: The 14 participants showed an increase in attention, concentration and short-term memory scores following the therapy ( $Z = -2.533^b$ ,  $p = .011$ ,  $p < .05$ ). The results of the study could support the use of the alternative therapy with ASD children to increase their attention, concentration and short-term memory.

**Keywords:** attention; children with ASD; cognitive abilities; concentration; drum rhythm therapy; short-term memory

**Abstrak:** Anak dengan *Autism Spectrum Disorder* (ASD) mengalami berbagai permasalahan perkembangan, termasuk kemampuan kognitif, yaitu atensi, konsentrasi, dan memori jangka pendek. Penelitian ini bertujuan mengetahui efektifitas model *drum rhythm therapy* untuk menstimulasi kemampuan kognitif anak dengan ASD. Penelitian ini menggunakan metode eksperimen dengan desain penelitian *one group pretest-posttest*, yaitu melakukan eksperimen pada kelompok yang sama, kemudian diukur menggunakan *pretest* dan *posttest*. Alat ukur observasi yang digunakan adalah *check list* atensi dan konsentrasi. *Drum rhythm therapy* diterapkan pada 14 anak dengan ASD yang berusia 4-12 tahun selama 3 bulan, setiap satu minggu sekali selama tiga bulan. Partisipan adalah siswa Gilang Ramadhan Studio Band (GRSB) Surakarta, Indonesia. Hasilnya 14 partisipan penelitian menunjukkan perbedaan skor sebelum dan setelah mengikuti terapi. Ada perbedaan yang signifikan kemampuan kognitif anak dengan ASD sebelum dan sesudah terapi ( $Z = -2.533^b$ ,  $p = 0.011$ ,  $p < 0.05$ ). Hasil penelitian menunjukkan bahwa *drum rhythm therapy* dapat menjadi alternatif terapi anak dengan ASD untuk meningkatkan atensi, konsentrasi, dan memori jangka pendek.

**Kata Kunci:** atensi; anak ASD; kemampuan kognitif; konsentrasi; *drum rhythm therapy*; memori jangka pendek

\*Corresponding Author: Nailul Fauziah ([nailulburhan@gmail.com](mailto:nailulburhan@gmail.com)), Faculty of Psychology, Universitas Diponegoro, Jl. Prof. Soedharto, Tembalang, Semarang, Jawa Tengah 50275 – Indonesia.

## Introduction

Autism spectrum disorder (ASD) is a type of developmental disorder commonly found in children. It refers to a pervasive developmental disorder that inhibits cognition, language, behavior, communication, and social interaction, thus inhibiting children's physical and mental development (Veskarisyanti, 2008). In general, ASD is a developmental disorder characterized by communication, social, and behavioral problems. For example, poor social interaction and relationships, as well as delays in spoken language, are its most common symptoms. In addition, children also experience developmental regression, impaired motor skills and eating problems (Parmeggiani et al., 2019).

ASD occurs in five out of every 10,000 births, with the number of male ASD children being four times greater than that of females. Survey results from several countries have shown that compared to 10-20 years ago, when the number of children with ASD was recorded at 2-4 per 10,000, the current number has increased to 15-20, or one per 500 children (Maulana, 2019). UNESCO reports have recorded 35 million people with ASD around the world, which indicates that an average of six out of 1,000 people globally have the condition. The Research Center for Disease Control (CDC) in the US stated in 2012 that every one out of 68 children had ASD. In Asia, a Hong Kong study (2012) reported that the prevalence rate of ASD was 1.68 per 1,000 children under 15 years. The data shows that by 2021 the number of autism sufferers in Indonesia would be around 2.4 million (Hafil, 2021).

Psychiatric and neurological disorders involve the function of the "social brain." Behavioral disorders, such as in children with ASD, result from the social brain malfunctioning, affecting the cognitive brain and an individual's social behavior (Kennedy & Adolphs, 2012). ASD is characterized by disruption to social skills and the presence of

cognitive and behavioral rigidity. Poor cognitive ability in the brain has been noted to contribute to social behavior inflexibility in individuals with ASD (Uddin et al., 2015). There is an urgent need to identify effective service provision models to support adults with ASD as they seek to lead independent lives (Hillier et al., 2022).

Cognitive abilities in the brain include paying attention, short-term memory, perception, and concentration (Santrock, 2006). ASD is characterized by a high level of clinically observed attention problems. An impaired neurocognitive function has been postulated to underlie inattentive behavior and attention disorders. Innate behavior and attention problems predict neurocognitive impairment in children with ASD. However, related studies often include ASD children with comorbid ADHD, with research focussing on executive functions rather than basic ones. Developed a multi-component model of attention that includes basic and executive functions. The basic attention function is subdivided into the dimensions of intensity and selectivity, while the dimension of intensity consists of alertness and sustained attention. Selectivity consists of divided and focused attention. The results show that specific disorders in ASD children mainly relate to divided attention, which could occur in all types of autism. Such a disorder may also underlie reduced joint attention, a core deficit in ASD (Van Zomeren & Brouwer, cited in Boxhoorn et al., 2018).

The concept of concentration is related to attention, which refers to the ability to selectively pay attention to part of all incoming stimuli, whereas concentration refers to the level of attention involvement (Hughes et al., 2013). The atypical attention of children with ASD plays an important role in the development of cognitive and behavioral disorders (Keehn et al., 2013). The attention process can have an impact on the development of socio-communicative functions at

a higher level. Therefore, understanding the development of attentional mechanisms in children with ASD may help to explain the trajectory of abnormal or delayed attention development in them, and furthermore, how these attentional abnormalities may contribute to the manifestation of core ASD disorders (Keehn et al., 2013).

Mundy et al. (2016) found that ASD children with higher functioning showed low initiating joint attention. The results of other studies have shown that children with ASD are weaker in processing information about objects in responding to joint attention. The attenuated processing bias in responding to joint attention can negatively impact learning opportunities in such children (Falck-Ytter et al., 2015).

There is a tendency for children with ASD to have difficulty in focusing attention, concentrating, and persisting in working on a specific task. Such children need to receive appropriate education and special attention to overcome these developmental constraints and avoid further delay in the following developmental stages (Matson et al., 2009). One of the abilities that must be considered when dealing with ASD children is cognitive ability, the basic foundation for learning. Concentration could determine children's memory and learning processes (Hanley et al., 2014); more specifically, it is essential in determining the effectiveness of a learning process (Nally et al., 2018).

Several studies have explored brain abnormalities that could result in poor cognitive abilities in children with ASD. A study at ten research centers in various countries (e.g., Canada, France, and Japan) involving 250 individuals with ASD discovered reduced activity within the cerebellum region, which causes chaotic passing of impulses in the brain. The cerebellum regulates balance and plays a role in sensory processes, thinking, memory, learning, language, attention,

and concentration. The inability of children with autism to swiftly divert their attention is characteristic. Their primary cognitive abilities are limited and related to executive functions, central coherence, and feelings (Fauziah et al., 2019; Lei & Ventola, 2018). Therefore, it is necessary to stimulate the cognitive abilities of such children to ensure optimal progress in their developmental stages.

In general, most children have a stimulus-response pattern: listen-think-do. However, this pattern does not exist in children with ASD because their system is not sensorily integrated. In other words, what is heard by the children is not directly carried out through the typical processing system. An example of this is the delay in learning and peculiar motor movements that differentiate ASD children from others. Elements of thinking and doing can be almost non-existent in such children, who display unrelated behavioral actions on a daily basis (Berger, 2002). After receiving a stimulus, children with autism experience an inability to code (capture information), encode (interpret information), integrate, and coordinate the stimulus they receive. As a result, children with ASD often display "unusual" behaviors; for example, not looking when being called, not responding to instructions given, and repetitive behavior. They usually appear flat (without emotion) or uncontrolled (overwhelmed with emotion) in the face of all stimuli (Greenspan et al., 1998).

The issues mentioned above are the core problems faced by children with ASD. However, a solution exists to reconnect regions of the brain of such children, allowing them to receive stimuli once again. Some researchers have argued that ASD is caused more by cognitive development problems. A neurological imaging study by Spaulding et al. (2010) identified brain areas connected to physical, psychological, and learning processes. In addition, previous research has

revealed that more functional connectivity was present in the brains of children with ASD compared to children in general when observed through neuroimaging. Hyperconnectivity in ASD has been found to exist at the level of the whole brain and subsystem (Supekar et al., 2013), which proves that research related to the brain and cognitive abilities of children with autism is essential. Therefore, this study focuses on exploring the attention and concentration abilities that are a major part of developing individual cognitive abilities.

Dharmono (2010) defined concentration as the effort needed to direct mental activity to a particular experience. It has a significant impact on the learning process of people with ASD. If a child with ASD has difficulty concentrating, their activities will be more likely to be in vain, especially in classroom settings. Those with good concentration skills will typically be better at learning. Therefore, children with ASD must train their ability to concentrate. One of the ways to build concentration is through activating the sensory abilities of children. Concentration is also called attention. Solso et al. (2008) explained that attention is a form of concentration one makes on several objects or simultaneous thoughts. It helps filter vital information to avoid the brain from experiencing information overload. One of the characteristics of children with ASD is their difficulty in maintaining attention; that is, difficulties in listening to instructions, characterized by not wanting to stare when spoken to or not responding when being called by name (Desiningrum, 2016).

It is necessary to be relaxed and in a pleasant atmosphere to activate body sensations as the basis for attention processes. One of the reasons for this is because in a tense state a person's mind will become blank, inhibiting them from using their optimal brain capacity (Dennison, 2006). Prihastuti (2009) states that a pleasant atmos-

phere (i.e., with the child in a very relaxed state) poses no physical or non-physical threats to the child. Therefore, an entertaining method is needed to allow children with autism to relax while improving their attention and concentration. Concentration will help them record what they have learned better, allowing more ease in retrieving and removing memory when needed.

Matlin (2005) argues that concentration is part of attention, because the latter involves broader understanding than concentration. Attention prepares individuals to receive various types of information and refers to the concentration required to separate unwanted stimuli from the many available ones. Matlin (2005) defines concentration as a mental activity that is part of attention.

From the description above, it can be concluded that concentration is an effort to focus attention on the information needed by ignoring information that is not needed. Flanagan (2005) revealed several ways to improve concentration: a) providing a clear time frame so that children know exactly how long they have to complete a specific task; b) preventing children from switching too quickly from one task to another by limiting choices; c) reducing the amount of interference in the room; d) giving immediate feedback to motivate children to keep working or redirecting their attention to the task being performed; e) planning smaller assignments rather than giving one long session; and f) setting goals and offering rewards to motivate children to continue working.

Berger (2002) observed an 8-year-old non-verbal child with ASD running around the music-piano therapy room. The child remained unconcerned, displaying chaotic and uncontrolled behavior. However, they started to pay attention when the therapist/researcher started playing the drums without singing or a melody (only rhythm), even showing a desire themselves to play.

Humans are naturally drawn to rhythm because it can stimulate the paleocephalon brain/limbic system to the neocortex. It affects the limbic system and elicits happy emotions and comfortable feelings. In turn, people want to enjoy that feeling for a long time, thus increasing their attention and concentration (for survival), and reflecting a higher cognitive domain. Once attention is formed, it will be easier for information, or other stimuli, to be received. It can also be integrated with other sensory stimuli. For example, rhythmic jumping, standing and sitting rhythmically, or jumping on rhythmic trampolines. In other words, rhythm therapy can be integrated with other sensory integration therapies to stimulate various sensory aspects, ranging from auditory integration and discrimination, distinguishing rhythm, physical integration, motoric, vestibular (balance), and brain-body coordination (Berger, 2002).

Based on the research results of Berger (2002), the researchers in this study are interested in the application of drum rhythm therapy. That referred to in this study is a modification of music therapy that uses a drum instrument that produces a specific rhythm. The concept used in the study is rhythm, not music, because the latter is too broad in scope. Rhythm is the repetition of certain sounds according to a specific pattern. Rhymes are also used to give music a deep spiritual meaning.

The drum is a rhythmic musical instrument that has the function of playing rhythmic patterns in music. Rhythm-based music training has been shown to improve high-level cognition (Slater et al., 2017). Activities designed to improve beat synchronization skills can develop neurological processes that support executive function skills (Williams, 2018). Rhythm is the repetition of certain sounds according to specific patterns in a song. The repetition of these sounds gives rise to

beauty and makes a song pleasant to listen to. This beat is the core of a song that ASD children can capture to help them develop cognitive abilities (Berger, 2002).

Based on the background of the issues described above, the purpose of the study is to determine whether drum rhythm therapy can help stimulate the cognitive abilities (attention and concentration) of children with ASD. It is hypothesized that a difference will be seen in ASD children before and after undergoing rhythm therapy.

## Method

### *Participants*

The study participants were students at Gilang Ramadhan Studio Band (GRSB), Surakarta Indonesia, which was also the research location. The work met the standards of research ethics. Prior to the data collection process, the parents of the participants gave informed consent. After receiving approval from Gilang Ramadhan Studio Band leaders and parents, the researchers determined which students would be participants. Due to the limited number of ASD children who take part in rhythm therapy ( $n = 19$ ), five were allocated as tryout participants, while the remaining 14 students became the primary participants; ten in their first years of study and four in their second year.

The study involves participants with the following inclusion criteria: 1) children diagnosed with ASD based on the Childhood Autism Rating Scale (CARS) or on clinical judgment from doctors; 2) aged 4-12, as international studies on the highest prevalence rate of ASD occurs at preschool and school age (Özerk & Cardinal, 2020); and 3) new students at Gilang Ramadhan Studio Band (GRSB), Surakarta, Indonesia. The study did not limit the criteria for ASD children with high function or not.

*Procedures*

The study employed drum rhythm therapy, an intervention that utilizes a harmonic rhythm in a drumbeat to stimulate attention, concentration and short-term memory. It should ultimately improve these skills in children with ASD. In the first year, the research team collected and analyzed various scientific studies related to rhythm therapy, attention, concentration, and the short-term memory skill of children with ASD. The process of developing measuring instruments, namely cognitive observations (attention, concentration and short-term memory) and weekly observations, was undertaken based on expert judgment from professionals, Gilang Ramadhan Studio Band leaders, parents and therapists. At the same time, a briefing was given to parents so that the recording of the observations was perceived in the same way by the therapist who made weekly observations, and the observer who recorded the results of monthly observations (the interrater process).

The field data on the children's attention, concentration, and short-term memory skills were analyzed using context analysis. In brief, both the literature review and field data were used to develop the concept of drum rhythm therapy and the instruments to measure the three skills.

Next, a model trial was conducted on five children with autism. Individual assessment observations were made and given to ten children with ASD during their first year of study and and

to four in their second year because of the limited number of ASD children at GRSM. The study used an experimental research design. More specifically, it employed the one group pretest-posttest group design, an experimental design that takes measurements before (pretest) and after (posttest) treatment and is given to one experimental group without a control group. The independent variable was drum rhythm therapy, while the dependent variable was the cognitive ability (attention, concentration and short-term memory) of children with ASD. The experimental design of this study following is shown in Figure 1.

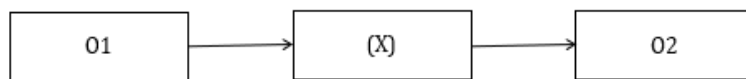
As shown in Figure 1, the experimental design applied by conducting treatment before and after therapy in the same group. Effectiveness of the intervention was defined from the score's differences on cognitive abilities before and after therapy. The analysis will be carried out on various scores test of attention, concentration, and short-term memory measured before and after therapy.

*Instruments*

*Drum Rhythm Therapy*

Drum rhythm therapy was employed in the study. According to Berger (2002), children with autism are more attracted to drums than other types of musical instruments such as the piano. Drum rhythm therapy is an intervention approach that utilizes harmonious rhythms in the form of drumbeats, capable of stimulating attention,

**Figure 1**  
*Experimental Design*



*Note.* Notes: O1 is the group before intervention. (X) is the treatment, namely drum rhythm therapy. O2 is the group after intervention (Latipun, 2011).

forming positive perceptions, and increasing the concentration level of children with ASD (Berger, 2002). It is a modification of music therapy that uses drums to produce a certain rhythm. The concept used in this study is rhythm, not music, because the latter is too broad in scope.

Rhythm is the repetition of certain sounds according to a specific song pattern that gives rise to beauty. According to Berger (2002), the drum is one of the oldest instruments designed by humans and can be found in every culture in the world. Rhythm is a physiological organizer. Research shows that the hearing cortex and motor are involved in rhythmic movements. Internalization of the rhythm is key to the success of music therapy for sensory integration through continuous drumming (external rhythmic stimulation). Repeating specific patterns will affect internal physiology (e.g., pulse, muscle contraction, heart-beat, blood pressure, breathing) before finally affecting the internal processes, that is, cognition and language.

The drum rhythm therapy steps are as follows: 1) Prepare the children by making them sit quietly. 2) Teach them to hold the stick correctly. 3) Train their endurance and strength by holding a stick while enjoying the rhythm of the song that the child likes. 4) Help the children understand the parts of the drum. 5) Ask the children to imitate the instructor's movements. 6) Observe the children following the rhythm of the music and the drumbeat in the song (Fauziah et al., 2019).

According to Berger (2002), components in drum rhythm therapy are: 1) Pulse (thump/beat/boom): the boom is often equated with the term rhythm in general. Beat/boom is a repetitive rhythm such as a strong-weak-strong-weak or falling-bounced consistent sound motion with a specific average sound interval between each beat. 2) Pattern: rhythmic patterns (favored by the brain) fill in the blanks and keep the brain ready

and interested in the constantly changing varieties of music information. 3) Perseveration: the most compelling aspect of this is consistency and repetition, which are drum blows, attending to the repetitive nature of the brain from the interaction of the thumps with rhythmic patterns. 4) Tempo: tempo, or speed, is classified in the booming element. The speed of the boom usually determines the effectiveness of a part of music in eliciting specific psycho-emotional or physiological sensory responses from musical gatherings.

The 3P plus T components described above are part of the rhythm and underlie music therapy intervention to improve physiological adaptation and cognitive learning.

The technical implementation of the research was as follows: 1) the observers conducted a pre-test to observe each participant's attention, concentration and short-term memory. 2) treatment was given once a week (according to the child's schedule following rhythm therapy) and the results of the weekly observations were recorded by the therapist. 3) the observers conducted a posttest in the third month to observe changes in attention, concentration and long-term memory in each participant.

#### *Observation Checklist*

The results of the FGD (Focus Group Discussion) became the foundation for developing the tool for measuring ASD children's cognitive abilities (attention and concentration) through observation. The measurement tool was produced through a focus group discussion process with parents/guardians and therapists. The cognitive ability observational tools were arranged based on the conclusions from the FGD results and refer to the theory proposed by James (2012). Table 1 explains the aspects and indicators which defines the measure of attention, concentration, and short-term memory, structured in the observational checklist.

Clapping hands, playing drumsticks, clapping to the rhythm of the song and the behavioral impact is measured during the intervention to define the ability of paying attention, imitate, and maintain attention when there is distraction on the participants. When the child can imitate the clapping exemplified by the therapist, the child earns the scores. Likewise, when they are able to imitate drumming. A treatment of distraction is given to the child to observe the child's level of attention. When the child is able to stay focused, a score is given.

Table 2 illustrates the intervention procedures on attention and the behavioral indicators to

measure attention. The intervention was conducted by presenting another objects and observed the behavioral impact on how much attentions children are able to pay without being distracted, and how many activity they are able to engaged. The score is given based on the number of activities they engaged. Starts from 1 if they are able to engaged on 1 activity, to 6 if being able to do six activities. The therapist will provide toys and see how the child responds.

The score is given when the child plays according to the given toy. Likewise, when the therapist gives other toys, along with distractions, the observer will see the child's response, when

**Table 1**  
*Attention, Concentration and Short-term Memory - General*

No.	Intervention	Behavioral Impact on Child
1	Applause	Pays attention when doing certain activities
2	Imitating playing with drumsticks	Willing to complete tasks even with help
3	Clapping to the rhythm of the song Distractor: tymbal drum sound	Attention can be maintained with help even if there are distractors (e.g., TV sounds, radios, cars, etc.)
Subtotal Score A (sum of all item scores)		

*Note.* Items were translated from the attention aspects of James (2012). Scores show an assessment of attention and concentration in general, ranging from 1, being able to do one activity, to 6, being able to do six activities.

**Table 2**  
*Attention - Object Use*

No.	Intervention	Behavioral Impact
1	Presenting toy objects	Playing with toys does match its function
2	Presenting other toy objects	Playing usual game according toys given
3	Presenting other toy objects, with distraction (such as dispensers, air conditioners, sound systems, chairs, shoes, etc)	Children are interested in items that are toys given
4	Give a knock on two drumsticks	Children understand how to play after instructions are given
Subtotal Score B (sum of all item scores)		

*Note.* Items are translated from the attention and concentration aspects from James (2012). Score B indicates an assessment of attention with scores ranging from 1, being able to pay attention to one activity, to 6, being able to pay attention to six activities.



the child plays the given toy, is not affected by distraction, a score is given. Likewise with the drum stick game, a score is given when the child plays the drum stick according to its function. The next observation checklist is to measure the concentration while working with puzzle. Behavior indicators to measure concentration is shown in Table 3.

The assessment of concentration using a puzzle observation made to determine reaction speed, understanding of instructions, ability and speed in solving puzzles. Puzzles are used to see the level of concentration of children, also to measure children's memory about the shape of an object. But overall, the puzzle is used to see the level of concentration of children. Scores are given to children if they are able to complete the given puzzle. The score difference is also determined by the speed of solving the puzzle. Another checklist used in this study is a weekly observation checklist as illustrated in Table 4.

Weekly observation was used as control procedure, ensuring the changes in attention and concentration abilities only due to the treatment given to the experimental group. Weekly observations are used to strengthen the validation of the observation measuring instrument after drum rhythm therapy is given to children. The difference

in children's condition each week shows that drum rhythm therapy can significantly help children develop their cognitive areas in terms of attention, concentration and short-term memory.

Table 4 shows the weekly observation guide to observe changes in attention and concentration abilities, given 10 treatments, scoring 1-5 with observation time. Observations are seen by the gradual behavioral differences that occur weekly, from children who do not want to hold drum sticks, become willing, even following the therapist's movements, even to being able to enjoy music and follow rhythm music given every week, showing increased attention, concentration and short-term memory of ASD children.

*Content Validity and Concurrent Validity*

Content and concurrent validity were used in the research; content validity to determine what theory or concept would be used as a reference for observation. The concept or theory was then reduced to several indicators to become the operational benchmarks for the concept. The observational checklist was based on the cognitive dimensions of James (2012), namely attention and concentration. Attention refers to the ability to maintain a state of alertness to stimuli, while concentration is the process of directing one's

**Table 3**  
*Concentration – Puzzle*

No.	Behavior
1	Reaction speed when puzzle instructions are given
2	Understands the game according to the instructions
3	Does the puzzle
4	Ability to solve the puzzle
5	Speed in solving the puzzle
Subtotal Score C (sum of all item scores)	

*Note.* Items are translated from the attention and concentration aspects from James (2012). A C score indicates a concentration assessment with scores ranging from 1, being able to concentrate on one activity, to 6, being able to concentrate on six activities and complete the puzzle correctly.

**Table 4**

*Weekly Observation Guide*

Name : \_\_\_\_\_

Age : \_\_\_\_\_

Therapist : \_\_\_\_\_

Observation date : \_\_\_\_\_

No.	Behavior	Score (1-5)	Observation Date
1	Sits quietly and holds the drumstick		
2	Uses the drumsticks with the help of an instructor (without music)		
3	Pays attention when working on drum activities		
4	Enjoys playing the drum by showing a smiling or happy face		
5	Plays the drum by following the music played by the instructor when prompted		
6	Plays the drum by following the music played by the instructor without being prompted		
7	Willing to complete a task with the instructor's help (completing the song)		
8	Able to maintain attention on the instructor despite distraction (noises from the TV or other people)		
9	Remembers the beats taught by the instructor		
10	Able to play the drum according to the music previously taught by the instructor		

*Note.* A checklist for observing the ability of attention and concentration which consists of 10 items and each is given an assessment rating of 1–5.

attention to the source of the stimulus, aiming to strengthen the stimulus (concentration). Moreover, executive attention is the aspect of attention that acts to execute things that arise when someone pays attention. Short-term memory is a person's ability to recall things or information they were told a few seconds before. Such memory is only able to store information briefly, for around 30 seconds. Information that is not quickly sent to

the short-term memory will disappear forever. One psychological test tool that measures this type of memory is that of Weschler (Anastasi & Urbina, 1997). The ability to control attention is linked to working memory capacity (Brose et al., 2012). On the WISC, working memory is measured by the working memory index (WMI). This includes the digit span (forward and backward) subtest. These two memory systems, short-term and working

are separate, but at the same time interdependent, since the information held by short-term memory is necessary for working memory to manipulate it (Catinas, 2017).

Content validity shows the extent to which items in a measurement tool represent all the conceptual framework aspects. For a measurement tool to be considered valid, the data must reflect the characteristics that have been determined, namely the intended measure. In this study, the researchers employed autism experts to judge the items of the measurement tool professionally. The teacher/therapist and parents were also invited to review the instrument.

Concurrent validity is assessed by comparing two observed behaviors at two different times. This was done by observing the behavior of ASD children every week by the teacher to synchronize the pretest and posttest results.

#### *Interrater Reliability*

A reliability check needs to be made if the observation data are produced in quantitative data. In this case, measurement of reliability was made by comparing the scores of all the observers (interrater reliability). A group of people within the observation team conducted this process. Before data collection, the team held a briefing to ensure that everyone understood the study concepts. Each observer's data were averaged, and the final results were obtained for further analysis (Neuman, 2007).

#### *Data Collection*

Data were collected by measuring the pretest and posttest results of each ASD child for three months. The measurement tool was used with a checklist method, with a minimum checklist of 1 to a maximum of 6 per indicator. The researcher observed each child before the 3-month therapy and collected the data again using an observational checklist after the therapy had been given. Three observers observed each child to strengthened

inter-rater validity. From both the first-years and second-year studies, an observational instrument checklist completed by teachers was used to observe each child's progress every week. Observation of the child's development was also made every week during the 3-month therapy intervention. This weekly observation was conducted to check the consistency of the results of the drum rhythm therapy with changes in the children's attention and concentration.

#### *Data Analysis*

The experiment data were analyzed using Wilcoxon test analysis. The different mean scores of each child were used as the basis for the research analysis. Data analysis was performed using SPSS 23.

## **Results**

This study involved a total of 14 children aged between 4–12 who had been diagnosed with ASD using the CARS clinical detection tool. Symptoms of autism include impairments in several aspects: 1) Communication (i.e., being late/unable to speak). 2) Social interaction. 3) Behavior and play. 4) Feelings emotions. 5) sensory perception. Classification of moderate and severe autism is made after a child has been diagnosed with the condition and can be determined using CARS tool (Desiningrum, 2016). The details about demographic characteristics of is as shown in Table 5.

Table 5 shows demographic characteristics of the participants in this study, involved a total of 14 participants aged between 5–10 who had been diagnosed with ASD using the CARS clinical detection tool. The age range of the participants are met the category of children. The gender of the participants in this study was dominated by male sex, with details of 13 boys and 1 girl.

Based on the implementation of the drum rhythm therapy method given to the 14 children, Table 6 shows the scores before and after the

intervention. Table 6 shows pretests and posttest scores of 14 children participate in this study, measured before and after the intervention. Pretest scores ranging from 19 to 76 and posttest scores ranging from 22 to 84. Based on the data presented in Table 6, it is clear that there is an

increased scores compare from pretest (before intervention) to posttest (after intervention). It can be concluded that the participants made progress in terms of attention and concentration during the intervention process with drum rhythm therapy. The result of Wilcoxon test is shown in Table 7.

**Table 5**  
*Demographic Characteristics of the Participants*

ID	Age	Gender
VK	6 years 9 months	Female
JL	6 years 5 months	Male
MX	5 years	Male
Ar	10 years	Male
SM	7 years	Male
HD	7 years	Male
HS	7 years 10 months	Male
KZ	5 years 2 months	Male
WT	6 years 6 months	Male
Nf	5 years 5 months	Male
IZ	7 years	Male
DF	9 years	Male
LK	6 years	Male
Mrl	6 years 3 months	Male

*Note.* Demographic table to determine subject identity, age range and gender.

**Table 6**  
*Pretests and Posttest Scores*

ID	Pretest	Posttest
VK	51	59
JL	72	84
MX	70	72
Ar	69	70
SM	70	70
HD	58	62
HS	46	50
KZ	21	25
WT	28	40
Nf	19	22
IZ	76	79
DF	38	41
LK	45	51
Mrl	75	77

*Note.* The pretest is the total score of each item A+B+C before intervention, while posttest refers to the total score of each item A+B+C after the intervention.

Table 7 shows the descriptive statistical results of the Wilcoxon test analysis of 14 participants, the value of pretest minimum 19, maximum 76, total 506 and average 50.40. The value of posttest minimum 22, maximum 84, total 542 and average 54.20. Based on the data presented in table 7, it can be seen that there was an increase in the minimum, maximum and mean scores of participants after being given drum rhythm therapy. It Can be concluded that the participants made progress after the intervention process with drum rhythm therapy. Table 8 describe the significance value of different test performed.

Table 8 shows that 14 participants showed an increase in attention, concentration and short-term memory scores following the therapy ( $Z = -2.533^b$ ,  $p = .011$ ),  $p < .05$  these results indicate that rhythm therapy can significantly increase the attention and concentration levels of children with ASD. The data analysis results show that drum rhythm therapy can significantly increase the attention and concentration level of children with ASD ( $p < .05$ ). This indicates that, despite many limitations, children with ASD are still capable of growing and developing optimally. However,

parents must provide appropriate support, care, and education for their children as early as possible (Becker et al., 2012).

Based on the observations, it is concluded that children with ASD typically show cognitive limitations, particularly in relation to memory. At the start of the therapy, five participants threw tantrums, not wanting to follow the given instructions. Once the therapist played the drum a few times while encouraging the subjects to hold a stick and beat the drum, they eventually showed more willingness and calmness to interact. The subjects even appeared to play a song, indicating extraordinary progress.

Another distinctive characteristic of children with ASD was also shown in four of the participants. That is, they were able to show aspects of short-term attention but with poor concentration levels. A cognitive problem often experienced by most children with ASD is related to short-term memory. Attention can be directed to facilitate such memory performance, and this proved useful in enhancing the quantity or quality of short term memory in people with impoverished memory capacity (Strunk et al., 2019).

**Table 7**  
*Descriptive Statistics from the Wilcoxon Test Analysis*

	N	Minimum	Maximum	Sum	Mean	SD
Pretest	14	19	76	504	50.40	21.109
Posttest	14	22	84	542	54.20	19.222

Note. Wilcoxon pretest-posttest test analysis. N is the total number of participants.

**Table 8**  
*Wilcoxon Signed-rank Test*

	Posttest-Pretest
Z	-2.533 <sup>b</sup>
Asymp. Sig. (2-tailed)	.011

Note. a. Wilcoxon Signed-ranks Test; b. Based on negative ranks.

## Discussion

This research suggests that drum rhythm therapy can effectively improve the cognitive ability of children with ASD. It activates sensations in their bodies which helps them feel more relaxed and contributes to creating a fun atmosphere. A light-hearted atmosphere allows the children to be in a very relaxed state, convincing them that there is no physical or non-physical treat. This level of ease must be achieved because being in a tense state could typically inhibit people from optimally using their brain, as their mind turns blank (Dennison, 2006). A comfortable atmosphere will allow children with ASD to develop cognitive abilities and pave the way for them to utilize all their potential.

Such children are prone to present sensory alterations in different contexts, giving non-adaptive behavioral and learning responses (Gentil-Gutiérrez et al., 2021). Incorporating a stimulus that suits their interests (i.e., fun activities) is essential for maintaining their healthy development (Huang & Kang, 2021).

The findings also support ones from previous studies that have highlighted the significant impact of music on people with special needs. Many researchers have provided evidence of the effectiveness of music therapy in such cases. For example, studies on the use of music therapy have found that it can be used for children with autism because it is non-verbal and non-cognitive (Dimitriadis & Smeijsters, 2011). In other words, music therapy does not depend on a person's cognitive abilities or intelligence. Music creates interest in children with special needs. In general, the tempo of the music itself can provide a stimulus to regulate the intensity of physical activity (Faulkner et al., 2021). Therefore, music therapy can serve a wide variety of special needs. The rhythmic and melodic aspects of familiar songs can promote children's engagement and prolong their attention to the instructions given

(Vaiouli & Ogle, 2015). Other studies have shown that the musical repertoire can support the development of joint attention communication skills in students with ASD (Scholtens, 2019).

The results of the study show that various music therapies could be given to children with autism. Music has a positive influence on increasing attention span and building more positive interactions (Dolgun, 2018; Zhang et al., 2012). In another study, cooperative music therapy, non-music cooperative play, and independent play conditions were shown to effectively develop joint attention in children with autism. Overall, cooperative music therapy is more effective than non-music cooperative and independent play (Davis, 2016).

Studies on the effect of drum therapy on the social-emotional development of children with autism have been previously conducted, showing that group drumming can significantly improve the social relations between children with autism (Willemin et al., 2018). In this study, such therapy was employed to improve the cognitive abilities of such children, especially their level of attention and concentration.

Rhythmic music can be an alternative therapy, as evidenced by various studies. Harmaini (2012) and Rickson et al. (2015) discovered that drums could be used to overcome the challenges experienced by children with hearing impairments in recognizing numbers. Using rhythmic music attracts children's attention, ultimately helping them to increase their attention span (Dolgun, 2018). Drum practice can also improve selective attention (Slater et al., 2017). Another study showed that drum therapy can improve cognitive functioning (Deyo, 2016), while Cahart et al. (2022) investigated the impact of a drum-based intervention on neural and behavioral outcomes in autistic adolescents, showing that improvements in drumming performance increased functional connectivity in brain areas responsible

for inhibitory control, action outcomes monitoring, and self-regulation.

The application of drum rhythm therapy can improve cognitive abilities in children with ASD (Berger, 2002). Berger found that drums seemed to attract children with autism more than other musical instruments. It is an intervention approach that utilizes harmonious rhythms in drumbeats, which can stimulate attention, form positive perceptions, and ultimately increase the concentration ability of children with ASD.

Various goals can be achieved by playing a drum. In general, drum rhythm therapists provide opportunities for individuals to explore musical instruments before notifying them of or being asked the instrument's name. In addition to increasing their knowledge of musical instruments, participants are also free to play an instrument. In doing so, they can also be trained to focus and increase their attention span. The author usually incorporates games into the instruction (i.e., seeing rhythm). By playing instruments, they can increase their range of motion and strengthen their muscles. Therefore, in conclusion, drum rhythm therapy can become one of the most common techniques used in this field as it can be employed with various types of people with various age ranges.

In conclusion, many goals can be achieved using drum rhythm therapy techniques. Therapists can adjust how they use the musical instrument to support their patients' needs. Providing appropriate and fun therapy, with social support from a harmonious family, and with fully support for ASD childcare will help ASD children develop optimally (Fauziah, 2020). A previous study has shown a significant relationship between family support

and cognition (Yilmaz et al., 2015). Social contact, informational support, and emotional and informational support from the family had any remaining significant relations with specific cognitive abilities (La Fleur & Salthouse, 2016).

The study has limitations. It did not use a randomized controlled trial, meaning the results can only be generalized in a limited way. Such trials are suggested for use as an improvement in further research, allowing results to be generalized more broadly.

## Conclusions

Research on drum rhythm therapy to stimulate the cognitive abilities of children with ASD could be applied to several other music schools so that its application can benefit other children with ASD. When children with ASD learn music and drums, they will follow the incorporated musical elements (i.e., rhythm, melody, and dynamics). The children will instinctually be attracted to the rhythm and play along with the music. At that moment, they will learn to follow instructions. After a time, students who truly enjoy playing the beat of a drum will see improvements in their cognitive skills.

### *Declaration of Conflicting Interests*

The author(s) declare no potential conflict of interest and no financial support for this article's research, authorship, and/or publication.

### *Acknowledgements*

The research obtained a research feasibility permit from the Faculty of Psychology, Universitas Diponegoro, and Gilang Ramadhan Studio Band (GRSB).[]

## References

- Anastasi, A., & Urbina, S. (1997). *Psychological testing*. Prentice-Hall.
- Becker, J. B., Perry, A. N., & Westenbroek, C. (2012). Sex differences in the neural mechanisms mediating addiction: A new synthesis and hypothesis. *Biology of Sex Differences*, 3(1), 14. <https://doi.org/10.1186/2042-6410-3-14>

- Berger, D. S. (2002). *Music therapy, sensory integration and the autistic child*. Jessica Kingsley Publishers.
- Boxhoorn, S., Lopez, E., Schmidt, C., Schulze, D., Hänig, S., & Freitag, C. M. (2018). Attention profiles in autism spectrum disorder and subtypes of attention-deficit/hyperactivity disorder. *European Child & Adolescent Psychiatry*, 27(11), 1433–1447. <https://doi.org/10.1007/s00787-018-1138-8>
- Brose, A., Schmiedek, F., Lövdén, M., & Lindenberger, U. (2012). Daily variability in working memory is coupled with negative affect: The role of attention and motivation. *Emotion*, 12(3), 605–617. <https://doi.org/10.1037/a0024436>
- Cahart, M.-S., Amad, A., Draper, S. B., Lowry, R. G., Marino, L., Carey, C., Ginestet, C. E., Smith, M. S., & Williams, S. C. R. (2022). The effect of learning to drum on behavior and brain function in autistic adolescents. *Proceedings of the National Academy of Sciences*, 119(23), e2106244119. <https://doi.org/10.1073/pnas.2106244119>
- Catinas, O. (2017). *Exploring the effects of ageing on short-term memory performance*. [Undergraduate thesis]. University of Suffolk.
- Davis, M. (2016). *The effect of music therapy on joint attention skills in children with autism spectrum disorder*. [Master thesis]. University of Kansas.
- Dennison, P. E. (2006). *Brain gym and me - Reclaiming the pleasure of learning*. Edu Kinesthetics.
- Desiningrum, D. R. (2016). *Psikologi anak berkebutuhan khusus*. Psikosain-Graha Ilmu.
- Deyo, L. J. (2016). Cognitive functioning of drumming and rhythm therapy for neurological disorders. *Chancellor's Honors Program Projects*. [https://trace.tennessee.edu/utk\\_chanhonoproj/1983](https://trace.tennessee.edu/utk_chanhonoproj/1983)
- Dharmono. (2010). *Buku ajar psikiatri*. Badan Penerbit FKUI.
- Dimitriadis, T., & Smeijsters, H. (2011). Autistic spectrum disorder and music therapy: Theory underpinning practice. *Nordic Journal of Music Therapy*, 20(2), 108–122. <https://doi.org/10.1080/08098131.2010.487647>
- Dolgun, T. C. Ö. B. (2018). Music therapy in ADHD and autism. *IOSR Journal Of Humanities And Social Science (IOSR-JHSS)*, 23(7), 90–96. <https://www.iosrjournals.org/iosr-jhss/papers/Vol. 23 Issue7/Version-9/L2307099096.pdf>
- Falck-Ytter, T., Thorup, E., & Bölte, S. (2015). Brief report: Lack of processing bias for the objects other people attend to in 3-year-olds with autism. *Journal of Autism and Developmental Disorders*, 45(6), 1897–1904. <https://doi.org/10.1007/s10803-014-2278-4>
- Faulkner, M., McNeilly, A., Davison, G., Rowe, D., Hewitt, A., Nevill, A., Duly, E., Trinick, T., & Murphy, M. (2021). Music tempo: A tool for regulating walking cadence and physical activity intensity in overweight adults? *International Journal of Environmental Research and Public Health*, 18(15), 7855. <https://doi.org/10.3390/ijerph18157855>
- Fauziah, N. (2020). The concept of family's harmony in multiple cultural settings, what about the family harmony with autism children in Indonesia? A literature study. *The Family Journal*, 28(4), 365–370. <https://doi.org/10.1177/1066480720904027>
- Fauziah, N., Prasetyo, A. R., Kustanti, E. R., & Desiningrum, D. R. (2019). *Modul drum rhythm therapy untuk anak autis*. Fastindo.
- Flanagan, R. (2005). *ADHD kids: Attention deficit hyperactivity disorder*. Prestasi Pustakaraya.
- Gentil-Gutiérrez, A., Cuesta-Gómez, J. L., Rodríguez-Fernández, P., & González-Bernal, J. J. (2021). Implication of the sensory environment in children with autism spectrum disorder: Perspectives from school. *International Journal of Environmental Research and Public Health*, 18(14), 7670. <https://doi.org/10.3390/ijerph18147670>



- Greenspan, S. I., Wieder, S., & Simons, R. (1998). *The child with special needs: Encouraging intellectual and emotional growth*. Addison-Wesley/Addison Wesley Longman.
- Hafil, M. (2021, December 21). *Penderita autis dilaporkan meningkat*. *Republika.Co.Id*. <https://www.republika.co.id/berita/r4gawp430/penderita-autisme-dilaporkan-meningkat>
- Hanley, M., Riby, D. M., McCormack, T., Carty, C., Coyle, L., Crozier, N., Robinson, J., & McPhillips, M. (2014). Attention during social interaction in children with autism: Comparison to specific language impairment, typical development, and links to social cognition. *Research in Autism Spectrum Disorders, 8*(7), 908–924. <https://doi.org/10.1016/j.rasd.2014.03.020>
- Harmaini, S. (2012). Efektivitas penggunaan media drum untuk meningkatkan pengenalan bilangan 1 – 10 bagi anak tunarungu di SLB Sabiluna Pariaman. *E-JUPEKhu (Jurnal Ilmiah Pendidikan Khusus)*, *1*(1), 123–132. <https://doi.org/10.24036/jupe7840.64>
- Hillier, A., Poto, N., Schena, D., Dorey, J., Buckingham, A., Santangelo, M., & Frye, A. (2022). Overview of a life skills coaching program for adults on the autism spectrum: Coaches' perspectives. *Psychological Reports, 125*(2), 937–963. <https://doi.org/10.1177/0033294121991021>
- Huang, C.-C., & Kang, L.-J. (2021). Participation in play and leisure activities of young children with autism spectrum disorder and typically developing children in Taiwan: A preliminary study. In *International Journal of Environmental Research and Public Health* (Vol. 18, Issue 11). <https://doi.org/10.3390/ijerph18115787>
- Hughes, R. W., Hurlstone, M. J., Marsh, J. E., Vachon, F., & Jones, D. M. (2013). Cognitive control of auditory distraction: Impact of task difficulty, foreknowledge, and working memory capacity supports duplex-mechanism account. *Journal of Experimental Psychology: Human Perception and Performance, 39*(2), 539–553. <https://doi.org/10.1037/a0029064>
- James, W. H. (2012). A potential explanation of some established major risk factors for autism. *Developmental Medicine & Child Neurology, 54*(4), 301–305. <https://doi.org/10.1111/j.1469-8749.2012.04225.x>
- Keehn, B., Müller, R.-A., & Townsend, J. (2013). Atypical attentional networks and the emergence of autism. *Neuroscience & Biobehavioral Reviews, 37*(2), 164–183. <https://doi.org/10.1016/j.neubiorev.2012.11.014>
- Kennedy, D. P., & Adolphs, R. (2012). The social brain in psychiatric and neurological disorders. *Trends in Cognitive Sciences, 16*(11), 559–572. <https://doi.org/10.1016/j.tics.2012.09.006>
- La Fleur, C. G., & Salthouse, T. A. (2016). Which aspects of social support are associated with which cognitive abilities for which people? *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 72*, 1006–1016. <https://doi.org/10.1093/geronb/gbv119>
- Latipun. (2011). *Psikologi eksperimen*. UMM Press.
- Lei, J., & Ventola, P. (2018). Characterising the relationship between theory of mind and anxiety in children with Autism Spectrum Disorder and typically developing children. *Research in Autism Spectrum Disorders, 49*, 1–12. <https://doi.org/10.1016/j.rasd.2018.01.005>
- Matlin, M. W. (2005). *Cognition* (6th ed.). John Wiley & Sons Inc.
- Matson, M. L., Mahan, S., & Matson, J. L. (2009). Parent training: A review of methods for children with autism spectrum disorders. *Research in Autism Spectrum Disorders, 3*(4), 868–875. <https://doi.org/10.1016/j.rasd.2009.02.003>
- Maulana, M. (2019). *Anak autis: Mendidik anak autis dan gangguan mental lain menuju anak cerdas dan sehat*. Ar-Ruzz Media.
- Mundy, P., Kim, K., McIntyre, N., Lerro, L., & Jarrold, W. (2016). Brief report: Joint attention and information processing in children with higher functioning autism spectrum disorders. *Journal of Autism and Developmental Disorders, 46*(7), 2555–2560. <https://doi.org/10.1007/s10803-016-2785-6>

- Nally, A., Healy, O., Holloway, J., & Lydon, H. (2018). An analysis of reading abilities in children with autism spectrum disorders. *Research in Autism Spectrum Disorders*, 47, 14–25. <https://doi.org/10.1016/j.rasd.2017.12.002>
- Neuman, W. L. (2007). *Basic social research methods: Qualitative & quantitative approaches* (2nd ed.). Allyn & Bacon.
- Parmeggiani, A., Corinaldesi, A., & Posar, A. (2019). Early features of autism spectrum disorder: A cross-sectional study. *Italian Journal of Pediatrics*, 45(1), 144. <https://doi.org/10.1186/s13052-019-0733-8>
- Prihastuti, P. (2009). Pengaruh braingym terhadap peningkatan kecakapan berhitung siswa sekolah dasar. *Cakrawala Pendidikan*, 1, 35–47. <https://doi.org/10.21831/cp.v1i1.45>
- Rickson, D., Molyneux, C., Ridley, H., Castelino, A., & Upjohn-Beatson, E. (2015). Music therapy with people who have Autism Spectrum Disorder-Current practice in New Zealand. *New Zealand Journal of Music Therapy*, 13, 8–32.
- Santrock, J. W. (2006). *Psychology* (8th ed.). McGraw Hill.
- Scholtens, M. C. (2019). Using music to encourage joint attention for students with Autism Spectrum Disorder: Attention as a reciprocal relationship. *Music Educators Journal*, 105(4), 45–51. <https://doi.org/10.1177/0027432119846954>
- Slater, J., Azem, A., Nicol, T., Swedenborg, B., & Kraus, N. (2017). Variations on the theme of musical expertise: Cognitive and sensory processing in percussionists, vocalists and non-musicians. *European Journal of Neuroscience*, 45(7), 952–963. <https://doi.org/10.1111/ejn.13535>
- Solso, R. L., MacLin, M. K., & MacLin, O. H. (2008). *Cognitive psychology*. Pearson Education.
- Spaulding, L. S., Mostert, M. P., & Beam, A. P. (2010). Is brain gym® an effective educational intervention? *Exceptionality*, 18(1), 18–30. <https://doi.org/10.1080/09362830903462508>
- Strunk, J., Morgan, L., Reaves, S., Verhaeghen, P., & Duarte, A. (2019). Retrospective attention in short-term memory has a lasting effect on long-term memory across age. *The Journals of Gerontology: Series B*, 74(8), 1317–1325. <https://doi.org/10.1093/geronb/gby045>
- Supekar, K., Uddin, L. Q., Khouzam, A., Phillips, J., Gaillard, W. D., Kenworthy, L. E., Yerys, B. E., Vaidya, C. J., & Menon, V. (2013). Brain hyperconnectivity in children with autism and its links to social deficits. *Cell Reports*, 5(3), 738–747. <https://doi.org/10.1016/j.celrep.2013.10.001>
- Uddin, L. Q., Supekar, K., Lynch, C. J., Cheng, K. M., Odriozola, P., Barth, M. E., Phillips, J., Feinstein, C., Abrams, D. A., & Menon, V. (2015). Brain state differentiation and behavioral inflexibility in autism. *Cerebral Cortex*, 25(12), 4740–4747. <https://doi.org/10.1093/cercor/bhu161>
- Vaiouli, P., & Ogle, L. (2015). Music strategies to promote engagement and academic growth of young children with ASD in the inclusive classroom. *Young Exceptional Children*, 18(2), 19–28. <https://doi.org/10.1177/1096250614523968>
- Veskarisyanti, G. A. (2008). *12 terapi autis paling efektif & hemat: Untuk autisme, hiperaktif & retardasi mental*. Pustaka Angrek.
- Willemin, T., Litchke, L. G., Liu, T., & Ekins, C. (2018). Social emotional effects of Drumtastic®: A dyadic within-group drumming pilot program for children with autism spectrum disorder. *International Journal of Special Education*, 33(1), 94–103. <https://internationalsped.com/ijse/issue/view/24>
- Williams, K. E. (2018). Moving to the beat: Using music, rhythm, and movement to enhance self-regulation in early childhood classrooms. *International Journal of Early Childhood*, 50(1), 85–100. <https://doi.org/10.1007/s13158-018-0215-y>

- Yilmaz, F. T., Sabancıoğulları, S., Aldemir, K., & Kumsar, A. K. (2015). Does social support affect development of cognitive dysfunction in individuals with diabetes mellitus? *Saudi Medical Journal*, *36*(12), 1425–1431. <https://doi.org/10.15537/smj.2015.12.12845>
- Zhang, F., Liu, K., An, P., You, C., Teng, L., & Liu, Q. (2012). Music therapy for attention deficit hyperactivity disorder (ADHD) in children and adolescents. In L. Teng (Ed.), *Cochrane Database of Systematic Reviews*. John Wiley & Sons, Ltd. <https://doi.org/10.1002/14651858.CD010032>

This page has been intentionally left blank.