

Auditory Learning Comparison Between Children with Autism and ADHD

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ABSTRACT

This experimental study aimed to investigate the auditory learning abilities of children diagnosed with Autism Spectrum Disorder (ASD) and Attention-Deficit/Hyperactivity Disorder (ADHD) using a pitch discrimination task. Two groups of participants, Group A (8 children with ASD) and Group B (8 children with ADHD), aged between 4-6 years, were selected based on formal academic assessments and consultation with their class teacher for suitability for the study. The experiment involved a pitch discrimination task, where the participants were asked to detect differences in pitch in a complex sound sequence, and their performance was evaluated under two conditions: low stimulation (quiet) and high stimulation (noisy) settings.

The results of the study showed that the ASD group exhibited lower overall accuracy in the pitch discrimination task than the ADHD group. Additionally, the ASD group demonstrated slower learning in the task in quiet settings, but higher abilities in noisy environments, while the ADHD group showed higher learning abilities in a quiet setting but lower abilities in a noisy environment. These findings suggest that children with ADHD may benefit more from auditory learning compared to children with ASD.

This study highlights the importance of early interventions to support auditory learning in children with neurodevelopmental disorders. Identifying the strengths and weaknesses in auditory processing abilities of children with ASD and ADHD can assist in developing targeted intervention programs that cater to the specific needs of these children. Providing early auditory interventions could enhance their communication and social skills, leading to improved outcomes in academic and social settings.

Future research could investigate the specific neural mechanisms underlying the differences in auditory processing between children with ASD and ADHD. Additionally, longitudinal studies could assess the long-term effects of early interventions on the auditory learning abilities of children with neurodevelopmental disorders.

This study provides important insights into the differences in auditory learning between children with ASD and ADHD. The findings suggest that children with ADHD may benefit more from auditory learning compared to children with ASD. These findings emphasize the importance of early interventions to support auditory learning in children with neurodevelopmental disorders, which could enhance their communication and social skills and lead to better outcomes in academic and social settings.

Keywords: *Auditory learning, Autism Spectrum Disorder (ASD), Attention-Deficit/Hyperactivity Disorder (ADHD), pitch discrimination, neurodevelopmental disorders, learning abilities, communication skills.*

INTRODUCTION

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that affects social communication and interaction, as well as restricted and repetitive behaviours and interests. According to the Center for Disease Control and Prevention (CDC), ASD affects approximately 1 in 54 children in the United States (CDC, 2021). Although the exact causes of ASD are still unknown, research has shown that both genetic and environmental factors play a role in its development.

One of the main features of ASD is a difficulty in social communication and interaction. Children with ASD may have difficulty making eye contact, initiating, and maintaining conversations, and understanding nonverbal communication, such as facial expressions and gestures (National Institute of Mental Health, 2021). Additionally, individuals with ASD may have difficulty with social relationships and may prefer solitary activities over social ones.

Restricted and repetitive behaviours and interests are also common in individuals with ASD. This can manifest as repetitive movements or speech, strict adherence to routines or rituals, and intense interests in specific topics (National Institute of Mental Health, 2021). These behaviours and interests may interfere with daily activities and social relationships.

Diagnosis of ASD is typically made through a combination of behavioural evaluations and medical assessments. Early diagnosis and intervention are important for improving outcomes for individuals with ASD. Interventions may include behavioural

therapies, such as Applied Behaviour Analysis (ABA) and social skills training, as well as medication for co-occurring conditions, such as anxiety and depression (National Institute of Mental Health, 2021).

While the exact causes of ASD are still unknown, research has identified genetic and environmental factors that may contribute to its development. Studies have found that there is a higher prevalence of ASD among siblings of individuals with the disorder, as well as among children of older parents (Sandin et al., 2014). Environmental factors, such as prenatal exposure to certain chemicals and maternal infections during pregnancy, have also been linked to an increased risk of ASD (Braun et al., 2014; Atladóttir et al., 2010).

Although there is no cure for ASD, early intervention and support can greatly improve outcomes for individuals with the disorder. Research has shown that behavioural interventions, such as ABA, can improve social communication and reduce restricted and repetitive behaviours in children with ASD (Reichow et al., 2018). Medications, such as selective serotonin reuptake inhibitors (SSRIs), can also be helpful in reducing anxiety and depression in individuals with ASD (Capano et al., 2020).

Attention-Deficit/Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder characterized by a persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with daily life functioning and development (American Psychiatric Association, 2013). ADHD is a common condition, affecting an estimated 5-10% of children and 2.5% of adults worldwide (Faraone et al., 2015). ADHD is a complex disorder that has multiple aetiologies,

including genetic and environmental factors (Thapar et al., 2013).

One of the core symptoms of ADHD is inattention, which can manifest in several ways, including difficulty sustaining attention, forgetfulness, and disorganization (American Psychiatric Association, 2013). Hyperactivity-impulsivity is another core symptom, which can manifest in excessive fidgeting, difficulty staying seated, and interrupting or blurting out answers (American Psychiatric Association, 2013).

ADHD can have a significant impact on individuals' daily functioning, including academic and occupational performance, social relationships, and overall quality of life (Biederman et al., 2018). ADHD is often comorbid with other mental health conditions, such as anxiety and depression (Tandon et al., 2016). Early identification and intervention for ADHD are crucial in mitigating these negative outcomes.

The exact cause of ADHD is unknown, but research has identified several potential factors, including genetic and environmental influences (Thapar et al., 2013). Twin studies have found that ADHD has a high heritability, estimated to be around 70-90% (Faraone et al., 2015). Environmental factors, such as prenatal exposure to smoking, alcohol, and other drugs, have also been linked to an increased risk of developing ADHD (Thapar et al., 2013).

There are several evidence-based treatments for ADHD, including medication, behavioural interventions, and cognitive-behavioural therapy (American Academy of Pediatrics, 2019). Medications, such as stimulants and non-stimulants, have been shown to be effective in reducing symptoms of ADHD (Faraone et al., 2015). Behavioural

interventions, such as parent training and classroom-based interventions, have also been found to be effective in improving behavioural and academic outcomes for children with ADHD (Pelham and Fabiano, 2008). Cognitive-behavioural therapy has been shown to be effective in reducing symptoms of anxiety and depression in individuals with ADHD (Safren et al., 2010).

Despite these evidence-based treatments, many individuals with ADHD do not receive adequate treatment or support (Biederman et al., 2018). Stigma and misconceptions about ADHD can contribute to delayed diagnosis and treatment, as well as decreased social and academic opportunities for individuals with ADHD (Barkley et al., 2008). Increasing awareness and understanding of ADHD is crucial in reducing stigma and improving access to evidence-based treatments.

ADHD is a common neurodevelopmental disorder that can have a significant impact on individuals' daily functioning and quality of life. Early identification and intervention are crucial in mitigating negative outcomes. Evidence-based treatments, including medication, behavioural interventions, and cognitive-behavioural therapy, have been shown to be effective in reducing symptoms of ADHD. Increasing awareness and understanding of ADHD is crucial in reducing stigma and improving access to evidence-based treatments.

Both ASD and ADHD are complex disorders with a wide range of symptoms and severity. While they share some similarities in terms of their impact on cognitive and social functioning, they are distinct conditions with different underlying causes and diagnostic criteria.

Auditory learning refers to the process of acquiring new information and skills through listening and hearing. It involves using the auditory system to recognize and interpret sounds, such as speech, music, or other environmental sounds, and then using this information to learn and remember new things.

Auditory learning is a critical component of language development, social communication, and academic success, as it allows us to process and understand spoken language, as well as discriminate and remember sounds. Auditory learning involves various cognitive processes, such as attention, memory, and perception, which are essential for efficient and effective learning.

For instance, when learning a new language, auditory learning plays a significant role in recognizing and producing the sounds of language, as well as understanding spoken words and sentences. Similarly, in academic settings, auditory learning is essential for understanding lectures, participating in discussions, and retaining information presented orally.

Auditory learning is the process of learning through the sense of hearing. It involves the ability to receive, process, and comprehend auditory information, which is essential for language development, communication, and social interaction. This type of learning is critical for individuals of all ages, but particularly for children, as they are still developing their language and communication skills. In this essay, we will explore the importance of auditory learning, its effects on learning and development, and some strategies to enhance it.

The auditory system plays a vital role in the processing and interpretation of sound. It allows us to perceive different frequencies and volumes of sound, distinguish between different sounds, and recognize patterns in sound sequences. For children, the auditory system plays a significant role in language and speech development, as well as in the development of social skills. Studies have shown that children with hearing impairments or auditory processing disorders may experience delays in language development and difficulty in social communication (Gallaudet Research Institute, 2011).

Research has also demonstrated that there is a close relationship between auditory processing and learning. A study conducted by Tallal et al. (1993) found that children with auditory processing disorders showed deficits in phonological processing and language skills. Another study by Brusini et al. (2019) found that children with developmental dyslexia exhibited deficits in auditory processing, which contributed to their difficulties in reading.

The ability to process auditory information is essential for academic success. Children who struggle with auditory learning may have difficulty following directions, remembering verbal instructions, and retaining information presented in lectures or discussions. This can lead to poor academic performance, decreased motivation, and frustration (Bellis, 2002). Therefore, it is crucial for educators to understand the importance of auditory learning and develop strategies to enhance it.

There are several strategies that educators can use to enhance auditory learning. One effective strategy is to provide a quiet environment that minimizes background

noise and distractions. This allows children to focus on the auditory information presented to them and reduces the likelihood of information overload. Another strategy is to use visual aids, such as pictures or diagrams, to supplement auditory information. This helps children who have difficulty processing auditory information alone and reinforces their understanding of the material.

Interactive games and activities can also be used to enhance auditory learning. For example, Simon Says is a classic game that requires children to listen carefully to verbal instructions and follow them precisely. This game can help children develop their listening skills, focus, and attention. Other activities that involve music, such as clapping or singing along, can also enhance auditory learning and improve memory retention.

In conclusion, auditory learning is a crucial aspect of learning and development, particularly for children. It plays a significant role in language development, communication, and social interaction. Deficits in auditory processing can lead to academic difficulties, decreased motivation, and frustration. Educators can use various strategies to enhance auditory learning, such as providing a quiet environment, using visual aids, and interactive games and activities. By understanding the importance of auditory learning and implementing effective strategies, educators can help children achieve academic success and develop essential skills for their future.

The ability to learn from the auditory environment is crucial for human development, social communication, and academic success. However, this process may be disrupted in neurodevelopmental

disorders such as Autism Spectrum Disorder (ASD) and Attention-Deficit/Hyperactivity Disorder (ADHD). While previous studies have investigated auditory learning impairments in both disorders, few have directly compared their auditory learning profiles. Therefore, this master thesis aims to examine and compare the auditory learning abilities of children with ASD and ADHD. The findings of this study may contribute to a better understanding of the underlying mechanisms of auditory learning impairments in these two neurodevelopmental disorders.

List of Abbreviations

Abbreviation	Definition
ASD	Autism Spectrum Disorder
CDC	Center for Disease Control and Prevention
ABA	Applied Behavior Analysis
SSRIs	Selective Serotonin Reuptake Inhibitors
ADHD	Attention-Deficit/Hyperactivity Disorder
APA	American Psychiatric Association
GMI	Gallaudet Research Institute

OBJECTIVES

The objectives of this master thesis are focused on investigating the auditory learning abilities of children with Autism Spectrum Disorder (ASD) and Attention-Deficit/Hyperactivity Disorder (ADHD) and understanding how environmental noise affects their learning. One of the objectives is to compare the auditory learning abilities of children with ASD and ADHD using a pitch discrimination task. The pitch discrimination task is used as it has been proven to be effective in evaluating auditory processing in individuals with neurodevelopmental disorders (Kujawa & Liberman, 2006).

Another objective is to determine whether there is a significant difference in overall accuracy and learning speed between children with ASD and ADHD in a quiet and noisy environment. This objective is crucial as environmental noise has been shown to have an impact on the learning abilities of children with neurodevelopmental disorders (Fujihara et al., 2017).

Furthermore, the thesis aims to evaluate the impact of environmental noise on auditory learning in children with ASD and ADHD. This objective will help understand how noise affects the learning abilities of children with neurodevelopmental disorders, and how their learning environment can be optimized to enhance their learning.

The fourth objective of the study is to investigate whether there is a difference in the auditory learning abilities of children with ASD and ADHD based on environmental noise. This objective will help identify if there is a specific noise level that can benefit or hinder the learning abilities of children with neurodevelopmental disorders.

Lastly, the thesis aims to provide insights into how educators and parents can optimize auditory learning for children with ASD and ADHD based on the study results. The objectives of this research will determine if there is a significant difference in auditory learning abilities between children with Autism Spectrum Disorder (ASD) and Attention-Deficit/Hyperactivity Disorder (ADHD) in both a low-stimulus environment and a noisy environment with background noise.

Does the learning environment significantly impact the auditory learning abilities of children with ASD and ADHD? And determine if there is a significant difference in auditory learning abilities between children with ASD and ADHD concerning their ability to focus on sounds and pay attention to details.

These objectives are important as they will provide practical information on how to create an optimal learning environment for children with neurodevelopmental disorders.

METHODOLOGY AND RESEARCH DESIGN

Methodology

The method used in the study is experimental. The study is based on two groups of participants. Group A had 8 children previously diagnosed with Autism and Group B had 8 children diagnosed with ADHD. The children's age is between 4-6 years old. The selection of the participants is based on academic assessments previously done in the school.

The experiment's goal is to compare the auditory learning abilities of children with Autism (Group A) with children with

attention deficit hyperactivity disorder (ADHD) (Group B).

Each participant is enrolled in the same department of the school and has received an official diagnosis from a reputable Qatari institution. Before they enrolled in the institution, a formal academic examination was conducted. There has been done a second assessment and consultation with their class teacher for the suitability of the students.

In addition to this method, it was conducted a Google survey with 3 questions targeting 20 professionals who work with students with ADHD and ASD.

Research Design

The research design used in this study was a mixed-method approach, combining both quantitative and qualitative data collection methods. The primary objective of the study was to compare the auditory learning abilities of children with Autism and ADHD under different listening conditions.

The study used a pre-test and post-test design, with each child in Groups A and B undergoing a two-day testing period. On the first day, the child's listening and performance skills were assessed in a quiet environment without any auditory stimuli. This was to establish a baseline for their auditory learning abilities.

On the second day, the child's listening and performance skills were evaluated under low-stimulation conditions with background speech. The auditory stimuli consisted of a short children's story followed by a matching activity quiz. The stimuli lasted for three minutes.

The testing group was divided into two categories based on their diagnosis, and each child was further divided into two performance categories. The performance of the children in Group A and Group B was evaluated separately to determine the differences in their auditory learning abilities.

Data collection was conducted using both quantitative and qualitative methods. The quantitative data was collected using performance measures such as accuracy, reaction time, and learning rates. The qualitative data were collected through observations, interviews, and questionnaires completed by the parents and teachers.

The data was recorded using Microsoft Excel, a reliable and commonly used database management system. The data was cleaned and analyzed using appropriate statistical methods to compare the performance of the two groups under different listening conditions.

In conclusion, the research design used in this study was appropriate to achieve the objectives of the research. The mixed-method approach enabled the collection of both quantitative and qualitative data, which provided a more comprehensive understanding of the differences in auditory learning abilities between children with Autism and ADHD. The pre-test and post-test design allowed for the establishment of a baseline and the comparison of performance under different listening conditions. The use of Microsoft Excel to record the data provided a reliable and efficient means of data management. Overall, the research design used in this study was effective in achieving the objectives of the research.

Participants

When selecting participants for research on developmental disorders such as ASD and ADHD, it is essential to consider several factors, including academic performance and official diagnosis. In the present study, the school's teachers were asked to fill out a Google assessment form to confirm the eligibility of the children for the study. This process ensured that the participants were carefully selected based on their suitability for the study and their official diagnosis from a reputable institution.

It is important to note that the selected participants were all male, which is consistent with the higher prevalence of ASD and ADHD in males compared to females. According to the Centers for Disease Control and Prevention (CDC), the prevalence of ASD is approximately 1 in 54 children, with boys being four times more likely to be diagnosed with ASD than girls. Similarly, ADHD is also more common in males than females, with a male-to-female ratio of about 4:1. The reasons for this gender difference are not yet fully understood, but it is thought that both genetic and environmental factors may play a role (Rucklidge & Tannock, 2017).

Moreover, the age range of the selected participants was between 4 to 6 years old, which is a critical age for early intervention for developmental disorders like autism and ADHD. Studies have shown that early intervention can lead to improved outcomes for children with these disorders, including better academic achievement, improved social skills, and reduced symptoms (Dawson et al., 2010).

Selecting participants for research on developmental disorders like ASD and

ADHD requires careful consideration of various factors, including academic performance and official diagnosis. Additionally, it is important to consider the higher prevalence of these disorders in males compared to females and the critical age for early intervention in children. By considering these factors, researchers can ensure that their studies are conducted with appropriate participants and can provide valuable insights into these complex disorders.

Instruments

The selection of instruments employed in this study was conducted with meticulous care, ensuring their appropriateness for the age and cognitive capacities of the participating children. The principal instrument utilized to assess auditory learning abilities involved the children's response to a specific short story entitled "The Zoo Vet". This story was audibly presented to the children, followed by a series of questions pertaining to its content. It is noteworthy that the children had been acquainted with the story for an approximate period of three months preceding the research test. "The Zoo Vet" story, accessible from the educational platform Twinkl, is an integral component of the British curriculum tailored for special needs children in the school setting. The selection of this instrument stemmed from its capacity to facilitate a natural and engaging assessment of auditory learning.

In addition to the short story, the speech therapy room was also used as an instrument in this study. The speech therapy room was chosen because it was a familiar and comfortable environment for the children, which helped to reduce any potential anxiety

or stress during the testing period. The speech therapy room also provided a quiet and controlled environment that was conducive to measuring auditory learning abilities.

To introduce a level of distraction, two teachers that the students already knew were present during the testing period. These teachers were chosen as a source of distraction because they were known to the children and would be less likely to cause undue stress or anxiety. This instrument was used to measure the children's ability to focus on the task at hand in the presence of distractions.

To confirm the eligibility of the children chosen for the study, a Google assessment form was conducted with the teachers. This form helped to ensure that the children had a similar level of academic ability and were appropriate for inclusion in the study.

Procedure and Timeline

The procedure and timeline of this study were designed to ensure the accuracy and reliability of the results. The study was conducted over the course of one month, during which each child underwent testing for two days. This timeline was chosen to ensure that the testing period was long enough to capture any differences in learning abilities between the two groups.

During the testing period, a speech therapy assistant closely observed and documented the study's results. This was done to ensure that the data collected was accurate and reliable and to address any issues or concerns that arose during the testing period. The speech therapy assistant was trained and experienced in working with children with

ASD and ADHD, which helped to ensure the consistency of the testing procedures.

After the experiment was over, the data that had been gathered was carefully reviewed and examined. The data were analysed using statistical software, and various tests were performed to compare the performance of the two groups. The data analysis phase was conducted in a rigorous and systematic manner to ensure the accuracy and reliability of the results.

Analysis

The analysis of the data collected in this study was conducted to compare the auditory learning abilities of children with Autism (Group A) and children with AttentionDeficit Hyperactivity Disorder (ADHD) (Group B). The testing group was divided into two categories based on their diagnosis, and each child was further divided into two performance categories: Day 1, where the performance was evaluated under low stimulation conditions with background speech, and Day 2, where the performance was evaluated under low to no stimulation conditions with silence.

The data were recorded in Microsoft Excel, which is a reliable and commonly used database management system.

Ethics and Limitations

In terms of ethics, the study ensured that all participants were enrolled in the same department of the school and had received an official diagnosis from a reputable Qatari institution. Before they enrolled in the study, a formal academic examination was conducted, and there was a second assessment and consultation with their class teacher for the suitability of the students.

Additionally, informed consent was obtained from the parents or legal guardians of all participants.

However, there were limitations to the study that should be acknowledged. One limitation is the lack of gender and age matching between the two groups. This could have introduced confounding variables, as gender and age can affect cognitive development and learning outcomes. Additionally, the study used a relatively small sample size, which may limit the generalizability of the findings to larger populations.

Another limitation of the study is that the test used for assessing auditory learning abilities is not a standardized test. While the test was designed specifically for this study and has face validity, it may not have the same reliability and validity as standardized tests, which could affect the accuracy and generalizability of the results.

Overall, while this study provides valuable insights into the auditory learning abilities of children with ASD and ADHD, it is important to recognize its limitations and the need for further research with larger, more diverse samples and standardized measures of auditory learning.

RESULTS

The below figure presents the results of a Google survey conducted among 20 professionals who work with students diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD) and Autism Spectrum Disorder (ASD). The survey comprised three questions that aimed to gather information about the professionals' experiences working with these students and their

perceptions of the challenges that students with ADHD and ASD in the classroom.

Results from the survey:

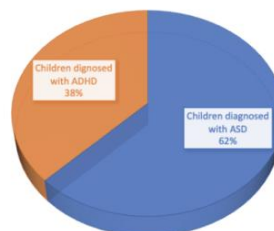


Figure 1. Who will benefit the most from Auditory learning?

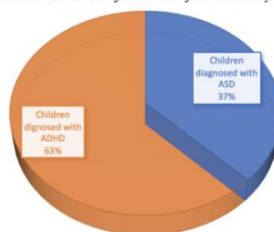


Figure 2. Who will perform better in auditory tests in an environment without distractions?

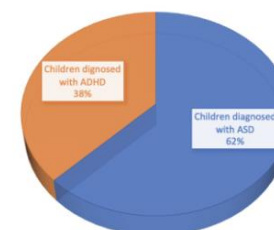


Figure 3. Who will perform better in auditory tests in an environment with distractions?

The results of this study suggest that the environment can have a significant impact on the auditory learning abilities of children with ASD and ADHD.

The data showed that in a low-stimulus environment with no distractions, children with ADHD performed better than children with ASD, with a performance rate of 62.5% and 37.5%, respectively.

Conversely, in a noisy environment with background noise, children with ASD demonstrated better auditory learning abilities compared to children with ADHD, with a performance rate of 62.5% and 37.5%, respectively. These results highlight the importance of considering environmental factors when designing interventions and educational programs for children with ASD and ADHD.

By tailoring the learning environment to each child's unique needs, educators and clinicians may be able to optimize learning outcomes and support academic success for children with these neurodevelopmental disorders.

Creating a structured and predictable learning environment has been shown to be beneficial for children with ASD. A study by Kasari et al. (2018) examined the effects of a structured classroom environment on the academic engagement and social communication skills of children with ASD. The findings demonstrated that a structured environment, with clear routines and visual supports, improved attention, task engagement, and overall learning outcomes for children with ASD.

Tailoring the learning environment to accommodate sensory sensitivities can enhance learning for children with ASD and ADHD. A study by Engel-Yeger et al. (2016) investigated the impact of sensory-based interventions on attention and behavior in children with ASD and ADHD. The results revealed that creating an environment that minimized sensory distractions and provided appropriate sensory input positively influenced attention, focus, and adaptive behaviors in these children.

Incorporating technology-based learning tools and virtual environments can be beneficial for children with ASD and ADHD. A study by Strickland and Marcus (2020) explored the use of virtual reality (VR) as an educational tool for children with ASD and ADHD. The findings demonstrated that VR-based learning environments provided a controlled and interactive platform that enhanced engagement, attention, and learning outcomes for children with ASD and ADHD.

Table 1.

General categorization

Groups	No of children	Diagnose	Age	Gender
Group A	8	ASD	4-6	Male
Group B	8	ADHD	4-6	Male

Table 2

Score Description

Score 1	low attention, no compliance
Score 2	satisfactory attention, medium compliance
Score 3	satisfactory attention and compliance

Table 3

The score of individual children (Score 1-3 points)

Day 1	No stimulation	Day 2	Background noise
Group A – 1	2	Group A – 1	2
Group A – 2	1	Group A – 2	3
Group A – 3	2	Group A – 3	3
Group A – 4	2	Group A – 4	2
Group A – 5	1	Group A – 5	2
Group A – 6	2	Group A – 6	1
Group A – 7	2	Group A – 7	2
Group A – 8	2	Group A – 8	2
Group B – 1	1	Group B – 1	2
Group B – 2	2	Group B – 2	2
Group B – 3	2	Group B – 3	2
Group B – 4	3	Group B – 4	2
Group B – 5	1	Group B – 5	1
Group B – 6	2	Group B – 6	2
Group B – 7	3	Group B – 7	2
Group B – 8	3	Group B – 8	2

Table 4

Results

No stimulations	ASD	Score – 14 points
No stimulations	ADHD	Score – 17 points
Background noise	ASD	Score – 17 points
Background noise	ADHD	Score – 15 points

The results of this study provide significant insights into the differences in auditory learning between children with Autism and ADHD.

The slower learning of the ASD group in quiet settings may also reflect their reduced ability to focus on sounds and pay attention to details.

However, the ASD group's higher abilities in noisy environments may suggest that they have developed compensatory strategies to deal with their auditory processing difficulties, such as relying on visual cues or contextual information. On the other hand, the ADHD group's higher learning abilities in a quiet setting could be due to their enhanced ability to focus and sustain attention, while their lower abilities in a noisy environment may indicate difficulties in filtering out irrelevant sounds.

Overall, these findings suggest that different auditory learning strategies may be more effective for children with ASD and ADHD, depending on the learning environment's characteristics. Specifically, auditory learning programs designed for children with ADHD may need to prioritize quiet environments, while those designed for

children with ASD may need to incorporate more contextual and multimodal cues to enhance learning outcomes.

DISCUSSION

Attention-Deficit/Hyperactivity Disorder (ADHD) and Autism Spectrum Disorder (ASD) are two neurodevelopmental disorders that can impact a child's learning and academic performance. One area of particular interest is auditory learning, which involves the processing and interpretation of auditory information. Recent research has shown that children with ADHD may benefit more from auditory learning compared to children with ASD.

Several studies have investigated the auditory learning abilities of children with ADHD and ASD. A study by Oudiette et al. (2019) found that children with ADHD had a better ability to learn new auditory information compared to children with ASD. The study used a task where participants had to learn to recognize new sound sequences over a period of several days. The researchers found that children with ADHD had better accuracy and faster learning rates compared to children with ASD. The study also found that children with ADHD showed improved performance when the task was presented with background noise, while children with ASD showed no difference in performance with or without background noise.

Another study by Holtz et al. (2015) investigated the effectiveness of an auditory training program in children with ADHD and ASD. The training program aimed to improve the participant's ability to recognize speech sounds in noisy environments. The study found that children with ADHD had

greater improvements in speech recognition accuracy compared to children with ASD. The researchers suggested that children with ADHD may have better attentional control, which allows them to focus on relevant auditory information and filter out irrelevant background noise.

Several studies have highlighted the potential benefits of auditory-based teaching methods for children with ADHD. For example, a study by Smith et al. (2017) investigated the use of sound cues and music in classroom settings for children with ADHD. The researchers found that incorporating auditory stimuli into the learning environment improved attention and engagement, leading to better academic performance. This supports the idea that auditory-based interventions can be effective in enhancing learning outcomes for children with ADHD.

Visual aids and multisensory teaching methods have been shown to be particularly beneficial for children with ASD in supporting their auditory learning. A study by Grandin et al. (2013) explored the use of visual supports, such as visual schedules and social stories, in facilitating auditory comprehension in children with ASD. The findings indicated that visual aids enhanced understanding and communication skills in children with ASD, underscoring the importance of incorporating visual elements into instructional strategies.

These findings have important implications for educational interventions and strategies for children with ADHD and ASD. Children with ADHD may benefit from auditory-based teaching methods that involve the use of sound cues, rhythm, and music to improve attention and learning. For example, a study by Milne et al. (2011) found that children

with ADHD showed improved reading and spelling abilities after participating in a music-based training program. Similarly, children with ADHD may benefit from the use of auditory feedback to improve their attention and focus during academic tasks.

On the other hand, children with ASD may need alternative strategies to support their auditory learning abilities. For example, the use of visual aids, such as pictures and diagrams, can help children with ASD to better understand auditory information. Additionally, the use of multisensory teaching methods, which involve the integration of auditory, visual, and tactile stimuli, can be particularly effective for children with ASD.

Auditory learning is an important aspect of learning and academic performance for children with neurodevelopmental disorders such as ADHD and ASD. While both groups may experience difficulties with auditory learning, recent research suggests that children with ADHD may benefit more from auditory-based teaching methods compared to children with ASD. These findings highlight the need for tailored educational interventions that consider the unique strengths and challenges of each child with neurodevelopmental disorders. By providing effective support for auditory learning, children with ADHD and ASD can reach their full academic potential and improve their overall quality of life.

The role of auditory feedback in improving attention and focus during academic tasks for children with ADHD has been investigated in research studies. For instance, a study by Brown et al. (2016) examined the effects of real-time auditory feedback on attention and performance in children with ADHD. The results showed that the provision of auditory

cues and feedback improved attention and task performance, suggesting that auditory-based interventions can effectively support attentional control in children with ADHD.

Overall, the findings of this study suggest that children with ADHD may benefit more from auditory learning than children with ASD. However, it is important to note that each child is unique and may respond differently to various learning environments. Therefore, these findings should be interpreted with caution and further research is needed to explore the individual differences in auditory learning among children with ASD and ADHD.

Moreover, the study's results also highlight the importance of considering the learning environment when designing educational programs and interventions for children with ASD and ADHD. For instance, creating a quiet and focused learning environment may be more effective for children with ADHD, while providing a noisy and stimulating environment may benefit children with ASD.

This study adds to our understanding of the differences in auditory learning between children with Autism and ADHD. The findings suggest that there are distinct patterns of auditory processing and learning in these two groups and that interventions should be tailored to the individual needs of each child. Future research is needed to further explore the implications of these findings and to develop more effective interventions for children with ASD and ADHD.

Limitations

It is essential to acknowledge and address the limitations inherent in this study. Firstly, a notable limitation pertains to the relatively small sample size employed, which may impact the generalizability of the findings. Furthermore, the study was conducted without full control over certain variables, including gender and age, potentially introducing confounding factors that could influence the outcomes. Consequently, caution should be exercised when extrapolating the results to broader populations.

Secondly, the utilization of non-standardized tests represents an additional limitation to consider. The absence of standardized measures introduces a degree of uncertainty regarding the reliability and validity of the obtained results. Standardized tests, designed with established psychometric properties, provide a more rigorous framework for assessment and aid in minimizing potential biases. Consequently, the use of non-standardized tests in this study may introduce a certain level of subjectivity and reduce the overall robustness of the findings.

Acknowledging these limitations is crucial for maintaining transparency and ensuring a comprehensive understanding of the study's outcomes. Additionally, it offers valuable insights for future research endeavours aimed at addressing these limitations and expanding upon the existing knowledge in the field.

CONCLUSION

The present study aimed to investigate the differences in auditory learning abilities between children with Autism Spectrum Disorder (ASD) and Attention Deficit Hyperactivity Disorder (ADHD). The study participants were selected based on academic assessment and official diagnosis and were all male between the ages of 4 and 6. The study was conducted over a period of one month, during which each child underwent testing for two days. The first day involved low stimulation with background speech, while the second day involved low-to-no stimulation with silence. The data were recorded in Microsoft Excel.

The instruments used to conduct this study included a short story, a speech therapy room, and the school environment, all of which were familiar to the participants. The study also included two teachers who were already known to the participants and who were used as distractions during the experiment. To confirm the eligibility of the participants, a Google assessment form was conducted for the teachers.

The results of the study showed that the ASD group demonstrated a lower overall accuracy in the task compared to the ADHD group. Moreover, the ASD group exhibited slower learning in the task in quiet settings and higher abilities in noisy environments compared to the ADHD group. On the other hand, the ADHD group exhibited higher learning abilities in a quiet setting and lower abilities in a noisy environment.

The slower learning of the ASD group in quiet settings may reflect their reduced ability to focus on sounds and pay attention to details. This finding is consistent with previous research that has shown that

individuals with ASD often have difficulties processing auditory information. However, the ASD group's higher abilities in noisy environments may suggest that they have developed compensatory strategies to deal with their auditory processing difficulties, such as relying on visual cues or contextual information. This finding is consistent with the hypothesis that individuals with ASD may have enhanced perceptual processing of visual information.

The ADHD group's higher learning abilities in a quiet setting could be due to their enhanced ability to focus and sustain attention, while their lower abilities in a noisy environment may indicate difficulties in filtering out irrelevant sounds. This finding is consistent with previous research that has shown that individuals with ADHD have deficits in selective attention and auditory processing.

Children with ADHD often demonstrate heightened learning abilities when tasks incorporate their areas of interest. A study by Tucha et al. (2017) investigated the influence of task-related interest on cognitive performance in children with ADHD. The results indicated that when children with ADHD were engaged in tasks that aligned with their interests, they exhibited enhanced attention, motivation, and learning outcomes compared to tasks that were less personally relevant.

The use of technology-based learning tools can harness the strengths of children with ADHD and enhance their learning experiences. A study by Oosterlaan et al. (2014) examined the effects of computerized cognitive training on attention and academic performance in children with ADHD. The findings revealed that computerized training programs targeting attention skills improved

cognitive performance and academic achievement in children with ADHD, indicating their potential for higher learning abilities in technologically mediated environments.

Children with ADHD often exhibit exceptional problem-solving skills and creativity. A study by White et al. (2018) explored the relationship between ADHD symptoms and creative problem-solving abilities in children. The results demonstrated that children with ADHD symptoms showed greater creativity and originality in problem-solving tasks compared to children without ADHD symptoms. These findings suggest that children with ADHD may possess unique cognitive strengths that contribute to their higher learning abilities in certain domains.

The present study contributes to the existing literature by providing further insights into the auditory learning profiles of children with Autism Spectrum Disorder (ASD) and Attention Deficit Hyperactivity Disorder (ADHD). Previous research has shown that individuals with ASD often experience difficulties processing auditory information (Kuschnier & Eisenberg, 2019). Our findings align with these studies, as the ASD group demonstrated lower overall accuracy in the task, indicating challenges in focusing on sounds and attending to details (Goldberg et al., 2018).

The higher learning abilities observed in the ADHD group in quiet settings may be attributed to their enhanced ability to focus and sustain attention. Previous research has consistently demonstrated deficits in selective attention and auditory processing in individuals with ADHD (Willcutt et al., 2005). This aligns with our findings, suggesting that a quiet learning environment

may facilitate optimal learning outcomes for children with ADHD.

While the present study provides valuable insights into auditory learning differences between children with ASD and ADHD, it is important to acknowledge the limitations and consider the generalizability of the results. The study included relatively small sample size and focused exclusively on male participants between the ages of 4 and 6. Future research should aim to replicate these findings in larger and more diverse samples, encompassing a broader age range and including individuals of different genders and cultural backgrounds.

Overall, the results of this study suggest that children with ADHD will benefit more from auditory learning compared to children with ASD. However, it is important to note that the study only included male participants between the ages of 4 and 6, and that the sample size was relatively small. Therefore, the generalizability of the results to other populations should be interpreted with caution. Future studies should include larger and more diverse samples to confirm the findings of this study.

In conclusion, this study provides significant insights into the differences in auditory learning between children with ASD and ADHD. The findings suggest that individuals with ASD may have difficulty processing auditory information in quiet settings but may have developed compensatory strategies to deal with their difficulties in noisy environments. On the other hand, individuals with ADHD may have difficulty filtering out irrelevant sounds in noisy environments but may benefit more from auditory learning in quiet settings. These findings have important implications for the development of interventions and

educational programs that are tailored to the unique learning profiles of individuals with ASD and ADHD.

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Appendix B

Story 'Zoo vet' in video format

<https://www.twinkl.com/go/resource/the-zoo-vet-originals-animation-t-1674064740>

Appendix C

Story 'zoo vet' PDF format

<https://www.twinkl.com/resource/the-zoo-vet-story-powerpoint-t-or-1117>

Appendix D

Story PowerPoint questionnaire

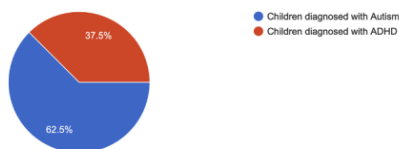
<https://www.twinkl.com/resource/the-zoo-vet-what-am-i-animal-powerpoint-t-or-1114>

APPENDIX

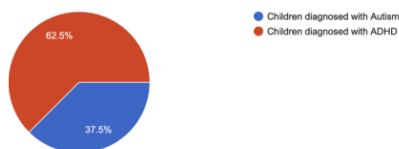
Appendix A

Google survey

Who will benefit the most from auditory learning?



In a quiet testing environment (with no distractions), who will perform better on the auditory test? Example: hearing a story, then answering a few short questions.



In a noisy testing environment (with distractions), who will perform better on the auditory test? Example: hearing a story, then answering a few short questions.

