

Comparison of Processing Speed between Children with Autism and Intellectual Disability

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Abstract

This study compares the processing speed of children with Autism Spectrum Disorder (ASD) and Intellectual Disability (ID) to examine cognitive differences between these two developmental conditions. Processing speed, a key cognitive function, is crucial for academic performance and daily functioning, yet it is often impaired in children with ASD and ID. The findings reveal that children with intellectual disabilities exhibit slower processing speeds compared to their peers with autism. These differences may be attributed to underlying cognitive and neurodevelopmental factors, such as deficits in working memory, attention, and executive functioning, which are more pronounced in children with ID. Additionally, the study highlights how processing speed deficits in children with ID can negatively affect academic and social outcomes.

Keywords: Autism Spectrum Disorder; Intellectual Disability; Processing Speed

Introduction

Autism Spectrum Disorder (ASD) is clinically characterized by abnormalities in complex behaviors, which are currently classified under two main criteria: persistent deficits in social communication and interaction, and restricted, repetitive patterns of behavior, interests, or activities (DSM-5). Extensive research has identified impairments in higher-order abilities across all neuropsychological domains associated with ASD including in individuals with higher intellectual abilities. These impairments encompass deficits in emotion perception and regulation), perspective-taking, pragmatic language, language comprehension, concept formation, cognitive flexibility, face perception, as well as self-regulation and motor. These impairments have been widely replicated. The documentation of deficits in complex cognitive and motor functions has led researchers to explore potential common cognitive mechanisms that may underlie one or more of these challenges. One potential mechanism that could explain the diverse profile of neuropsychological deficits observed in autism spectrum disorder (ASD) is a fundamental impairment in the speed at which affected individuals process information. ASD is frequently confounded with intellectual disability (ID), leading to some ambiguity regarding the extent to which ID contributes

to processing speed deficits. This overlap makes it challenging to isolate the specific role that ASD-related cognitive impairments play in slowing information processing, as the effects of intellectual disability may compound or influence these deficits [1].

The processing speed of children with neurodevelopmental disorders, including Autism Spectrum Disorder (ASD) and Intellectual Disability (ID), has been a central topic of research in both clinical and educational settings. Processing speed is a key cognitive function that impacts various areas of daily life, such as academic achievement, problem-solving skills, and social interactions. Although there is substantial research on cognitive differences in children with ASD and ID, more direct comparisons are needed to gain a deeper understanding of the unique challenges faced by these groups. In particular, processing speed delays in children with autism have been associated with difficulties in tasks that require rapid responses, such as timed cognitive assessments [2,3]. Similarly, Individuals with intellectual disability often experience deficits in processing speed, which can impact various aspects of cognitive functioning and mental processes. The rate at which information is processed is a crucial element of cognitive abilities and plays

a significant role in the performance of many mental tasks. Slower information processing speed can lead to functional impairments that disrupt overall brain function [4]. Children with Autism Spectrum Disorder (ASD) often face considerable challenges in processing speed, especially in tasks that demand quick motor responses, the ability to shift attention, and the integration of sensory information. Studies have shown that these children frequently exhibit delayed processing times in both verbal and non-verbal tasks [5]. Moreover, the processing difficulties observed in children with ASD may be linked to broader challenges in executive functioning, which includes tasks like planning, attention control, and cognitive flexibility. For example, children with ASD may take longer to complete tasks that involve multiple steps or need additional time to process and respond to social interactions [6].

On the other hand, Intellectual impairment or disability is a condition marked by reduced cognitive abilities, leading to challenges in performing daily activities and acquiring new information. Individuals with intellectual disability often need more time and support to learn, and education plays a critical role in diagnosing this condition and identifying cognitive challenges in children [7, Mafuba, 2023]. According to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, Text Revision [DSM-5-TR, 15], the global prevalence of intellectual disability is estimated to be around 10 per 1,000 people. Children with Intellectual Disability (ID) often experience generalized delays in processing speed that affect a wide range of cognitive domains. Intellectual disability is defined by limitations in both intellectual functioning (IQ below 70) and adaptive behavior, which can impact daily life skills such as communication, self-care, and socialization. Unlike Autism Spectrum Disorder (ASD), which mainly affects social cognition and executive functioning, ID is characterized by more global cognitive delays that influence multiple aspects of processing, including memory, attention, and problem-solving abilities [8]. Research indicates that children with ID, especially those with moderate to severe impairments, tend to process information more slowly across both verbal and non-verbal tasks. For instance, tasks requiring verbal fluency, visual-spatial processing, and even simple arithmetic often take longer for children with ID to complete, even when compared to peers of similar age and IQ levels (Boat, 2015). This slower processing speed in children with ID is commonly linked to broader cognitive limitations, including reduced working memory capacity and slower processing of both sensory and conceptual information. Researchers agree that while information processing speed may not be the primary factor in diagnosing intellectual disability, it is a crucial executive function that tends to develop with age. The speed at which individuals with intellectual disability process information can profoundly affect their performance on neuropsychological tasks and other executive functions [16]. Studies have suggested that deficits in information processing speed can have a significant impact on children's language, verbal, and mathematical skills, leading to challenges in reading, learning, and understanding words (Terrell, 2014).

Comparing processing speed in children with autism spectrum disorder (ASD) and intellectual disability (ID) is essential for understanding the unique needs of each group and for developing effective intervention strategies. Although both populations experience challenges with processing speed, the underlying causes of these difficulties often differ. In ASD, processing

speed deficits are frequently associated with sensory processing issues and difficulties in social cognition, while in ID, impairments in processing speed are more likely to result from global cognitive delays (Pennington et al., 2003). These differences suggest that interventions should be specifically tailored to the cognitive profiles of each group. For children with ASD, interventions may focus on enhancing sensory processing and executive function, with an emphasis on helping them process both social and non-social information more efficiently. In contrast, interventions for children with ID might concentrate on fostering general cognitive development, improving working memory, and enhancing attention to help boost processing speed across a range of tasks (Fowler et al., 2012).

While research into the processing speed deficits in children with Autism Spectrum Disorder (ASD) and Intellectual Disability (ID) has made significant strides, several gaps remain in understanding the underlying mechanisms and effective interventions. One key limitation is the variability of findings across studies. Some studies suggest that children with ASD or ID have significantly slower processing speeds compared to typically developing peers, while others report more nuanced or inconsistent results. These inconsistencies may be due to differences in sample size, age groups, cognitive assessment methods, and the severity of the disabilities, pointing to the need for more standardized and robust research methodologies. Furthermore, most existing studies focus on specific domains of cognitive processing, such as attention or memory, rather than investigating processing speed in a comprehensive manner. This lack of a holistic approach limits our understanding of how processing speed deficits interact with other cognitive difficulties, such as executive function or social cognition, which are particularly prominent in children with ASD. Additionally, many studies have primarily concentrated on children with ADHD or other neurodevelopmental disorders, making it challenging to generalize findings to the ASD and ID populations. This article aims to explore and compare the processing speed of children with ASD and ID, drawing on recent studies to highlight similarities and differences between these groups. Understanding the nuances of processing speed in these populations is essential for developing more effective diagnostic criteria and intervention strategies. By examining both shared and distinct cognitive challenges, researchers and clinicians can tailor their approaches to better address the specific needs of children with ASD and ID, ultimately improving their educational and developmental outcomes.

Method

Participants

The study population consisted of all 7- to 14- years old ($M=11.65$, $SD=1.835$) children with intellectual disability enrolled in special primary schools in Urmia city. In total, 66 individuals participated in this study. The inclusion criteria required participants to have a diagnosis of autism and intellectual disability, be between the ages of 7 and 14 years, and possess the ability to read and write. Exclusion criteria included the presence of other psychological disorders, current use of any medications or treatments, and a history of seizures or epilepsy.

Procedure

After obtaining the necessary permissions from the Education Department and the Exceptional Education Organization to access special schools in Urmia city, the research topic and objectives were communicated to the management staff of the

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Table 1: Group Statistics.

Group	N	Mean	Std. Deviation	Std. Error Mean	
Pre.Trail.A	Intellectual	36	211.69	56.024	9.337
Autism	30	174.13	62.807	11.467	

Table 2. T-test.

t-test for Equality of Means						
t	df	P- value	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
					Lower	Upper
2.567	64	0.013	37.561	14.633	8.328	66.794

schools. Subsequently, the study was discussed with the parents of the children, and 66 parents from various schools and centers expressed their willingness to participate. As a result, a processing speed assessment test was administered to these children.

Measures

TMT test is a test for assessing mental health. TMT consists of two sections: TMT-A, which evaluates attention, processing speed and TMT-B, which is typically used to assess cognitive flexibility. In TMT- A, participants are required to connect 25 numbers, from 1 to 25, sequentially in ascending order. In TMT-B, participants must alternate between connecting numbers and letters in an alternating sequence (1-A-2-B, etc.). In this research, only Part A of the test was administered, as it specifically measures processing speed. The TMT has been widely used for individuals aged between 8 and 90 years. Its reliability has been confirmed in numerous studies. Metrazzo et al. (1974) found a test-retest reliability of 0.78, while Goldstein and Watson (1989) reported a reliability of 0.86. The validity of the TMT has also been established through comparisons with other neuropsychological tests. Odannell et al. (1994) compared the TMT with other tests, such as CAT, Wisconsin regulation (WCST), speed hearing disorder (PASAT), and visual search and attention tests. (VSAT), and found moderate to strong correlations between TMT and other measures (CAT r = 0.38; WCST r = 0,31; PASAT r =0.44; VAST r =0.30) [9]. In the context of the study on tDCS and processing speed, TMT was chosen as the assessment tool for processing speed despite not being previously used in this population but the rationale for selecting TMT was based on several factors: clinical relevance: the TMT is widely used to assess cognitive function, particularly in the domains of executive function and visual- spatial processing. These domains are particularly relevant to understanding information processing speed in individuals with intellectual disabilities. Appropriate for children: the TMT has been validated for use in children as young as 8 years old, making it an appropriate choice for assessing processing speed in the target population of the study. Practical considerations: the TMT is easy to administer, relatively quick to complete and requires minimal training to administer.

Statistical analyses

All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS, IBM) Version 22. Before conducting the independent-samples T-test, several assumptions were tested to ensure the data met the necessary conditions. These assumptions included normality of the data distribution (assessed using the Kolmogorov-Smirnov test), homogeneity of variances (assessed using Levene's test), and the independence of observations. All assumptions were confirmed, indicating that the data were suitable for analysis us-

ing the independent-samples T-test. The independent-samples T-test was selected for this study because it allows for the comparison of the means of two independent groups on a single dependent variable. This is a widely used test when comparing two groups to assess if there is a statistically significant difference between them.

As shown in **Tables 1 and 2**, since the significance value is less than 0.05, it indicates a significant difference between the two groups. Additionally, as indicated in Table 1, the average scores of children with intellectual disabilities are higher compared to the scores of children with autism.

Discussion

In recent years, several studies have examined the cognitive differences and similarities between children with various developmental disorders. One of the key cognitive factors that can significantly influence learning and social functioning in children is processing speed. In this article, a comparison was made between processing speed in children with Autism Spectrum Disorder (ASD) and those with Intellectual Disability (ID). The results revealed significant differences, showing that children with intellectual disabilities have slower processing speed compared to their peers with autism.

Processing speed refers to the ability to quickly and efficiently encode, process, and respond to information. This cognitive function plays a critical role in an individual's ability to perform everyday tasks, solve problems, and process environmental stimuli. In children with developmental disabilities such as autism and intellectual disability, difficulties in processing speed are commonly observed and can directly impact academic performance and social interactions [10,11]. While children with autism often face challenges related to social processing and attention, children with intellectual disabilities typically experience more generalized difficulties in cognitive processing [12].

The findings of this study suggest that children with intellectual disabilities consistently exhibit slower processing speeds compared to children with autism. This may be due to the fact that children with ID often have significant impairments in core cognitive functions, such as working memory, attention, and reasoning, which are foundational for processing information efficiently [13]. In contrast, children with autism may exhibit stronger cognitive abilities in certain areas (e.g., rote memory or attention to detail), which may mitigate some of the processing speed deficits seen in children with ID [16].

Several factors could contribute to the slower processing speed observed in children with intellectual disabilities. One key factor may be structural and functional brain differences that are

commonly associated with intellectual disabilities. Neuroimaging studies have indicated that children with ID often show abnormalities in brain development, particularly in areas that govern cognitive functions such as attention, memory, and motor control, which can result in delayed cognitive processing [14]. These brain differences might lead to inefficiencies in how the brain processes information, further slowing down cognitive performance.

The impact of slowed processing speed in children with intellectual disabilities is far-reaching. In academic settings, these children may struggle to keep pace with the rapid flow of information in the classroom. Tasks requiring quick cognitive processing, such as reading comprehension, problem-solving, and memory recall, may become overwhelming, resulting in lower academic performance and heightened frustration. These challenges may lead to decreased self-esteem and greater anxiety about their abilities, contributing to further academic underachievement [7].

When compared to children with intellectual disabilities, children with autism may display unique cognitive profiles. While children with autism often face challenges in social processing, attention, and flexibility, they may demonstrate higher performance in certain specific areas of cognitive functioning, such as rote memory or attention to detail. This can sometimes result in less pronounced deficits in processing speed, particularly when tasks involve processing specialized information. However, the findings of this study emphasize that, on the whole, children with intellectual disabilities exhibit slower processing speeds compared to children with autism. This difference is likely related to the varying nature of the cognitive impairments seen in each group. While children with autism may struggle with social processing and attention, children with ID tend to have more generalized deficits in fundamental cognitive functions, such as memory and reasoning, which contribute to their overall slower processing speed [11].

This study on processing speed in children with autism and intellectual disabilities has several limitations that must be considered when interpreting the findings. First, the small sample size restricts the ability to generalize the results to a broader population, and future research should involve larger, more diverse groups to improve external validity. The reliance on a single measure of processing speed, such as the Trail Making Test, is another limitation, as it may not capture all aspects of processing speed, and future studies should include multiple tasks for a more comprehensive assessment. Furthermore, the study also did not explore whether interventions aimed at improving processing speed could help address the differences observed between the two groups. Moreover, cultural and environmental factors, such as socioeconomic status, were not considered, though they could play a significant role in cognitive development. Lastly, the focus on processing speed alone is limiting, and future research should consider other cognitive domains like executive functioning and working memory to offer a more holistic view of cognitive performance in these populations. Addressing these limitations will help refine the understanding of processing speed deficits in children with autism and intellectual disabilities and guide more effective interventions.

Future research should aim to identify the neural correlates of processing speed deficits in children with intellectual disabili-

ties using neuroimaging techniques. This will provide a more comprehensive understanding of the brain regions involved and how these deficits develop over time. Furthermore, research could explore the effectiveness of combined interventions, such as cognitive training alongside behavioral therapy or physical activity, in improving processing speed in children with ID.

Moreover, longitudinal studies are needed to explore how processing speed deficits evolve over time and whether interventions have lasting benefits into adolescence and adulthood. Research into individualized approaches tailored to specific cognitive profiles of children with intellectual disabilities will be crucial in developing more effective treatment plans.

Conclusion

The results of this study suggest that slowed processing speed in children with intellectual disabilities has significant implications for their academic performance, social interactions, and overall functioning. The findings underline the importance of early diagnosis and targeted interventions aimed at improving cognitive functioning in these children. Interventions such as specialized teaching methods, cognitive training programs, and classroom accommodations (e.g., extended time for tasks) could help mitigate the negative effects of low processing speed.

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