Comparative Visual Perception Patterns in Autism Spectrum Disorder and Mild Intellectual Disability: A Cross-Sectional Study

Сравнительные паттерны зрительного восприятия при расстройстве аутистического спектра и легкой степени умственной отсталости: поперечное исследование

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Original research

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ABSTRACT

BACKGROUND: Visual perception plays a crucial role in cognitive and behavioral development. Individuals with autism spectrum disorder (ASD) and mild intellectual disability (ID) exhibit distinct patterns of visual processing that influence their learning and interaction with the environment.

AIM: This study aims to compare the visual perception abilities of children with ASD and those with mild ID.

METHODS: This study employed an experimental comparative design. The Bender Visual-Motor Gestalt Test was administered to assess visual-motor integration, perceptual organization, and spatial processing abilities. It was scored based on standard qualitative and quantitative criteria. Group comparisons were conducted using descriptive statistics and cross-group performance patterns.

RESULTS: A total of 15 children (8 with ASD and 7 with mild ID), aged between 7 to 12 years, participated in the study. Children with ASD demonstrated superior spatial organization and attention to local details, whereas children with mild ID demonstrated significant difficulties in perceptual coherence, spatial alignment, and motor coordination.

CONCLUSION: The study highlights the importance of developing tailored intervention strategies that address the distinct perceptual processing styles associated with ASD and mild ID. However, limitations such as a lack of detailed diagnostic criteria, absence of symptom severity differentiation, and failure to control for developmental age must be considered when interpreting the findings. Future research should aim to overcome these limitations by including standardized diagnostic measures, creating a larger and more diverse sample, and involving additional assessment tools for a more comprehensive analysis.

АННОТАЦИЯ

ВВЕДЕНИЕ: Зрительное восприятие играет важнейшую роль в развитии когнитивных и поведенческих функций. У людей с расстройствами аутистического спектра (РАС) и легкой степенью умственной отсталости (УО) отмечаются различные паттерны обработки зрительной информации, которые влияют на их обучение и взаимодействие с окружающей средой.

ЦЕЛЬ: Целью настоящего исследования является сравнение способностей к зрительному восприятию у детей с РАС и детей с легкой степенью УО.

МЕТОДЫ: Исследование имело экспериментальный сравнительный дизайн. Для оценки зрительно-моторной интеграции, перцептивной организации и способности к пространственной обработке проводили зрительно-моторный гештальт-тест Бендер. Он подразумевал оценку в баллах по стандартным качественным и количественным критериям. Группы сравнивали с использованием описательной статистики и межгрупповых паттернов выполнения теста.

РЕЗУЛЬТАТЫ: В исследовании приняли участие 15 детей (8 детей с РАС и 7 детей с легкой степенью УО) в возрасте от 7 до 12 лет. У детей с РАС отмечались лучшие пространственная организация и внимание к локальным деталям, в то время как у детей с легкой степенью УО наблюдались значительные трудности в восприятии, пространственном расположении и координации движений.

ЗАКЛЮЧЕНИЕ: Исследование подчеркивает важность разработки индивидуальных стратегий вмешательства, направленных на различные стили перцептивной обработки, связанные с РАС и легкой степенью УО. Однако при интерпретации полученных результатов следует учитывать такие ограничения, как отсутствие подробных диагностических критериев, отсутствие дифференциации тяжести симптомов и отсутствие контроля возраста развития. Дальнейшие исследования должны быть направлены на преодоление этих ограничений путем включения стандартизированных диагностических мер, более крупной и разнообразной выборки, а также дополнительных инструментов оценки для более полного анализа.

Keywords: *visual perception; autism spectrum disorder; intellectual disability; Bender-Gestalt test; visual-motor integration*
Ключевые слова: *зрительное восприятие; расстройство аутистического спектра; умственная отсталость; Бендер-тест; зрительно-моторная интеграция*

INTRODUCTION

Autism spectrum disorder (ASD) is a neurodevelopmental condition characterized by difficulty in social communication and interaction, along with restricted and repetitive patterns of behavior, interests, or activities. These features often include atypical sensory responses, such as hypersensitivity or hyposensitivity to environmental stimuli[1]. Intellectual disability (ID), another neurodevelopmental disorder, is defined by significantly impaired intellectual functioning (IQ[2]<70) and deficits in at least two areas of adaptive behavior that affect daily life[3,4] [1]. ID is frequently reported as a common, co-occurring condition in individuals with ASD. The co-occurrence rate of ASD and ID was estimated to be as high as 69% in the 1980s [2]; however, with refined diagnostic criteria, this figure has dropped to approximately 30% [3]. The overlap between these two conditions complicates both diagnosis and intervention planning. A study conducted

[1] National Health Service England. Enhanced SECURE STAIRS team: COVID-19 guide — Autism Spectrum Condition (ASC) [Internet]. Redditch: NHS; 2020 [cited 2025 June 5]. Available from: https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/04/C0447-autism-spectrum-condition-guidance-june-2020.pdf

[2] IQ stands for Intelligence Quotient. It is a score derived from standardized tests designed to measure a person's cognitive abilities, in relation to the average performance of others in the same age group. Average IQ is set at 100. Most people (about 68%) score between 85 and 115.

[3] Rosa's Law: A Rule by the Education Departament. Federal Register [Internet]. 2017[cited 2025 June 12];82(113):31910–31913. Available from: https://www.federalregister.gov/documents/2017/07/11/2017-14343/rosas-law

[4] Ansberry C. Erasing a Hurtful Label From the Books: Decades-long quest by disabilities advocates finally persuades state, federal governments to end official use of retarded. The Wall Street Journal [Internet]. 2010[cited 2025 June 12];4(1):1–23. Available from: http://www.wsj.com/articles/SB10001424052748704865104575588273153838564

in 2016 identified ID (75.83%) and epilepsy (72.50%) as the primary comorbidities associated with ASD [4]. Although ASD and ID can co-occur, they are distinct conditions. A diagnosis of ASD typically meets the criteria outlined in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), which emphasizes deficit in social communication and restricted behaviors [5]. ID, on the other hand, is diagnosed based on standardized IQ assessments and measures of adaptive behavior [6]. Given the substantial variation in cognitive ability among individuals with ASD, it is crucial for studies comparing ASD and ID to clearly determine whether participants exhibit overlapping or distinct cognitive pattern.

Visual perception, the ability to interpret and organize visual stimuli, is fundamental to learning and everyday ability to function[5]. While, typically, developing children fine-tune their visual perception skills as they grow, children with neurodevelopmental disorders often show delays or impairment in this domain [7]. The prevalence of visual impairment in the general population is estimated to stand at 0.5–2%, but it is at least 8.5 times higher in individuals with ID [8]. Moreover, children with ASD are significantly more likely to display ocular comorbidities, with studies reporting higher rates of strabismus (22–57%), amblyopia (19–31%), optic neuropathy (4%), and nystagmus (3%) [9, 10]. These conditions suggest that the visual deficits in ASD and ID may stem from both neurological and ophthalmological factors.

Gestalt psychology provides a framework for understanding how individuals holistically process visual information [11]. The Gestalt Principles of Perceptual Organization describe how people tend to group visual elements into structured patterns rather than process them as isolated occurrences[6]. These principles — including similarity, continuation, closure, proximity, figure/ground distinction, symmetry, and common region — are critical in higher order visual processing and may be diminished in individuals with neurodevelopmental disorders. Prior research indicates that children with ID often exhibit a fragmented and inconsistent perception of visual stimuli, making it difficult for them to identify key features, recognize relationships between objects, and interpret complex visual scenes [12, 13]. These difficulties are exacerbated when the visual input is novel or contains multiple elements, as individuals with ID tend to focus on isolated details rather than the overall encounter [14–16]. Additionally, physiological incongruities in the visual system of children with ID can lead to problems with spatial orientation, depth perception, and contrast sensitivity [17, 18]. Children with ASD, on the other hand, often exhibit abnormalities in visual exploration, fixation patterns, and spatial perception [19, 20]. These issues can interfere with social interactions, as individuals with ASD may struggle to interpret facial expressions, track moving objects, or disengage attention when necessary [21]. Additional studies have identified deficits in visual orientation [22], continuous visual exploration [23], and spatial perception [24, 25], which may contribute to difficulties in reading, handwriting, and overall spatial awareness [26].

Visual perception is recognized as a fundamental sensory function essential for learning [27], and deficit in this domain can have far-reaching consequences for both academic performance and daily functioning. Evidence from neuroimaging studies suggests that individuals with ASD process visual stimuli differently at the basic level of visual-perceptual processing, contributing to atypical patterns of perception and interaction [28]. Nonetheless, some individuals with ASD demonstrate certain strengths in processing visual details and artistic expression. Research shows that individuals with ASD may excel in local visual processing but struggle with global integration. According to the Weak Central Coherence theory, individuals with ASD tend to focus on details rather than discern holistic patterns [29–31]. While this perceptual peculiarity can be welcome when dealing with tasks requiring detailed recognition, it may hinder real-world ability to adapt, such as when interpreting facial expressions or navigating complex visual scenes [32, 33]. Children with ID also face challenges with visual perception, particularly with visual-motor coordination, spatial awareness, and pattern recognition [34–37]. Based on the Information processing model (IPM), these challenges stem from limited cognitive resources, which impair one's ability to process and integrate visual stimuli efficiently [38, 39]. Overall, these findings highlight the complexity and many facets of visual perception in

[5] Blakeley S, De Luca H. Understand the meaning of visual perception in psychology [Internet]. 2023[cited 2025 June 12]. Available from: https://study.com

[6] Soegaard M. The Law of Similarity — Gestalt Principles (Part 1) [Internet]. Aarhus: Interaction Design Foundation; 2022 [cited 2025 June 12]. Available from: https://www.interaction-design.org/literature/article/the-law-of-similarity-gestalt-principles-1

individuals with ASD and ID, underscoring the importance of advancing our understanding of the distinct perceptual profiles within these two populations.

In light of previous findings, this study aimed to compare the visual perception abilities of children with ASD and those with mild ID. In particular, the study aimed to compare visual-motor integration (the coordination of visual perception and motor control), perceptual organization (the ability to structure visual input into coherent patterns), and spatial processing (the capacity to understand spatial relationships between objects) between children with ASD and those with mild ID.

METHODS

Study design

A comparative experimental study design was employed for the purposes of this study. The study involved administering standardized visual-motor and perceptual assessments, followed by a statistical comparison of the performances between the two groups.

Setting

The study was conducted in an educational and clinical setting at School No. 4 in Yekaterinburg, Russia, between October 2023 and June 2024.

Participants

Participants were selected based on the following inclusion criteria: (1) a formal diagnosis of ASD or mild ID documented by school or clinical professionals, (2) an age range between seven and 12 years, (3) enrollment in specialized education programs, and (4) parental or guardian consent for participation. Children with dual diagnoses (e.g., both ASD and mild ID), unverified diagnoses, or significant motor impairments affecting test completion were excluded.

Sampling strategy

A purposive sampling strategy was carefully adopted and subsequently implemented in several steps. Firstly, participants were identified from one special education school and two centers located in Yekaterinburg that specifically served children with ASD or mild ID. Secondly, the inclusion criteria listed above were applied to screen potential participants. Thirdly, the exclusion criteria were used to eliminate ineligible participants. Finally, participants who met all the criteria were selected for inclusion in the study.

Recruitment

School psychologists and special-need teachers referred students based on an existing clinical or educational diagnosis of ASD or mild ID. The teachers and coaches completed a detailed interview form for each child, drawing on their own knowledge, as well we the child's diagnostic and admission records from the centers and school reports. The examiner maintained direct contact with the coaches, while communication with the child's parents was channeled through the coaches. The parents also completed a questionnaire focused on the child's personal background and family health history, including factors such as birth complications and a family history of mental illness.

Procedure

At the beginning of the study, the parents or legal guardians were provided with an information sheet and a written consent form acquainting participants with the purposes of the study and highlighting that participation was anonymous and all the provided information was going to be kept confidential. After securing informed consent from the parents (or legal guardians), each child was assessed individually in a quiet, distraction-free room within the school grounds. The researcher explained the task using age-appropriate language to ensure understanding and comfort. Testing sessions lasted approximately 15 to 20 minutes, during which the children were encouraged to do their best without external rewards or penalties. All assessments were conducted by the same trained researcher using a standardized administration protocol. Observations about behavior during the test were recorded alongside score results to enhance interpretation.

The primary instrument used for the assessment was the Bender Visual-Motor Gestalt Test, First Edition (Bender-Gestalt Test) [40]. The test is designed for children aged three years and older and is used to assess visual-motor performance, visual-perceptual skills, and to screen for developmental delays, neurological deficits, and emotional disorders [40, 41]. Research has shown a significant correlation between children's ability to copy geometric figures and their intellectual capabilities, including non-verbal intelligence, as well as the likelihood of learning difficulties such as dyslexia and dysgraphia [42]. These qualities make the Bender-Gestalt Test a valuable tool for child psychologists.

Table 1. Study variables

Variables	Values
Outcomes (dependent variables)	1. Visual-motor integration 2. Perceptual organization 3. Spatial processing abilities
Exposures (independent variables)	1. ASD 2. Mild ID
Predictors	1. Age 2. Cognitive functioning level (based on clinical and teacher-reported information about ASD or mild ID)
Effect modifiers	1. Attention and focus (differences in attention regulation between the ASD and mild ID groups may affect performance outcomes) 2. Previous experience with visual tasks (some children may have had exposure to visual-motor training, influencing test performance)

Note: ASD — autism spectrum disorder; ID — intellectual disability.

Each child was instructed to copy nine geometric figures (see Figure S1 in the Supplementary), presented one at a time, onto a blank paper using a pencil. The task did not involve reading or writing, but instead focused on accuracy, alignment, integration, and the structure of the copied forms. The test results were used to derive measures of visual-motor integration (the coordination of visual input and motor control), perceptual organization (the ability to form structured visual patterns), and spatial processing (the understanding of spatial relationships among components). The study variables are summarized in Table 1.

Statistical analysis

The Bender-Gestalt Test was scored using a combination of qualitative and quantitative criteria. Common error types such as rotations, omissions, distortions, and integration issues were noted. The Mann–Whitney U test, a non-parametric statistical method, was used to compare the two groups (ASD and mild ID) on measures of visual-motor integration, spatial processing, and perceptual organization. This test was selected due to the small sample size and the non-normal distribution of scores, as it is more robust against outliers and violations of normality. For each variable, the Mann–Whitney U test and the corresponding p-value (*p*) were calculated to determine whether the differences between the two groups were statistically significant. All the tests were conducted using a two-tailed significance level of $\alpha=0.05$. A *p*-value below 0.05 was considered statistically significant. Descriptive statistics for non-normally distributed continuous variables were reported as a median and interquartile range (IQR). The IQR is defined as the range between the first quartile (25th percentile) and the third quartile (75th percentile), representing the middle 50% of the data. All statistical analyses were performed using IBM SPSS Statistics. The study's independent and dependent variables are summarized in Table 1.

Ethical considerations

No formal ethical approval from a recognized ethics board was secured. Informed consent was obtained from every parent or legal guardian of the participants, and assent was secured from the children using age-appropriate language. All the personal data collected was anonymized in order to protect participant confidentiality.

RESULTS

A total of 15 children (eight with ASD and seven with mild ID) aged seven to 12 years, were included in the study. The study explored group differences between children with ASD and those with mild ID in three key areas: visual-motor integration, perceptual organization, and spatial processing. Descriptive statistics and statistical comparisons are presented below.

Visual-motor integration

Visual-motor integration was assessed using the General Trends (GT) score from the Bender-Gestalt Test, which aggregates performance across all 9 geometric figures. According to the scoring framework (Appendix 1 in the Supplementary), higher scores indicate greater visual-motor disintegration, perceptual distortion, and developmental lag. Children with ASD had a wide range of scores (32 to 124; median=55.0, IQR=34.0), reflecting considerable heterogeneity in visual-perceptual functioning: from severely impaired to near-typical levels. This vast range likely reflects the diverse cognitive and neurological profiles characteristic of ASD. In contrast, the mild ID group showed a narrower and consistently higher score range (73 to 98; median=83.0, IQR=19.0), indicating more uniform deficit in the visual-motor and spatial domains (Table 2).

The statistical analysis using the Mann–Whitney U test revealed a significant group difference (U=10.0, $p=0.0186$), with the ASD group generally outperforming the mild ID group in visual-motor tasks. The recurring errors among children with ASD included rotations and omissions, particularly in complex geometric figures such as figures 6–8,

Table 2. Total scores in the visual-motor domain of the Bender-Gestalt Test

No	Age	Scores	Group	Normal range
1	7	74	Mild ID	33–41
2	8	95	Mild ID	25–32
3	8	76	Mild ID	25–32
4	8	95	Mild ID	25–32
5	8	98	Mild ID	25–32
6	8	77	Mild ID	25–32
7	9	83	Mild ID	20–28
8	9	73	Mild ID	20–28
9	9	42	ASD	20–28
10	10	55	ASD	18–26
11	11	76	ASD	15–25
12	11	48	ASD	15–25
13	11	18	ASD	15–25
14	12	124	ASD	15–25
15	12	32	ASD	15–25

Note: ASD — autism spectrum disorder; ID — intellectual disability.

Table 3. *p*-values for each figure

Geometric figure	Median (mild ID)	Median (ASD)	*p*-value	U	Significance
1	5.0	2.0	0.08	16.0	No
2	8.0	4.0	0.02	11.0	Yes
3	11.0	6.0	0.24	22.0	No
4	9.0	7.0	0.04	13.0	Yes
5	10.0	5.0	0.02	10.0	Yes
6	10.0	4.0	0.04	12.0	Yes
7	12.0	6.0	0.03	11.0	Yes
8	10.0	5.0	0.01	6.0	Yes
A	8.0	4.0	0.05	15.0	Yes (borderline)

Note: ASD — autism spectrum disorder; ID — intellectual disability; U — the Mann–Whitney U test.

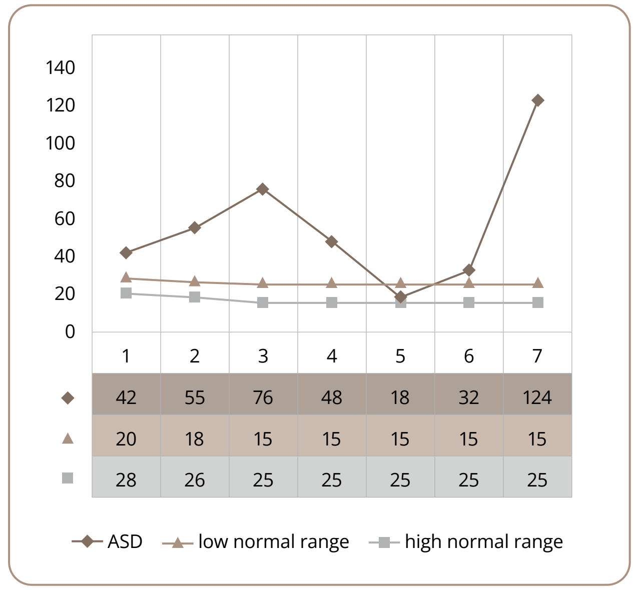

Figure 1. Comparison of autism spectrum disorder group scores to normal range extremes.

Note: ASD — autism spectrum disorder.
Source: Khamenehei, Tokarskaya, 2025.

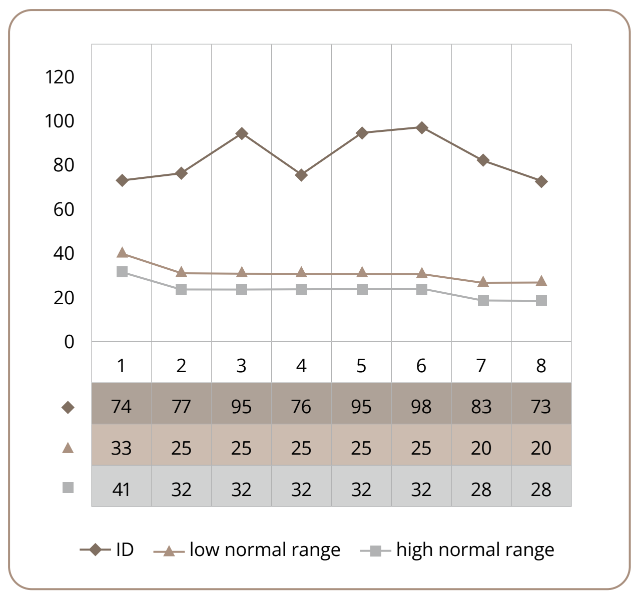

Figure 2. Comparison of mild intellectual disability group scores to normal range extremes.

Note: ID — intellectual disability.
Source: Khamenehei, Tokarskaya, 2025.

consistent with an individual facing challenges in holistic integration. The mild ID group more frequently exhibited distortions and figure integration issues across all items, suggesting deeper difficulties in coordinating visual input with motor execution.

To further assess these differences, each of the 9 Bender-Gestalt geometric figures was analyzed individually. The results showed that 7 out of 9 figures demonstrated statistically significant group differences, favoring better visual-motor performance in the ASD group (Table 3). This figure-level analysis reinforces the overall pattern: while both groups performed below normative developmental expectations, their error types and the variability of their performance suggest distinct underlying cognitive processing mechanisms. Figures 1 and 2, along with Table 2, illustrate these patterns in comparison to age-specific normative ranges (e.g., 25–32 for age 8, 20–28 for age 9).

In summary, the results indicate that children with ASD and those with mild ID differ in their visual-motor performance, with the ASD group showing a wider range of performances compared to the mild ID group.

Perceptual organization

Perceptual organization, which reflects the ability to structure visual input into coherent forms [43], was evaluated using scores from the geometric figures 1–4, which emphasize pattern recognition and figure-ground distinction. The ASD group had a median score of 36.0 (IQR=38.25, range from 18 to 76), indicating a variety of performances, with some children excelling in detail-oriented tasks but struggling with overall pattern integration. The mild ID group had a higher median score of 83.0 (IQR=19.0, range from 73 to 95), suggesting a more uniform but impaired ability to perform (Table 4). The Mann-Whitney U test indicated a significant group difference: U=89.0, p=0.021. The qualitative analysis revealed that children with ASD often produce accurate reproductions of individual elements but fail to maintain geometric figure coherence (e.g., misaligned segments in figure 3). The mild ID group showed frequent omissions and distortions, particularly in figures 1 and 2, indicating that these participants experienced in recognizing and organizing visual patterns.

Spatial processing

Spatial processing, assessing one's understanding of spatial relationships, was evaluated using the scores from figures 5–8 and A, which involve complex spatial alignments and rotations. The ASD group had a median score of 37.0 (IQR=26.50, range from 18 to 124), reflecting strengths in local spatial detail but difficulties with global spatial integration. The mild ID group had a median score of 43.0 (IQR=35.25), indicating consistent weakness in this area (Table 4). The Mann-Whitney U test confirmed a significant difference: U=91.0, p=0.037. Children with ASD showed errors such as rotations in figures 5 and A, suggesting challenges in mental rotation and spatial orientation. The mild ID group exhibited frequent spatial misalignments and oversimplifications, particularly in figures 6–8, reflecting limited spatial awareness.

Table 4 summarizes the median scores, IQRs, and statistical comparisons for all domains. The ASD group demonstrated greater variability and strengths in local processing, particularly in visual-motor integration and perceptual organization, but struggled with holistic integration. The mild ID group showed more consistent deficit across all domains, with pronounced challenges in spatial alignment and perceptual coherence.

Table 4. Summary of the results

Variable	Group	Median score	IQR	U	*p*
Visual-motor integration	ASD	55.0	34.0	10.0	0.0186
	Mild ID	83.0	19.0	-	-
Perceptual organization	ASD	36.0	38.25	89.0	0.021
	Mild ID	45.0	38.00	-	-
Spatial processing	ASD	37.0	26.50	91.0	0.037
	Mild ID	43.0	35.25	-	-

Note: Median and interquartile range (IQR) values reflect Bender-Gestalt Test. Normative ranges vary by age (see Appendix 1 in the Supplementary). ASD — autism spectrum disorder; ID — intellectual disability; IQR — interquartile range; U — the Mann–Whitney U test.

DISCUSSION

Main results

This study compared visual perception abilities in children with ASD and mild ID using the Bender-Gestalt Test, focusing on visual-motor integration, perceptual organization, and spatial processing. Children with ASD showed a wide range of performances in visual-motor integration, reflecting a wider range of performances, from severe to near-typical function. These participants demonstrated strength in local detail reproduction but struggled with holistic integration. In contrast, the mild ID group showed more a consistent deficit marked by general distortions and poor coordination. In perceptual organization, participants with ASD were able to reproduce individual features accurately but had difficulty forming coherent patterns, while those in the mild ID group produced more frequent omissions and disorganized forms. Group differences were statistically significant (p=0.021). In spatial processing, ASD children exhibited variable performances and specific errors like mental rotations, whereas the mild ID group showed consistent spatial misalignments and oversimplifications (p=0.037). Overall, ASD children produced a greater variety of performances and showed strength in local processing, while ID children showed a more uniform and global pattern of impairments. Below, we discuss the strengths and limitations of this work, attempt to fit the study's results within existing literature, and outline the implications for future research and practice.

Limitations

This study offers several notable strengths. First, it focuses on a direct comparison of visual-perceptual processing in children with ASD and mild ID, two populations that are often studied separately. By employing the Bender-Gestalt Test within a controlled school setting, the research provides standardized, ecologically valid insights into visual-motor and spatial functioning. Additionally, the inclusion of a narrow and developmentally comparable age bracket (7 to 12 years) increases the internal integrity of the findings. Finally, the combination of teacher-reported diagnoses with observational data enhances the practical relevance of the results for educators and school psychologists.

This study has several limitations that should be considered when interpreting the findings. First, the sample size was small (n=15), which reduces the statistical weight and increases the risk of both Type I errors (false positives due to multiple comparisons) and Type II errors (failure to capture meaningful differences). The limited sample also affects the ability to generalize the results and raises concerns about the robustness of the statistical conclusions. Additionally, ties within small datasets can further reduce the effectiveness of non-parametric tests such as the Mann–Whitney U test. Second, the study lacked clearly defined diagnostic criteria for ASD and mild ID. The diagnoses were based on school records and teacher reports, without formal confirmation using diagnostic tools such as the DSM-5 or standardized IQ assessments. This introduces the potential for misclassification and reduces the reliability of group comparisons. Moreover, the study did not clarify whether any of the participants in the ASD group also had comorbid mild ID, despite estimates that roughly 30% of individuals with ASD met the criteria for mild ID. The severity of autistic symptoms and degree of intellectual impairment were also not reported, which could have influenced test performance. Third, the study relied solely on the Bender-Gestalt Test to assess visual perception. While useful for identifying visual-motor integration issues, this test alone may not fully capture the breadth of perceptual processing differences. Future research should include a broader battery of visual-perceptual assessment tools, such as computerized tracking or scanning tasks, to ensure a more comprehensive profile. Fourth, the absence of a typically developing control group limits the interpretive framework of the findings. Without a neurotypical baseline, it is difficult to contextualize the deviations observed in the ASD and mild ID groups relative to typical development. Finally, the research was conducted in the setting of a single school, which may limit the cultural and educational value of the findings to other populations.

Comparison with existing literature

The observed differences in visual perception between children with ASD and mild ID align with and extend upon existing research on neurodevelopmental profiles. While both groups experience visual-perceptual challenges, the nature and underlying mechanisms of these difficulties differ significantly, as supported by prior theoretical and empirical findings.

Consistent with the Weak Central Coherence theory [32], the children with ASD in this study demonstrated a marked tendency toward local detail processing, often at the expense of global integration. This cognitive pattern, previously documented in tasks requiring figure reconstruction and perceptual grouping, has been shown to contribute to enhanced performance in certain domains such as mathematics, coding, or artistic reproduction [44]. Our findings support this, as the ASD children showed high accuracy in reproducing individual features — especially in simpler figures (e.g., figures 1–3) — but struggled to integrate those details into complex forms, resulting in misalignments, rotations, and omissions (e.g., figures 6–8). This aligns with Zhou et al.'s eye-tracking data, which suggests that ASD children selectively fixate on salient visual features, enhancing detail orientation but impairing broader spatial integration [44].

In contrast, the children with mild ID exhibited a more uniform and globally impaired visual performance. The narrower score range and frequent distortions observed across all the figure types reflect broader visual-motor coordination challenges. These results echo findings from Boot et al. [44], who associated visual-motor challenges in this population with lower IQ and broad neurocognitive deficits. Memisevic and Djordjevic further attributed spatial and visual integration issues in ID to diffuse neural inefficiencies [45], consistent with Castaldi et al., who highlighted general developmental delays as a hallmark of visual-spatial deficits in ID [46].

Importantly, the perceptual patterns observed in ASD — marked by heightened attention to visual detail but poor pattern integration — are well-supported by empirical work. For instance, Samson et al. demonstrated that children with ASD exhibit superior performance in visual search tasks, particularly for complex or high-contrast stimuli [47]. Similarly, Chung and Son reported that ASD individuals show enhanced sensitivity to visual features such as color and edge contrast, though they may struggle to organize these elements into coherent wholes [28]. These findings support the gap seen in our data between accuracy in reproducing isolated parts of figures and difficulty in producing integrated patterns.

The spatial orientation challenges noted in both groups can also be contextualized within prior work. Chung and Son found that ASD-related spatial difficulties often stem from limitations in mental rotation and depth perception, rather than general spatial unawareness [28]. In contrast, the spatial errors in children with mild ID appear more aligned with developmental immaturity and generalized attention deficits. Zhou et al. further emphasized the passive visual processing typical in ID, where key secondary visual cues may be overlooked due to limited engagement with the visual environment [44]. Neurologically, these differences are underpinned by distinct pathways. Atypical connectivity patterns in ASD — particularly between the visual, parietal, and frontal regions — are thought to support intense local processing but may disrupt global integration [48, 49]. Meanwhile, in ID, impairment in visual-motor and spatial tasks likely reflect broader disruptions across multiple brain systems, rather than localized anomalies [45, 46].

However, these conditions are not entirely discrete. As Baio et al. noted, roughly one-third of children diagnosed with ASD may also meet the criteria for ID [3]. This overlap may explain the broad range of performances observed within the ASD group in our study, with some children displaying near-typical visual-motor abilities and others showing severe impairment. By contrast, the mild ID group showed consistency in low performance, reinforcing the interpretation of generalized developmental delay [8].

These findings reinforce the distinctions between cognitive and perceptual functioning: children with ASD exhibit enhanced ability for local processing, sensitivity to contrast and detail, and reduced integration of visual information into global patterns [29, 44, 50], whereas children with mild ID often struggle with attention span, filtering relevant visual input, spatial reasoning, and visual memory [28]. The neurological basis for these differences likely varies: ASD is frequently associated with atypical connectivity [48, 49], while ID is linked to more generalized neurodevelopmental impairments [8, 44–46, 51, 52].

Finally, although ASD and ID are diagnostically distinct, recent research highlights overlapping genetic and behavioral characteristics that can complicate differential diagnosis and help explain the shared perceptual deficits [44, 53]. These findings underscore the importance of nuanced assessment and tailored intervention strategies that consider both the shared and unique features of these neurodevelopmental profiles.

Implications for future research and practice

The results in this study have practical significance for both educational and clinical applications. The distinct visual-perceptual profiles identified in children with ASD and those with mild ID underscore the importance of individualized approaches in both assessment and intervention. For children with ASD, whose strengths lie in local detail processing but experience challenges with global integration, educational programs may benefit from leveraging their visual discrimination skills in areas such as mathematics, design, and structured problem-solving. At the same time, therapeutic interventions should aim to advance global processing and visual-motor planning to enhance everyday functioning ability. For children with ID, who demonstrated more generalized visual-perceptual impairment, structured and repetitive training targeting basic spatial cognition, attention to salient features, and visual-motor coordination may be particularly beneficial.

This study also highlights key considerations for future research. Larger and more diverse samples are essential to increasing statistical relevance and allow for greater ability to generalize across neurodevelopmental populations. The inclusion of typically developing control groups would enable a clearer interpretation of perceptual deviations and provide developmental baselines. Additionally, future work should strive to apply formal diagnostic assessments, such as the Autism Diagnostic Observation Schedule (ADOS-2)[7] and standardized IQ measures to reduce diagnostic ambiguity and clarify the potential impact of comorbid conditions. Expanding the assessment tools beyond the Bender-Gestalt Test — such as incorporating

[7] Loftus Y. Autism vs Intellectual Disability: Similarites and Differences. Autism Parenting Magazine [Internet]. 2025[cited 2025 June 12]. Available from: https://www.autismparentingmagazine.com/autism-vs-intellectual-disability

computerized visual tracking, eye-movement analysis, or neuroimaging — would offer deeper insight into the cognitive and neurological mechanisms that underlie visual-perceptual processing in these groups.

In educational and psychological practice, these findings emphasize the necessity of adapting evaluation tools and intervention strategies to the distinct needs of children with ASD and mild ID. Developing neurodiversity-informed assessment frameworks and tailoring visual tasks to each group's cognitive profile will enhance both diagnostic accuracy and the effectiveness of learning supports. As research continues to illuminate the perceptual and cognitive mechanisms specific to ASD and mild ID, more refined, individualized, and inclusive practices can be developed to promote optimal learning and developmental outcomes.

CONCLUSION

This study found significant differences in visual perception between children with ASD and those with mild ID. Children with ASD showed greater variability and stronger performance in visual-motor integration, but they also struggled with holistic organization. In contrast, children with ID exhibited more consistent deficits, including spatial misalignment, figure distortions, and rotation errors — indicating broader limitations in visual-perceptual processing. These findings should be considered in light of the study's limitations, including the small sample size, reliance on a single assessment tool, and lack of a neurotypical control group, all of which limit generalizability and interpretive depth. Despite these limitations, these results highlight the distinct perceptual processing profiles of children with ASD and those with ID, underscoring the need for tailored assessment and intervention strategies in educational and clinical settings. Future research with larger, more diverse samples and multi-method assessment approaches is essential if we want to expand our understanding of how neurodevelopmental differences shape visual perception.

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