

The Mental imagery in children with autism spectrum disorder

الصورة الذهنية عند الطفل التوحدي

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ABSTRACT:

This study aims to analyse the level of mental imagery ability in children with autism spectrum disorder (ASD) and compare it with that of typically developing children. Three core cognitive processes will be examined — generating, retaining and rotating mental images — to determine the nature and direction of any differences and reveal strengths and weaknesses in cognitive performance. The Kosslyn Test, a computer-based test, will be used on a research group consisting of 25 children, divided into two groups of 10 and 15 children respectively. These groups are matched by chronological age and intellectual level: the first group includes 10 children with ASD, and the second group includes 15 neurotypical children. The results revealed statistically significant differences between the two groups in image generation and mental rotation tasks, favouring the neurotypical children. This suggests that autistic children have a qualitative deficiency in their ability to create and manipulate mental images at the visual-spatial level. However, no significant differences were found in the task of retaining mental images.

Keywords: Autism, Mental image, Generation, Retention, Rotation

الملخص:

تهدف هذه الدراسة الى تحليل مستوى القدرة على التصور الذهني لدى أطفال طيف التوحد، ومقارنته بنظرائهم من الأطفال الأسوياء، والسعي لتحديد طبيعة الفروق واتجاهها والكشف عن أبعاد الضعف والقوة في الأداء العقلي. قمنا بتحليل ثلاث عمليات معرفية أساسية وهي توليد الصورة الذهنية والاحتفاظ بها، وتدويرها باستخدام اختبار كوسلين المبرمج حاسوبيا. طبق هذا الاختبار على مجموعة بحث قوامها 25 طفلا موزعين على مجموعتين، المجموعة الأولى مكونة من 10 أطفال ذوي طيف التوحد والمجموعة الثانية مكونة من 15 طفلا أسوياء متماثلين في العمر الزمني والمستوى العقلي. أظهرت النتائج وجود فروق دالة إحصائية بين المجموعتين في مهام التوليد والتدوير العقلي لصالح الأطفال الأسوياء، ما يشير الى قصور نوعي لدى أطفال التوحد في القدرة على إنشاء الصور الذهنية والتعامل معها على المستوى البصري المكاني، في المقابل لم تسجل فروق في مهمة الاحتفاظ بالصورة الذهنية.

كلمات مفتاحية: التوحد، الصورة الذهنية، مستوى التوليد، مستوى الاحتفاظ، مستوى التدوير

1- Introduction:

Autism Spectrum Disorder (ASD) is considered one of the special needs conditions. Tracing the history of this disorder reveals significant developments and changes in our understanding of its causes, contributing factors, and clinical manifestations. Researchers have identified several types of autism, leading to the term “spectrum disorder,” which refers to the wide range of degrees, severities, and behavioural manifestations it encompasses.

Etymologically, the term “autism” is a word translated from Greek meaning isolation or Seclusion; and in Arabic, it was named ‘al-dhatawiya’. In addition, there exist various behaviours and different problems, as mentioned by Wing and Gold (1979). Autism is not introversion; it is a pathological condition, and not a form of social withdrawal. Autistic individuals tend to avoid interaction and engagement with others exhibiting a variety of behaviors and problems, depending on the case. (Marie H       Plumet. P 110-109, 2014)

The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) indicates that it is a Pervasive Developmental Disorder classified as a neuro-developmental disorders because it affects a range of psychological functions during the early years of life.

Its main characteristics are:

- Disorder in communication and social interaction.
- Repetitive and restricted patterns of behaviour, interests, and activities.

This disorder has not only changed in terms of its name, but its symptoms are also no longer classified as mild, moderate or severe, as was previously common. Instead, there are now three levels of severity: Level 1: symptoms requiring support; Level 2: symptoms requiring substantial support; and Level 3: symptoms requiring a great substantial support (5-DSM). Autism spectrum disorders constitute a heterogeneous group in terms of characteristics and traits (Plumet, M. H., 1994, pp. 195–196).

It is worth noting that people with autism spectrum disorder suffer from incomplete development of ideas in line with normal growth. They are unable to solve problems in social situations and are, to some extent, incapable of receiving and interacting with sensory stimuli. (Azza Abdel Gawad Mohamed, 2010) They demonstrate weakness and deficiency in the use of symbols and have limited imagination (Bilam, 1986) and also suffer from thinking and perception disorders characterised by an inability to see the bigger picture, whether it requires verbal or visual ability. (Francesca, Appe, 1994)

The ability to visualise is one of the central cognitive functions associated with mental representation processes. This field has been the subject of numerous studies, particularly by pioneers in cognitive psychology, such as J. Piaget, Denis, Kosslyn and Pavio. Jean Piaget is widely regarded as one of the most important figures who contributed to the development of the cognitive standard of mental imagery by emphasising two key aspects: cognitive structure and mental function.

According to Piaget, mental images emerge and influence us from the age of seven, although he refers to them from the sensory-motor stage when symbolic function emerges. This process drives perception and is linked to mental activities as are other mental processes (Bin Abdullah Muhammad 2019, p. 109). This leads us to Michel Denis's definition of mental imagery as a cognitive event that manifests as a symbolic representation of absent perceptions. It is a cognitive tool that is used not only to recall the past and represent the formal aspects of previous events, but also to understand the present and anticipate future situations (Peraya, D., 1995).

It is heavily relied upon and is used in: (Denis, M, 2001)

- Problem solving.

- Analysis and retention of visual information.
- Remembering appropriate linguistic information.
- Facilitating the process of acquiring knowledge.

Early Arab scholars considered the mental image to be a concept formed in the mind after abstracting external facts; an acquired response. Mental perception is a level of existence built on another level; its basis and principle are external existence. Al-Ghazali says: 'A thing has four levels of existence: the first is its reality in itself; the second is the presence of its representation in the mind, expressed through knowledge; the third is the composition of its representation in sounds and letters that refer to it—which is the expression of this representation within one's soul; and the fourth is the composition of symbols perceived by sight that refer to word which is writing.' (Al-Ghazali, Sulayman, Dunya, 1961).

Through our aspirations, it becomes clear that the various definitions of mental imagery are linked to scientists' different perspectives, angles of vision and interests. Some view it as mental representations (Matlin & Flechensteing, 2000), while others consider it a memory strategy (Abdul Ali Al-Jismani, 1994), a mental image as an experience (Chaplin, 1985), or an ability (Kosslyn, 1995).

Based on the above, the following can be noted:

- Mental images can produce images that do not necessarily resemble the original perception.
- Mental imagery is an internal process that varies from one person to another, resulting from the activity of specific parts of the brain.
- Mental imagery processes all information, regardless of its nature, whether verbal or otherwise.
- The form and content of mental images vary from one individual to another, depending on their previous experiences and situation.

It develops from early childhood (2-3 years old), forming a simple image linked to the direct sensory perception of objects and events. With age, the child's ability to generate and retain images after the external stimulus has disappeared develops, becoming more accurate and organised at the age of 7. In adolescence, mental images reach a level of abstraction that allows for the circulation of mental representations such as scientific concepts and creative imaginings (Neisser, 1967). The average child reaches a level close to that of an adult at 10-12 years of age.

A number of theories have sought to explain the process of mental imagery, the most prominent of which are: The Dual Coding Theory and Kosslyn's Theory of Functional Equivalence, which we have relied on in our study.

The Dual Coding Theory (Paivio)

This is one of the most prominent theories explaining information representation, assuming the existence of two different systems for representing and processing information: the verbal system and the non-verbal (visual) system. The first system processes information of a linguistic nature, while the second deals with the representation of visual information.

Kosslyn's Image Theory – The Functional Equivalence

Kosslyn's theory of imagery Functional equivalence: Kosslyn (1980) considered that the perceptual system cannot be reduced to symbols or internal linguistic processing and argued that the dual coding theory did not cover most areas of work such as imagery's format, generation, inspection, and transformation, and did not address how these tasks could be processed, providing only an explanatory adequacy (Kosslyn and Pinker, 1983, p. 84).

Kosslyn presented a model based on the visual spatial environment that processes information in a spatial manner similar to what occurs in the visual system. Kosslyn transferred mental imagery from a symbolic framework to a more accurate neural cognitive framework, which constituted a qualitative advance in understanding the nature of mental images. It became possible to study mental imagery as a complex cognitive process involving several interrelated levels: retention, generation, and rotation.

The first stage involves retaining the mental image in working memory for a specific period after the stimulus disappears. In other words, the image does not disappear immediately when the visible object disappears; rather, it remains active for a period of time during which it can be recalled and used. Generation is the process of producing a new mental image based on memory storage or verbal or visual commands. Mental rotation is the ability to perform spatial transformations. Kosslyn relied on these levels in his tests to measure mental imagery in individuals. He developed his theoretical model based on the similarities between how the human brain and a computer function. He considered mental imagery to comprise a set of distinct abilities, as well as the ability to combine many parts into a single image. Just as an individual image may weaken and strengthen at different times, some individuals may perform well in one of these abilities and poorly in others.

Several studies have examined differences in mental imagery abilities between typically developing children and those with developmental disorders, with a focus on generation, retention and rotation processes.

In a recent study by Booth et al. (2022), children with autism spectrum disorder were compared to typically developing children. Aged between seven and nine years, their abilities in motor visualisation and mental rotation were tested. The results indicate that children with autism spectrum disorder have a visual-spatial processing deficit, whereas typical children performed more accurately and quickly.

A group of researchers, (Johansson, A. M., Backstrom, A. 2022), conducted a longitudinal study examining the development of mental representation of motor imagery (mental imagery of movements) in children with autism spectrum disorder aged 7 to 9 years and comparing it with that of neuro-typical developing children of the same age.

The sample consisted of 14 children with autism spectrum disorder and 17 typically developing children. This study found that the motor rotation ability of children with autism is delayed or weak compared to typically developing children, but it is not completely absent and shows improvement with growth.

Clara, Bled.2024 and others also studied the visual mental imagery abilities of adults with autism spectrum disorder through four basic stages of mental imagery.

1. Generation, maintenance - retention, examination or inspection, manipulation and rotation of geometric shapes.

This is a comparative study between a sample of 44 adults with autism spectrum disorder and 42 neurotypical adults.

The study concluded that visual mental imagery abilities in autism are not homogeneous; some aspects are normal, some are weaker, and some are stronger. These results support the existence of significant individual variation among people with autism.

In 2016, Professor Dahal studied the relationship between mental imagery and text comprehension in children. This developmental study focuses on understanding the cognitive processes responsible for mental imagery and how the ability to store and understand spatially oriented texts develops in typically developing children aged 6 to 11. The results revealed differences in the use and development of mental imagery among the groups according to age.

Through field practice with children with autism, we have observed that this ability does not manifest itself symmetrically in all children, but rather exhibits patterns of variation, with some children showing difficulties in generating mental images associated with social situations, while others demonstrate remarkable competence in constructing accurate mental representations in specific visual or spatial domains. Therefore, perception in children with autism spectrum disorder is a complex cognitive domain that reflects the heterogeneous nature of the disorder.

In this context, the current study addresses the following question:

General question:

Are there statistically significant differences in mental imagery ability between a group of children with autism spectrum disorder and a group of typically developing children?

Sub-questions:

- Are there statistically significant differences in the level of generation testing in terms of correct answers between children with autism spectrum disorder and neurotypical children?
- Are there statistically significant differences in generation test performance in terms of response time between children with autism spectrum disorder and neurotypical children?
- Are there statistically significant differences in retention test performance between children with autism spectrum disorder and neurotypical children?
- Are there statistically significant differences in the level of the rotation test between children with autism spectrum disorder and neurotypical children?

Basic hypothesis:

There are statistically significant differences in mental imagery ability between children with autism spectrum disorder and neurotypical children.

Partial hypotheses:

- There are statistically significant differences in the level of generation testing in terms of correct answers between the group of children with autism spectrum disorder and the group of neurotypical children.
- There are statistically significant differences in the level of the generation test in terms of response time between the group of children with autism spectrum disorder and the group of neurotypical children.
- There are statistically significant differences in the retention test level between the group of children with autism spectrum disorder and the group of neurotypical children.
- There are statistically significant differences in the rotation test level between the group of children with autism spectrum disorder and the group of neurotypical children.

Study objectives:

The study aims to analyse and evaluate the mental perception of neurotypical children and children with autism spectrum disorder by comparing the indicators retained by both groups through the application of Kosslyn's test.

To reveal a manifestation of the mental development of this group.

To deepen the scientific understanding of the cognitive characteristics associated with autism.

To provide a theoretical and practical basis for the development of intervention strategies aimed at improving the mental abilities of this category.

To identify the differences between children with autism spectrum disorder and neurotypical children in terms of their ability to retain, generate and rotate mental images.

Definition of terms:

Autism: A neurodevelopmental disorder that typically emerges in early childhood. It is characterised by impaired social communication and interaction with others, as well as repetitive behaviours and restricted interests.

Procedural: Any child who is diagnosed with autism according to the criteria set out in the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), whose level of autism is determined using the Childhood Autism Rating Scale (CARS), and who meets at least 14 of the criteria.

Mental image: A mental representation of a visual, auditory or tactile stimulus that is formed or recalled in the absence of the actual external stimulus.

Procedural: This is measured by the child's ability to recall or form a mental image of a shape or event after it has been presented to them. It is assessed using tasks such as recognising a shape after it has been hidden or describing its details when it is not in front of them.

Generative: The ability to generate a new mental image without direct reliance on an external sensory stimulus.

Procedural: This is measured by the child's ability to imagine a shape after a simple visual or verbal stimulus has been presented.

Retention: The ability to hold a mental image in short-term or long-term memory for a certain period of time.

Procedural: This is measured by a child's ability to remember the details of an image or shape that has been shown to them after a certain period of time.

Rotation: The ability to imagine a mental image of two-dimensional stimuli that have been rotated at a certain angle and mentally rotate them to match the original shape in terms of whether they match.

In the current study, it is measured procedurally by the number of correct answers.

2- Method:

Due to its suitability for the nature of the subject and the objectives of the research, the study relied on comparative descriptive methodology, which allows us to describe the phenomenon under study as it appears in reality, as well as making quantitative and qualitative comparisons. This helps us to identify similarities and differences, and reveal the factors that may explain these differences (Al-KhatibAbdul Rahman, 2018, Research Methods in Education and Psychology).

Study group: Members of both groups were selected according to the following specific criteria:

We identified two groups for the study: the first consisted of children with autism spectrum disorder and the second of typically developing children.

The participants were selected according to predefined inclusion and exclusion criteria, as well as the availability of participants who met these criteria. In selecting the participants for the two groups, particular attention was given to their similarity in chronological age and cognitive level. Their performance during the training phase of the mental imagery tasks, namely generation, retention, and rotation, was also taken into consideration. Accordingly, only participants who successfully completed this preliminary phase were retained in the study.

First group: This group consisted of ten boys aged between eight and nine years old with mild autism spectrum disorder who did not suffer from any concomitant disorders.

They were diagnosed based on the criteria in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), and classified as Level 1 (requiring support). The degree of autism was determined by applying the Childhood Autism Rating Scale (CARS), and *Kohs Block Design Test* was administered to assess intellectual ability at a private clinic specialising in examinations and orthophonic care, located in Hussein Dey in the capital. The test was conducted individually.

A training phase on mental perception testing was also implemented, and those who excelled at this stage were retained.

The second group: representing the neurotypical category, consisted of 15 pupils aged between eight and nine. We administered the Kohs intelligence test to assess their mental ability level.

A training phase was conducted to test mental perception individually in the teachers' hall at Asma School in Hussein Day, and those who passed this phase were retained.

CARS test results showed that all scores ranged between 30 and 34, with an average score of 31.6. According to the classification of Schopler et al. (1980), this falls within the mild autism level.

Therefore, the individuals in the group are similar in terms of the level of disorder, with a standard deviation of 1.26.

Regarding the results of the KOHS Block Design Test for children with Autism Spectrum Disorder,

the mean chronological age was 8.5 years with a standard deviation of 0.53, and the mean IQ was 104, with a standard deviation of 6.98.

For the second group, the KOHS Block Design Test showed an arithmetic mean chronological age of 8.73, a standard deviation of 0.46, and the mean IQ was 105.53 with standard deviation of 6.07.

3- Materials:

Mental Imagery Tests: The children were administered three tasks designed to assess image generation, image retention, and mental rotation. With the aim of analyzing their imagery abilities. According to Kosslyn, these processes are considered to be relatively independent of one another. To assess the children's performance in the domain targeted by the present study, the original instructions regarding task presentation, administration procedures, and response recording were strictly followed. The three tasks were administered consecutively and in the same order to all participants, using a computer-based procedure.

1- Generation test: This is the first test proposed to children, which requires assessing their abilities to create the correct image in their visual buffer memory. Children are asked to make a judgement and check the empty grid.

In order for young children to be able to apply these tests, Lejeune and Courbois made some simple modifications to make them suitable for this purpose. During the training phase, the child learns the process of recognising and matching the shape with the appropriate animal. We then ask the child to give each animal its appropriate shape and reinsert it into the empty grid.

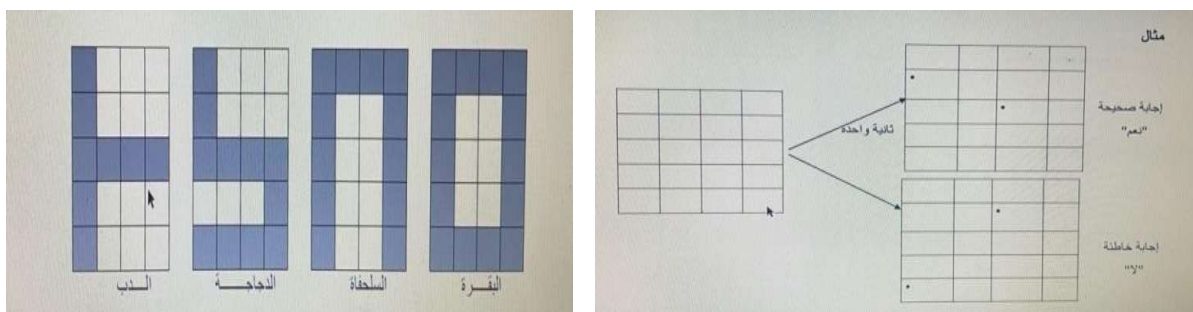


Fig 1. Retention test

The items of the generation test consist of:

- Associative control (C.A)
- Imagery conditioning (C. I)
- Perceptual control (C. P)

2- Retention test: The child observes a shape displayed on the screen, and after it disappears, two dots appear and the child must evaluate the position of the dots and is given one point for each correct answer.

3- Rotation test: After training on the rotation stage at multiple angles, the child is asked to judge whether the two bears are similar. After each answer, the child sees the tilted bear slowly return to its position so that the child can verify their answer.

4- Results:

In order to verify the general hypothesis and the sub- hypotheses, a t-test was used to examine the differences between the two groups.

Presentation and Analysis of the Results Related to the partial Hypothesis

To verify the effectiveness of the first partial- hypothesis, which states that there are statistically significant differences between children with autism and neurotypical children in the generation level (in terms of answer accuracy), a t-test was used to examine the differences between the two groups.

The homogeneity of variances between the two groups was assessed using Levine's test. The results indicated no statistically significant difference in variances ($p > 0.05$), confirming the assumption of homogeneity of variances.

Table 1. Results of children with autism and neurotypical children in the Generation Test (Answer Accuracy).

Mental Image Test Results for children		Arithmetic Mean	Standard Deviation	t-test Value	Significance Level	Decision
Generation Answer Accuracy	Autistic children	36.80	13.02	-2.20	0.03	Significant
	Neurotypical children	47.13	10.38			

Considering the value of the t-test (which was -2.20) and the table, we can see that the value is significant at the 0.03 significance level. Therefore, we can conclude that there are statistically significant differences between children with autism and typically developing children in terms of mental imagery. Reading the above table, we can see that the result supports the first partial hypothesis, which states that there are statistically significant differences between children with autism and neurotypical children in terms of generation at the level of correct answers. To verify the validity of the second partial hypothesis, which states that there are statistically significant differences between children with autism and neurotypical children in terms of generation in response time, a t-test was used to examine the differences between the two groups.

Table2. Generation test results (response time) for children with autism and neurotypical children.

Mental Image Test Results for children		Arithmetic Mean	Standard Deviation	t-test Value	Significance Level	Decision
Generation (Response Time sec) –	Autistic children	1554.00	391.357	-0.56	0.58	Non Significant
	Neuro-typical children	1488.00	195.34			

Considering the t-test value of -0.56 and the table, we can see that the value is significant at a significance level of $\alpha = 0.58$. Therefore, we can conclude that there are no statistically significant differences in response time for the generation skill between typical children and children with autism. Reading the table above, we see that the result refutes the second partial hypothesis, which states that there are statistically significant differences between children with autism and neuro-typical children in terms of response time for generation skills.

To verify the validity of the third partial hypothesis, which states that there are statistically significant differences between children with autism and neuro-typical children in terms of retention, a t-test was used to examine differences between the two groups.

Table 3. Results of the retention test for children with autism and neuro-typical children.

Mental Image Test Results for children		Arithmetic Mean	Standard Deviation	t-test Value	Significance Level	Decision
Retention	Autistic children	11.40	4.74	-1.81	0.83	Non significant
	Neurotypical children	13.87	1.95			

Considering the t-test value of -1.81 and the significance level of $\alpha=0.83$, we can see from the table that the value is significant. Therefore, we can conclude that there are no statistically significant differences between children with autism and neurotypical children with regard to mental imagery. Reading the above table reveals that the result refutes the third partial hypothesis, which states that there are statistically significant differences between children with autism and neurotypical children in terms of retention.

To verify the fourth partial hypothesis, which states that there are statistically significant differences between children with autism and neurotypical children in terms of rotation, a t-test was used to examine differences between the two groups.

Table 4. Results of the rotation test for neurotypical children and children with autism.

Mental Image Test Results for children		Arithmetic Mean	Standard Deviation	t-test Value	Significance Level	Decision
Rotation	Autistic children	11.30	4.448	-3.33	0.003	Significant
	Neurotypical children	16.00	2.619			

Considering the t-test value of -3.33 from the table, we can see that the value is significant at a significance level of $\alpha = 0.003$. Therefore, we can conclude that there are statistically significant differences between children with autism and neurotypical children in terms of rotation. Reading the above table, we can see that the result supports the fourth partial hypothesis, which states that there are statistically significant differences between children with autism and neurotypical children in terms of rotation.

Analysis of the results related to the general hypothesis

To verify the general hypothesis that there are statistically significant differences in mental imagery between children with autism and neurotypical children, a t-test was used to examine differences between the two groups.

Table 5. Results of Kosslyn's mental imagery test for children with autism and neurotypical children.

Mental Image Test Results for children		Arithmetic Mean	Standard Deviation	t-test Value	Significance Level	Decision
Total	Autistic children	59.50	13.86	-3.31	0.003	Significant
	Neurotypical children	77.00	12.28			

Considering the t-test value of -3.31, we can see from the table that the value is significant at a significance level of $\alpha = 0.003$. Therefore, we can conclude that there are statistically significant differences between children with autism and neurotypical children in terms of mental imagery. Reading the above table confirms that the result supports the general hypothesis that there are statistically significant differences between children with autism and neurotypical children in terms of mental imagery.

5- Discussion

First Partial hypothesis: There are statistically significant differences in the level of generation testing in terms of answer accuracy between the group of children with autism spectrum disorder and the group of typically developing children.

These results indicate that typically developing children have a higher ability to generate mental images, while children with autism spectrum disorder show weakness in this ability in terms of correct answers that require recalling images from memory without direct visual support, which is consistent with the results of the study by Courbois et al. 2013.

Second partial hypothesis: There are statistically significant differences in the level of the generation test in terms of response time between the group of children with autism spectrum disorder and the group of typically developing children.

The results showed that the difference between the average response time of typically developing children and children with autism spectrum disorder was not statistically significant. This means that the difference in response time between the two groups is not statistically significant, and that the performance of the two groups in terms of mental image generation speed is relatively similar.

Therefore, it can be concluded that generating mental images is more affected by the quality of visual processing than by speed. In other words, children with autism spectrum disorder may require more time, but not to a degree that distinguishes them from neurotypical children in this respect. This finding partly supports Kosslyn's (1980) suggestion that differences may not always manifest in response time, but rather in the accuracy of mental representation and the quality of the image formed. It is also consistent with the study by Courbois et al. (2013), which found that time differences between groups were weak or insignificant for simple tasks. Based on this, the absence of significant differences can be explained by the fact that the temporal ability to generate mental images is relatively similar between the two groups. When comparing the correctness of the answers with the response time at generation level, it is evident that there are statistically significant

differences between the two groups in terms of the correctness and accuracy of the answers (-20.2), favouring typically developing children. However, the differences are not significant in terms of response time (-0.56). This discrepancy suggests that the difference between typically developing children and those with autism spectrum disorder lies not in the speed of temporal processing, but in the quality and efficiency with which mental images are generated.

Third partial hypothesis: There are statistically significant differences in retention test levels between children with autism spectrum disorder and typically developing children.

However, the results showed that the difference in retention level ($t = -1.81$) was not statistically significant at the 0.83 significance level. Therefore, it can be concluded that the performance of the two groups in the mental image retention task is statistically convergent. This convergence can be explained by the fact that the retention task mainly relies on short-term visual memory, which is a cognitive function that may be less affected by characteristics of autism spectrum disorder than generative processes requiring deeper cognitive processing. These results are consistent with those of previous studies (Bled, Semino, Zanobini), which also found statistically insignificant differences in retention tasks, particularly when the task was simple and did not require significant processing. This was observed during the test: the more complex the shape, the fewer correct answers there were among all children in the sample, and vice versa. The standard deviation results for typically developing children showed homogeneous and stable performance at 1.95. Meanwhile, the group of children with autism spectrum disorder exhibited highly variable performance, with a standard deviation of 4.74. This large variation in retention results among children with autism spectrum disorder indicates that mental image retention is inconsistent among individuals with autism. This internal variation also explains why there was no statistical significance in the comparison results despite the differences in means. Previous studies, such as (2024 Bled), have also shown high variability in the performance of individuals with autism in visual memory tasks.

Fourth Partial hypothesis:

Fourth partial hypothesis: There are statistically significant differences in the level of mental rotation test between children with autism spectrum disorder and typically developing children.

The results of the current study showed statistically significant differences in mental rotation test performance between the typically developing and autism spectrum disorder groups. This indicates that typically developing children have a greater ability to rotate mental images, i.e. perform spatial transformations of visual elements in their minds, than their peers with autism spectrum disorder. Mental rotation requires an advanced level of integration between visual perception, spatial working memory and executive functions. These are areas in which children with autism often experience difficulties (Frith, 2003; Kosslyn, 1994). The significant decline in performance of the autism group (30.11) compared to the typically developing group (16.00) can be explained by deficiencies in processing spatial relationships and three-dimensional mental representations. These processes require high cognitive flexibility and the ability to visualise shapes after rotation. Such deficiencies may be related to malfunctions in areas of the brain responsible for spatial processing, such as the right parietal lobe, as indicated by neuro-imaging studies (Just et al.,

2007). The greater standard deviation in the autism group (4.484) indicates significant individual variation within the group, reflecting the spectrum-like nature of the disorder as hypothesised by Mottron (2011) in his theory of 'cognitive diversity within the autism spectrum'. This variation also highlights the importance of treating this group on an individual basis, taking into account the differences within the group itself rather than just between groups.

Interpretation of the General Hypothesis

Interpretation of the basic hypothesis: The current study enables us to conclude the following:

There are statistically significant differences in mental imagery ability between children with autism spectrum disorder and typically developing children.

The study proved the general hypothesis to be true, as there were real differences in mental imagery ability between the two groups, with children with autism spectrum disorder performing worse on average than typically developing children. This suggests that they have difficulty processing visual and spatial information, which has a negative impact on the formation, retention and generation of mental images. These results corroborate those of studies conducted by Kosslyn in 1994 and Courbois in 2013.

The results also reinforce the hypothesis that deficits in mental imagery in children with autism spectrum disorder are a distinctive cognitive feature associated with deficits in information processing. The difficulties faced by this group are not the result of general cognitive impairment, but rather a specific pattern of information processing. Therefore, mental imagery can be considered a sensitive indicator of the level of cognitive integration in children with autism spectrum disorder.

General Conclusion

The results show that the overall performance in mental imagery tasks differs significantly between children with and without autism spectrum disorder. Typically developing children outperformed their peers with autism spectrum disorder in tests requiring accuracy in visual representation (generation) and flexibility in processing spatial rotation information. No significant differences were found in processing speed or short-term retention.

These results confirm that mental visualisation impairment in children with autism is not comprehensive in all its dimensions, but mainly focuses on higher-level processing aspects related to image integration, mental transformation and the use of mental symbols. This reinforces the hypothesis that cognitive impairment in this group is related to the connection between perceptual and cognitive representations, rather than being solely primary cognitive impairment.

6- Recommendations

Based on the results obtained, it revealed:

- The necessity for future research using larger and more diverse samples in terms of disorder severity.
- The necessity to propose cognitive training programmes that focus on developing mental imagery abilities through generation and rotation activities to improve spatial processing and create cognitive flexibility.
- The necessity to continuously develop and modify the proposed programmes to suit the severity of the disorder.

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