

Assessment of selected theory of mind tasks in children with autism spectrum disorders

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Summary

Theory of Mind (ToM) describes the ability to attribute mental states in order to explain or predict the behavior of others. Research indicates that individuals with autism spectrum disorders (ASD) have deficiencies in theory of mind. In this sense, we selected a group of six children with moderate-grade ASD with normal intellectual capacity. This group was subjected to four tests: Distinguishing emotions, recognizing feelings based on desire, recognizing true feelings and false belief in the first degree. Analysis of the results indicates that the ASD subjects assessed are able to distinguish between different emotions, however, the scores recorded for all the remaining tasks remain low; these results corroborate previous studies that have raised the issue of theory of mind in ASD subjects and its impact on social and language interaction in these subjects.

Keywords: Autism Spectrum Disorder (ASD); Theory of Mind (ToM).

1-Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by social communication deficits, restricted interests, and repetitive behaviors (DSM5, 2013). This definition is marked by significant changes from the DSM-4 (Hodges et al., 2020); indeed, the DSM-5 created the concept of a “spectrum” ASD diagnosis, combining the separate DSM-IV pervasive developmental disorder (PDD) diagnoses: autistic disorder, Asperger syndrome, childhood disintegrative disorder, and pervasive developmental disorder not otherwise specified (PDD-NOS). Rett syndrome is no longer included in the DSM-5 ASD, as it is considered a separate neurological disorder.

According to the study by Zeidan et al. (2022) adopted by the WHO, a ratio of approximately 1 child with ASD in 100 children is estimated worldwide. Prevalence estimates have increased over time and vary considerably within and between sociodemographic groups. In North Africa and the Middle East, this estimate is much lower than the global estimate with 0.13%

(Akomolafe et al., 2024), an estimate to be taken with caution given the lack of precise data (Ebrahimi Meimand et al., 2023), in Algeria the number of ASD subjects is estimated at 500,000 with a proportion of 1/150 (Boulekrone, 2022). The sex of the subject seems to impact the prevalence of ASD, which appears to be more frequent in men than in women, with a ratio of 4 men for a woman¹ (Fombonne, 2009). Recently, a meta-analysis reported a ratio of 3 men to 1 woman (Loomes et al., 2017).

The DSM5 in its revised version (DSM5-TR, 2022) emphasizes the Persistent Deficit in Social Communication and Social Interaction in Multiple Contexts. In this sense, we can find deficits in socio-emotional reciprocity, ranging, for example, from an abnormal social approach and the inability to dialogue normally; to a reduced sharing of interests, emotions or affects; to the inability to initiate or respond to social interactions. Deficits also affect nonverbal communication behaviors used for social interaction, ranging, for example, from poorly integrated verbal and nonverbal communication; to abnormalities in eye contact and body language or deficits in understanding and using gestures; to a complete absence of facial expressions and nonverbal communication. On the other hand, Deficits in the development, maintenance and understanding of relationships, ranging, for example, from difficulties in adapting one's behavior to various social contexts; difficulty sharing imaginative play or making friends; lack of interest in peers.

In individuals with ASD, language development is particularly impacted from a pragmatic perspective regardless of language level or age (Baird & Norbury 2016; La Valle et al. 2020). Seen from this perspective, children with autism often present with incomplete stages of language processing and use (Cantiani et al., 2016; DiStefano et al., 2019). These difficulties, evident in social communication among individuals with autism, often manifest as verbal or nonverbal difficulties. These individuals generally have difficulty respecting social conventions and switching from the role of speaker to that of listener in conversations, which underlines the pragmatic complexity of their social interactions. Given the considerable prevalence of these difficulties in children and their impact on social communication (Cheng et al., 2022). Pragmatic skills require the use of both language and social context to achieve the intended meaning. As such, they lie at the intersection of structural language and social skills (Volden et al. 2009). Although Norbury (2014) argued that pragmatic language skills are closely related to the structural aspects of language, and are not necessarily identical to social communication skills, others emphasize the interaction between social communication deficits and the pragmatic dimension (Hage et al., 2021). Social communication refers to the communication of cognitive and emotional information through facial expressions, gestures, and prosody, as well as through the implicit understanding of pragmatics and theory of mind (Tanguay et al., 1998). According to Costescu et al. (2022), several terms are used interchangeably to refer to social communication, such as pragmatic communication or pragmatic language. These communicative deficits would be explained by the theory of mind, this term was first used by Premack and Woodruff, who defined it as the ability of an individual to attribute different mental states to themselves as well as to others (Polónyiová et al., 2024); Theory of mind remains one of the essential capacities that make us human (Whiten, 1993). By theory of mind, we mean the ability to infer the set of mental states (beliefs, desires, intentions, imagination,

emotions, etc.) that induce action. In summary, having a theory of mind is being able to reflect on the contents of one's own mind and those of others. Difficulty understanding the minds of others is a fundamental cognitive characteristic of autism spectrum disorders. These difficulties appear to be universal among these individuals (Baron-Cohen, 2001).

Individuals with ASD generally perform significantly worse on tasks designed to measure ToM than typically developing individuals (Mathersul et al., 2013; Peterson et al., 2012). These deficits appear in a variety of theory of mind tasks, including those examining false belief (Baron-Cohen et al., 1985), the wrong steps (Baron-Cohen, et al., 1999), cartooning (Castelli et al., 2002), or inferring mental states from photographs (Baron-Cohen et al., 1997). Other research has shown that the ability to successfully perform such theory of mind tasks varies with age, IQ, and the nature of the task (Begeer, Malle, et al., 2010). Based on this literature review, we will seek, through this study, to evaluate some of the tasks of the theory of mind in the cognitive and emotional domains in children with moderate ASD at school age. Here we limit ourselves to: first-degree false belief, inference of feelings based on desire, inference of hidden feelings and distinction of feelings. From the above we formulate the following question: does the child with ASD present a deficit in first-degree false belief, inference of feelings based on desire, inference of hidden feelings and distinction of feelings?

2- Methodology

2-1- Method

This study is descriptive in nature. We will conduct a quantitative assessment of the abilities of children with ASD in:

- False belief in the first degree.
- The inference of feelings based on desire.
- The distinction of feelings.

2-2- Work sample

Our working sample consists of six children with ASD of average type according to the CARS scale. Table 1 shows the characteristics of our sample.

Table 1. *Characteristics of the working sample.*

Case	Intelligence quotient	Age	Sex
1	Normal	9 years old	Male
2	Normal	7 years old	Male
3	Normal	7 years old	Male
4	Normal	8 years old	Male
5	Normal	9 years old	Male
6	Normal	8 years old	Male

As we can see our sample consists of male children with an age ranging from 7 to 9 years and normal intelligence.

2-3- Assessment tools

A- Autism Assessment Tool

To determine the degree of autism in the cases studied, we used the Childhood Autism Rating Scale (CARS). This scale includes 15 items to detect behavioral deviations in social relationships, attachment, emotional responses, body use, object use, adaptation to change, visual responses, taste, smell and touch, auditory production patterns, responses to fear and anxiety, nonverbal communication, verbal communication, activity level and intelligence level. Each of these items is rated on a scale of 1 to 3.5 points, indicating the degree of behavioral deviation of the child compared to a normal case. We used it in our study to determine the degree of autism in the case studied.

B- Theory of Mind Assessment Tool

We applied the theory of mind test designed by Morgane Brunel (2004). This test consists of three stages and assesses most theory of mind tasks. It is a nonverbal test that requires only some basic acquisitions from the child and consists of seven theory of mind tasks. We used only four tasks in this study: a cognitive task (first-order false belief) and emotional tasks (emotion discrimination, covert emotion inference, and desire-based emotion inference). The test contains instructions illustrated with pictures representing the tasks. Scoring is one point for each correct answer and zero for failure.

We ensured an optimal working environment with individual assessment. We will present the quantitative results and their analysis below.

3- Presentation of results

3-1- Results relating to affective tasks of the theory of mind

Table 2 summarizes in percentage the results relating to the affective tasks of the theory of mind.

Table 2. *Percentage of results relating to ToM affective tasks.*

Tasks %	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Distinguishing emotions	58.33	66.66	62.5	62.5	54.32	87.5
Recognizing feelings based on desire	8.33	12.5	50	12.5	16	8.53
Recognizing true feelings	3.33	16	33	33	8.33	16.33

Figure 1 represents the results shown in Table 2.

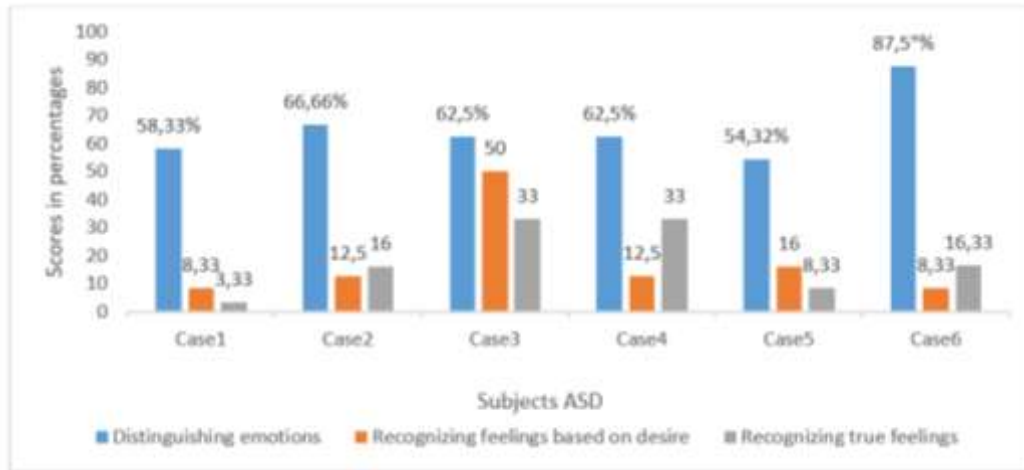


Figure 1. Percentage columns for ToM affective task results.

3-2- Results relating to cognitive tasks of the theory of mind

Table 3 summarizes in percentage the results relating to the cognitive tasks of the theory of mind: False belief in the first degree.

Table 3. Percentage of results for cognitive tasks in the ToM..

CASE	Scores %
1	8.33
2	5
3	4.16
4	5
5	8.33
6	12

Figure 2 represents the results shown in Table 3.

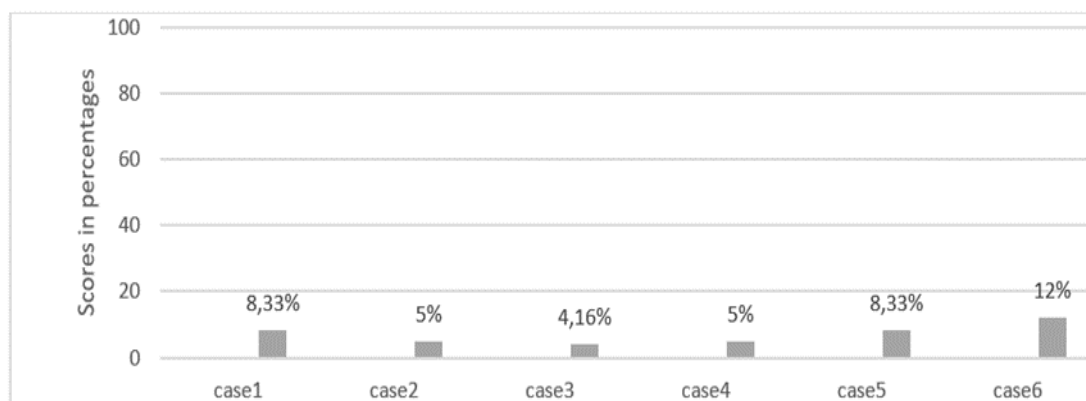


Figure 2. Percentage columns for results on cognitive tasks in the ToM.

In order to have an overview for the four theory of mind tasks we calculated the average of the scores as shown in Table 4 and Figure 3.

Table 4. Average scores for ToM tasks.

Tasks	Average score
Distinguishing emotions	65.3
Recognizing feelings based on desire	18.33
Recognizing true feelings	17.94
False belief in the first degree	7.13

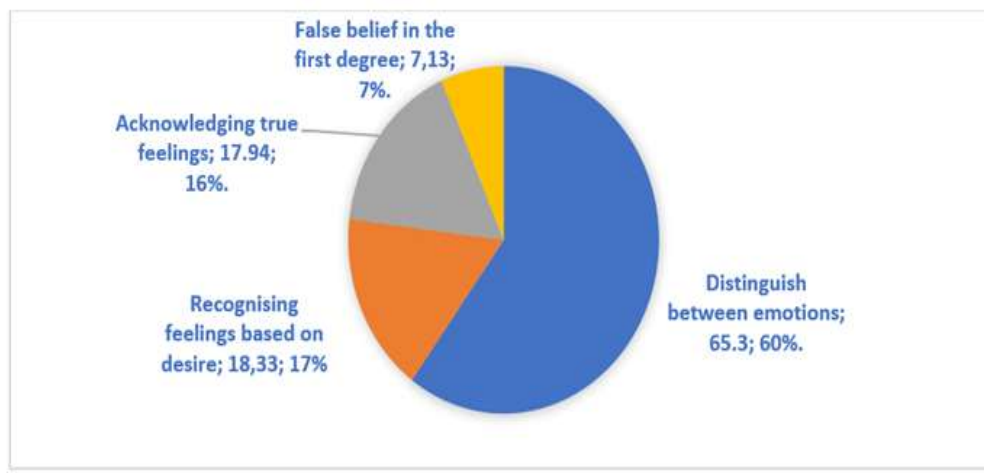


Figure 3. Pie chart of average ToM task scores.

4- Analysis and discussion

The results for the affective tasks, presented in Table 2 and Figure 1, show a marked difference in performance related to the emotional aspect of theory of mind. When analyzing the initial tasks related to emotion discrimination, the results for this task were relatively acceptable, with cases recording similar percentages above 50% in a range from 58.33% to 87.5%. This indicates that children with ASD are relatively better able to recognize emotions associated with desires. This may be explained by the fact that desires are linked to basic needs, which may be more obvious and easier for them to identify, thanks to the possibility of early therapeutic interventions. Overall, children show a reasonable ability to understand desires and link them to feelings. This is consistent with studies indicating that this type of task is less complex than others. According to Baron-Cohen, the gaze detection and intentionality modules are not affected in autism. He specifies that some autistic people do not suffer from a total absence of the theory of mind, but rather from a delay in the development of this capacity without ever reaching the level of maturity (Fooudon cited by Trari Medjaoui & Abderrahim, 2021).

Regarding the desire-based emotion recognition task, a sharp decline in results was observed, with values ranging from 8.33% to 12.5% across all cases. This deterioration in performance

indicates that children have difficulty distinguishing complex emotions, requiring a greater ability to read facial expressions or understand indirect emotions and tone of voice, indeed according to Suslow et al. (2023) The ability to recognize facial expressions of emotions plays a vital role in establishing interpersonal bonds from an early age, as it is essential for understanding the intentions and feelings of other individuals. From an early age, children with ASD generally show reduced interest in the emotional behaviors and faces of others (Dawson et al., 2012). We also recorded percentages regarding the covert emotion recognition task with values ranging from 3.33% to 33%, with a notable difference between cases. This large difference could be due to individual differences between children, as well as the length of care and educational support. It also indicates that children have a clear difficulty recognizing hidden emotions, which requires inferences of emotions based on indirect situations.

In this study, we assessed a single task from the cognitive perspective of theory of mind: first-order false belief. The graph immediately shows that all six subjects achieved very low scores, ranging from 4.16% to 8.33%. This indicates a clear weakness in the ability to manage false belief, a cognitive skill that requires understanding that others may hold beliefs that differ from reality. This skill is essential for theory of mind and is often difficult for children with autism spectrum disorders to master due to their limited ability to understand another's perspective (Fouad et al., 2018).

The circle of mean ratios clearly shows that the six children with ASD failed in most tasks, especially in the hidden emotion recognition task, where we recorded 18.33%, which requires understanding subtle and indirect signals, such as hidden facial expressions, body language, or understanding social context, which is difficult for children with ASD. The overall average for the desire-based emotion recognition task was also low, at 17.94%, which explains the inability of children with ASD to understand that others' emotions are based on their desires. We also found very poor results in the first-order false belief task in all cases, where the overall average performance did not exceed 7.33%. This indicates that children are unable to understand that others may have beliefs different from their own, while we recorded a relatively high average compared to previous tasks in the emotion recognition task, which reflects the importance and role of early intervention because this task relies on clear cues such as facial expressions or tone of voice, which are easy to develop with training and repetition. From a neurological point of view, observations made with FMRI show that the prefrontal cortex, which is involved in conscious cognitive processing but also social interaction, seems less activated in subjects with ASD during theory of mind tasks (O'Nions et al., 2014).

5- Conclusion

The results obtained allowed us to observe that children with ASD suffer from deficits in theory of mind tasks, although we did not consider all levels, but only some elementary tasks: hidden emotion elicitation task, emotion recognition task, first-order false belief task. The results ranged from low to above average in all cases.

These challenges highlight the importance of developing early intervention programs focused on developing theory of mind to improve social communication and interaction skills. Strategies that rely on repetition and practice may be useful in improving these skills. The study

also highlights the need for further studies focused on developing more accurate and comprehensive assessment tools to understand individual differences among children with ASD.

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