Theory of mind in children with attention deficit hyperactivity disorder

Beatriz Coelho, Bárbara Mota, Victor Viana, Ana I. Igreja, Linda Candeias, Hélia Rocha, Diogo Fernandes-da Rocha, Micaela Guardiano

Introduction. Theory of mind (TM) is involved in social cognition, as it evaluates our ability to impute our mental states to the others in order to predict and explain behaviour. In the literature, it has been noticed that children with attention deficit hyperactivity disorder (ADHD) show some impairments of TM when compared with children not neurodevelopmental impaired. Our goal in this study was to compare the TM in two groups: schooler children with normal development and schooler children with ADHD.

Subjects and methods. A total of 35 children, aged between 6 and 12 years, were recruited: 17 with ADHD and 18 not neurodevelopmental impaired. TM was evaluated using an assessment method validated for the Portuguese population: Turtle on the Island-Battery of Assessment of Executive Functions in Children.

Results. We obtained two comparable groups concerning sociodemographic data. There were no significant differences between the two groups regarding TM.

Conclusion. The TM assessment in Portuguese children did not reveal significant impairment regarding this cognitive skill in children with ADHD.

Key words. ADHD. Children. Executive functions. Neurocognitive development. Social cognition. Theory of mind.

Faculty of Medicine (B. Coelho). Faculty of Food Sciences and Nutrition Sciences (V. Viana). Psychology Center. Universidade do Porto (H. Rocha). Centro Hospitalar Universitário São João. Porto (B. Mota, V. Viana, A.I. Igreja, D. Fernandes-da Rocha, M. Guardiano). Prisma-Centro de Desenvolvimento e Terapias. Custóias, Portugal (L. Candeias).

Correspondence:
Dr. Beatriz Coelho. Faculdade de Medicina. Universidade do Porto. Alameda Prof. Hernâni Monteiro, 4200-319 Porto, Portugal.

E-mail:
beatrizccoelho4@gmail.com

ORCID:
0009-0001-4924-4028 (B.C.).

Accepted:
10.07.23.

Conflict of interests:
The authors declare no conflicts of interest.

How to cite this article:
Cruz B, Mota B, Viana V, Igreja AI, Candeias L, Rocha H, et al. Theory of Mind in children with ADHD. Rev Neurol 2023; 77: 109-14. doi: 10.33588/rn.7705.2023099.

Versión española disponible en www.neurologia.com

Introduction

Theory of Mind (TM) is a complex neurodevelopmental milestone that combines social and cognitive abilities, usually acquired around 4 to 6 years of age in children with normal neurocognitive development [1]. This competence gives to the individuals the ability to recognize their own mental states, but also other people's mental state by anticipating their feelings, beliefs, desires, and intentions [2]. This becomes even more evident when we have to face a social context where we must adapt our behaviour and interactions to others [3].

The evaluation of TM, in childhood, is based on children's tales, with a character who has a belief different from the reality and, therefore, has the false belief paradigm as a pillar [4,5]. It is expected that around 4 to 5 years of age, children are able to successfully perform false belief tasks and that from 6 years onwards they can understand second-order mental states (i.e., inference made by a child about a character's mental state regarding a third character) [6]. However, we cannot rule out other factors that may influence the acquisition of these skills, such as language, the quality of learning and social interaction, family context and socioeconomic level [7].

The relationship between TM and autism spectrum disorder (ASD) is well established, with deficits in these skills clearly recognized in individuals with the latter [8]. These translate into changes in focus, eye contact, word's double meaning, use of communication, recognition of facial expressions and affective reciprocity, which ultimately interferes with social interactions.

Recent studies have compared groups of children with attention deficit hyperactivity disorder (ADHD), ASD, and normal neurodevelopment on cognitive tasks such as TM. Those results confirmed the previous known deficits in ASD, but also demonstrate that children with ADHD performs worse than children in the control group. Although children with ADHD usually performs better performance than children with ASD, when focusing on second-order false belief tasks, it appears that the results were similar between the two groups [9-11].

In children with ADHD, impairment of executive functions has been described [12,13]. The com-

mon ground between TM and executive function comes from their shared brain affected areas (frontal lobe), from both influencing the children's neurodevelopment and having an identical starting age and, ultimately, from the fact that TM rely to some extent on behavioural inhibition and working memory (executive functions).

The main goal of our study was to compare, in the Portuguese population, the TM of school-aged children with ADHD to schooler children with normal development.

Subjects and methods

Participants and procedure

We conducted a cross-sectional observational study. A total of 35 children were included: 17 children with ADHD and 18 children with normal neurodevelopment. Their ages varied from 6 to 12 years. Informed consent was collected from all the guardians' children. The study was submitted and authorized by the Ethics Committee of Centro Hospitalar Universitário São João. Children with ADHD were selected from the medical records of Pediatrics Neurodevelopment Unit of Centro Hospitalar Universitário São João (all met diagnosis criteria according to the *Diagnostic and statistical manual of mental disorders, fifth edition* criteria [14], and in all cases the Conners Rating Scale was applied to parents and professors). Of the 17 children with ADHD, only one was not receiving pharmacological therapy. The others were medicated with psychostimulants, namely methylphenidate, but their parents were told to stop the medication on the day of the evaluation (minimum time from the last dose of 24 hours). We excluded from our study children with other co-morbidities such as psychiatric or neurodevelopmental disorders, cognitive impairment or motor/sensory deficits.

Children included in the control group were recruited through primary care (without any explicit reference to neurodevelopmental disturbance).

The tests applied were performed under the supervision of a physician and with parents present (mean evaluation duration was 20-30 minutes). Considering socio-demographic data, we collected information about sex, age, and parents' degree. Parents were also asked to fill a questionnaire about educational support, such as speech and occupational therapies, psychology follow-up and what educational measures were implemented at school.

Material

TM was evaluated using the assessment method validated for the Portuguese population: Turtle on the Island-Battery of Assessment of Executive Functions in Children *(Tartaruga na ilha-Bateria de Avaliação de Funções Executivas em Crianças)* [15].

This method was developed with the intent to complement the assessment of executive functions in the Portuguese population, specifically in the paediatric setting (which lacked instruments developed in European Portuguese for this purpose). It is composed by a set of tests that assesses cognitive executive functions (verbal fluency, attention, memory, and planning), emotional executive functions (TM, irony, and emotional decision) and mixed executive functions (direction). In each test, it is possible to obtain an independent score and compare that to the corresponding percentile for age.

Regarding the TM assessment method, this consists of three tests, with different levels of complexity, which are presented in a cartoon format where the child is invited to follow the sequence of events and then say what he/she thinks it will happen:

'At night' *('À noite'):* this is the first test and, therefore, the least complex. Evaluates the ability to understand the subject's point of view (TM0).

'The snack' *('O lanche'):* this second test assesses the ability to understand the point of view of two subjects simultaneously, common and different (TM1).

'The snack 2' *('O lanche 2'):* this is the third test and the most complex. Assesses the ability to perceive what the subject does or does not know about what the character knows (TM2).

Example of first test ('At night'): comic strip, featuring two little houses in a night setting a penguin and a turtle. The turtle says goodbye to the penguin and enters the little red house. However, the turtle moves into the blue house when the penguin is sleeping. When the next day arrives, the question arises 'Where is the turtle?' (question wanting to understand the story and the reality), 'Where does the penguin think the turtle is?' (aiming to understand the penguin's perspective), 'Where do you think the penguin will look for the turtle?' (inference related to the penguin behaviour). This story is told to the child by simultaneously pointing to the respective images and asking the questions at the end.

With the score obtained in the TM evaluation, we were able to objectify the children's performance and place them in the corresponding devel-

opment stage and, simultaneously, perceive if each of them were able to integrate only one perspective or two crossed perspectives.

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 27. When applying the Kolmogorov-Smirnov test, we noticed that the TM-related data did not follow a normal distribution. For that reason, statistical analysis was performed using non-parametric tests, namely the Mann-Whitney U Test. A significance level of p <0.05 was defined.

A descriptive and comparative analysis of the collected sociodemographic data was carried out.

Results

From table I, we note that the average age in the ADHD group is 8.9 years and in the control group is 8.4 years, meaning that there isn't statistically significant difference between them. Regarding the sex distribution and mother's education, there isn't either a statistically significant difference. Thus, regarding sociodemographic data, the two groups are comparable.

When analysing the results of the different TM evaluations, the median values (50th percentile) were considered instead of the mean values [15]. This procedure was adopted because the distribution of these results does not follow a normal distribution and the median is considered a more robust index even in situations of small samples [16]. Since the median values vary according to age groups, to obtain comparable results at different ages, the percentage of the median was calculated for each one [17]. The mean presented in the results (Table II) corresponds to the mean of the percentage calculated to each one. Total TM score refers to the combination of the results in the three tests.

By analysing table II, we concluded that there aren't any statistically significant differences between the two groups. However, we acknowledged that the control group is, on average, in a higher percentile, when compared to the ADHD group.

We also compared the performance on each test and total score regarding the attendance or not of educational support. We observed that children with ADHD that have certain educational support (occupational therapy, psychology follow-up and school adaptions) does not perform different to the ones that haven't. However, when we compared those children with ADHD who have speech therapy, we find a positive correlation in those who attended and their performance on TM2 test (TM2 percentile). It should also be noted that, although we did not find any significant differences, the children with ADHD who attended occupational therapy performed better than those who did not.

Table I. Analysis of sociodemographic data of children and mothers.

	n (%) ADHD	Control	*p*
Sex			
F	5 (29.4)	10 (55.6)	0.125
M	12 (70.6)	8 (44.4)	
Age (mean)	8.9	8.4	0.317
Mother's education			
Primary school	0	0	0.801
5th-6th grade	3 (17.6)	3 (16.7)	
7th-9th grade	4 (23.5)	6 (33.3)	
High School	4 (23.5)	3 (16.7)	
University	6 (35.3)	6 (33.3)	

ADHD: attention deficit hyperactivity disorder; F: female; M: male.

Table II. Comparison of each test (TM0, TM1 and TM2) and the theory of mind score (TotalTM) in the different groups.

	Mean		*p*
	ADHD	Control	
TM0	104.9	120.37	0.405
TM1	101.96	120.37	0.207
TM2	99.41	111.67	0.443
TotalTM	102.09	117.47	0.077

ADHD: attention deficit hyperactivity disorder.

Discussion

The main objective of our study was to compare, in the Portuguese population, the results of TM in school-aged children with ADHD to school-aged children with normal neurodevelopment. Different from what has being reported so far in the literature, we did not find any significant differences between the two groups.

Although ADHD and ASD are distinct disorders, it is believed that they are related since they present similarities in the cognitive and affective domains, although with characteristic profiles. The existence of opposite patterns has been studied since ADHD has more marked deficits in inhibitory control and children with ASD have increased difficulties in cognitive flexibility and planning [18]. Furthermore, dysfunction of the frontostriatal system has been presented as an aetiology in both disorders, as a factor in social cognition and executive dysfunction [19,20]. However, we cannot forget that brain organization also depends on the environment that surrounds us, being shaped by family factors and the social microsystem [19].

As mentioned, it has been shown that children with ADHD have deficits in some executive functions responsible for self-regulation and inhibitory control, which translate into deficits in working memory, emotional regulation, and cognitive flexibility [21]. At the same time, deficits in the social cognition of these children have been demonstrated using TM, which appears affected when compared to children with normal neurodevelopment. Thus, the relationship between executive functions and TM in the context of this disorder is hypothesized. In fact, there are several characteristics that corroborate this relationship, such as the fact that both are affected in certain neurodevelopmental disorders, such as ASD; that self-control and the ability to understand 'false-belief' develop simultaneously; that they share the same neuroanatomical areas, such as the frontal lobe; and yet, the need for behavioural inhibition and working memory to perform TM tasks [12,21,22].

Some studies have shown that children with ADHD have early TM skills preserved, but their deficits in executive functions and their difficulty in establishing social relationships deprive them of developing adequate social cognitive skills, causing deficits in the use of social skills [18,19,23]. In fact, one study, Mary et al [24], demonstrated that, controlling for inhibition and attention (executive functions), TM results in children with ADHD were similar to children with normal neurodevelopment, which may indicate a unidirectional relationship between executive functions and deficits in TM [24]. This seems to go against some theories that consider the TM deficit as a secondary and consequent symptom of executive system dysregulation [12,25,26]. Supporting this hypothesis, it is known that the administration of psychostimulants causes changes in the activity of affected areas, mainly the increase in activation of the frontal cortex, one of the main areas of cognitive control, and, during tasks that require attention, improves performance by normalizing the right caudate nucleus [27,28].

Regarding our results, we have two comparable groups, since no significant differences were demonstrated between age, sex, and mother's education. The analysis of the TM results shows that there are no significant differences between the two groups. Despite this, we were able to perceive that the control group had, on average, better results than the group with ADHD. In fact, there may be different reasons for not observing differences, such as the use of different inclusion and exclusion criteria; having a small sample; pharmacological treatment, whose long-term effect we cannot exclude; and, as well, the fact that we have not discriminated the severity of the disorder, since the literature shows us that severe ADHD is related to worse performance in the TM [29].

Although most of the studies in this area found significant differences when comparing children with ADHD and children with normal neurodevelopment, there are studies like ours that did not find that. In addition to the study mentioned before [24], Pitzianti et al [30] did not find any significant differences in TM tasks when comparing children with drug-naive ADHD and healthy children. Like our study, this one was limited by its small sample, with 23 children with ADHD and 20 with normal neurodevelopment, aged between 7-15 years. However, these studies demonstrate that, in fact, there are contradictory results on this subject and that we cannot conclude with certainty that there are deficits in TM in children with ADHD [30].

The presence of different inclusion and exclusion criteria may also influence the results. Some studies excluded controls with a family history of first-degree ADHD [31,32]; and two studies excluded children with ADHD who had some type of therapy in social cognition [12] and another one that excluded children under pharmacological therapy [32], should also be highlighted.

One of the factors to consider, as mentioned, is the pharmacological treatment of this disorder. Regarding the action of psychostimulants, it was demonstrated that these drugs promote a significant improvement in executive functions and, therefore, a better performance in TM [28,33].

Although it is not possible for us to draw conclusions about the impact of different therapies, due to the small sample size, it is important to reflect on the impact of cognitive therapies in children with this disorder. Some studies have shown that cognitive-

behavioural therapies have a positive effect on executive functions [34]. Other studies have reported that cognitive therapies help to improve attention which will have a positive impact on TM [35].

Conclusions

This study is included in a project that intends to evaluate the TM in children with ADHD comparing them with children with ASD in the Portuguese population. In the first phase of our investigation, no significant differences were found in the TM assessment when comparing a group of children with ADHD to a group of children with normal neurodevelopment.

In the future, it is important that other studies, in Portuguese population, include a larger sample and carry out the assessment prior to the institution of pharmacological therapy.

References

1. Şahin B, Karabekiroğlu K, Bozkurt A, Usta MB, Aydın M, Çobanoğlu C. The relationship of clinical symptoms with social cognition in children diagnosed with attention deficit hyperactivity disorder, specific learning disorder or autism spectrum disorder. Psychiatry Investig 2018; 15: 1144-53.
2. Happé F, Cook JL, Bird G. The structure of social cognition: in(ter)dependence of sociocognitive processes. Annu Rev Psychol 2017; 68: 243-67.
3. Slaughter V, Imuta K, Peterson CC, Henry JD. Meta-analysis of theory of mind and peer popularity in the preschool and early school years. Child Dev 2015; 86: 1159-74.
4. Wellman HM, Cross D, Watson J. Meta-analysis of theory-of-mind development: the truth about false belief. Child Dev 2001; 72: 655-84.
5. Osorio A, Castiajo P, Ferreira R, Barbosa F, Martins C. Metodologias de avaliação do desenvolvimento da cognição social da infância até à idade pré-escolar. Análise Psicológica 2011; 29: 259-74.
6. Devine RT, Hughes C. Silent films and strange stories: theory of mind, gender, and social experiences in middle childhood. Child Dev 2013; 84: 989-1003.
7. Grazzani I, Ornaghi V, Conte E, Pepe A, Caprin C. The relation between emotion understanding and theory of mind in children aged 3 to 8: the key role of language. Front Psychol 2018; 9: 724.
8. Baron-Cohen S, Wheelwright S, Hill J, Raste Y, Plumb I. The 'Reading the Mind in the Eyes' test revised version: a study with normal adults, and adults with Asperger syndrome or high-functioning autism. J Child Psychol Psychiatry 2001; 42: 241-51.
9. Bora E, Bartholomeusz C, Pantelis C. Meta-analysis of theory of mind (ToM) impairment in bipolar disorder. Psychol Med 2016; 46: 253-64.
10. Buitelaar JK, van der Wees M, Swaab-Barneveld H, van der Gaag RJ. Theory of mind and emotion-recognition functioning in autistic spectrum disorders and in psychiatric control and normal children. Dev Psychopathol 1999; 11: 39-58.
11. Miranda-Casas A, Baixauli-Fortea I, Colomer-Diago C, Roselló-Miranda B. Autismo y trastorno por déficit de atención/hiperactividad: convergencias y divergencias en el funcionamiento ejecutivo y la teoría de la mente. Rev Neurol 2013; 57 (Suppl 1): S177-84.
12. Lavigne R, González-Cuenca A, Romero-González M, Sánchez M. Theory of mind in ADHD. A proposal to improve working memory through the stimulation of the theory of mind. Int J Environ Res Public Health 2020; 17: 9286.
13. Szamburska-Lewandowska K, Konowałek Ł, Bryńska A. Theory of mind deficits in childhood mental and neurodevelopmental disorders. Psychiatr Pol 2021; 55: 801-13.
14. Regier DA, Kuhl EA, Kupfer DJ. The DSM-5: classification and criteria changes. World Psychiatry 2013; 12: 92-8.
15. Mesquita MIQM. Avaliação das funções executivas em crianças: estudos psicométrico, desenvolvimental e neuropsicológico. Repositório Institucional da Universidade Fernando Pessoa - FCHS (DCPC) - Teses de Doutoramento 2011.
16. Leys C, Ley C, Klein O, Bernard P, Licata L. Detecting outliers: do not use standard deviation around the mean, use absolute deviation around the median. Journal of Experimental Social Psychology 2013; 49: 764-6.
17. Cole TJ, Faith MS, Pietrobelli A, Heo M. What is the best measure of adiposity change in growing children: BMI, BMI %, BMI z-score or BMI centile? Eur J Clin Nutr 2005; 59: 419-25.
18. Miranda A, Fortea I, Colomer C, Miranda B. Autismo y trastorno por déficit de atención/hiperactividad: convergencias y divergencias en el funcionamiento ejecutivo y la teoría de la mente. Rev Neurol 2013; 57: 177.
19. Miranda A, Berenguer C, Roselló B, Baixauli I, Colomer C. Social cognition in children with high-functioning autism spectrum disorder and attention-deficit/hyperactivity disorder. Associations with executive functions. Front Psychol 2017; 8: 1035.
20. Gargaro BA, Rinehart NJ, Bradshaw JL, Tonge BJ, Sheppard DM. Autism and ADHD: how far have we come in the comorbidity debate? Neurosci Biobehav Rev 2011; 35: 1081-8.
21. Pineda-Alhucema W, Aristizabal E, Escudero-Cabarcas J, Acosta-López JE, Vélez JI. Executive function and theory of mind in children with ADHD: a systematic review. Neuropsychol Rev 2018; 28: 341-58.
22. Carlson SM, Mandell DJ, Williams L. Executive function and theory of mind: stability and prediction from ages 2 to 3. Dev Psychol 2004; 40: 1105-22.
23. Perner J, Kain W, Barchfeld P. Executive control and higher-order theory of mind in children at risk of ADHD. Infant and Child Development 2002; 11: 141-58.
24. Mary A, Slama H, Mousty P, Massat I, Capiau T, Drabs V, et al. Executive and attentional contributions to theory of mind deficit in attention deficit/hyperactivity disorder (ADHD). Child Neuropsychol 2016; 22: 345-65.
25. Barkley RA. Attention-deficit/hyperactivity disorder. Behavioral and emotional disorders in adolescents: nature, assessment, and treatment. New York, NY, US: Guilford Publications; 2006.
26. Pineda-Alhucema W, Puentes-Rozo P. Estudio *ex post facto* de la teoría de la mente en niños escolarizados diagnosticados con trastorno por déficit de atención-hiperactividad. Tesis Psicológica 2013; 8: 144.
27. Hart H, Radua J, Nakao T, Mataix-Cols D, Rubia K. Meta-analysis of functional magnetic resonance imaging studies of inhibition and attention in attention-deficit/hyperactivity disorder: exploring task-specific, stimulant medication, and age effects. JAMA Psychiatry 2013; 70: 185-98.
28. Rubia K, Alegria AA, Cubillo AI, Smith AB, Brammer MJ, Radua J. Effects of stimulants on brain function in attention-deficit/hyperactivity disorder: a systematic review and meta-analysis. Biol Psychiatry 2014; 76: 616-28.
29. Kılınçel Ş. The relationship between the theory of mind skills and disorder severity among adolescents with ADHD. Alpha Psychiatry 2021; 22: 7-11.
30. Pitzianti M, Grelloni C, Casarelli L, D'Agati E, Spiridigliozzi S, Curatolo P, et al. Neurological soft signs, but not theory of mind and emotion recognition deficit distinguished

children with ADHD from healthy control. Psychiatry Research 2017; 256: 96-101.
31. Parke EM, Becker ML, Graves SJ, Baily AR, Paul MG, Freeman AJ, et al. Social cognition in children with ADHD. J Atten Disord 2021; 25: 519-29.
32. Maoz H, Gvirts HZ, Sheffer M, Bloch Y. Theory of mind and empathy in children with ADHD. J Atten Disord 2019; 23: 1331-8.
33. Maoz H, Tsviban L, Gvirts HZ, Shamay-Tsoory SG, Levkovitz Y, Watemberg N, et al. Stimulants improve theory of mind in children with attention deficit/hyperactivity disorder. J Psychopharmacol 2014; 28: 212-9.
34. Shuai L, Daley D, Wang YF, Zhang JS, Kong YT, Tan X, et al. Executive function training for children with attention deficit hyperactivity disorder. Chin Med J (Eng) 2017; 130: 549-58.
35. Abdollahian E, Mokhber N, Balaghi A, Moharrari F. The effectiveness of cognitive-behavioural play therapy on the symptoms of attention-deficit/hyperactivity disorder in children aged 7-9 years. Atten Defic Hyperact Disord 2013; 5: 41-6.

Teoría de la mente en niños con trastorno por déficit de atención/hiperactividad

Introducción. La teoría de la mente (TM) está involucrada en la cognición social, ya que evalúa nuestra capacidad para atribuir estados mentales a los demás con el fin de predecir y explicar el comportamiento. En la bibliografía, se ha observado que los niños con trastorno por déficit de atención/hiperactividad (TDAH) muestran algunas alteraciones en la TM en comparación con los niños sin problemas de neurodesarrollo. Nuestro objetivo en este estudio fue comparar la TM en dos grupos: niños en edad escolar con desarrollo normal y niños en edad escolar con TDAH.

Sujetos y métodos. Se reclutó a 35 niños con edades comprendidas entre los 6 y los 12 años: 17 con TDAH y 18 sin problemas de neurodesarrollo. La TM se evaluó utilizando un método de evaluación validado para la población portuguesa: Tortuga en la Isla-Batería de Evaluación de Funciones Ejecutivas en Niños.

Resultados. Obtuvimos dos grupos comparables en cuanto a datos sociodemográficos. No hubo diferencias significativas entre los dos grupos en cuanto a la TM.

Conclusiones. La evaluación de la TM en niños portugueses no reveló alteraciones significativas en esta habilidad cognitiva en niños con TDAH.

Palabras clave. Cognición social. Desarrollo nerocognitivo. Funciones ejecutivas. Niños. TDAH. Teoría de la mente.