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The Challenging Role of Theory of Mind in the Mothers of Children with Attention Deficit - Hyperactivity Disorder

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ABSTRACT

Background: While theory of mind (ToM) deficit is frequently reported in children and adult with ADHD, there is no study investigating characteristics of ToM in their parents. This study aimed to investigate understanding intentionality as an important component of ToM ability in ADHD mothers and typically developing children's mothers.

Methods: Through available sampling, (50 mothers), 23 ADHD's mothers were compared to 27 age and IQ matched typically developing children's mothers. All participants were assessed using the Animated Triangle Task for ToM performance and the Conners' Continuous Performance Test (CPT) to evaluate neurocognitive performance. The Mann–Whitney and t-test were used as data analysis methods to examine differences between two groups.

Results: poor performance of ADHD mothers was at ToM task. ($p < 0.001$) However, no significant difference was found between the two groups of mothers in CPT-II performance ($p > 0.001$). Performance of ToM was not significantly associated with CPT-II.

Conclusions: ADHD mothers may have deficits in understanding intentionality**.** The findings suggest that researchers pay more attention to recognizing social cognition and social communication characteristics of the parents of ADHD children. It seems that using specific training programs for the parents of ADHD children to achieve ToM capacities can contribute to the pro motion of their children's social development.

Keywords: ADHD, Theory of Mind, Mental States, Executive Functions

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Introduction

Attention deficit - Hyperactivity disorder (ADHD) is a common neurodevelopmental disorder in children and adults with an estimated prevalence of around 7% in general population (Thomas et al., 2015). It is characterized by inattention, impulsivity, hyperactivity, and significant impairment of the daily functioning(Barkley & Murphy, 1998). Although social impairments are not essential for the diagnosis, more social and interpersonal problems like rejection by peers and conflicts with other children and adults are frequently reported in children with ADHD compared to typically developing children (Nigg, 2013). These inappropriate social behaviors may arise from impaired social cognition, which is defined as the capacity to process and interpret information about oneself and other people in social situations (Caillies et al., 2014), including empathy, emotion perception (EP), attributional style (AS), social perception (SP) and theory of mind (ToM), the latter being the main objective of the current study (Arioli et al., 2018; Uekermann et al., 2010). ToM refers to the ability to recognize and attribute mental states such as desires, beliefs, feelings, thoughts, and intentions to oneself and others and to understand how these mental states might affect behavior (Şahin et al., 2018; Shamay-Tsoory et al., 2005).

ToM deficits have been reported in children with ADHD in the literature. Some studies suggest that ADHD is associated with poorer performance in ToM tasks, which may lead to inappropriate social behaviors and poor interpersonal relationships in these children (Aduen et al., 2018; Uekermann et al., 2010).However, the findings are inconsistent. Papadopoulos et al. (2005) found that children with ADHD were deficient in ToM tasks in comparison with typically developing children. Similar results were reported by Sodian et al. (2003) and Mohammadzadeh et al. (2016). In contrast, Charman et al. (2001) and Dyck et al. (2001) found similar performance in ToM related tasks in children with ADHD as in typically developing children. The results of some follow-up studies investigating ToM deficits in adults with ADHD are also inconsistent. Perroud et al. (2017) found that these patients had impaired mental state thinking. Moreover, Ibanez et al. (2014) reported impaired performance in adults with ADHD while doing ToM task (Reading the Mind in the Eyes Test). In contrast, a meta-analysis study by Bora et al. (2016) did not find any evident ToM impairment in adults with ADHD. Moreover, the study of Abdel-Hamid et al. (2019) found no significant differences between ADHD participants and healthy group in ToM assessment. Inconsistent findings might be due to some differences in the ToM components measured (belief, intention, and desire), task type (verbal or nonverbal), age range of the subjects, and sample size.

Although ToM deficits have been extensively studied in ADHD children, ToM abilities have not been adequately investigated in their relatives.However, studies in other disorders with ToM deficits and typically developing children suggest that genetic and environmental factors may affect children's understanding of mind (Meins, 2013; Xia et al., 2012).

In this respect, a number of researchers have proposed that some environmental factors such as family context might play an important role in children's early understanding of mind (Arranz et al., 2010). Several variables of the family context such as family size, siblings, and the quality of interactions (especially the mother-child interaction) have been associated with ToM capacity of children (Arranz et al., 2002). Maternal mind-mindedness (described as a mother's ability to consider her child as an individual with thoughts, feelings and desires) is one of the most important aspects of mother-child interaction that contributes to the child's development of social understanding and secure attachment (Ontai & Thompson, 2008). Higher levels of mind-mindedness demonstrate a mother's ability to focus and comment appropriately on her child's feeling or mental state, which can predict the child's better

performance in false-belief tasks (Ruffman et al., 2002). In fact, this process helps children to consider people as individuals with intention and mental states, promotetheirsensitivityto other people's mental states, and develop an organized mental representation that can be used to predict and guide behavior (Farrow & Blissett, 2014; Ontai & Thompson, 2008). It seems that mothers who are unable to comprehend their children's mental states may undermine ToM development in their children (Fonagy & Luyten, 2009). These findings may suggest that ToM capacity of mothers may well contribute to children's understanding of themselves and others.

In addition to environmental factors, several studies have supported the notion that the children's understanding of mind is also influenced by genetic factors (Warrier & Baron-Cohen, 2018). Research into autism has provided evidence that mental states might have a genetic basis, and first-degree relatives of these children may have some specific deficits related to autism such as social, communicative, and cognitive deficits (Eyuboglu et al., 2018). Since ADHD is also highly inheritable (Bidwell et al., 2017), genetic susceptibility factors may have a causal influence on the familial risk of ADHD and may increase the risk of ADHD-related features, such as social and communicative impairments in the relatives of these children.

Considering the role of environmental and genetic factors in the development of ToM, there is a possibility of impairment in this ability in parents of children with ADHD. However, limited research has been carried outin this area. Only in one study, Mazzeschi et al. (2019) evaluated parental metallization in parents of ADHD children using self-report and showed they had mentalizing deficits. In this study, ADHD children's mothers had difficulties in understanding why their children showed a particular behavior, and consequently responded to them inappropriately. This finding suggests that impairments in comprehending others intentions may contribute to interpersonal problems and maladaptive parenting in ADHD children's mothers. In this respect, we evaluated intentionality as an important component of ToM using the Animated Triangle Task (ATT). To the best of our knowledge, no study has investigated the ability of ADHD childrenmothers' toappreciateintentionality. We hypothesized that these mothers may show impairments in understanding other people's intentions, which may result in incorrect assumptions about their children's state of mind.

In addition to theory of mind, numerous studies have investigated Executive Functions (EFs) in ADHD. EFs refer to a set of skills required for cognitive control or behavior monitoring (Diamond, 2013). EFs problems have been demonstrated consistently in ADHD and their relatives(Elosúa et al., 2017; Kessler et al., 2006). A meta-analysis of 83 studies revealed that ADHD was associated with significant deficits in EF domains, including inhibition, spatial and verbal working memory, impulsivity, vigilance, organization, and some measures of planning (Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005). However, according to the Barkley's (1997) inhibition model, behavioral disinhibition is the core neuropsychological impairment that leads to secondary abnormalities in other executive functions in ADHD. Previous studies have described a relationship between EFs and ToM in children with ADHD (Caillies et al., 2014; Shin, Lee, Kim, Park, & Lim, 2008). However, to date, no study has examined relationship between these functions in the relatives of these children. In this study, we evaluated sustained attention and inhibition responses using\the\Conner's continuous performance test (CPT-II). Moreover, we examined the relations between EFs and ToM in the mothers of children with ADHD. We hypothesized that the EFs subcomponents and ToM are correlated.

Methods

Participants

This quasi-experimental investigation was

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conducted for 9 months in Cognitive Science Studies Institute. Through the available sampling, a total of 50 mothers with their children in two groups of ADHD and normal participated in this investigation.

Children with ADHD were recruited through the outpatient clinic of child and adolescent psychiatry, and typically developing children were opted fromtypicalprimary schools. A child psychiatrist assigned diagnoses based on DSM-IV (APA 1994) criteria for ADHD. The Conners' Parent Rating Scales—Revised (CPRS-R) was also used to confirm the diagnosis and evaluate the severity of ADHD symptoms (Mohammadzadeh et al., 2016). Initially, the children's mothers (No. 60) were interviewed during routine examinations of their child at the outpatient clinic. Inclusion criteria were similar educational and IQ levels in mothers of ADHD and control groups. Exclusion criteria comprisedthepresenceof any psychiatric disorder, severe neurological pathology, brain trauma, psychosis, and an estimated IQ score < 85 for both groups. We used the Wechsler Adult Intelligence Scale (Wechsler, 1981)to exclude mothers with an intellectual weakness. The reliability coefficients for the WAIS-R subsets were between 0.58 and 0.87 and the test-retest coefficients for the three IQs turned out to bebetween 0.76 and 0.94 in an Iranian population (Abedi, unpublished). We also evaluated symptoms of ADHD using the Conners' Adult ADHD Rating Scales–Self Report: Short Version (Conners, Erhardt, & Sparrow, 2002). Among the mothers who were suitable based on the criteria, 50 mothers (23 mothers of children with ADHD and 27others with typically developing children) agreed to participate. The age range in both groups was 25–47 years. It means was 3.28 (SD=7.59) in mothers of children with ADHD and 37.2 (SD=4.9) in mothers of typically developing children. Participation was voluntary in all cases. All the participants were informed of the study objectives and provided signed informed consent before enrolling.

Measures

All mothers were assessed using the Animated Triangle Task for ToM performance and the Conners' Continuous Performance Test (Conners et al., 2000)for evaluation oftheirneurocognitive performance.

Animated Triangle Task (ATT). ToM was assessed using the Animated Triangle Task (ATT) according to itsoriginal type initially introduced by Castelli(Castelli, Happé, Frith, & Frith, 2000)and redesigned in 2012 by Mohammadzadeh and colleagues (Mohammadzadeh, Tehrani-doost, & Banaraki, 2012). In this test, some animations are displayed on the monitor including one large red and one small blue triangle that move around the black screen, asking participants to express their actions, interactions, and mental states. These triangles may move without interacting (random motion sequence) or may interact with each other (ToM sequence).There are four dimensions to score the means of intentionality, appropriateness, length of phrases, and emotional words. Intentionality demonstrates the degree of attribution of mental states to the animations and is calculated by analyzing the content of each description given by the subjects. Its score ranges from 0 (non-deliberate action) to 5 (deliberate action). Appropriateness of descriptive measures assesses to what extent the event understood by the subject appropriate iscompared to what is intended by the examiner (measured by 0–3 points). Phrase Length describes the number of words and phrases that children use to describe animation (4-4 points).Emotional Word Score calculates emotional expressions (e.g., happy, sad, and afraid) and behaviors which cannot exist without a shared emotional state among the characters (cheering, hugging, and kissing). Shahrivaret al. (2020) assessed reliability of the Animated Triangle Taskin a group of Iranian school-aged children (N= 398). The test-retest reliability was fair to good (0.43 - 0.79) for different groups of animations. The inter-rater agreement was also 80%.

Conners' Adult ADHD Rating Scales–Self

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Report: Short Version (CAARS–S: S). The Conners' Adult ADHD Rating Scales–Self Report: Short Version (CAARS–S: S) was used to evaluate symptoms of ADHD or related problems. It has five subscales: Inattention/Memory Problems, Hyperactivity/ Restlessness, Impulsivity/Emotional Label, Problems with Self-Concept, and ADHD Index. The reliability of CAARS–S:S was examined in an Iranian clinical study and its Cronbach's alpha proved to be0.81 (Arabgol, Hayati, & Hadid, 2004).

Conner's continuous performance test (CPT-II). The Conner's continuous performance test (CPT-II) is a clinical measure for the evaluation of attention and response inhibition as an executive function that can help the assessment of ADHD and other neurological disorders. During approximately 14-minutes, 360 stimuli trials including letters appear, and participants have to press the appropriate key for any letter target' stimulus but they must ignore non-target stimuli. (''X''). The following measures are reportedincludingnumbers (%) of commission errors which include response to any stimulus other than the target; numbers (%) of omission errors which refer to the missing target; and Hit Reaction Time (Hit RT) which is the average speed of correct responses.

Procedure

All mothers were assessed in two sessions with an interval of one week in a quiet room. During the first session, both groups were inter viewed. Then the CAARSS was completed and the WAIS-R was assigned to them. During the second session, the CPT-II and the ATT were presented for both groups. Prior to the ATT main task, two practice trials were shown to the participants. They were primarily instructed to freely explain what they sawwithout any guidance from the examiner. Then they were asked to describe movements based on their understanding of interactions, actions and mental states based on the questions offered by the examiner. Later, the CPT-l l task was performed for fourteen minutes and data were collected and entered into the SPSS for analysis.

Ethical considerations

This study was derived from a thesis for a master degree in cognitive psychology and was approved by the Institute of Higher Education of Cognitive Sciences studies (code; 2208619).

Statistical analysis

Data were analyzed using the SPSS version 17.0. Demographic and clinical comparisons between the two groups of mothers were performed using independent samples t-test. We also used the Mann–Whitney test to examine the differences between the two groups in terms of ToM variables and CPT-II measures. Spearman non-parametric correlations (Rho) were also used to assess correlations between CPT-II and ATT scores.

Results

Demographic and clinical variables

The means and SD of mothers' age, IQ and CAARS are set outin Table 1. Results of independent samples t-test revealed no significant differences between the two groups for age (t 48 = -2.901, P =0.47) and IQ (t 46) = -.001, P =0.285). The mothers of ADHD children gainedhigher scores than mothers of typically developing children as toproblems with self-concept (t (46) =2.84; P<.01) and ADHD index in CAARS variables (t (46) =2.84; P<0.05).

Table 2 presents the variable of education for themothers of both groups. No significant difference between t/he two groups was observed with regard to this variable (x^2=0.181, P=0.91).

Table 1. Means and standard deviations of mothers' age, IQ, and CAARS variables

	Mother			
	ADHD Mean±SD	Control Mean±SD	t	p-value
Age	32,8 ±7,59	37±.2±4,2	-2.901	0.47
IQ	106.57±11.92	106.58±14.87	-.001	0 .285
CAARS variables				
Inattention	48.71 ±9.98	43,93±6,51	2.0	0.162
Hyperactivity	44,33±7,00	46,44 ±6,44	-1.08	0 .869
Impulsivity	52,29 ±9,73	49,74±7,48	1.02	0 .276
Problems with Self-Concept	53,33±11,31	45,57±7,2	2.84	0 .005**
ADHD Index	52.62±9.97	45.85±6.44	2.84	0 .037*

* = P<0.05, ** = P<0.01

Table 2. Mothers' education comparing the two groups

	Mother					
	ADHD		Control		x^2	p-value
	N	%	N	%		
Level of education						
High school	14	60.9	18	66,7		
High school+ [a]	2	8.7	2	7.4	0.181	0.913
Academic [b]	7	30.4	7	25,9		

[a] High school post high school studies that offer a graduation certificate.
[b] Academic: academic degree (B.A., M.A., or Ph.D.).

ATT performance

There was significant differences between the two groups for intentionality (U=177.00, P=0.009), appropriateness (U=179.50, P =0.011), length of phrases (U=137.5, P=0.001) and emotional words (U=184.00, P=0.012). (Table 3). Lower values of intentionality, length of phrases and appropriateness and higher value of emotional words were observed for mothers of ADHD children.

Table 3. Animated Triangle Task (ATT) measures in the mothers of ADHD and control groups

Measures	Mothers		U
	ADHD Mean rank	Control Mean rank	
Intentionality	19.70	30.44	177.00**
Appropriateness	19.80	30.35	179.50*
Length of phrases	17.98	31.91	137.5**
Emotional words	31.00	20.81	184.00*

* = P<.05, ** = P<.01

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CPT-II performance

No significant differences were between the two groups of mothers for CPT-II variables including omission (U=235.50, P=0.262), commission (U=244.50, P=0.416), hit rate (U=202.00, P=0.090), detectability (U=241.00, P=0.377) and perseveration (U=254.00, P=0.385).**(Table 4)**

Insert table 4 here

Correlations between CPT-II and ATT scores

Correlation analysis proved that ToM and neuropsychological abilities tested were not significantly associated.(table 5)

Table 4. Conner's continuous performance test (CPT-II) measures in mothers of ADHD and control groups

Measures	Mothers		U
	ADHD Mean rank	Control Mean rank	
Omission	22.21	26.28	235.50
Commission	22.64	25.94	244.50
Hit rate	28.38	21.48	202.00
Detectability	26.52	22.93	241.00
Perseveration	23.10	25.59	254.00

Table 5. Spearman's correlation (Rho) values between Animated Triangle Task (ATT) and CPT-II in ADHD children's mothers

	Intentionality	Appropriateness	Length of phrases	Emotional words
Omission	-0.101	0.050	0 .013	-0.071
Commission	-0.199	-0.146	-0.127	-0.192
Hit rate	-0.070	-0.060	0 .286	0.206
Detectability	0.163	0 .179	0 .114	0 .169
perseveration	-0.037	0.068	0.034	-0.267

Discussion

This study assessed understanding intentionality as an important component of ToM ability in ADHD's mothers compared to healthy children's mothers using the Animated Triangle Task (ATT).As the result demonstrated, intentionality score (as the main outcome of ATT) in ADHD's mothers was significantly lower than the control group. Based on this result, the ADHD's mothers may interpret other people's behaviors as different attributions and respond inappropriately. The appropriateness of answers scores was also significantly lower in the ADHDs mothers that means they frequently refer to mental states that are not appropriate for the expected intentions. The mean score of length of phrases was also significantly lower in the ADHDs mothers. They used significantly fewer mental state words to describe feelings and social interactions compared to the control group. Finally, an unexpected result was achieved in terms of the number of emotional words, as they used more affective words in comparison to the control group. Musser et al. (2018) examined paternal emotional expressiveness using specialized emotion word counting software in the parents of ADHD children compared to a control group. The results identified no differences in the use of total emotional words between the two groups. However, the ADHD children's parents used fewer positive emotional words during the task. Since investigating the maternal emotional expressiveness was not an objective of the present study, further studies using specific tasks are required to examine the number of emotional words in the mothers of ADHD children.

Previous studies found deficits in ToM in children with attention deficits (Hughes et al.,

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1998; Papadopoulos, Panayiotou, Spanoudis, & Natsopoulos, 2005). To the best of our knowledge, this is the first direct study as for ToM (specifically comprehending intentionality) in the mothers of ADHD children, which provided evidence for impaired ToM in relatives of these children. However, previous studies have shownthe possible effects ofenvironmental and genetic factors on theory of mind.

A number of researchers have investigated the effects of environmental factors on the children's early understanding of mind. Although ToM may be considered a basic ability in humans (Baron-Cohen et al., 1999), it seems that its appropriate developmental changes can be influenced by social experiences(Ruffman et al., 2002). Family interactions such as parent–child interactions are one of the most important social experiences that contribute to the development of understanding of mind(Arranz et al., 2010). Some studies found that parental mind-mindedness or the ability of the parents (especially mothers) to focus on the mental states and feeling of their children can play an important role in the development of theory of mind appreciation (Hughes, Devine, & Wang, 2018; Meins, 2013). Studies also have uncovered that the mothers' mental state language can contribute to ToM(Ebert, Peterson, Slaughter, &et,al, 2017). A better performance in false-belief understanding is reported in securely attached children whose mothers have a tendency to use appropriate mental state terms to describe them (Meins, Fernyhough, Russell, & Clark-Carter, 1998). There is evidence of a significant relationship between child-mother conversations and affective as well as belief understanding. According to these findings, ToM deficits in parents, especially mothers, may have a great potential impact on the mental development of ADHD patients.

Some researchers have also suggested that genetic factors may contribute to children's mental states ability. Research into some heritable disorders such as autism and Turner's syndrome as well as some other biological and genetic-based disorders like schizophrenia (which demonstrates extensive social cognition deficits) has demonstrated that genetics might influence the children's understanding of mind (Warrier & Baron-Cohen, 2018). In this respect, researchers have proposed that ToM tasks may be impaired in the relatives of these patients (García-Laredo, 2018). To the best of our knowledge, no study has to date researched the features of ToM ability in relatives of ADHD children. However,ADHD is highly inheritable and a cogent collection of evidence supports genetic involvement in this disorder (Bidwell et al., 2017).The results of current study put forward thehypothesisthatthe relatives of the patients with ADHD may also exhibit ADHD-related impairments such as ToM deficits.

This study also examined sustained attention and inhibition responses of the ADHD children's mothers. The results revealed no significant differences in these functions between the two groups of mothers. Previous studies suggested deficits in different domains of EFs such as inhibitory control, working memory, and cognitive flexibility in ADHD children's first-degree relatives (Gau& Shang, 2010; van Lieshout et al., 2019). However, most of these studies administrated the Go/No-Go or the Stop Signal Tasks, which are specific measures to assess inhibition responses. In this study, only the CPT-II was used to evaluate sustained attention and inhibition responses. Lack of difficulty in one task does not mean that mothers of children with ADHD would perform at the same level as the mothers of typically developing children in all other EF tasks. Using other types of tasks to evaluate EFs may show different results.

The relationships between sustained attention and inhibition responses with ToM were also investigated in this study, and the results showed that CPT-II measures were not significantly correlated with ToM indexes. The kind of relationship between EF and ToM is on the hard debates. There is evidence that EF deficits contribute to deficits in ToM performance (Hughes

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1998). However, there is also evidence that impairments in ToM account for EF deficits (Perner and Lang 2000). In contrast, another theory suggests that EF and ToM are two separate functions independent of each other (Şahin, Bozkurt et al. 2019). As far as we know, no study has investigated attention and response inhibition contributions to ToM deficits in ADHD children's mothers and the results of this study did not show any correlation between these functions and ToM. It seems that far more studies are required to examine the relationship between other aspects of EF and ToM to address the question whether ToM ability can be considered a distinct trait related to neuropsychological deficits in ADHD and their relatives.

Advantages and limitations

This study had several advantages including its focus on comprehending intentionality as an important aspect of ToM and the application of ATT as a major task of evaluating intentionality. To the best of our data, this is also the first direct study on ToM function and its relationship with EFs in mothers of ADHD children. While a review of literature did not show any specific study investigating ToM in mothers of ADHD patients, the current study provided some preliminary information about ToM impairment in this group. However, this study had some limitations. Firstly, only one ToM task, the ATT, was used, which did not cover all aspects of ToM. Secondly, only one neuropsychological test, the CPT-II, was applied. It seems that further studies using additional tasks and considering other aspects of ToM and executive functions and socioeconomic status are needed to evaluate ToM and neuropsychological ability in the parents of ADHD children.

Conclusion

In conclusion, poorer ToM performance in mothers of ADHD children considerably suggests that researchers are needed to pay more attention to recognize social cognition and social communication characteristics of the parents of ADHD children. In fact, further studies in this area may help to find appropriate interventions for ADHD patients. It appears that using specific training programs for the parents of ADHD children to achieve social skills and ToM abilities may contribute to the promotion of their children's social development.

Conflict of interest

We have no competing interests.

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Authors' Contributions

A.M; main researche. A.K.B; designed and supervised the project. and analysis. A.N; drafting and revising the manuscript.

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