

Deficits in theory of mind and Executive function in children with Attention Deficit Hyperactivity Disorder

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ABSTRACT: This study was designed to examine the existence of deficits theory of mind (ToM) and Executive function(EF) in children with Attention Deficit Hyperactivity Disorder (ADHD).Tom and EF functioning was assessed in 40 children aged 6-8 years with (ADHD) and normal children. *The Sally–Anne tes(Wimmer & Perner, 1983) t is a psychological test, used in developmental psychology to measure TOM.* The Behavior Rating Inventory of Executive Function (BRIEF) was developed by Gioia et al. (1996) measures of EF. *DSM-IV used for assessing ADHD.* The group(ADHD)was significantly impaired relative to controls on the advanced ToM measure and EF. (ADHD) may disrupt the developmental acquisition of emotion recognition and advanced ToM skills. The clinical and theoretical importance of these findings is discussed and the implications for the assessment and treatment of children who have experienced ADHD are outlined.

Keywords: Executive function, Attention Deficit Hyperactivity Disorder, theory of mind.

INTRODUCTION

Attention Deficit Hyperactivity Disorder (ADHD) is a neurological condition that involves problems with inattention and hyperactivity-impulsivity that are developmentally inconsistent with the age of the child. This loss of self-regulation impairs other important brain functions crucial for maintaining attention, including the ability to defer immediate rewards for later gain (Barkley, 1998). Recent scientific research has developed a new paradigm which recognizes ADHD as a developmental disorder of the cognitive management system of the brain, its executive functions. Executive.Functioning includes skills such as organizing, planning, sustaining attention, and inhibiting inappropriate responses (Ozonoff et al., 1991) .

Theory of Mind refers to one's ability to perceive how others think and feel, and how that relates to oneself. Theory of Mind can be summed up as a person's inability to understand and identify the thoughts, feelings and intentions of others. Individuals with ADHD can encounter have difficulty recognizing and processing the feelings of others, which is sometimes referred to solving problem. This challenge often leads others to believe that the individual with ADHD does not show empathy or understand them, which can create great difficulty in social situations Difficulties in the area of Executive Functioning can manifest themselves in many different ways. Attention Problems (Reynolds and Kamphaus, 2004). ToM skills as measured by their understanding of false beliefs and second order thinking Additionally, Subsequent research (Lesli, 1987; Bloom & Markson, 1998) has been relatively consistent, and it culminates with Wellman et al, (2001).

1Although three-year-olds are able to understand the mental states of desires and beliefs, which have strong ties to everyday functioning, they may still have problems understanding other mental states (Yirmiya et al., 1998). Garson, (2003) suggests that simulation theory is the most parsimonious account in that it uses 'cognitive capacities already known to exist on independent grounds, such as being able to reason, to imagine a case

different from our own, and to appreciate what is relevantly different about it'. Research involving ToM abilities has not been limited to typically developing children, but has also included children with various clinical diagnoses, most notably autism (Baron-Cohen et al., 1985; Baron-Cohen, 1989; Tager-Flusberg et al., 1993). groups may be experienced for different reasons. For example, children with ADHD may have ToM difficulties associated with attention; whereas, the difficulties on ToM tasks experienced by children with autism may have more to do with language.

However, the social abilities evidenced by the learning disabled and typically developing groups were 'strikingly absent' in. Recently, these two different theories have been connected to a distinction between two subcomponents of ToM: cognitive ToM and affective ToM (Péron et al., 2009; Shamay-Tsoory et al., 2007) . appropriate problem-solving set to attain a later goal" (Willcutt et al., 2005). EF seem to constitute the capacity to monitor and to control thought and action. With regard to concepts in cognitive psychology, one could try to break this down to working memory, monitoring (Gordon and Olsen, 1998) and inhibitory control (Hala et al., 2003). Inhibitory control is the ability to deliberately inhibit automatic responses. These automatic behaviors could be based on habits or strong desires. Some researchers claim that there are more abilities at the core of EFs than working memory and inhibitory control. One candidate is *set shifting* – the capacity to shift between tasks or mental sets. In particular, this includes producing different types of responses to the same stimuli. This ability has also been called cognitive flexibility . It is that set shifting is a combination of working memory and inhibitory control. These relations typically persist even when factors such as age and verbal ability are controlled (Perner and Lang, 2000).

Several studies of children have shown that their performance on false-belief and other theory-of-mind tasks can be predicted from tasks that tap executive-functioning skills such as response inhibition, cognitive conflict resolution, and working memory (Faraone et al., 2001). This impression stems from a magnitude of correlational evidence, which points to a parallel development of ToM and EF. Although there are usually some irregularities, in general, the results show an impressive level of coherence, even after partialling out factors like age and receptive vocabulary. This pattern can even be found cross-culturally (Sabbagh et al., 2006). Besides correlational studies of normal children, empirical evidence for a parallel development comes from the domain of psychopathology. For instance, children with ADHD also have problems with EF tasks (Hughes et al., 1998). Davis and Pratt, (1995) argued that it is working memory. In ToM tasks, children need to represent a lot of information simultaneously, so poor working memory could account for bad results. In their experiment, they found significant correlations between ToM tasks and the backwards digit span task. At first glance, this seems to support their theory, because the backwards digit span task is a classical working memory task. ADHD children have deficit in working memory (Kashani, 2005). Congruent with the findings of Davis Theory of Mind and Executive Functions control and execute our actions in favor of a long-term goal (Zelazo et al., 1997). In this research we ask that is Deficits in theory of mind and Executive function in children with Attention Deficit Hyperactivity Disorder?

MATERIALS AND METHODS

Method

Participants

Participants were 20 ADHD students (8 boys and 12 girls) from Tehran, Iran, ages 72 to 96 months ($M = 81.28$ months, $SD = 12.78$) from the Learning disorder Research Institute and elementary school in Tehran. Children's ages were calculated to the day from birth records provided to the school where the children were tested. The Normal student comparison group consisted of 20 normal students (9 boys and 11 girls) ages 78 to 94 months ($M = 83.11$ months, $SD = 8.34$). The slight differences between the two samples in normal ADHD distribution were statistically significant

Measures

Behavior Rating Inventory of Executive Function (BRIEF)

The Behavior Rating Inventory of Executive Function (BRIEF) was developed by Gioia et al. (1996), and was used to assess executive function in the sample. The BRIEF is a rating instrument designed to assess impairment of executive function in individuals aged 5 to 18. Reliability is reported in terms of internal consistency (ranging from 0.80 to 0.98), and test-retest reliability (ranging from 0.76 to 0.85). The BRIEF is easily administered to either parents or teachers and it provides clinical scales on various executive function components. In this study Parents and teachers form was used. The Meta cognition Index is composed of the Initiate, Working Memory, Plan/Organize, Organization of Materials and Monitor scales. The Global Executive Composite score is a

composite score incorporating all eight scales of the BRIEF. The scale also contains items. Parents also completed the Brief Betrayal Trauma Scale – Parent version

Attention Deficit Hyperactivity Disorder Test (ADHD)

Parents completed the Attention Deficit Hyperactivity Disorder Test (ADHDT-item nor med test based on the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) (American Psychiatric Association, 1994) criteria. Children with a raw score of 8 or higher (percentile rank = 25) on any of the hyperactivity, impulsivity, or inattention scales were included in the study. Participants' scores were as follows: Hyperactivity subscale: $M = 13.3$, $SD = 5.0$, range = 6–23; Impulsivity:

$M = 10.8$, $SD = 4.8$, range = 2–20; Inattention: $M = 15.6$, $SD = 6.9$, range = 3–26; Total score (sum of subscale scores): $M = 39.7$, $SD = 13.6$, range = 18–65. The total score scale had a Chronbach's α of 0.92 in this sample.

Sally–Anne test for assessing Theory of Mind Test

The Sally–Anne test is a psychological test, used in developmental psychology to measure a person's social cognitive ability to attribute false beliefs to others (Wimmer and Perner, 1983). The flagship implementation of the Sally–Anne test was by Baron-Cohen et al, (1985), in 1988, Leslie and Frith repeated the experiment with human actors (rather than dolls) and found similar results. Concurrent validity of the test, as measured by Dolls House Task was .89 ($p < 0.01$). Subscale total correlation as another index of validity were between .82 and .96. Reliability of the test was studied using test-retest, Cronbach Alpha and interrater agreement reliability. Test-retest coefficient ranged from .70 to .94 ($p < 0.01$). Internal consistency of the test with Alpha value were .86 for total score, .72 (Tom 1), .90 (Tom 2) and .81 (Tom 3). Interrater reliability coefficient was .98 ($p < 0.01$). Taken together, the finding of this study indicate that the Theory of Mind Test (Tom test) is a valid instrument for using in Iran.

RESULTS AND DISCUSSION

Results

Normal and ADHD children standardized performance on the executive-function tasks.

Table 1. Group differences on the BRIEF Parent Form

BRIEF index	ADHD (n = 20)		Controls (n = 20)		t
	M	S.	M	S.D	
Working Memory	2.39	0.34	1.23	0.29	2/98
Inhibit scalea	2.23	0.48	1.22	0.26	2/62
Metacognition	2.37	0.28	1.38	0.25	3/21
Regulation	2.06	0.46	1.30	0.29	2/99
Global Executive	2.25	0.29	1.35	0.25	3/06

Group means for the five BRIEF scales are presented in Table 1. There was a significant multivariate group effect for the five scales ($P < .00001$). Univariate tests for the two scales considered to be useful for differentiating the subtypes of ADHD (Working Memory and Inhibit) and three primary index scores revealed significant group differences ($P < .0001$). There were significant differences any of the BRIEF scales or indices between the ADHD normal groups. It was. However, in the analyses reported above, there was difference between the individuals with ADHD and controls on four of the five BRIEF indices; however, normal individuals did have higher ratings ($P < .05$) than ADHD participants on the Executive function.

Table 2. Group differences on the TOM test in children with and without ADHD

	ADHD(n=20)		Control (n = 20)		
	M	SD	M	S.D	t
Recognition senses	8/9	12/11	16	13	2/89
false beliefs	2/21	6/3	8/6	7	3/01
Social understanding	2/09	4/1	5/6	2	2/91

In Table 2. There was a significant multivariate group effect for the three scales of TOM. ($P < .00001$). Univariate tests for the two scales considered to be useful for differentiating the subtypes of ADHD (Recognition senses, *false belief*, Social understanding). significant group differences ($P < .0001$). showed that the ADHD. There were significant differences on the TOM scales between the ADHD and normal groups. However, in the analyses reported above, there was difference between the individuals with ADHD and controls on three of the TOM , normal individuals did have higher ratings ($P < .05$) than ADHD participants on the TOM.

Table 3. correlation between TOM and EF in children with and without ADHD

	working memory	Inhibi	Metacognition	Regulation	r
Recognition sensecs	8/9	11/12	16	13	0/63
false beliefs	2/21	6/3	8/76	7	0/59
Social understanding	2/09	4/1	5/6	2	0/47

Our final question concerned whether the relation between theory-of-mind reasoning and executive function would hold as well as normal and ADHD children. We found that in raw correlations executive function aggregate measure was related to the theory-of-mind measure in the ADHD disorder and in the normal student sample, $r(40) = 0/63, p < .001, , r(40) = 0/59, p < .001$, and, $r(40) = 0/47, p < .001$. Thus, despite the differences in the development of executive functioning, the relation between executive functioning and theory of mind was robust and virtually identical across the two sample. This finding suggests that some of the underlying processes that contribute to the development of students theory of mind are similar across executive function This article is an attempt to critically review the empirical findings which tried to shed light on the connection between ToM and EF. In the following, I will first give an overview of the empirical methods that are used in ToM research. All analyses were performed on the standardized data.conducted one of the most definitive children establishing the relation between executive skills and theory-of-mind development in ADHD students. To meet the goals of our study, we collected data from a sample of children using the same relevant tasks. These ADHD children data were then compared with the normal students. Answering these questions will help inform the relation between executive functioning and theory of mind.

CONCLUSION

Normal student performance on executive-functioning tasks was clearly advanced relative to that of their age-matched ADHD children . Moreover, the fact that all the tasks showed a significant believe that the observed advantage in executive functioning is not an artifact of task bias somehow providing an advantage to the Theory of Mind (Carlson and Moses, 2001).

The idea that ToM development may primarily involve the development of executive functioning was first suggested by Russell et al, (1991). Connecting EF to ToM has a lot of intuitive appeal, because in ToM-thinking, it seems necessary to *inhibit* the content one's own perspective, *flexibly switch* to the mindset of someone else, and *integrate* all the relevant factors into a coherent picture.

This impression stems from a magnitude of correlational evidence, which points to a parallel development of ToM and EF. There are robust correlations between performance on ToM and EF tasks, independent of intelligence, sex, and age (Carlson and Moses, 2001; Frye et al., 1995; Hala et al., 2003; Perner and Lang, 2000). For example, Carlson and Moses, (2001) compared performances in 4 ToM tasks and 10 EF tasks in a large study, including 107 preschoolers. Their results showed a strong correlation between ToM and EF tasks, and results like these have been replicated numerous times. Although there are usually some irregularities, in general, the results show an impressive level of coherence, even after partialling out factors like age and receptive vocabulary. This pattern can even be found cross-culturally (Sabbagh et al., 2006). Besides correlational studies of normal children, empirical evidence for a parallel development comes from the domain of psychopathology. For instance, children with autism are known to show deficits in ToM tasks, but they also have problems with EF tasks (Pennington and Ozonoff, 1996). Similar findings have been discovered in ADHD patients (Hughes et al., 1998 ;Miyake et al, 2000; Davis and Pratt ,1995; Gordon and Olson ,1998).

ToM is a rapidly growing field, and much progress has already been made.

The idea of a potential link of EF to ToM has fruitfully contributed to the debate. Most importantly, it helped to shift the debate from a rather isolated view on ToM to a more contextualized perspective. Robust developmental correlations suggest that there has to be *some* relation between ToM and EF, which begs for a causal explanation. But hopes for straightforward reductions had to be disappointed, and the story seems to be more complex. Although expression theory can be dismissed with some confidence, other theories are still perfectly plausible candidates: EF could be a Theory of Mind and Executive Function (Garson, 2003) . There are robust correlations between performance on ToM and EF tasks, independent of intelligence, sex, and age (Carlson and Moses, 2001; Frye et al., 1995; Hala et al., 2003; Perner and Lang, 2000). For example, Carlson and Moses, (2001) compared performances in 4 ToM tasks and 10 EF tasks in a large study, including 107 preschoolers. Their results showed a strong correlation between ToM and EF tasks, and results like these have been replicated numerous times ToM could be a necessary precursor of the development of EF, or the two might interact in a complex way ? the

empirical evidence is not yet decisive. evidenced in children with attention deficit hyperactivity disorder. For example, Dodge, (1986) found that children with ADHD have a great deal of difficulty in both adopting the perspective of others and evaluating others' intentions. This gives rise to the question of whether impairment in aspects of executive functioning may coexist in children with ADHD (Barkley, 1997).

Although executive functioning has been defined by some in such broad terms as to include almost all human cognition, and by others so narrowly as to overemphasize one area and completely overlook all others (Zelazo et al., 1997; Perner and Lang, 1999; Carlson et al., 2002) it remains an important Construct. Ozonoff et al, (1991) explain executive function as 'the ability to maintain an appropriate problem-solving set for attainment of a future goal' and note that executive function includes such behaviors as planning, impulse control, inhibition, set maintenance, organized search, and flexibility of Thought and action Despite obfuscation in the construct, Hughes, (2002) reported that there is a 'robust association shown in numerous studies between executive function performance and performance on tests of theory of mind ability' (p. 205). Hughes and Graham, (2002) note that research has shown that when effects of age and IQ are controlled, normative differences in executive function and ToM are significantly correlated. For example, Carlson et al, (2002) found that inhibitory control related strongly to false belief performance even when working memory capacity was held constant. As early as, (Ozonoff et al., 1991) conducted a study exploring the connection between ToM and executive function and found that that executive function and second-order ToM deficits were 'significantly more widespread' among the autistic subjects than those with other clinical deficits. Exactly what this relationship is remains debated. Perner et al., (2002) find a strong correlation between false belief tasks and executive function but do not support the view 'that the observed relations between theory-of-mind and executive function tasks are due to problems of inhibition in the theory-of-mind tasks .

Shallice and Burgess, (1991) predicted that impairment in executive function in children will manifest in behaviors such as distractibility, impulsivity, and perseverative errors when presented with changes to routine situations. These behaviors are seen in children with autism and are commonly seen in children with

ADHD. In fact, Yirmiya et al., (1998) reported that children with ADHD have frequently been studied as a comparison group when examining executive function impairments in individuals with autism; however, children with ADHD have not yet been fully tested on ToM tasks For example, Buitelaar et al, (1999) conducted a study of ToM and emotion recognition in children with autism, in which children with ADHD made up half of the control group. An important finding of the study was that children with ADHD performed significantly worse than other controls on second order ToM tasks. Related, Hughes et al, (1998) conducted a study aimed at Charman et al, (2001) expressed the belief that theirs was the first empirical work to test directly both ToM and executive function in children with ADHD. This study aimed at exploring social competence, ToM ability, and two aspects of executive function (inhibition and planning) in boys with ADHD. No significant impairment on ToM abilities was found. Charman et al, (2001) and reasoned that the conflict of findings between their study and the Buitelaar et al. (1999) and. Perner et al, (2002) reported that 'only three studies have so far explored the association between ToM abilities and executive functions in 6 to 10 year old ADHD children'. The studies cited were Charman et al, (2001) and Hughes et al, (1998), which have been previously discussed, and the work of Speltz et al, (1999), who examined the relationship between executive function, behavioral difficulties associated with oppositional defiant disorder (ODD) with or without ADHD, and verbal abilities. Perner et al, (2002) cautiously noted that findings among these three studies were inconsistent, used varying ToM tasks, and involved only small numbers of children. Still, they summarized the three studies by noting that children with ADHD appear to have no (or minimal) deficits in ToM tasks involving first order beliefs but called for further research on second order false belief tasks due to Based on this premise, Perner et al, (2002) themselves examined ToM and executive function in children deemed 'at risk of ADHD'. Their study found impairment on several executive function tasks in the ADHD group, but failed to find impairment on the ToM tasks. Fahie and Symons, (2003) examined the relations between executive function and ToM in children referred to a clinic for attention and behavior problems Using parent and teacher ratings for social and behavioral problems, Fahie and Symons, (2003) found a negative correlation between reports of social functioning and both ToM and executive function. Likewise, Joe, (2004) found that performance on a false belief task strongly correlated with inhibition processing in his sample.

Carlson et al, (2002) found that inhibitory control tasks (Bear-Dragon, Whisper, Gift Delay) were strongly correlated with ToM tasks (false-belief, appearance-reality), but working memory tasks (backwards digit span, counting/labelling, backward word span) only showed weak correlations. A majority of ToM studies have supported a strong correlation between ToM abilities Additional findings According to Reynolds and Kamphaus, (2004), behaviors associated with Developmental Social Disorders (SocD) scale are deficits in social skills, The implications of a relationship between social competence, attentional difficulties, and ToM are important for school counselors, clinical psychologists, and teachers. As noted earlier the developmental continuum of ToM abilities

Conclusions and implications Our data suggest that children identified by teachers as evidencing attention difficulties scored lower on false belief measures and were more likely to be identified as exhibiting behavioral difficulties associated with executive dysfunction than children identified as evidencing fewer attentional difficulties. A combination of attention and executive function, specifically the inability to initiate tasks, were predictive of total ToM scores. Specifically, higher scores on the attention problems documented. An important practical question then becomes, can we manipulate the early school environment in such a way as to foster the development of theory of mind skills? A growing number of studies indicate that environmental factors can positively influence the development of ToM skills. It may be that teaching social skills, such as perspective taking, empathy development, etc. may help us to avoid the negative social consequences that may be inherent for children with ToM deficits. Further research on social skills interventions in early childhood TOM and EF seems need.

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