

Investigation of Theory of Mind in ADHD and Normal Children and its Relationship with Response Inhibition

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Objectives: The purpose of this study was to compare the relationship between theory of mind and inhibitory responses in normal children and ADHD. **Methods:** This study is descriptive study, a sample size of 25 patients ADHD children and 30 normal children, who were randomly selected. Research instruments are questionnaires Theory of mind and computerized Stroop test. **Results:** The results showed that, there are significant differences between in response inhibition and theory of mind in ADHD and normal children, so that children with ADHD, both components have a problem. The correlation and regression results showed that there is significant relationship between theory of mind and Response inhibition, also response inhibition is as a predictor of theory of mind. **Discussion:** The present study showed in comparison with normal children, the performance in executive function and theory of mind is weaker in ADHD children, also relationship between executive function and theory of mind.

Keywords: response inhibition, theory of mind, ADHD, executive function

Attention deficit hyperactivity disorder (ADHD) is a developmental disorder (Gupta, Kar, 2009). This disorder is one of the most prevalent neurobehavioral disorders in childhood (Sadock, Sadock, 2007). The cognitive-behavioral methods, in spite of other types of behavior therapy, deal directly with thoughts and feelings, which are obviously important in any mental disorder. In contrast to the dynamic psychotherapy, these methods have scientific foundations and are exhibited more efficient in the assessment of clinical activities (Houghton, Keith, 1989). ADHD is basically an executive dysfunction causing severe problems in social interactions. Given the intricate relationship between EF and ToM development, children with ADHD fail in some tests of ToM and display impairments involving emotion, face and prosody perception, and reduced empathy (Uekermann et al., 2010).

It is likely that it is their impulsivity and lack of ability to focus attention, and the behavioral problems that these give rise to, that hinder ToM development in children with ADHD (Perner et al., 2002).

Theory-of-mind development is the area of cognitive development research that investigates the nature and

development of our understanding of the mental world—the inner world inhabited by beliefs, desires, emotions, thoughts, perceptions, intentions, and other mental states (Flavell, 2004).

On the basis of precursors and the incorporation of several other neuropsychological functions, children's social interactions (with peers and adults) triggers and promotes spontaneous development of ToM around the age of 3–4 without any formal instruction or overt effort. The distinction between mental and physical appears first so that the child conceives that mental phenomena are abstract, subjective, and intangible, whereas physical objects and overt behaviors are concrete, visible, and manifest (Baron-Cohen, 1995).

Second, common sense notions of psychological causality develop, e.g. “When somebody receives a present, they feel happy”; hence, children understand that mental phenomena are states-with-contents as causes of behavior (Leslie et al., 2004). They understand why people feel a certain way and notice others' motives and learn to induce some mental states. They realize that the same world can be experienced in different ways by different people and infer from gaze direction what a person is thinking or what a person might want. They explain events by attributing them to unobservable

entities, such as beliefs or desires. One of the essential features of ToM, which basically depends on “emotion cognition,” is false-belief understanding;

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therefore, concepts of belief, desire, and pretend form the core of the ToM framework (Leslie et al., 2004).

Development of ToM depends largely on the normal functioning of memory systems including short-term and long-term declarative memory, source memory, and different forms of implicit memory including emotional memory. Although the age interval of ToM development roughly coincides with that of the development of autobiographical memory (Nelson, Fivush, 2004).

Recent studies indicate ToM functioning is partly independent of episodic memory (Rosenbaum et al., 2007). However, a certain minimum working memory capacity is required to develop a ToM as children cannot frame concepts about others' minds until they are capable of contemporarily keeping in mind different perspectives of thoughts. The ability to simultaneously take into account the real situation and the pretend version of the same situation to shift between external events and internal representations emerges between 18 and 24 month (Nielsen, Dissanayake, 2004), and after this time, children are able to manipulate the information held in memory: realizing that their own thoughts may not be known by others, they can freely compare and contrast different lines of thought.

Developing a full ToM requires the presence of several of the executive functions (EF), such as processes of analysis, inference, deduction, and estimating. Despite a close association between EF and ToM, they are discrete functions (Fine et al., 2001). Some components of ToM codevelop with EF (Carlson et al., 2004), whereas others develop independently in adults (Qureshi et al., 2010). Attaining a particular level of EF is not itself sufficient to yield strong ToM performance (Hughes, Ensor, 2007). In autism, there may be spared or superior executive abilities.

Executive and cognitive functions are excellent set of skills, retention, start casting, strategic planning, impulse control and cognitive flexibility to conduct. In fact, functions such as organizing, decision-making, cognitive flexibility, working memory, retention and transfer of motor control, perception of time, predict future, reconstruction, internal language and problem solving can be the most important executive functions nerve as cognitive learning tasks and actions in life and contribute to human intelligence (Barkley, 1998).

One component of executive function is inhibition; this inhibition may lead to impulsivity and attention problems. Including difficulties in response inhibition is a careless person to answer questions and is easily distracted by stimuli. Difficulty in stopping an ongoing response, if the person is aware that it is the wrong answer (Mashhadi et al., 2009).

Research showed that children with autism and hearing impairment, impaired theory of mind. (Pellicano, 2010; Kushalnagar et al., 2010), as well as

research Uekerman et al (2010) showed that ADHD children are weak in theory of mind test.

Nigg et al (2005) and Lansbrgn et al (2007) showed that children with ADHD than normal children in response inhibition that is lower.

The purpose of this study was to compare the relationship between theory of mind and inhibitory responses in normal children and ADHD. This research questions: Do inhibition response predict theory of mind? Is there significant difference between theory of mind and inhibition response in normal and ADHD children?

Methods

This research is a descriptive research category of ex-post factor (causal - comparative) and a case - control study in which a group of children with hyperactivity disorder / attention deficit, and controls are normal children that are reviewed results of correlation and regression methods. The population of the rows of male children ages 8 to 14 years with ADHD city of Mashhad. Examples of ways available sample after permission from the parents on a voluntary basis the city of Mashhad 20 patients were selected. The 30 children with ADHD is normal subjects matched for gender and age range of the sample of normal children were randomly selected primary schools in the city of Mashhad.

Tools

Theory of Mind: Test as a test of theory of mind, was built by Stipman that measures social factors such as perception, feeling. This test is based on evolutionary approach Flavell et al; there are three subscales and 78 item. Subscales include elementary theory of mind, theory of mind is preliminary and advanced theory of mind (muris et al., 1999). The reliability of the test in this questionnaire is Cronbach's alpha coefficient 0.72 (Ali Akbari et al., 2013).

Computerized Stroop Test: The first was built in 1935 by Raydly Stroop, Stroop was made measure of selective attention and cognitive flexibility. Stroop test is one of the main tests used to measure response inhibition. In this test, 50 word color (congruent) with the meaning of the word is the same as red, yellow, green and blue, 50 word color (incongruent) (color word with the meaning of the word is not the same, for example, the word blue in red shown), with an interval of stimulus presentation time of 800 ms and 3000 ms stimulus presentation is presented. This is a task which is subject only to choose the correct color.

To scoring and interpreting the results of this test, the scores are calculated separately for each group of words congruent and incongruent number of errors, number correct, reaction time and the interference score. Interference score by calculating the reaction time difference between incongruent words and

congruent words (interference score is equal to the difference between the reaction time for incongruent words and reaction time, congruent words) is calculated. Research conducted on this test represents

a reliable and valid measure of inhibition in both adults and children. Retest reliability of this test in the range of .80 to .91 has been reported (Mashhadi et al., 2009).

Results

Table 1

frequency, mean and standard deviation of the sample

	GROUP	N	M	SD
Age	normal	30	9.64	1.45
	ADHD	25	9.93	1.29

Table 1 showing descriptive indices of mean, standard deviation in normal children and ADHD children. The first group is the average sample size of

30 participants, and ADHD disorders group are 25 people. As you can see, are matched in terms of age.

Table 2

Descriptive indicators of ADHD and normal performance in the classic Stroop test and T-test results for two independent community

Component of the Stroop test	ADHD		NORMAL		T	DF	SIG
	M	SD	M	SD			
Number of errors	36.65	31.14	18.96	17.19	2.31	53	0.05
The number of correct	63.7	31.41	81.36	16.40	2.31	53	0.05
Interference Score	186.62	27.04	60.33	67.55	2.63	53	0.05

As is indicated in Table 2, the mean errors of the classic stroop test in ADHD children more than the normal child's and there is a significant difference between the two groups ($P < 0.05$). Average number of correct answers to the test in ADHD children lower

than normal and there were significant differences ($P < 0.05$). Mean interference scores in children ADHD with normal children are different and this difference is significant ($P < 0.05$).

Table 3

Mean and standard deviation of ADHD and normal children's theory of mind tests. T-test results for two independent community

	NORMAL		ADHD		T	DF	SIG
	M	SD	M	SD			
Total score of Theory of Mind	29.33	7.40	19.36	4.57	6.15	53	0.0001

Based on the above table, the average overall scores on tests of theory of mind in normal children is 29.33 and ADHD children is 19:36. The difference between the means of two groups of ADHD and normal, based on T-test is significant (0.0001).

Predicting	R	R^2
Response inhibition	0.68	0.46

According to the regression results, Theory of Mind 46% inhibition of response is expected. Theory of mind is a good predictor for response inhibition.

Table 4

Correlation coefficient associated with response inhibition, and theory of mind

Response inhibition	ADHD	NORMAL
Theory of Mind	-0.60	-0.40

As you can see table 4, there is a significant correlation between theory of mind and response inhibition in two groups ADHD and normal child's (0.01).

Table 5

Regression predicting theory of mind in terms of response inhibition

Discussion

The purpose of this study is comparison of theory of mind and response inhibition in normal and ADHD children and investigation of relation between theory of mind and inhibition responses. As can be seen in findings, results showed that normal and ADHD children have significant differences theory of mind. This findings show that ADHD children are at lower level in theory of mind. The evolutionary process of ADHDs theory of mind is slower in comparison with normal children.

Another component of study is response inhibition. Response inhibition and interference control are basis

core of many explanatory theories in ADHD disorder (Barkley, 2006; Barkley, 1997; Barkley, 2005; Nigg, 2006). In this study we used stroop test for assessment of response inhibition. Two important components of this test are reaction time and interference the findings of this study show that ADHD children differ with moral children in reaction time and interference scores, ADHD children have acquired more score than moral children in reaction time and interference. This result is similar to (Nigg, 2005; Lansbergen et al., 2007; Nigg et al., 2002; Homack & Riccio, 2004; Schweiger, 2007). The problem and damage in inhibition process could explain impulsivity, lack of concentration and other symptoms of this disorder.

As for research question is there a relationship between theory of mind and inhibitory response, conclusions indicated significant correlation between response inhibition and theory of mind. This finding aligned with Lough and et al (2007), Najmi (2007), Van Deurzen et al (2007). Response inhibition as one of executive functions prefrontal lobe inhibitions in response can predict development of mind theory. Many evidences are that show brain maturation is prerequisite for theory of mind.

Also disorder in functions of planning, self-regulation and problem solving caused interpersonal problems (Hughes, 2002; Zelazo et al, 2003). Generally, there are significant relationship between defects of executive functions with disability in creation of understanding, empathy and interaction with others (Klinger & Dawson, 1996; Lopez, 2005). The individuals with defects in executive function, inhibition and flexibility because of head injury and autism children had lower scores on tests of theory of mind (Hughes & Russell, 1993).

There are several theories about the relationship between these two constructs. The first theory suggests growth of theory of mind improves self-control (Frith, 1996) and needs growth of system of Attention and inhibition (Jeannerod, 1997). The second theory discusses that theory of mind need to observation of behavior. This means that person for achievement to theory of mind require that observe his self and reach to self awareness, and after conceptualize relationships .this ability need to executive functions as reasoning and response inhibition (Russell, 1996).

One the other, some theories have discussed that perhaps the mind-reading capability; consist of multiple executive function, similar general problem solving, flexibility and response inhibition (Hughes & Russell, 1993).

In the area of neurological studies are evidences that show relationship between two variables. The few studies by fMRI technology showed that activity in different regions of the frontal lobes is involved in executive functions and theory of mind (Castelli et al., 2002; Mehrinejad & Davoodabadi, 2011). Frontal lobe injuries cause the person not to understand understand,

emotional messages and cannot response to them. Therefore reduce score in theory of mind and executive functions.

The results of this study and other studies on the relationship between response inhibition and theory of mind arises questions that whether we can teach executive function to ADHD children and improve their theory of mind? And what other factors involve in development of theory of mind? Finally, we suggest that perform future research with large sample size in other deficiencies of frontal lobe.

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