Arch Neurosci. 2015 October; 2(4): e25066. DOI: 10.5812/archneurosci.25066

Published online 2015 October 17. **Research Article**

Relationship Between Sustained, Selective and Shifting Attention and Behavioral Symptoms in Children With High-Functioning Autism

Vali Shiri,[1] Ali S. Hosseini,[2] Ali Tahmasebi,[3,*] Ebrahim Pishyareh,[2] Esmail Shiri,[4] and Mahbobeh Emami[2]

[1]Department of Occupational Therapy, School of Rehabilitation Sciences, Isfahan University of Medical Sciences, Isfahan, IR Iran
[2]Department of Occupational Therapy, University of Social Welfare and Rehabilitation Sciences, Tehran, IR Iran
[3]Department of Occupational Therapy, School of Rehabilitation, Tehran University of Medical Sciences, Tehran, IR Iran
[4]Department of Psychology, Shahid Beheshti University of Medical Sciences, Tehran, IR Iran

*Corresponding author: Ali Tahmasebi, Department of Occupational Therapy, School of Rehabilitation, Tehran University of Medical Sciences, Tehran, IR Iran. Tel: +98-9136914501, E-mail: a-tahmasebi@razi.tums.ac.ir

Received: November 10, 2014; **Revised:** February 14, 2015; **Accepted:** March 14, 2015

Background: The association of autism symptoms and cognitive abilities can facilitate the etiology and treatment of autism disorders. Destruction of executive functions is one of the several potential cognitive phenotypes in autism.
Objectives: The purpose of this study was to investigate the relationship between deficit executive functions and behavioral symptoms in children with high-functioning autism.
Materials and Methods: In this cross-sectional study, 50 children with high-functioning autism were selected using the convenience sampling method. The Gilliam autism rating scale, high-functioning autism spectrum screening questionnaire, The Stroop color and word test, continuous performance test and shifting attention test were administered. Pearson correlation coefficient and multi-variant regression were used to analyze the data.
Results: There was a positive correlation between selective attention with communication and social interactions ($P < 0.01$, $P < 0.05$). There was a positive correlation between sustained attention with social interactions and stereotyped behaviors ($P < 0.05$, $P < 0.001$). Moreover, there also was a positive correlation between shifting attention and communication, social interactions and stereotyped behaviors ($P < 0.05$, $P < 0.01$, $P < 0.001$). The results of regression analysis showed that selective attention and shifting attention can predict communication ($P < 0.01$). Sustained attention can predict social interactions and stereotyped behaviors ($P < 0.01$, $P < 0.05$).
Conclusions: The results of this study suggest that executive functions play an important role in symptoms of children with high-functioning autism. It is recommended to design new therapeutic interventions to restore executive functions in children with high-functioning autism.

Keywords: Executive Function; Attention; High Function Autism

1. Background

Autism was first introduced by Leo Kanner in 1943. Autism disorders refer to a spectrum of neuro-developmental disorders in early stages of development identified by impairments in social interactions, communication and daily functions (1, 2). Repetitive actions, behaviors, and interests of children with autism are representative of deficit executive functions (3). Executive functions play an important role in socio-emotional functions (4), educational functions, use of working memory, problem solving, goal setting for doing tasks (5) and motor behaviors (6). Children with autism have a defective cognitive flexibility (7, 8), planning abilities (7, 9), response inhibition (10) and attention (11) in executive functions.

Attention is one of the most important aspects of cognition known as concentration and awareness and it is divided into sustained attention, selective attention, divided attention, and shifting attention which are controlled by certain areas of the human brain. Involvement of the cerebral frontal regions in children with autism could be responsible for the notion that says "children with autism have an impaired sustained attention" (12).

With regard to deficit executive functions in autism disorders (13) and the importance of executive functions in regulation of behavioral and educational functions, executive functions theory in autism has attracted a lot of attention to explain the symptoms of autism.

Bishop and Norbury (2005) reported a significant relationship between executive functions and communication impairments in children with autistic symptomatology. They suggested that deficiencies of pragmatic language in children with autism can be caused by com-

munication impairments and social problems. That is, deficiencies of executive control and selective attention can negatively impact the ability of children in behavioral modulation during social interactions. They also noted that the ability to control impulsive responses, to focus on target stimulation, and to modulate emotional responses requires sufficient selective attention and response inhibition (14).

Thanks to the hypo-activity of the frontal Cingulate cortex, children with autism have difficulty completing Continuous performance test II and the Go/No-Go tasks which results in a deficient response inhibition and attention (15). Moreover, impairment of the prefrontal cortex in children with high-functioning autism can lead to a more impaired sustained attention compared to children with attention deficit hyperactivity disorder (16).

Lopez et al. (2005) suggested that there is a positive correlation between cognitive flexibility and restricted and repetitive patterns of behavior in autism; however, there is no correlation between restricted and repetitive patterns of behavior and planning and fluency in children with autism (17). South et al. (2007) found that there is a poor association between repetitive behavior and executive function, whilst there is no relationship between repetitive behavior and central coherence in children with autism (13).

Zingerevich and Patricia (2009) showed that executive functions are involved in school activities. They found that executive functions such as: controlling impulsiveness, stopping the behavior at the right time and emotional regulation had an important impact on school activities (18).

Joseph and Tagr-flusberg (2004) investigated the relationship between theory of mind and executive functions with type and severity of symptoms in children with autism. The results showed that the theory of mind and executive functions can explain the variance of communication; however, they cannot explain the variance of social interactions and stereotyped behaviors (19). Lemonda et al. (2012) investigated the relationship between stereotyped behaviors and executive functions in children with autism. The results showed that executive functions can predict stereotyped behaviors (20).

2. Objectives

According to the given background, most of the previous studies focus on the relationships between executive functions and stereotyped behaviors, where as other behavioral symptoms (i.e. communication) have discussed fewer. It should be noted that executive functions can be used to provide a better explanation of behavioral symptoms in autism disorders. Due to the absence of a treatment protocol taking into account the role of executive functions in children with autism, investigating the relationship between executive functions and behavioral symptoms could be a catalyst to design a more comprehensive treatment protocol. Thus, the purpose of this study was to investigate the relationship between deficit executive functions and behavioral symptoms in children with high-functioning autism.

3. Materials and Methods

In this cross-sectional study, 50 children with high-functioning autism (31 children with autistic disorder and 19 children with Asperger's syndrome) were selected using the convenience sampling method and the below-mentioned formula. The research population included all children with high-functioning autism referred to the Roshd Occupational Therapy Center, Treatment and Rehabilitation Center for Autism of Behara and Tehran Pars Treatment Center in 2013. This study was approved by the ethics committee for human experiments, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran and informed consents were obtained from the parents of children before assignment. All information about the participants remained confidential and participants were allowed to leave the study whenever they wanted.

$$n = \left[\frac{z_{1-\frac{\alpha}{2}} + z_{1-\beta}}{\frac{1}{2}\ln\left[\frac{1+r}{1-r}\right]} + \right]^2 + 3 \quad (1)$$

One clinical psychologist and one pediatric psychiatrist confirmed the diagnosis of autism, separately using DSM-IV-TR diagnostic criteria for autism (1) and Gilliam Autism Rating Scale (GARS) (21). In order to select children with high functioning autism, Autism Spectrum Screening Questionnaire (ASSQ) was utilized. Children who scored 22 (if ASSQ completed by the therapists) or 19 (if ASSQ completed by parents) participated in this study (22). Moreover, participants met the following inclusion criteria: (a) to be aged between 7 and 12 years old, (b) not to be afflicted with seizure disorders, (c) not to be afflicted with acute medical or genetic conditions, and (d) not to be afflicted with an uncorrected visual impairment.

Exclusion criteria included: (a) Taking medicines that can affect the results of this study according to the psychiatric (b) History of seizures.

The Gilliam autism rating scaleand ASSQ were completed by occupational therapists. The Stroop Color and Word Test, Continuous Performance Test (CPT) and Shifting Attention Test (SAT) were completed by the participants.

3.1. The Stroop Color and Word Test

One measure of executive function that originally developed in 1935 by Stroop to measure selective attention or focused attention and response inhibition. It measures the ability of an individual to shift cognitive set (23) and provides a way of scoring cognitive inhibition (24, 25). The Stroop is

used frequently to test the function of frontal lobe. There are three components to this task. First, a therapist asks the individual to name a series of color words (Word task). Then, the therapist asks the individual to name the color of a bar (Color task). Third, the therapist asks the individual to name Color-Word on which the names of colors printed in conflicting ink colors (i.e., the word "red" in blue ink) (26).

3.2. Shifting Attention Test

The test measures the ability of an individual to transfer from one set of instruction to another with high speed and accuracy. The shifting attention test was originally developed by Martin & Rubin in 1995. The scale's internal reliability is $\alpha = 0.76$, with a Pearson test-retest correlation of 0.83. It consists of 12 statements, which are scored on a six-point Likert scale. The statements measure awareness of shifting in communication, tendency toward adaption to the situation and self-efficacy in being flexible (27). Concurrent validity and convergent validity of this test have been approved by Sanders et al. (12). Due to the fact that this test is not dependent on culture, it also can be used in the Persian cultural context.

3.3. Continuous Performance Test

The term CPT was first introduced by Beck et al. (28). The continuous performance test is used to investigate the pattern of cortical activation in individuals with autism across a variety of neurodevelopmental and psychiatric conditions. In addition, it serves as an objective measure of treatment outcome (12). The continuous performance test is comprised of 22 subscales and intends to produce errors of commission (requires responding) and errors of omission (requires not responding) through a series of trial sets. That is, the CPT provides data regarding inattention, inhibition, consistency of response, variability in attention and overall speed of discriminating reaction time.

3.4. Autism Spectrum Screening Questionnaire

The ASSQ was originally developed in 1993 by Ehlers and Gillberg to screen school children for Asperger syndrome and later it used for screening of other autism spectrum disorders. The ASSQ consists of 27 items and each item can be scored from 0 to 2. The ASSQ can be completed by teachers or parents. Children who scores 22 (if ASSQ was completed by the teachers) or 19 (if ASSQ was completed by parents) are considered to be high function autism. The ASSQ is valid and reliable, with good sensitivity and specificity in clinical settings (22). It has good internal consistency and a stable three-factor structure (29).

3.5. Gilliam Autism Rating Scale

The GARS is both a professional and a parent report scale for screening autism. The GARS constructed from criteria in the Diagnostic and Statistical Manual of Mental Disorders: Fourth Edition (DSM-IV) (30) and from definition of autism by the Autism Society of America (1994). Gilliam believed that the scale can be used for identification of autism, identification of serious behavioral problems, measuring progress for educational purposes, and provide a measurement for research purposes (21). The four domains of GARS include: stereotyped behavior, communication, social interaction, and developmental disturbances. The four domains of GARS represent an autism quotient to determine probability and severity of autism (with a mean of 100 and a standard deviation of 15). The GARS has the adequate validity and reliability for test domains and for the autism quotient (21).

Statistical Package for the Social Science version 16 (SPSS, Inc. Chicago, Illinois, USA) was used to analyze data. Pearson correlation coefficient and multi-variant regression were used for data analysis.

4. Results

Participants were 50 children with high functioning autism including 40 boys with a mean age of 9.8 years old (S.D = 1.25) and 10 girls with a mean age of 8.8 years (S.D = 1.25). Table 1 depicts the mean and standard deviation of GARS, CPT, Stroop Color and Word Test and SAT.

Table 2 shows the correlation between GARS variables and CPT, Stroop Color and Word Test and SAT.

There was a positive correlation between sustained attention with social interactions and stereotyped behaviors. There was a negative correlation between the number of correct responses in steps 1, 2 and 3 of the Stroop test with communication, social interactions and stereotyped behaviors; on the contrary, there was a significant and positive correlation between the reaction time in steps 1, 2 and 3 of the Stroop test with social interactions.

There was a negative correlation between the number of correct responses in steps 1 and 2 of the SAT with communication, social interactions and stereotyped behaviors; on the other hand, there was a significant and positive correlation between the reaction time in steps 1 with communication and social interactions and there was also a significant and positive correlation between the reaction time in steps 2 of the SAT with communication and stereotyped behaviors.

Table 3 depicts the result of multi-variant regression analysis to predict behavioral symptoms of children with high-functioning autism using variables of CPT, Stroop Color and Word Test and SAT.

According to Beta coefficients in Table 3, correct responses in first step of the Stroop test and correct responses in first step of the SAT are the best predicators of communication problems. Errors of omission and reaction time of CPT are the best predicators of stereotyped behaviors in children with high functioning autism. Errors of omission index of CPT is the best predicator of social interaction problems.

Table 1. Mean and Standard Deviation of Indexes of Gilliam Autism Rating Scale, Continuous Performance Test, Stroop Color and Word Test and Cognitive Flexibility Score.

Variables	Values [a]
Gilliam autism rating scale indexes	
Communication	16.5 ± 3.36
Social interactions	23.12 ± 6.15
Stereotyped behaviors	18.72 ± 4.37
Continuous performance Test	
Errors of commission	28.84 ± 5.90
Errors of omission	25.18 ± 8.87
Reaction time	0.93 ± 0.29
Stroop color and word test indexes	
Number of correct responses, step 1	85.06 ± 10.67
Number of correct responses, step 2	88.58 ± 10.88
Number of correct responses, step 2	88.22 ± 10.32
Reaction time, step 1	3.22 ± 1.34
Reaction time, step 2	3.57 ± 1.46
Reaction time, step 3	3.54 ± 1.31
Cognitive flexibility Score	
Number of correct responses, step 1	16.80 ± 8.70
Reaction time, step 1	3.56 ± 1.39
Number of correct responses, step 2	16.80 ± 8.61
Reaction time, step 2	3.60 ± 1.36

[a] The values are presented as mean ± SD.

Table 2. The Correlation Between Variables of Gilliam Autism Rating Scale With Continuous Performance Test, Stroop Color and Word Test and Cognitive Flexibility Score

Variables	Gilliam Autism Rating Scale Indexes		
	Communication	Social Interactions	Stereotyped Behaviors
Continuous performance test			
Errors of commission	0.28	0.66 [a]	0.73 [a]
Errors of omission	0.21	0.58 [a]	0.43
Reaction time	0.26	0.23	0.68 [a]
Stroop color and word test indexes			
Number of correct responses, step 1	-0.44 [a]	-0.54	-0.63
Number of correct responses, step 2	-0.34 [b]	-0.39 [a]	-0.49 [c]
Number of correct responses, step 2	-0.32 [a]	-0.36 [a]	-0.55 [c]
Reaction time, step 1	0.33	0.42 [a]	0.27
Reaction time, step 2	0.31	0.36 [b]	0.42
Reaction time, step 3	0.32 [b]	0.34 [b]	0.52
Cognitive flexibility score			
Number of correct responses, step 1	-0.33 [b]	-0.43 [a]	-0.33 [b]
Number of correct responses, step 2	-0.49 [c]	-0.51 [c]	0.41 [b]
Reaction time, step 1	0.30 [b]	0.29 [b]	0.14
Reaction time, step 2	0.33 [b]	0.11	0.32 [b]

[a] P > 0.01.
[b] P > 0.05.
[c] P > 0.0001.

Table 3. Multi-Variant Regression Analysis to Predict Behavioral Symptoms of Children With High-Functioning Autism Using Variables of Continuous Performance Test, Stroop Color and Word Test and Cognitive Flexibility Score [a]

Criterion (Dependent) Variables	Predictor (Independent) Variables	MR	RS	F	Nonstandardized Coefficients		Standardized Coefficients (Beta)	T-Score
					b	SE		
Communication problems	Correct responses (step 1 of cognitive flexibility score)	0.712	0.507	0.486	0.05	-0.14	-0.283	-2.67 [b]
	Correct responses (step 1 of Stroop color and word test)	0.828	0.685	0.679	0.08	0.86	0.828	10.22 [c]
Stereotyped behaviors	Errors of omission	0.683	0.466	0.455	0.06	0.39	0.683	6.48 [c]
	Reaction time	0.795	0.632	0.608	1.48	3.43	0.296	2.32 [b]
Social interactions problems	Errors of omission	0.658	0.432	0.421	0.08	0.49	0.658	6.05 [b]

[a] Abbreviations: MR, multiple regression; RS, R-squared; F, F-ratio; SE, standard error; b, beta.
[b] $P > 0.05$.
[c] $P > 0.01$.

5. Discussion

The purpose of this study was to investigate the relationship between sustained attention, selective attention and shifting attention, which are elements of executive function, with behavioral symptoms in children with high-functioning autism. The results showed that there was a positive correlation between deficient selective attention with communication and social interactions. In other words, symptoms of communication and social interactions will be intensified when deficiency of selective attention increases. The results of regression analysis also showed that selective attention can predict communication and stereotyped behaviors, which is consistent with the results obtained by other researchers (3, 4, 19).

Selective attention is the ability of an individual to maintain a cognitive set of internalized rules that involve inhibiting and responding discriminatively to specific stimuli (31). Thanks to the high interference of other stimuli, inability to inhibit irrelevant stimuli (32) and low information processing speed, children with high-functioning autism (33) cannot focus on the necessary information required for communication and social interactions so that they would offer irrelevant reactions (34). Deficit selective attention can cause children to experience failure in their social interactions. Moreover, deficit selective attention damages the ability of an individual to control impulsive actions and to regulate emotional reactions.

The results of this study were not consistent with the research done by South et al. (2007) (13). Differences in study tools, age ranges and intelligence quotient of participants and severity of symptoms among participants could be possible reasons for different results.

Also, the results of this study showed that there was a positive correlation between deficient sustained attention with social interactions and stereotyped behaviors. That is, symptoms of social interactions and stereotyped behaviors will be intensified when deficiency of sustained attention increases. The results were consistent with the results obtained by other researchers (14, 18, 35). Sustained attention is controlled by reticular formation, brainstem and frontal areas (36). Sustained attention is the most basic and simplest level of attention and any deficiency of sustained attention can influence other types of attention (37).

According to CPT, errors of omission are related to inattention and errors of commission are related to impulsivity. With regard to the relationship between errors of omission and errors of commission with social interactions and stereotyped behaviors, it is noticed that children with high-functioning autism disregard the required information in social interactions so that they would offer impulsive reactions.

The results of this study also showed that there was a positive correlation between deficient shifting attention with communication, social interactions and stereotyped behaviors. That is, symptoms of communication, social interactions and stereotyped behaviors will score higher when deficiency of shifting attention increases. It is important to note that shifting attention can predict communication. With regard to the literature, no studies have examined the relationship between shifting attention and autism symptoms.

Shifting attention is the ability of an individual to flexibly shift mental set to different cognitive demands and it requires integration of different components in prefrontal cortex (38, 39). Children with high-functioning autism have more preservation errors and lower completed lev-

els in SAT (9). Riccio et al. (2001) believed that symptoms of communication, social interactions and stereotyped behaviors in children with high-functioning autism could be interpreted as behavioral preservations. Behavioral preservations are related to impaired ability of neural circuits in the dorsolateral area of prefrontal cortex and frontal cortex to inhibit cognitive planning (40).

Frontal lobes are involved in the development of socioemotional and communication competence. Moreover, frontal lobes play an important role in executive functions as a self-control process (41, 42). Executive functions are coordinating functions of cognitive motor outputs that are done by the prefrontal area or fronto-striatal areas in collaboration with other neural circuits (43). Damages to dorsolateral area of prefrontal cortex are associated with deficit executive functions such as motor preservation and impulsivity (44, 45). It is also noteworthy to mention that, injury to orbitofrontal cortex can cause social isolation, loss of continuity of behavior, destruction of social interactions, and inability to understand social rules (46-48). One reason for the relationship between deficit executive functions and autism symptoms is that they occur as a result of damages to the same areas of brain. However, some researchers believe that deficit executive functions are the reason for autism symptoms (36, 49-51).

This research focused on stereotypical and repetitive patterns of behavior in children with autism and investigated the three types of attention in conjunction with behavioral symptoms of children with high-functioning autism, which was new compared to the few similar studies.

The present research study is limited by a relatively low number of girl participating subjects and nonrandom assignment, which may represent a bias. Nevertheless, such studies provide an insight to the potential value of understanding the relationship between deficit executive functions and behavioral symptoms in children with high-functioning autism. Moreover, it could be a catalyst to design a more comprehensive treatment protocol taking into account the role of executive functions in children with autism.

The results of this study suggest that executive functions play an important role in symptoms of children with high-functioning autism. Therefore, deficient executive functions can lead to behavioral symptoms in children with high-functioning autism, which necessitates the need to focus on executive functions in order to correct/manage behavioral symptoms.

It is recommended to design new therapeutic interventions to restore executive functions in children with high-functioning autism (i.e. improving shifting attention to ameliorate symptoms of social interactions).

Acknowledgements

Authors would like to thank children and their family who participated in this study.

Authors' Contributions

Study concept and design: Vali Shiri, and Ebrahim Pishyareh. Analysis and interpretation of data: Esmail Shiri, Mahbobeh Emami, and Seyyed Ali hosseini. Drafting of the manuscript: Ali Tahmasebi. Critical revision of the manuscript for important intellectual content: Ali Tahmasebi, and Seyyed Ali hosseini. Statistical analysis: Esmail Shiri, and Mahbobeh Emami.

Financial Disclosure

No conflicts of interest have been reported by the authors or by any individuals in control of the content of this article.

Funding/Support

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

References

1. Association AP. *Diagnostic and Statistical Manual of Mental Disorders*. American Psychiatric Pub; 2000.
2. Eigsti IM, Shapiro T. A systems neuroscience approach to autism: biological, cognitive, and clinical perspectives. *Ment Retard Dev Disabil Res Rev.* 2003;**9**(3):205–15.
3. Boyd BA, McBee M, Holtzclaw T, Baranek GT, Bodfish JW. Relationships among Repetitive Behaviors, Sensory Features, and Executive Functions in High Functioning Autism. *Res Autism Spectr Disord.* 2009;**3**(4):959–66.
4. Klinger LG, Dawson G, Renner P. Autistic disorder. *Child psychopathol.* 1996;**2**:409–54.
5. Meltzer L. *Executive function in education: From theory to practice.* New York City: Guilford press; 2011.
6. Happe F, Booth R, Charlton R, Hughes C. Executive function deficits in autism spectrum disorders and attention-deficit/hyperactivity disorder: examining profiles across domains and ages. *Brain Cogn.* 2006;**61**(1):25–39.
7. Tervo RC. Identifying patterns of developmental delays can help diagnose neurodevelopmental disorders. *Clin Pediatr (Phila).* 2006;**45**(6):509–17.
8. Bennetto L, Pennington BF, Rogers SJ. Intact and impaired memory functions in autism. *Child Dev.* 1996;**67**(4):1816–35.
9. Ozonoff S, Pennington BF, Rogers SJ. Executive function deficits in high-functioning autistic individuals: relationship to theory of mind. *J Child Psychol Psychiatry.* 1991;**32**(7):1081–105.
10. Prior M, Hoffmann W. Brief report: neuropsychological testing of autistic children through an exploration with frontal lobe tests. *J Autism Dev Disord.* 1990;**20**(4):581–90.
11. Ozonoff S, Strayer DL. Inhibitory function in nonretarded children with autism. *J Autism Dev Disord.* 1997;**27**(1):59–77.
12. Sanders J, Johnson KA, Garavan H, Gill M, Gallagher L. A review of neuropsychological and neuroimaging research in autistic spectrum disorders: Attention, inhibition and cognitive flexibility. *Res Autism Spec Dis.* 2008;**2**(1):1–16.
13. South M, Ozonoff S, McMahon WM. The relationship between executive functioning, central coherence, and repetitive behaviors in the high-functioning autism spectrum. *Autism.* 2007;**11**(5):437–51.
14. Bishop DV, Norbury CF. Executive functions in children with communication impairments, in relation to autistic symptomatology. 1: Generativity. *Autism.* 2005;**9**(1):7–27.
15. Chan AS, Han YMY, Leung WW, Leung C, Wong VCN, Cheung M. Abnormalities in the anterior cingulate cortex associated with attentional and inhibitory control deficits: A neurophysiological study on children with autism spectrum disorders. *Res Autism Spec Dis.* 2011;**5**(1):254–66.

16. Johnson KA, Robertson IH, Kelly SP, Silk TJ, Barry E, Daibhis A, et al. Dissociation in performance of children with ADHD and high-functioning autism on a task of sustained attention. *Neuropsychologia.* 2007;**45**(10):2234–45.
17. Lopez BR, Lincoln AJ, Ozonoff S, Lai Z. Examining the relationship between executive functions and restricted, repetitive symptoms of Autistic Disorder. *J Autism Dev Disord.* 2005;**35**(4):445–60.
18. Zingerevich C, Patricia DL. The contribution of executive functions to participation in school activities of children with high functioning autism spectrum disorder. *Res Autism Spec Dis.* 2009;**3**(2):429–37.
19. Joseph RM, Tager-Flusberg H. The relationship of theory of mind and executive functions to symptom type and severity in children with autism. *Dev Psychopathol.* 2004;**16**(1):137–55.
20. Lemonda BC, Holtzer R, Goldman S. Relationship between executive functions and motor stereotypies in children with Autistic Disorder. *Res Autism Spectr Disord.* 2012;**6**(3):1099–106.
21. Gilliam JE. *Gilliam autism rating scale: examiner's manual.* Texas: Pro-ed; 1995.
22. Ehlers S, Gillberg C, Wing L. A screening questionnaire for Asperger syndrome and other high-functioning autism spectrum disorders in school age children. *J Autism Dev Disord.* 1999;**29**(2):129–41.
23. Strauss E, Sherman E, Spreen O. *A compendium of neuropsychological tests: Administration, norms, and commentary.* USA: Oxford University Press; 2006.
24. Archibald SJ, Kerns KA. Identification and Description of New Tests of Executive Functioning in Children. *Child Neuropsychol.* 1999;**5**(2):115–29.
25. Boone KB, Miller BL, Lesser IM, Hill E, D'Elia L. Performance on frontal lobe tests in healthy, older individuals. *Dev Neuropsychol.* 1990;**6**(3):215–23.
26. Stroop JR. Studies of interference in serial verbal reactions. *J Exp Psychol Gen.* 1992;**121**(1):15–23.
27. Martin MM, Rubin RB. A New Measure of Cognitive Flexibility. *Psycholo Rep.* 1995;**76**(2):623–6.
28. Beck LH, Bransome EJ, Mirsky AF, Rosvold HE, Sarason I. A continuous performance test of brain damage. *J Consult Psychol.* 1956;**20**(5):343–50.
29. Posserud B, Lundervold AJ, Steijnen MC, Verhoeven S, Stormark KM, Gillberg C. Factor analysis of the Autism Spectrum Screening Questionnaire. *Autism.* 2008;**12**(1):99–112.
30. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders.* 1994. Available from: http://www.psychiatry.org/.
31. Finneran DA, Francis AL, Leonard LB. Sustained attention in children with specific language impairment (SLI). *J Speech Lang Hear Res.* 2009;**52**(4):915–29.
32. Pascualvaca DM, Fantie BD, Papageorgiou M, Mirsky AF. Attentional capacities in children with autism: is there a general deficit in shifting focus? *J Autism Dev Disord.* 1998;**28**(6):467–78.
33. Sinotte MP, Coelho CA. Attention training for reading impairment in mild aphasia: a follow-up study. *NeuroRehabilitation.* 2007;**22**(4):303–10.
34. Cornblatt BA, Malhotra AK. Impaired attention as an endophenotype for molecular genetic studies of schizophrenia. *Am J Med Genet.* 2001;**105**(1):11–5.
35. Hill EL. Executive dysfunction in autism. *Trends Cogn Sci.* 2004;**8**(1):26–32.
36. Hughes C. Executive function in preschoolers: Links with theory of mind and verbal ability. *British J Deve Psy.* 1998;**16**(2):233–53.
37. Ames C, Fletcher-Watson S. A review of methods in the study of attention in autism. *Develop Rev.* 2010;**30**(1):52–73.
38. Miller EK, Cohen JD. An integrative theory of prefrontal cortex function. *Annu Rev Neurosci.* 2001;**24**:167–202.
39. Hughes C, Plumet MH, Leboyer M. Towards a cognitive phenotype for autism: increased prevalence of executive dysfunction and superior spatial span amongst siblings of children with autism. *J Child Psychol Psychiatry.* 1999;**40**(5):705–18.
40. Riccio CA, Reynolds CR, Lowe PA. *Clinical applications of continuous performance tests: Measuring attention and impulsive responding in children and adults.* John Wiley & Sons Inc; 2001.
41. Pennington BF, Ozonoff S. Executive functions and developmental psychopathology. *J Child Psychol Psychiatry.* 1996;**37**(1):51–87.
42. Winsler A, Abar B, Feder MA, Schunn CD, Rubio DA. Private Speech and executive functioning among high-functioning children with autistic spectrum disorders. *J Autism Dev Disord.* 2007;**37**(9):1617–35.
43. Gilotty L, Kenworthy L, Sirian L, Black DO, Wagner AE. Adaptive skills and executive function in autism spectrum disorders. *Child Neuropsychol.* 2002;**8**(4):241–8.
44. Miyake A, Friedman NP, Emerson MJ, Witzki AH, Howerter A, Wager TD. The unity and diversity of executive functions and their contributions to complex "Frontal Lobe" tasks: a latent variable analysis. *Cogn Psychol.* 2000;**41**(1):49–100.
45. Damasio AR, Anderson SW. *The frontal lobes. Clinical neuropsychology.* 1993. pp. 404–6.
46. Stuss DT, Benson DF. Neuropsychological studies of the frontal lobes. *Psychol Bull.* 1984;**95**(1):3–28.
47. Van Hoesen GW, Damasio. Emotional disturbances associated with focal lesions of the limbic frontal lobe. *Neuropsycho human emo.* 1983;**1**:85–110.
48. Deutsch R, Kling A, Steklis H. Influence of frontal-lobe lesions on behavioral interactions in man. *Res Comm Psy Psy Beh.* 1979;**4**(4):415–31.
49. Ozonoff S, Cook I, Coon H, Dawson G, Joseph RM, Klin A, et al. Performance on Cambridge Neuropsychological Test Automated Battery subtests sensitive to frontal lobe function in people with autistic disorder: evidence from the Collaborative Programs of Excellence in Autism network. *J Autism Dev Disord.* 2004;**34**(2):139–50.
50. Russell J, Hill EL. Action-monitoring and intention reporting in children with autism. *J Child Psychol Psychiatry.* 2001;**42**(3):317–28.
51. Fisher N, Happe F. A training study of theory of mind and executive function in children with autistic spectrum disorders. *J Autism Dev Disord.* 2005;**35**(6):757–71.