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An Investigation of the Relationship Between Set-Shifting and School Function in Children with Autism Spectrum Disorder, Tehran, Iran (2017 - 2018)

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Abstract

Background: One of the executive functions affected by autism spectrum disorder is set-shifting. Set-shifting leads to adaptive behaviors in different life situations, including school function.
Objectives: Accordingly, this study aimed to examine the relationship between set-shifting and school function in children with autism spectrum disorder.
Methods: In this cross-sectional (descriptive-analytic) study, a total of 52 students aged between 7 and 12 years old with autism spectrum disorder were selected through convenient sampling technique in schools specifically for the autistic children in Tehran, Iran (2017 - 2018). The required data were collected using school function assessment (SFA) and behavior rating inventory of executive function (BRIEF) and were analyzed using the Pearson correlation coefficient and regression analysis.
Results: The results showed that the shifting subscale of BRIEF has a significant reverse relationship with school function ($P < 0.5$). It should be noted that in BRIEF, the higher score indicates further damage. Also, the results of regression analysis revealed a predictive role for set-shifting in the school function of children with autism spectrum disorder ($\beta = -0.67$, $P < 0.05$).
Conclusions: Set-shifting is associated with the school function of children with autism spectrum disorders. Furthermore, set-shifting can predict the school function and autistic children with problems in set-shifting are expected to have a weak school function.

Keywords: Autism Spectrum Disorder, Executive Function, Social Participation, Occupational Therapy

1. Background

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by deficits in social communication, restrictive and repetitive behaviors and interests (RRBIs) (1). Some researchers believe that the second diagnostic criterion i.e. restrictive and repetitive behaviors and interests can be due to deficits in executive functions (2, 3). One of the executive functions affected by ASD is cognitive flexibility. Cognitive flexibility leads to an effective shift of attention. Naturally, one has to be able to take the attention from one subject at the appropriate time and shift it to another one, or, if necessary, dismiss one activity and engage in another activity. Such a shift can also take place in the process of thinking. Many studies have shown that this cognitive function is affected in people with ASD. Neurological studies on the structure and function of the brain indicate that individuals with ASD are injured in the prefrontal lobe that is associated with executive functions (4-6). Several psychological tools, including Wisconsin Card Sorting test and CANTAB, have also proved the interference with the shift among tasks, which is due to cognitive inflexibility in people with ASD (6-8).

Set-shifting leads to the emergence of efficient behavior and adaptive response to changing situations in different social conditions. Set-shifting involves cognitive control over targeted behaviors through the shift in action and makes the challenging behaviors suppressed (9, 10). Flexible behaviors in autistic individuals have a significant effect on their function. These behaviors include non-flexible routines (for example, the same path to school), strict adherence to rules, resistance to change, stereotype movements (such as clapping), obsession, and inability to adapt to new social situation (4, 7, 11) and they have problems in the set-shifting both during the implementation of an activity and among different activities. The more com-

plex the activity, the more difficult is to shift (12).

Children with disabilities have a clear restriction on adaptive behaviors. Adaptive behaviors lead to proper function in everyday activities (13, 14). One of the most important functions of childhood is appropriate adaptive behavior in school. In a qualitative study on children with disabilities, Simeonson et al. (2001) concluded that proper school function improves the well-being and quality of life of these children (15). Several studies exist concerning school function in children with disabilities; however, there is little information about ASD despite its increasing prevalence (16-21). Children with ASD have a lot of restrictions in school function, as some of them are unable to study and go to school despite having the appropriate intelligence. The school functions is not limited to academic achievements, such as mathematics, science, spellings, reading, and writing, but rather to the ability of students to carry out daily activities that contribute to their effective function in education and social aspects related to it or support their participation in daily activities include non-educational activities such as the use of books and writing tools, answering the questions of others, asking for help and information when needed, mobility in the classroom and school, meeting personal needs appropriately, and interacting with classmates in learning activities are among functional activities (22-24).

Adaptive behaviors, social competency, and school success in children with autism are significantly influenced by their executive functions (13, 14). Disorders in executive functions predict school entry and achievement in children with ASD (20-25).

2. Objectives

Given that previous studies have identified set-shifting as the most affected executive function in the ASD (26, 27), in this study, we aimed to determine the role of set-shifting as an integral part of the school function for children with ASD. Also, by examining the results of regression analysis, we answered the question of whether the ability to set-shifting can predict the school function of these children.

3. Materials and Methods

This research is a cross-sectional (descriptive-analytic) study. The research project was approved by the Ethics Committee of Iran University of Medical Sciences (ID number: IR.IUMS.REC1395.9411255002). The sampling was done in three schools specifically for the children with ASD (Peyk-e-honar, Beshaarat, and payambar-e-azam). These schools are located in three geographical parts of Tehran city (Central, West, and East). Sample size of 48 were calculated by Cochran formula with P = 0.50, q = 0.50, t = 1.96, d = 0.06. Because the comorbidity is common in children with ASD and the participants were likely to be excluded for this reason, the final sample consisted of 67 students aged between 7 and 12 years old with ASD selected through convenient sampling. All participants had an IQ score of $\geq$ 70. The inclusion criteria were the diagnosis of autism spectrum disorder according to the psychiatrist's diagnosis and based on the Gilliam autism rating scale - second edition (GARS-2), the lack of comorbidity of autism spectrum disorder and other psychiatric disorders such as attention deficit/hyperactivity disorder, age range of 7 to 12 years old, and education in specific autism schools. All participants received similar therapies from traditional rehabilitation intervention, but there was no interference with the objectives of this study. The informed consent form was completed by the volunteer parents and CSI-4, GARS, and BRIEF questionnaires were submitted to the respondents. A total of 67 individuals completed the questionnaires, of which 15 individuals were not included in the study due to attention deficit/hyperactivity disorder. Then the SFA questionnaire was given to the teacher for completion. There were no types of missing data in this research and a complete set of value were obtained for all variables.

3.1. Measurement

3.1.1. Behavior Rating Inventory of Executive Function (BRIEF)

It is a test evaluating the deficits in executive functions in people aged between 5 and 18 years old. The test consists of two sections, which includes the behavior regulation index and the meta-cognition index. The behavior regulation index includes three subscales of inhibition, shift, and behavior regulation. This test has a high test-retest reliability (0.88 for teacher form and 0.82 for parent form). Moreover, they have been proven in the Iranian context as well. The reliability of the test with the internal consistency method for all items has a Cronbach coefficient above 85%. Also, the reliability of this test using test-retest method showed that the correlation between the scores was above 0.7, which in total shows that this test has desirable reliability (28). In this study, only the subscale of set-shifting was used as an indicator of set-shifting and cognitive flexibility.

3.1.2. School Function Assessment (SFA)

Coster et al. in the United States developed SFA in 1998. The validity and reliability of this test have generally been verified. Moreover, they have been proven in the Iranian context as well. The Cronbach's alpha coefficient for the different parts of this tool was excellent (0.84 < alpha < 0.99). The test-retest reliability of the test was good for the

subtest of this tool (0.85 < ICC < 0.99) (29-31). The SFA includes 320 items categorized into three sections as follows: participation, task support, and activity performance. The participation section, which used in this study, assesses the level of student participation in the six major setting of the school, including classroom (regular or specialized), playground or recess, transportation, toileting, transition, meal time or snack time (24).

3.1.3. Gilliam Autism Rating Scale (GARS-2)

Autism diagnosis scale (Gilliam, 1995) is a tool for diagnosis and screening of autism in people aged 3 to 22 years old. The questionnaire consists of 56 items in four sections: stereotype behaviors, communication, social interaction, and developmental disorders. The psychometric properties of this tool have been investigated in Iran as well. The sensitivity and specificity of the scale were 99% and 100%, respectively. The reliability of this scale was also estimated at 0.89 using Cronbach's alpha coefficient (32).

3.1.4. Child Symptom Inventory (CSI-4)

It is a behavior rating scale. This inventory has two forms; parent and teacher and in this study, the parent form was used. The parent form has 112 items, which is arranged for 11 major groups and an additional group of behavioral disorders, whereas the teacher form has 77 items, which include nine major groups of behavioral disorders. The validity of the inventory for the parents and teachers form was estimated to be 0.90 and 0.93, respectively (33).

3.2. Statistical Analysis

The data were analyzed by SPSS software version 21 using the Pearson correlation coefficient and regression analysis.

4. Results

The study population consisted of 52 male students with autism spectrum disorder that were identical in IQ (70 and above). In terms of educational level, 5 students were in the pre-school, 25 students in the first grade, 8 students in the second grade, and 5 students in the third grade, and 9 students in the fourth grade.

Table 1 shows that set-shifting and school function (participation) have a moderate correlation. The negative Pearson correlation coefficient indicates an inverse relationship, which means that the higher the set-shifting variable, the lower the school participation will be. The BRIEF Test is set up on the list of disorders, and a higher score indicates a failure in the executive function. Thus it can be concluded from the table above that, the more defective the set-shifting, the lower the participation in the school will be.

Table 1. Correlation Between School Function (Participation) and Set-Shifting Variables

	Set-Shifting	
	Pearson Correlation Coefficient	P Value
School function (participation)	-0.65	0.02[a]

[a] Correlation is significant at the 0.05 level (1-tailed).

Table 2 reveals the predictive ability of set-shifting for the dependent variable of school function. As see, the ability to predict the independent variable for school function (participation) is 0.09. That 9% of the changes in school function (participation) is affected by set-shifting variable.

Table 2. Linear Multiple Regression Model

	Set-Shifting			
	R	R^2	Adjusted R^2	P Value
School function (participation)	0.38	0.15	0.09	0.04[a]

[a] Significant at the 0.05 level.

Table 3 reports the regression coefficient. It can be concluded that set-shifting has facilitated the predictive capability. In this sense, the change in set-shifting has a potential to impact on school function (participation), and one standard deviation of change in set-shifting leads to 67% of the changes in standard deviation in the school function (participation) variable, and since β coefficient is negative, it can be asserted that the increase in the set-shifting score leads to reduced school participation.

Table 3. Linear Regression Coefficient Related to the Set-Shifting Variable and Dependent Variable of School Participation

	Set-Shifting	
	β	P Value
School function (participation)	-0.67	0.006[a]

[a] Significant at the 0.01 level.

5. Discussion

The purpose of this study was to examine the relationship between set-shifting and school function in children with autism spectrum disorder. The results indicated that set-shifting correlates with the school function, also it is a predictor factor for the school function. In this

study, the SFA was used to measure set-shifting and BRIEF was used to assess school function. Both instruments examine the child's behavioral performance in the real setting. Set-shifting is a subscale that measures the ability to shift from one position, activity or problem to another position, activity or problem, ability to move, problem-solving flexibly, tolerate change, and attention shift (11). Set-shifting subscale consists of the elements that reflects resistance against the ability to shift behaviorally (for example, against displacements, food, and routine work, etc.) and cognitively (for example, over an issue, thinking too much). Children with autism spectrum disorder have a weak function on BRIEF test in set-shifting subscale. Van den Bergh et al., in studying the problems of executive function in autistic people across different age groups, concluded that the most common functional disorder in childhood was flexibility and set-shifting (27). Granader et al. also showed that among subscales of executive function in the BRIEF test, the most common problem was with shifting (26). The study carried out by Memari et al. also showed that the cognitive flexibility of ASD is related to the outputs of everyday life, including their education and social functioning (10). Several studies, including the one by Lopez et al., have mentioned cognitive flexibility as a factor for restrictive and repetitive behaviors in ASD (34). This feature leads to over engagement in part of the activity and the person cannot shift to another part of the activity or the next stage of a sequence. In addition, this cognitive attribute of individuals with ASD leads to resistance to any change (35). All of the six sections of SFA need to move between places, for example, from outside the school to the inside or from the schoolyard and break time into the classroom. In addition, each activity has multiple tasks. For example, at the meal or snack time, the child should perform a multi-task sequence. If the child over engaged in a part of the activity, for example, opening and closing a dish repeatedly, the performance of the activity (that is eaten here) is neglected. When a child with autism spectrum disorder entering the new location, he or she needs to spend more time on adapting to those situations, and sometimes this change will lead to a tantrum. Excessive engagement with restrictive and repetitive behaviors will also limit the child's function in school activities.

In terms of predictability, set-shifting is considered an effective factor in school function. According to Zingervich and LaVesser's study, executive function was also introduced as a predictor of school function in children with ASD, but the difference from the present study was that in Zingervich and LaVesser's study, instead of examining the components of the executive function, two indexes of behavioral regulation and meta-cognition have been investigated. Moreover, the behavior regulation index (part of which is set-shifting), has a more predictive role than metacognition for school function. He also independently investigated the ability to shift using Wisconsin Card Sorting Test (WCST); however, there was no link between set-shifting and school function. In the viewpoint of Zingervich and LaVesser, the reason for this is that WCST is a neuropsychological tool, but BRIEF is a tool that evaluates behavioral disorders associated with set-shifting in the real setting (21).

In general, based on the results of the present study, set-shifting and cognitive flexibility are associated with the school function of children with ASD. Furthermore, set-shifting can predict school function. In other words, the more the set-shifting and flexibility of the child with autism, the better the school function will be. According to these results, in order to proper school function in students with ASD, therapists, teachers and caregivers should pay attention to the ability to set-shifting in both preschoolers and school age children. There are some interventions and behavioral strategies that can be implemented to facilitate set-shifting such as neurocognitive rehabilitation, transition routine, representational objects, etc. (36). Nevertheless, there is no evidence for the effectiveness of these interventions and strategies for the school function in children with ASD.

5.1. Limitations

We encountered some limitations in this study, including the small sample size, failure to determine the level of autism spectrum disorder, the reference to the IQ identified in the student file, the lack of access to the latest revision of the GARS and CSI-4, and the use of diagnostic criteria based on DSM IV-R. Also, all participants of this study were boy because there was no specific school for girls with ASD in Tehran; the reason for it is the high prevalence of ASD in boys rather than girls. It is suggested to consider these factors in future studies.

5.2. Recommendations

Set-shifting is just one of the executive functions. Given the previous studies that emphasized the importance and prevalence of executive dysfunction in children with autism, it is suggested that in future studies other executive functions such as inhibition, emotion control, planning, working memory, etc. should be taken into account. It is also suggested that interventions aiming at improving set-shifting should be designed and their impact on the school function should be measured.

5.3. Conclusions

In this study, the role of set-shifting in the school function of children with ASD was studied. Set-shifting is associated with the school function of these children. This function relates to both academic and non-academic activities of students at school. In other words, the more the set-shifting and cognitive flexibility of children with ASD, the better the school function of them will be. Set-shifting can also be a predictive factor for the school function, and it is expected that a child with less set-shifting has a better school function.

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Footnotes

Authors' Contribution: Mahsa Kheirollahzadeh developed the original idea and the protocol, abstracted and analyzed data, wrote the manuscript, and is guarantor. Mehdi Alizadeh Zarei contributed to the development of the protocol, abstracted data, and prepared the manuscript.

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