Cognitive predictors of behavioral inflexibility in young children with autism spectrum disorder symptoms

Saeid Sadeghi1,2*, Hamid Reza Pouretemad2,3

1. Assistant Professor, Institute for Cognitive and Brain Sciences, Shahid Beheshti University, Tehran, Iran
2. Center of Excellence in Cognitive Neuropsychology, Shahid Beheshti University, Tehran, Iran
3. Professor, Institute for Cognitive and Brain Sciences, Shahid Beheshti University, Tehran, Iran

Abstract

Introduction: One of the symptoms of people with autism spectrum disorder (ASD) is behavioral inflexibility, which causes poor adaptation to environmental demands and behavioral problems. The present study investigated the role of executive functions in predicting the behavioral flexibility of young children with ASD.

Methods: In this correlational study, the convenience sampling method selected 45 children aged 16 to 36 months. Data were collected using the behavior rating inventory of executive functioning-preschool version (BRIEF-P) and the behavior flexibility rating scale-revised (BFRS-R). Pearson correlation coefficient and simultaneous regression were used to analyze the data using SPSS-24 software.

Results: The results of Pearson correlation coefficient and regression analysis revealed that the behavioral flexibility of children with inhibition (P<0.05, r=0.37), shifting (P<0.01, r=0.45), emotional control (P<0.01, r=0.49), planning/organizing (P<0.05, r=0.34), inhibitory self-control (P<0.01, r=0.44), cognitive flexibility (P<0.01, r=0.55), metacognition (P<0.05, r=0.30), and total score of executive functions (P<0.01, r=0.46) is correlated. Working memory had no significant relationship with young children’s behavioral flexibility (P>0.05, r=0.23). The overall score of young children executive functions predicts 18%, 15%, and 21% of the variance, respectively, of the behavioral flexibility of young children in relation to objects, the environment, and the overall score of behavioral flexibility. Executive functions did not have the ability to significantly predict behavioral flexibility toward individuals.

Conclusion: The present study concluded that executive dysfunction is associated with behavioral flexibility in young children with ASD. It is suggested that in future studies, the design of early interventions to improve executive functions with the aim of increasing the flexibility of children with ASD be considered.

Keywords
Autism spectrum disorder
Executive functions
Behavioral flexibility

Extended Abstract

Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by deficits in social interaction and social communication and a range of restricted, repetitive, and stereotyped behavior patterns, interests, and activities (1). The onset of ASD symptoms usually occurs in symptoms of autism in infancy and toddlers before the age of 2 years. Although new theories have been developed to explain different features of ASD core impair-
ments in recent years, no neuro-psychological theory has been proposed to explain all ASD aspects satisfactorily. EFs, theory of mind (ToM), and weak central coherence cognitive theories have dominated neuropsychological research into ASD (10, 11). It is assumed that the theory of mind and weak central coherence could explain many of the deficits in social interaction and social communication associated with ASD (12). However, the EFs theory may provide the best explanation for the non-social aspects of ASD, such as repetitive behaviors and restricted interests (13). EFs are a set of cognitive skills defined as an “umbrella” term that includes goal-directed and self-regulatory cognitive abilities such as inhibition, shifting, working memory, flexibility, and planning (20). Additionally, EF is the only theory that acknowledges both the motor and cognitive characteristics of ASD (e.g., perseveration, insistence on sameness, repetitive hand flapping, and rocking) (10). Deficits in behavioral flexibility have been repeatedly documented in ASD. Behavioral inflexibility in ASD is characterized by circumscribed interests, restricted and repetitive behaviors (RRBs), pervasive impairments in social interactions and communication. Behavioral inflexibility refers to rigid behavioral patterns that contrast with the need to adapt to the changing needs of the environment. Behavioral Inflexibility is a potential dimensional ability that can explain the RRBs domains. RRBs are a hallmark of ASD (1). The RRBS manifests across echolalia, stereotyped behaviors, self-injurious behaviors, ritualistic behaviors, sameness behaviors, restricted behaviors, compulsive behaviors, and hyper- or hypo-reactivity to sensory stimuli. Despite the findings of previous studies showing a deficit in the behavioral flexibility of people with ASD, determining the degree of predictability of each of the executive functions in the behavioral flexibility of children with ASD has not yet been studied. By identifying the cognitive underpinnings of behavioral inflexibility at an early age in people with autism spectrum disorder, early and specific interventions can be designed to improve the underlying cognitive function and thus increase behavioral flexibility. Indeed, clarifying the cognitive basis of behavioral flexibility in people with autism spectrum disorder can provide clues to its pathophysiology, improve clinical evaluation, and guide the development of new interventions to address behavioral flexibility as one of the hallmarks of autism spectrum disorder. The present study seeks to answer the question of what is the relationship between the components of executive functions and behavioral flexibility and can executive functions predict behavioral flexibility as one of the hallmarks of autism.

**Methods**

Participants included forty-five toddlers (34 males, 11 females; mean age=26.33 months; range 16–36 months) who were referred to the autism center. Each subject was diagnosed using comprehensive evaluation that included standardized testing, behavioral observation, and extensive parent reports gathered through interviews and questionnaires. Diagnoses were based on DSM 5 guidelines (1). All subjects were evaluated by an ASD specialist with a PhD in clinical psychology and at least one assistant (with at least a master's degree in clinical psychology). The diagnosis was made based on informed clinical judgment following interaction with the child, formal testing, and review parent reports and records review. Cross-sectional data were collected from mothers of toddlers. The behavior rating inventory of executive functioning-preschool version (BRIEF-P) and the behavior flexibility rating scale-revised (BFRS-R) was administered to mothers. To participate in the current study, parents completed an informed consent form for the child’s participation, executive functions and repetitive behavior measures (described below), and a demographic information checklist. Inclusion criteria included no known co-
morbid psychological and medical disorders or hearing and visual deficits.

**Results**
The results of the Pearson correlation test revealed that the degree of behavioral flexibility in young children was correlated with inhibition, shifting, emotional control, planning/organization, inhibitory self-control, cognitive flexibility, metacognition, and the overall score of executive functions. Only working memory had no significant relationship with children's behavioral flexibility among executive functions. Regression analysis was used to evaluate the predictive role of executive functions of defects in the behavioral flexibility of young children. Executive functions predict 18%, 15%, and 21% of the variance of children's behavioral flexibility towards objects, environment, and total behavioral flexibility score, respectively.

**Conclusion**
This study's findings showed that all executive functions studied, except working memory, have a significant relationship with behavioral flexibility in young children. The regression analysis results also showed that executive functions had the ability to significantly predict part of the variance of flexibility in children with symptoms of autism spectrum disorder to the environment and objects. At the same time, this predictive was not significant in behavioral flexibility towards individuals. According to this study's findings, it can be concluded that the ability to shift attention between different situations and tasks and inhibit thoughts and movements are essential cognitive predictions in the amount of behavioral flexibility in young children. Also, executive function theory has the ability to predict the behavioral flexibility related to non-social stimuli. Other cognitive theories such as ToM and weak central coherence should be considered to explain social and behavioral flexibility.

**Ethical Considerations**

**Compliance with ethical guidelines**
The present study observed ethical principles, including obtaining written consent in order to participate in the research, respecting the principle of confidentiality of the participants in such a way that the names of the participants were removed for confidentiality; adequate information on how the research was conducted was provided to all participating parents and they were free to leave the research process.

**Authors’ contributions**
Both authors of the present study collaborated in the design and conceptualization of the study and its final approval. The article's first author was responsible for preparing and revising the manuscript.

**Funding**
No financial support has been received from any organization for this research.

**Acknowledgments**
The authors would like to thank all the families who helped us in this research.

**Conflict of interest**
The authors declared no conflict of interest.