Research Paper: Relationship Between Executive Functions and Pragmatic Language in Children With Autism Spectrum Disorders

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ABSTRACT

Objectives: Children with Autism Spectrum Disorder (ASD) have problems in communicating and social interaction skills. Moreover, deficits in pragmatic language and executive functions are among the most important causes of communication and social interaction problems in this group. The present study aimed to determine the relationship between executive functioning and two of its indices (behavior regulation and metacognition), and pragmatic language in children with ASD.

Methods: This was a descriptive, cross-sectional study. The study population included all 6- to 11-year-old children with ASD in Tehran autism schools in the academic year 2017-2018. A total of 74 children with ASD (68 boys and 6 girls) (Mean±SD age: 8.58±1.88 y) were selected from autism schools in Tehran City, Iran, using a convenience sampling method. The Behavior Rating Inventory of Executive Function (BRIEF) and the Children's Communication Checklist (CCC) were used to collect data.

Results: The significant, negative correlations were found between executive functioning and pragmatic language (r=-0.47, P<0.001); behavioral regulation and pragmatic language (r=-0.42, P<0.001); and metacognition and pragmatic language (r=-0.45, P<0.001).

Discussion: The study results suggest that the better the executive functioning and its indices performance in children with ASD, the fewer their difficulties in the proper use of language in social situations would be. In addition, the ability to use language appropriately in different social situations allows students with ASD to control their behavior and thoughts in these situations better. According to the obtained results, the language skills of children with ASD can be improved through designing appropriate therapeutic interventions to improve executive functioning and its indices in them.

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Highlights

- Executive functioning plays an essential role in language processing in children with Autism Spectrum Disorder (ASD).
- ASD children with better behavioral regulation have fewer problems in properly using language in social situations.
- Metacognition deficit leads to compatibility and communication problems in children with ASD.

Plain Language Summary

Most children with Autism Spectrum Disorder (ASD) have problems in using pragmatic language (using language in the social context). Executive functioning plays an essential role in the daily lives of children with ASD. The present study examined the relationship between executive functioning indices (behavioral regulation and metacognition) and pragmatic language in children with ASD. According to the results, the children with ASD, who can consciously control their behavior and thoughts in different social situations, can better use language in these situations and vice versa. Also, the pragmatic language in children with ASD can be built up through improving their executive functions.

1. Introduction

Autism Spectrum Disorder (ASD) is a type of neurodevelopmental disorder defined in the Diagnostic and Statistical Manual for Mental Disorders, 5th Edition (DSM-V). ASD is characterized by deficits in communication and social interaction as well as repetitive and restricted behaviors and interests [1].

According to the last report of the Centres for Disease Control and Prevention (CDC), 1 in 68 children is diagnosed with an ASD; the prevalence of this disorder is 4 times higher in boys [2]. The latest prevalence of ASD has been reported as 60 per 10000 children in 2016 in Iran [3].

Most of the children with ASD have linguistic impairments which are most commonly observed in the context of pragmatic language [4]. One of the main aspects of communication skills is pragmatic language or functional language. It encompasses a range of social functions, continuous communication, flexibility in the use of language with different persons and various social situations, and the ability to transfer content in a coherent and integrated manner [5]. Impairment in the pragmatic language (mismatch and the inaccurate use of language in a particular situation) is highly correlated with ASD. Furthermore, it includes problems in the negotiation of turn-taking, the choice of referential expressions (“a” versus “the”), the lack of experience in peer interactions, problems in humor comprehension, as well as difficulty in understanding excitement and facial expressions [4].

Executive dysfunction is the main core of these problems [6]. Functions like planning, flexibility, and working memory affect concept formation, timely problem-solving transfer, and the use of alternative schemes and solutions to solve problems [7]. Studies have reported deficits in the pragmatic language in children with ASD and relationships between these deficits and executive functions [4, 6, 8, 9]. Akbar et al. found a strong correlation between verbal and non-verbal abilities and executive functions [8].

Additionally, they highlighted the significant role of working memory, as one of the metacognition scales, in pragmatic language. Schuh examined working memory among children aged 8-17 years [9]. The obtained data suggested that children with a higher working memory capacity respond more accurately to demands because they can consider the information that the speaker does not access. Another research indicated no significant relationship between executive functions (working memory, inhibition, and planning) and verbal skills [10]. Therefore, more detailed research is required on this subject. Pragmatic language essentially affects the long-term ability of a person to function in society. In other words, the ability to use practical language in social and communication skills is related to reduced social impairment [4].

According to previous studies, executive functioning plays an important role in social, communicative, and cognitive functions [11, 12]. Children who have better executive functions demonstrate better performance in the pragmatic language [6]. Regardless of Intelligence

Quotient (IQ) and the severity of ASD symptoms, two executive functioning indices, including metacognition (including inappropriate initiation, working memory, planning, the organization of materials, and monitoring) and behavioral regulation (including inhibition, shift, and emotional control) are highly correlated with communication and social skills [11]. A study was conducted on the relationship between pragmatic language and the executive functions of behavioral regulation and metacognition by Ileto [12]. The applied tool was the Behavior Rating Inventory of Executive Function (BRIEF) questionnaire. It was concluded that the pragmatic language predicted both executive functions.

Moreover, there was no significant relationship between age and executive functions; however, there was a significant association between IQ and metacognition. There is a strong correlation between verbal working memory and language learning, especially learning new vocabulary. In addition, childhood problems in executive functioning can lead to impaired social and communication skills in adulthood [13].

Individuals with ASD experience deficits in their executive functioning and pragmatic language. Moreover, there are conflicting results about the relationship between executive functions and pragmatic language. Thus more research is required on this topic. In addition, examining the relationship between executive functions and pragmatic language in children with ASD can help design proper interventions for them. The present study aimed to examine the relationship between executive functioning and two of its indices, including behavioral regulation and metacognition, and pragmatic language in children with ASD. We conducted the study based on the BRIEF.

2. Methods

This was a descriptive, cross-sectional study. The statistical population consisted of all students aged 6-11 years with ASD in autism schools in Tehran City, Iran, during the academic year 2016-2017.The authors were initially referred to the Exceptional Education Administration in Tehran by the Ethics Committee at the University of Social Welfare and Rehabilitation Sciences to receive permission to conduct the study in autism schools in Tehran.

The study objectives and importance and ethical considerations (informing parents about the methods, goals, benefits, nature, and the duration of research; obtaining informed written consents from students' parents; allowing the participants to withdraw from the study at any time; ensuring the confidentiality of the personal information of children and parents, and the commitment of the researcher to inform parents) were explained to school authorities. Accordingly, 82 students with ASD (70 boys and 12 girls) were selected as the statistical sample. We used convenience sampling method and followed a sample size formula. The inclusion criteria were as follows: speech ability, ability to speak Persian, and the diagnosis of ASD based on clinical interviews by a psychiatrist.

The exclusion criteria were having sensory problems, including visual and auditory impairments; physical problems, like cerebral palsy, epilepsy, etc.; and other problems, such as low IQ, behavioral problems, and Attention Deficit Hyperactivity Disorder (ADHD). Informed written consents were obtained from the students' parents for the participation of their children in the research. A psychiatrist reviewed the medical records of children to verify the diagnosis of ASD. Then, the children's parents completed the Children's Communication Checklist (CCC) and the BRIEF.

Study instruments

The Children's Communication Checklist: This checklist was designed by Bishop in 1998 [14]. It consists of 70 questions and 9 levels of speech, syntax, inappropriate initiation, coherence, conversation, context, rapport, social behavior, and restricted interests. The questions probe skills and problems in the mentioned areas. Of the 7 questions, 5 are related to impairments, and 2 are focused on strengths. In Iran, the checklist has been validated for children aged 6-11 years; a Cronbach's α coefficient of 0.82 has been reported for it [15]. In the present study, a Cronbach's α coefficient of 0.83 was calculated for the CCC.

The Behavior Rating Inventory of Executive Function: The original version of this inventory contains 86 items, assessing behavioral issues related to executive functions in children aged 6-11 years [16]. The items are rated on a 3-point Likert-type scale ranging from 1 (never) to 3 (often). The BRIEF assesses two executive functioning indices; behavioral regulation and metacognition. Behavioral regulation includes the measures of inhibition, shift, and emotional control. Furthermore, metacognition includes the measures of initiation, active memory, planning, organizing, and monitoring. Total scores range from 86 to 258. A score of 50 indicates the presence of problems, and a score above 65 indicates impairment in the respective area.

The reliability estimates of 0.84, 0.88, and 0.86 have been reported for behavioral regulation, metacognition, and the total inventory, respectively [16]. The original version of the inventory has been translated into Persian and validated in Iran by Zarei, Mohammadtaghi, Mehraban, and Fahimi [17]. The internal consistency of BRIEF using the Cronbach's α coefficient has been reported to be 0.83, 0.84, and 0.88 for behavioral regulation, metacognition, and the total inventory, respectively [17]. In the present study, the Cronbach's α coefficients of 0.78, 0.81, and 0.85 were measured for behavioral regulation, metacognition, and the total inventory, respectively.

After obtaining the data, 8 students (5 boys and 3 girls) were excluded from the study because of their parental lack of cooperation in completing the questionnaires or providing incomplete responses. Finally, the data achieved from 74 students (65 boys and 9 girls) with ASD were analyzed. The obtained data were analyzed using the Pearson correlation coefficient in SPSS.

3. Results

The study participants included 74 students with the Mean±SD age of 8.85±1.88 years; of whom, 9 were girls with the Mean±SD age of 9.83±2.86 years, and 65 were boys with the Mean±SD age of 8.92±3.92 years.

Table 1 demonstrates the descriptive characteristics of pragmatic language, executive functioning, and its indices (behavioral regulation and metacognition).

As per Table 1, among the pragmatic language scales, the lowest and highest mean scores belonged to the conversation (23.15) and speech (31.39), respectively. Moreover, the mean score of 238.9 was found for pragmatic language skills. Among the executive functions, the highest mean scores belonged to inhibition (27.2) and planning/ organization (28.34), furthermore, the lowest mean scores related to shifting (19.28) and organizing materials (14.22).

Table 1. Descriptive characteristics of pragmatic language, executive functioning, and its indices among children with ASD

Variable	Scale	Mean±SD	Median
Pragmatic language	Speech	31.69±3.99	32
	Syntax	27.95±2.25	28
	Inappropriate Initiation	24.22±3.08	24
	Coherence	26.86±3.36	26.5
	Conversation	23.15±3.26	23.5
	Context	23.55±3.11	23
	Rapport	27.65±3.27	28
	Social Behavior	24.99±4.27	25
	Restricted Interests	28.85±2.45	29
	Total	238.9±19.26	239.5
Behavioral regulation	Inhibition	27.2±7	26
	Shift	19.28±4.93	19
	Emotion control	21.32±4.24	21
	Total	67.5±13.45	68
Metacognition	Initiation	17.46±2.7	17
	Working Memory	23.45±4.14	23.5
	Plan/ Organize	28.34±7.15	28
	Organization of Materials	14.22±4	15
	Monitor	17.72±3.49	18
	Total	101.16±17.48	101
Global Executive Composite (GEC)	Total	168.66±30.93	169

Table 2. Shapiro-Wilk test results to assess the normality of variables

Variable	Shapiro-Wilk Statistics	P
Behavioral regulation	0.98	0.26
Metacognition	0.99	0.84
GEC	0.99	0.9
Pragmatic language	0.99	0.83

The normality of variables was investigated using the Shapiro-Wilk test; the results are presented in Table 2. As per Table 2, behavioral regulation, metacognition, executive functioning, and pragmatic language were all normally distributed (P>0.05). Accordingly, the research hypotheses were tested using the Pearson correlation coefficient (Table 3).

According toTable 3, significant negative relationships were found between GEC and pragmatic language (r=-0.47, P<0.001), behavioral regulation and pragmatic language (r=-0.42, P<0.001), and metacognition and pragmatic language (r=-0.45, P<0.001).

According to Table 4, there were significant relationships between inhibition and the pragmatic language scales (coherence, context, and social behavior). Furthermore, the highest and lowest correlation coefficients belonged to coherence (r=0.36, P<0.001) and context (r=-0.26, P<0.024), respectively. In addition, there were significant relationships between shift and the pragmatic language scales (coherence, conversation, context, rapport, and social behavior); the highest and lowest correlation coefficients related to the conversation (r=- 0.36, P<0.002) and social behavior (r=-0.30, P<0.009), respectively. Moreover, there were significant relationships between emotional control and the pragmatic language scales (initiation, coherence, conversation, context, and social behavior); the highest and lowest correlation coefficients belonged to social behavior (r=-0.42, P<0.001) and context (r=- 0.26, P<0.026), respectively.

According to Table 5, there were significant relationships between initiation and the pragmatic language scales (except syntax and initiation). Moreover, the highest and lowest correlation coefficients belonged to social behavior (r= -0.39, P<0.001) and speech (r=-0.23, P<0.044), respectively. Working memory was significantly related with all the pragmatic language scales (except syntax and initiation). Additionally, the highest and lowest correlation coefficients were related to coherence (r=-0.45, P<0.001) and speech (r=-0.23, P<0.044), respectively. Planning/ organizing was significantly correlated with coherence (r=-0.31, P<0.007) and rapport (r=-0.29, P<0.01). Furthermore, there was a significant relationship between the organization of materials and

Table 3. The Pearson correlation coefficient data to determine the relationship between variables

Variable	Statistic	GEC	Behavioural Regulation	Metacognition	Pragmatic Language
GEC	Coefficient (P)	1	0.88 (<0.001)	0.93 (<0.001)	-0.47 (<0.001)
Behavioral Regulation Index (BRI)		0.88 (<0.001)	1	0.69 (<0.001)	-0.42 (<0.001)
Metacognition Index (MI)		0.93 (<0.001)	0.69 (<0.001)	1	-0.45 (<0.001)
Pragmatic language		-0.47 (<0.001)	0.42 (<0.001)	-0.45 (<0.001)	1

Table 4. Correlation coefficients between the behavioral regulation and pragmatic language scales

Variable	Inhibition	Shift	Emotion Control
Speech	-0.03 (0.79)	-0.04 (0.73)	-0.19 (0.10)
Syntax	-0.08 (0.51)	-0.04 (0.76)	-0.006 (0.96)
Inappropriate initiation	-0.11 (0.35)	-0.12 (0.32)	-0.35 (0.002*)
Coherence	-0.36 (0.001*)	-0.32 (0.005*)	-0.13 (0.008*)
Conversation	-0.22 (0.06)	-0.36 (0.002*)	-0.41 (0.001*)
Context	-0.26 (0.024*)	-0.31 (0.008*)	-0.26 (0.026**)
Rapport	-0.18 (0.13)	-0.31 (0.008*)	-0.17 (0.14)
Social behavior	-0.3 (0.003*)	-0.30 (0.009*)	-0.42 (0.001*)
Restricted interests	-0.03 (0.8)	-0.17 (0.14)	-0.06 (0.63)

*Correlation is Significant at the 0.01 level (2-tailed); **Correlation is significant at the 0.05 level (2-tailed)

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Table 5. Correlation coefficients between the metacognition and pragmatic language scales

Variables	Initiation	Working Memory	Plan/ Organize	Organization of Materials	Monitor
Speech	-0.23 (0.044*)	-0.31 (0.008**)	-0.04 (0.72)	-0.14 (0.22)	-0.11 (0.34)
Syntax	-0.06 (0.59)	-0.05 (0.65)	-0.05 (0.67)	-0.07 (0.57)	-0.08 (0.50)
Inappropriate initiation	-0.22 (0.06)	-0.15 (0.19)	-0.12 (0.32)	0.02 (0.85)	-0.19 (0.10)
Coherence	-0.35 (0.002**)	-0.45 (0.001**)	-0.31 (0.007**)	-0.36 (0.002*)	-0.45 (0.001**)
Conversation	-0.31 (0.006)	-0.33 (0.004**)	-0.19 (0.09)	-0.12 (0.31)	-0.43 (0.001**)
Context	-0.35 (0.002**)	-0.39 (0.001**)	-0.13 (0.28)	-0.19 (0.10)	0.41 (0.001**)
Rapport	-0.37 (0.001**)	-0.37 (0.001**)	-0.29 (0.01*)	-0.19 (0.10)	0.39 (0.001**)
Social behavior	-0.39 (0.001**)	-0.38 (0.001**)	-0.15 (0.21)	-0.2 (0.08)	-0.50 (0.001**)
Restricted interests	-0.29 (0.013*)	-0.37 (0.001**)	-0.2 (0.08)	-0.04 (0.75)	-0.22 (0.06)

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* Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed)

coherence (r=-0.36, P<0.002). Besides, there were significant relationships between monitoring and the pragmatic language scales (coherence, conversation, context, rapport, and social behavior). Eventually, the highest and lowest correlation coefficients were related to social behavior (r=-0.50, P<0.001) and rapport (r=-0.39, P<0.001), respectively.

4. Discussion

There was a significant relationship between executive functions and pragmatic language. In other words, the more students with ASD can consciously control their behavior and thoughts in different social situations, the better they can use language in these situations and vice versa. It can be inferred that executive functioning plays an important role in language processing. Moreover, language-related tasks, like sentence comprehension, are largely influenced by executive functioning [18].

Bishop and Norbury compared children with high-functioning autism with children with Specific Language Impairment (SLI), and typically developing children. All subjects were matched in age, gender, and non-verbal ability [19]. They found a close relationship between pragmatic language and executive functions. Geurts and Embrechts examined the relationship between executive functioning and pragmatic language in three groups of children with ADHD, ASD, and SLI; they found positive correlations between executive functioning and pragmatic language. Furthermore, they stated that problems in executive functioning and pragmatic language in both groups of ASD and ADHD might have a similar cause; although executive functions associated with pragmatic language might be different in the two disorders [20].

In an examination, the pragmatic language and its association with executive functioning, adaptive functioning, and ADHD were explored in children with ASD. The applied tools were CCC-2 to assess pragmatic language, the BRIEF to assess EF, the Vineland Adaptive Behavior Scales (VABS) to assess adaptive functioning, and the ADHD Rating Scale to assess ADHD. As a result, Ileto [12] found significant relationships between pragmatic language and executive functioning, adaptive functioning, and ADHD symptoms.

The second study revealed a significant relationship between behavioral regulation and pragmatic language. Therefore, the better the performance of children with ASD in behavioral regulation, the fewer problems they will face in the proper use of language in social situations. In addition, executive dysfunction in children is due to their inability to use inner and spontaneous speech in regulating nonroutine behaviors [21].

The study results are consistent with those of Ileto regarding the significant relationship between pragmatic language and behavioral regulation [12]. According to previous studies, impairment in behavioral regulation is considered as the main core of ASD; it causes compatibility and communication problems in this group [6, 22]. Blain-Brière et al. [6] reported that high inhibition reduced daring and courage. They also suggested that executive functioning increased speech quality through enhancing fluency. However, Joseph et al. [10] concluded that executive dysfunction in people with autism was not directly related to deficits in pragmatic language; but disrupted the proper use of language to regulate behavior. Inconsistency between the study results and those of previous studies could be attributed to the use of different instruments.

The third study finding indicated a significant relationship between pragmatic language and metacognition [8, 9, 13]. This finding can be explained by a potentially close relationship between working memory, learning new words, lexical growth, and total language learning [13]. Executive dysfunction leads to deficiencies in other cognitive and metacognitive areas related to linguistic and social functioning; in turn, these lead to compatibility and communication problems in children with ASD [11].

Metacognition (including initiation, working memory, planning/ organizing, and self-control) as an executive function is directly associated with communication and social skills [23]. A study examined the relationship between language and executive functioning in children with ASD [8]. A positive relationship was found between working memory and pragmatic language.

Additionally, Ileto examined all the variables explored in the present study [12]. Accordingly, a significant relationship was found between pragmatic language and metacognition. The aforementioned points can explain the relationship between metacognition and pragmatic language in 6- to11-year-old children with ASD.

The present study had some limitations. First, we had difficulty accessing children with the ability to speak according to the inclusion criteria. Second, other scales of executive functioning that could be related to pragmatic language were disregarded in the BRIEF. Third, the data were gathered using self-report instruments that are as-

sociated with certain biases. Finally, there were problems in accessing girls with ASD.

According to the relationship between executive functions and pragmatic language, the study results suggest that pragmatic language in children with ASD can be improved through improving their executive functions. This was a cross-sectional and descriptive study; thus, it cannot be exactly determined which behavior had the first effect on other variables. Therefore, we suggest that further longitudinal/ experimental studies be conducted on this topic. It is also suggested that this relationship be studied using larger sample sizes, including both genders to increase the generalizability of the results.

5. Conclusion

The obtained results suggested a significant association between executive functioning, behavioral regulation, metacognition, and pragmatic language in children with ASD. The findings were in line with those of previous studies. Furthermore, due to the strong correlations detected between the variables, the results can be generalized to all children with ASD in the investigated age group. In addition, the results can be used to design interventions aimed at improving executive functioning and its different indices to enhance the communication skills of children with ASD. Moreover, the results can be used by psychologists, clinicians, parents, and teachers to improve the communication and social skills of this group.

Ethical Considerations

Compliance with ethical guidelines

The informed consent was obtained from the parents before enrollment in the research. The subjects were assured about the confidentiality of their information.

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Authors' contributions

Developing the study concept, design and the definition of intellectual content: Fateme Razavi, Masoume Pourmohamadreza-Tajrishi; Searching the literature: Fateme Razavi, Hojjatollah Haghgoo, and Sina Tavakoli; Conducting the study procedures and data collection: Fateme Razavi and Seyed Mohammad Ali Miri; Data analysis: Enayatollah Bakhshi and Fateme Razavi; Editing: Masoume Pourmohamadreza Tajrishi and Hojjatollah Haghgoo; Reviewing the manuscript and take responsibility for the integrity of the research as a whole from inception to published article: All authors.

Conflict of interest

The authors declared no conflict of interest.

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