Psychiatry and Behavioral Sciences 2024;14-1:31-39

Doi: 10.5455/PBS.20231107090226

ORIGINAL RESEARCH

Assessment of Executive Functioning in School-Age Children with and without Stuttering: A case-control study

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Abstract

Objective: Stuttering is defined as a neurodevelopmental disorder, with disruptions in the normal fluency and time patterning of speech that are inappropriate for the individual's age and language skills. Executive functions (EF) include various cognitive skills, such as directing the attention required for planning and maintaining thoughts and behaviors, suppressing inappropriate stimuli, keeping the processed information active, and providing the transition between the information. This study was aimed at investigating whether there is a difference between school-age children with and without stuttering about executive functions skills and attention.

Methods: Twenty-six children with stuttering (14 boys; mean age=10.1±2.88) and twenty-five children without stuttering (14 boys; mean age=10.2±2.77) aged between 7 and 12 were admitted to the study. The participants were administered the Visual Aural Digit Span Test-B Form (VADS-B), which evaluates working memory and audiovisual attention, and the Cancellation Tests (CT), which evaluates sustained attention. The parents of the participants applied the Behavior Rating Inventory of Executive Function (BRIEF), which was developed to evaluate executive functions, problem-solving skills, and adaptive behaviors. Differences in mean subscores of VADS-B, CT, and BRIEF were analyzed using univariate analysis of covariance (ANCOVA) with participant group as the factor and VADS-B, CT, and BRIEF subscores as the dependent variable; chronological age (years) was designated as a covariate.

Results: This study was conducted between two groups that were equal in terms of age, gender, developmental steps (walking, talking, toilet training), family structure, and socioeconomic status ($p>0.05$). All subscales of VADS-B (aural-verbal, aural-written, visual-verbal, visual-written) were found to be significantly lower in children with stuttering ($p<0.05$). In cancellation test results, there was a significant difference between the groups in terms of hit scores and total number of errors in organized letter and random letter forms ($p<0.05$). No difference was found between the two groups in the BRIEF scale completed by the parents ($p>0.05$).

Conclusion: This study demonstrated that school-aged children with stuttering had weaker working memory and sustained attention in performance-based tests. Thus, we believe that in the evaluation and treatment of stuttering, comprehensive approaches should be adopted to evaluate attention and executive functions and to improve these functions. In this area, studies with larger samples are needed in which stuttering, attention, and executive functions are evaluated more comprehensively with different tasks (computer-based performance tests, parent-teacher scales, etc.) and neuroimaging (magnetic resonance imaging [MRI]). Lastly, the tasks used in our study (VADS-B, CT, and BRIEF) were applied to Turkish-speaking school-age children with stuttering for the first time. In this regard, we think that our study will contribute to the literature.

Keywords: Attention, Executive Functioning, Stuttering

INTRODUCTION

Stuttering is defined as a neurodevelopmental disorder, with disruptions in the normal fluency and time patterning of speech that are inappropriate for the individual's age and language skills. These disruptions in the normal flow of speech include sound and syllable repetitions, blocks, broken words, and sound prolongations (1). The lifetime prevalence of this disorder, which begins in the early developmental period, has been reported as 4-5% (2). In a review by Yairi and Ambrose, which included more than 40 cross-sectional studies, the prevalence of stuttering was reported to vary between 0.3% and 5.6%. The review also reported that stuttering, similar to

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Citation: Tonkaz Yitik G, Demirdöğen Yıldırım E. Assessment of Executive Functioning in School-Age Children with and without Stuttering: A case-control study. Psychiatry and Behavioral Sciences 2024;14-1:31-39. Doi: 10.5455/PBS.20231107090226

Received: Dec 02, 2023 **Accepted:** Feb 28, 2024

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other neurodevelopmental disorders, is more common in males (3). Although the etiology of stuttering is not yet known, current models assume that stuttering is a multifactorial disorder with a dynamic nature (2). Along with genetic predispositions and epigenetic changes (4), motor, psycholinguistic, cognitive, and emotional factors are thought to play a role in the development and course of stuttering (2).

Executive functions (EF) include various cognitive skills, such as directing the attention required for planning and maintaining thoughts and behaviors, suppressing inappropriate stimuli, keeping the processed information active, and providing the transition between the information (5). Working memory (WM), inhibition, and cognitive flexibility are essential components of executive function (5). Areas that cover speech, language, motor, sensory, and emotional development interact with areas that cover executive function, attention, and processing. It is also stated one or more disorders in speech and language directly or indirectly affect executive function skills (6). A review published in 2019 suggested that developmental stuttering affects executive function directly by affecting one or more specific areas, or indirectly by disrupting the language process (7).

Studies investigating the possible relationship between executive function and stuttering have used performance-based tasks or parent report questionnaires to reveal potential differences between children who stutter (CWS) and children who do not stutter (CWNS). There are inconsistencies between the results of these studies. This is thought to be due to the age ranges of the participants and the differences in the tests used. This difference in the literature encourages further study of the relationship between executive functions and stuttering. In this context, we aimed to evaluate executive functions in Turkish-speaking school-age CWS using performance-based tests (Cancellation test [CT] and Visual Aural Digit Span [VADS-B]) and the parent report questionnaire Behavior Rating Inventory of Executive Function (BRIEF).

In the study, we aimed to evaluate the executive function skills of school-age children with stuttering both performance-based tests (VADS-B and CT) and parent reported BRIEF scale. We hypothesised that the CWS would have lower executive function performance than the CWNS on both performance-based tests and parent-report scales.

MATERIALS AND METHODS

Participants

Twenty-six children (14 boys; mean age=10.1±2.88) aged 7-12 years admitted to child and adolescent psychiatry outpatient clinic and diagnosed with developmental stuttering according to the Diagnostic and Statistical Manual of Mental Disorders, 5th ed., Text Revision (DSM V-TR) were included in the study. Children whose diagnosis of stuttering was accompanied by intellectual disability, autism spectrum disorder, social communication disorder, those who had a known neurological, metabolic, genetic, or endocrinological disorder, bilingualism, acquired stuttering, and those whose parents did not agree to participation were not included in the study. Twenty-five children (14 boys; mean age=10.2±2.77) who did not have a neurological, psychiatric, genetic, metabolic, or endocrinological disorder, and who were not using any substance or medication, who had good academic success according to their teachers, and whose parents agreed to participate were enrolled in the CWNS group. The groups were matched for age and sex. All children were native speakers of Turkish. All children passed a binaural hearing screening test at 20 dB HL at 500, 1000, 2000, 4000, and 8000 Hz. Regarding socioeconomic status, the groups were similar in terms of education levels, current occupation of both parents and family income status ($p>0.05$).

This study was a case-control study conducted by the principles of the Helsinki Declaration after obtaining ethics committee approval from the local ethics committee (2021/08-164).

Stuttering Diagnosis

The diagnosis of developmental stuttering was established by child psychiatrists based on diagnostic criteria from the DSM V-TR. After the initial interviews with the children, they were referred to a speech-language pathologist and subjected to assessments. Within the scope of the evaluations by a child psychiatrist and speech-language pathologist, during the unstructured play interaction with the child (20-30 minutes), speech samples were obtained and clinical evaluations were made based on DSM V-TR. The average of the children's stuttering-like disfluency per 100-word speech was calculated. The mean frequency of stuttering-like disfluencies in the CWS group was 8.60 (SD = 2.60). The mean frequency of stuttering-like disfluencies in the CWNS group was 0.64 (SD = 0.63).

Procedure

All participants were subjected to a semi-structured interview using the Schedule for Affective Disorders and Schizophrenia for School-Aged Children, Present and Lifetime version (KSADS-PL) (8)form during the psychiatry examination, to determine the psychiatric diagnosis and comorbid conditions. The parents of all participants were asked to fill out the sociodemographic data form and the Behavior Rating Inventory of Executive Function (BRIEF) (9). The chronological age of the participants was calculated by year. All children performed the Visual Aural Digit Span (VADS-B) (10) and Cancellation Test (CT) (11). The tests were conducted in a quiet room to avoid distractions. The researcher and the child sat in two opposing chairs during both tests. The time was determined using a chronometer. Participants had correct or corrected (eyeglasses, lens, etc.) visual ability. For the VADS-B, the test was started from the third unit of each subtest. When a successful response could not be obtained at the first attempt, a second test of the same length was presented, and the upper level was applied if the correct response was obtained. The subtest was terminated if the responses to the two attempts were false. The numbers were announced at 1-second intervals in the aural subtest. In the visual subtest, a booklet with a number on each page was shown to the child at 1-second intervals. A paper and a pencil were used for subtests, which were asked to be answered in written form and the application time varied between 15-20 minutes. On the CT, the child was asked to drop the pencil and say “Finished” after completing the cancellation. Organized letter and random letter forms were applied in the same order.

Data Collection Tools

Sociodemographic Data Form: This form, which was prepared by the researchers, was designed and applied to collect the sociodemographic data of the participants and family members.

Schedule for affective disorders and schizophrenia for school-age children, present and lifetime version (K-SADS-PL): Screening questions and assessment scales are used to evaluate each symptom. This scale, which can assess 20 different psychiatric diagnoses, was adapted to Turkish by Gökler et al. (2004) (8). In this study, K-SADS was used in the participants to exclude psychiatric comorbid diagnoses.

Behavior Rating Inventory of Executive Function: The BRIEF scale was developed by Gioia et. al (2000) to evaluate executive functions, problem-solving skills, and adaptation behaviors (9). The scale is completed by the person who knows the child (parent, teacher), considering the behaviors and attitudes of the child during the past 6 months. It is composed of 86 items; 8 subscale scores for executive functions (inhibition, shifting, emotional control, initiate, working memory, plan/organize, organization of materials, monitoring) and 2 comprehensive indices (Behavioral Regulation Index [BRI] and Meta-Cognition Index [MCI]) can be calculated. The Global Executive Composite Index (GCI) may also be calculated by the sum of the BRI and MCI. The obtained high scores indicate weak executive skills. The Turkish standardization of the BRIEF-first edition was made by Batan, Öktem-Tanör, and Kalem (2011) (12).

Visual Aural Digit Span (VADS-B): This is a neuropsychological test developed by Koppitz (1970) (10). The test evaluates working memory, short-term memory, and multimodal attention span. Also, attention span, measured by digit spans, represents a limitation in short-term memory (13). The Turkish validity study was conducted by Kılıç et. al. in 2002 (13). The VADS-B consists of sequences of numbers from 2 to 9 digits. The items are presented audibly and visually, and the children are asked to repeat the sequence in the forward direction verbally and in writing. The scoring is based on the number of digits in the longest digit sequences correctly repeated by the participants. Higher scores indicate better performance. The test is composed of 4 main subtests: auditory-oral, visual-oral, auditory-written, and visual-written (13). This study employed four (auditory-oral, visual-oral, auditory-written, visual-written) VADS-B scores to measure working memory. To avoid the negative effect of stuttering on test performance, correct answers that were not spoken fluently were counted as correctly remembered numbers.

Cancellation Test (CT): This test was developed by Mesulam and Weintraub (1987)(11), and the letter form of the cancellation test was used in the study. The test is mainly used to assess sustained attention (11). It also measures cognitive abilities, such as visual search, attention speed, and visuospatial attention. Scoring is usually made according to errors and the number of correctly hit targets (11). The completion time of each test form is also recorded as “response duration”. The Turkish standardization was done by Kılıç et al. (2002) (14). In this study, CT was used to assess sustained attention. The executive function evaluation tools used in the study and the functions they evaluated are explained in Table 1.

Table 1. Executive function evaluation tools and the functions

Content of subtest	Scores	Functional correlates
Visual Auditory Digit Span B (VADS-B) Test (10)		
• Auditory-oral • Visual-oral • Auditory-written • Visual-written	• VADS-B/AO: Auditory-oral • VADS-B/VO: Visual-oral • VADS-B/AW: Auditory-written • VADS-B/VW: Visual-written	Working Memory (Multimodal attention span and short-term memory)
Cancellation Test (11)		
• Organized letters • Random letters • Organized shapes • Random shapes	• Hit • Total number of errors • Response duration(in seconds)	Sustained attention
Behavior Rating İnventory Of Executive Function (BRIEF) (9)		
• Inhibition	• Impulse control and ability to stop one's behavior at the appropriate time	
• Shifting	• Ability to flexibly transition from one situation, activity, mindset, or aspect of a problem to another	
• Emotional Control	• Ability to modulate emotional response	
• Initiate	• Ability to start a task or activity and generate ideas independently	
• Working Memory	• Ability to retain information in mind to complete a task or make a response	
• Plan/Organize	• The ability to predict future events, set goals, develop appropriate steps in advance, perform tasks in a systematic way, understand and communicate main ideas	
• Organizations of materials	• Ability to manage current and future-oriented task demands within the situational context	
• Monitoring	• Ability to control work, evaluate performance, and monitor one's own and others' efforts	

Statistical Analysis

All data were analyzed using SPSS v21.0. The Shapiro-Wilk test was used to determine whether the distributions of continuous variables were normal. All of the variables were found to have a normal distribution. For descriptive statistics, the data for continuous variables were presented as mean±standard deviation and categorical variables were reported as frequencies and percentages. For comparison of the continuous variables, the independent groups t-test was used. The frequencies of categorical variables were compared using the Pearson Chi-Square, Yates' Chi-Square, or Fisher's Exact test, when appropriate. Differences in mean subscores of VADS-B, CT, and BRIEF were analyzed using univariate analysis of covariance (ANCOVA) with participant group as the factor and VADS-B, CT, and BRIEF subscores as the dependent variable; chronological age (years) was designated as a covariate. Partial Eta Squared ($\eta p^{2)} = 0.01$ indicates a small effect, $\eta p^2 = 0.06$ indicates a medium effect, $\eta p^2 = 0.14$ indicates a large effect. Statistical significance was considered when the p-value was<0.05.

RESULTS

There was no difference between the groups about characteristics of the participants including age, gender, delivery time, delivery type, developmental steps (walking, talking, toilet training), family structure, settlement, and socioeconomic status (p>0.05) (Table 2). Of the children diagnosed with stuttering, the mean age of onset was 5.5±1.24 years and there was a family history in 50% (n=13) of the children. Furthermore, 13 of the stuttering children were reported to have been subjected to peer victimization, and 10 had compensatory behavior during stuttering (Table 2).

All subscales of VADS-B were found to have significantly lower scores among CWS (p<0.05). While this difference has a weak effect size in verbally; the written perfromance also had medium effect size. The VADS-B subscale scores of the groups are shown in Table 3. There was a significant difference between the groups in terms of hit scores and total number of errors in organized letter and random letter forms (p<0.05). This difference had a small effect size for the number of hits in the regular letter form and a medium effect size for the total number of errors. In the random letter form, it had a small effect size for both the number of hits and the total number of errors. The response duration of CT did not differ statistically between the groups in both subtests (p>0.05) (Table 4). There was no difference between the groups in the BRIEF scale completed by the parents (p>0.05). The data regarding the BRIEF score are presented in Table 5.

Table 2. Demographic data and clinical characteristics for participants

Variables	Children who Stutter	Children who do not stutter	*p value*
Age (years) ± SD	10.1 ± 2.88	10.2 ± 2.77	0.874
Sex, Male n (%)	14 (53.8)	14 (56)	0.202
Delivery time Premature **n (%) Term**	3 (11.5) 23 (88.5)	1 (4) 24 (96)	0.478
Mode of Delivery Vaginal **n (%) C/S**	14 (53.8) 12 (46.2)	9 (36) 16 (64)	0.200
Family type Married **n (%) Divorced**	23 (33.5) 3 (11.5)	18 (72) 7 (28)	0.208
Settlement City center **n (%) Rural area**	18 (69.2) 8 (30.8)	21(84) 4(16)	0.493
Socioeconomic status, n(%) **Low income** **Middle income** **High income**	 10 (38.4) 12 (46.1) 4 (15.38)	 7 (28) 11 (44) 7 (28)	0.092
Descriptive information for CWS group			
Family history of stuttering, n (%)	13 (50)		
Mean age of onset of stuttering ± SD, years	5.5 ±1.24		
Compansatuar behaviour during stuttering, n(%)	10 (38.5)		
Peer victimization, n(%)	13 (50)		

CWS: *Children who stutter;* ***CWNS:*** *Children who do not stutter* ***C/S:*** *Cesarean Section* ***SD:*** *standard deviation*

Table 3. Comparison of the VADS-B subscale scores of CWS and CWNS

Variables	CWS (mean±SD)	CWNS (mean±SD)	p value	ANCOVA p value	ηp^2
Aural-Verbal	5.46 ±1.33	6.16 ±0.98	0.027**	**0.002**	0.041
Visual-Verbal	4.42 ±0.94	5.20 ±0.76	0.002*	**0.001**	0.002
Aural-Written	5.04 ±1.42	5.64 ±1.03	0.092*	**<0.001**	0.112
Visual-Written	4.69 ±1.22	5.20 ±0.70	0.082**	**0.001**	0.104
Total	19.61±2.5	22.2±2.9	0.009	**<0.001**	0.019

**Independent sample t test **Mann-Whitney U test*
Analysis of covariance (ANCOVA) was used for comparisons between the two groups after adjusting for chronological age (years).
CWS: *Children who stutter;* ***CWNS:*** *Children who do not stutter* ***SD:*** *standard deviation* ***VADS-B:*** *Visual Aural Digit Span Test-B Form*

Table 4. Comparison of Cancellation Test Scores of CWS and CWNS

Variables		CWS (mean±SD)	CWNS (mean±SD)	*p* value	ANCOVA *p value*	ηp^2
Organized letter	Hit scores	56.3 ± 3.17	58.8 ± 1.15	0.002**	**0.014**	0.016
	Total number of errors	4.52 ± 2.94	1.88 ± 0.88	<0.001**	**0.001**	0.063
	Response duration (in seconds)	161 ± 53.6	146 ± 54.2	0.311*	0.395	0.147
Random letter	Hit scores	56.4 ± 3.26	58.6 ± 1.46	<0.001**	**0.047**	0.028
	Total number of errors	4.24 ± 3.07	2.06 ± 1.34	0.008**	**0.042**	0.019
	Response duration (in seconds)	158 ± 43.8	143 ± 50.1	0.245*	0.275	0.253

*Independent sample t test **Mann-Whitney U test
*Analysis of covariance (ANCOVA) was used for comparisons between the two groups after adjusting for chronological age (years***).**
CWS: *Children who stutter;* ***CWNS****: Children who do not stutter* ***SD:*** *standard deviation sec: second*

Table 5. Comparison of BRIEF Scale scores of CWS and CWNS

Variables	CWS (mean ±SD)	CWNS (mean ±SD)	p value	ANCOVA p value	ηp^2
BRIEF					
Inhibition	21.7 ± 4.98	16.5 ± 2.13	<0.001**	0.160	0.000
Shifting	15.6 ± 4.17	13.6 ± 1.74	0.092**	0.456	0.046
Emotional Control	15.7 ± 4.93	14.6 ± 3.41	0.380*	0.986	0.386
Initiate	11.9 ± 3.72	10.5 ± 2.03	0.285**	0.707	0.142
Working Memory	18.6 ± 5.11	14.6 ± 3.18	0.005**	0.552	0.004
Plan/Organize	23.6 ± 7.31	17.8 ± 3.16	0.003**	0.876	0.002
Organization of materials	11.0 ± 4.06	9.90 ± 2.48	0.276*	0.835	0.286
Monitoring	12.5 ± 3.21	9.81 ± 1.25	<0.001**	0.729	0.001
Behavioral Regulation Index (BRI)	53.3 ± 11.7	44.8 ± 4.93	0.009**	0.750	0.005
Metacognition Index (MCI)	66.7 ± 17.6	52.8 ± 8.69	0.003**	0.918	0.003
Global Executive Composite (GEC)	119 ± 25.4	95.3 ± 17.6	<0.001*	0.665	0.001
Total Scores	131 ± 28.2	107 ± 13.8	0.005**	0.839	0.002

**Independent sample t test **Mann-Whitney U test*
Analysis of covariance (ANCOVA) was used for comparisons between the two groups after adjusting for chronological age (years)
***BRIEF:** Behavior Rating Inventory of Executive Function **CWS:** Children who stutter; **CWNS:** Children who do not stutter **SD:** standard deviation*
sec: second

DISCUSSION

In this study, CWS was found to have lower scores in all VADS-B subtests measuring working memory, and more errors and fewer hit scores in letter forms of CT, which measures sustained attention. Moreover, no difference was found between CWS and CWNS in the BRIEF scale completed by the parents.

Many studies have been conducted to evaluate executive functioning skills, and many tests have been applied. In most studies, shifting, working memory, and inhibition were analyzed separately. Hakim and Ratner (2004) first evaluated short-term memory using the Children Non-word Repetition (CNRep) (15). This test, which has been used by different researchers over the years, yields various results. Whereas some of these studies indicate that the stuttering group is less successful (6, 16), others indicate no difference (17, 18). Anderson et. al (2019) reported that this inconsistency between the results may have arisen from the differences between non-word repetition tasks (19). The authors also proposed that skills such as auditory-perceptual processing, phonological encoding, and speech-motor skills may affect the results of the test (19). Sasisekaran et al. (2019) and Sugathan and Maruthy (2020) used the digit span subtests of the Weschler Memory Scale-III in their studies, and no significant difference was found between the groups (20, 21). In another study that used the non-word repetition and memory for digits subtest of the comprehensive test of phonological processing (CTOOP) test, although no difference was found between the digit span tests, the CWS group was shown to be significantly less successful in non-word repetition (16). Kaganovich et al. (2010) evaluated non-linguistic auditory processing and working memory updates with event-related potentials (ERPs) among CWS and CWNS, finding no difference in the behavioral measures of working memory. However, the stuttering group was shown to have poorer attentional allocation and working memory updating in response to aural stimuli (22). Despite all of these results, a meta-analysis by Ofoe et al. (2018) reported that CWS had poor working memory functions compared to CWNS (23). Unlike other studies, we used the VADS-B test, which notably evaluates auditory and visual stimuli with both written and oral responses. We determined that both the VADS-B total score and all subtest scores were lower in CWS than in CWNS. The results of our study revealed that the CWS had poorer working memory performance in both visual and auditory stimuli. Although the results of our study are consistent with some studies evaluating WM performances (6, 15, 16); they differ with some (17, 18, 24). The results of VADS-B showed that the CWS had poorer WM performance when responding to auditory or visual stimuli not only verbal performances but also in written performances. Therefore, we think that it would be useful to evaluate both verbal and written performances of CWS during their clinical follow-up. We think that this result will contribute to the literature on stuttering and WM.

In a study published by Anderson and Wagovich (2010), there was a significant relationship between working memory performance and attention skills in children

who do not stutter, but no relationship was found between these skills in children with stuttering. The authors emphasized that it may be useful to examine working memory and attention together in children with stuttering in future studies (6). In this study, we used an attention test named letter forms of cancellation test, which is mostly used to measure sustained attention (14), the CWS group had more errors and fewer hits than the CWNS group ($p<0.05$). The literature on stuttering and attentional performance emphasizes that in different studies conducted with children and adults stuttering, they have weaker attentional performance than CWNS (23, 25). There are different studies on the attentional domain such as selective attention, sustained attention, attentional switching, attentional orienting, and divided attention (25). There are differences in studies investigating sustained attention with stuttering in the literature. Some studies claim that CWS shows poorer sustained attention than CWNS (26, 27), while others claim that there is no difference (28, 29). The results of our study supported studies showing poor sustained attention. We think that evaluating the attention span of CWS will make positive contributions to the treatment and follow-up process. In summary, when we evaluated the results of the performance tests together, we observed that both working memory and sustained attention were poorer in school-age CWS. This supports studies emphasizing that working memory and attention should be evaluated together (6), but studies with large samples in which different attention functions are evaluated are needed.

Lastly, we evaluated executive functioning skills through BRIEF filled out by parents in addition to performance tests applied to the children. BRIEF subscores did not differ significantly between CWS and CWNS groups when chronological age was excluded as a covariance factor by ANCOVA ($p>0.05$). In the literature, some studies reported that inhibitory control was worse in the CWS group (30, 31), others reported no significant difference (32, 33), and one study reported that inhibition skills were better in the CWS group (34). This inconsistency was suggested to have resulted from the differences in sample size and age groups (7). However, in a meta-analysis, the mean score of the CWS group was reported to be lower than that of CWNS (23). Another core component of executive functioning skills is “shifting”, investigated in many studies (32, 35). Although the study designs differed, the results showed limitations in shifting among CWS. In other words, the findings regarding cognitive flexibility in CWS revealed that CWS had lower performance compared to CWNS (35). Finally, working memory has generally been evaluated with performance-based tests (non-word repetition task, dual-task studies) in studies on school-age CWS, and studies based on parental feedback are limited. In one of the studies in which a scale based on parental feedback was used, Ntourou et al. (2018) showed that not only working memory but also shift/flexibility subtests and total scores were significantly higher (weaker executive skills) in preschool-age CWS (36). Another important issue mentioned in the literature on CWS is that these children are more emotionally reactive and less capable of regulating their emotions compared to their peers(7). Similar to our study, Ntourou et al. found no statistical difference between the groups in the BRIEF-P emotional control subtest filled out by parents of preschool-age CWS (36). The results of the BRIEF scale completed by the parents suggest that the executive function skills of school-age CWS were similar to those of their peers. This may have resulted from the fact that the test was based only on parental feedback. We believe that studies using self-reporting and performance-based tests will be beneficial. In addition, this study is the first to evaluate executive function skills in school-age CWS based on parental feedback via the BRIEF scale.

Limitations

The present study has some limitations. The first is the small sample size and the absence of an instrument to determine the severity of stuttering. In future studies, a larger sample size may allow intergroup evaluation of executive functions by dividing the sample into groups according to the severity of stuttering. Determining the possible relationship between stuttering severity and executive functions may provide a different perspective for future research on the etiology of stuttering. Another limitation of our study is that tests evaluating expressive and receptive language development levels, the severity of stuttering, and articulation abilities, which affected executive function skills, were not used. In future studies, researchers’ use of such tests will provide a more detailed assessment of executive function skills. Lastly, another limitation of our study is that inhibition and cognitive flexibility were evaluated only with parent-based questionnaires. In future studies, all three basic components of EF can be evaluated with performance-based tests (like the Go\No Go test for inhibition and; the Wisconsin Card Sorting task for cognitive flexibility), and these results can be compared with the parent questionnaire (BRIEF subtests). This may contribute

to a better explanation of the relationship between stuttering and executive function.

CONCLUSION

We demonstrated that school-aged CWS had weaker working memory and sustained attention performance in performance-based tests. We also observed that the CWS group was similar to their peers on the executive functions scale, completed by the parents. In Turkey, attention and executive function studies on CWS are limited. In the study conducted by Aydin (2021), 20 CWS working memory scale tests were applied in the 5-9 age range. No difference was found between CWS and CWNS in working memory verbal and visual subtest scores (24). The difference in the results from our study may be due to the different scales used and the age groups. Our study contributes to the literature on executive functions and attention performance in Turkish-speaking stuttering children. Thus, we believe that in the evaluation and treatment of stuttering, comprehensive approaches should be adopted to evaluate attention and executive functions and to improve these functions. In this area, studies with larger samples are needed in which stuttering, attention, and executive functions are evaluated more comprehensively with different tasks (computer-based performance tests, parent-teacher scales, etc.) and neuroimaging (magnetic resonance imaging).

Acknowledgements: We would also like to thank all children and their families for collaborating in the study.
Funding: We did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors for this research.
Conflicts of interest: The authors have no conflicts of interest to disclose.
Ethics Committee Approval: This study was approved by Ethics Committee of the Health Sciences University Erzurum City Hospital Non-interventional Clinical Research *(Decision date:19.4.2021 No: 2021/08-164)*
Peer-review: *Externally peer-reviewed.*
Author Contributions: *GYT, EYD*
Research idea: GYT,EYD
Design of the study: GYT,EYD
Acquisition of data for the study: GYT
Analysis of data for the study: EYD
Interpretation of data for the study: GYT,EYD
Drafting the manuscript: GYT,EYD
Revising it critically for important intellectual content: GYT,EYD
Final approval of the version to be published: GYT,EYD

REFERENCES

[1] American Psychiatric Association A. Diagnostic and statistical manual of mental disorders 5th edition text revision. 5th Edition Text Revision ed. Washington 2022.

[2] Smith A, Weber C. How stuttering develops: The multifactorial dynamic pathways theory. Journal of Speech, Language, and Hearing Research 2017;60(9):2483-2505. DOI: 10.1044/2017_JSLHR-S-16-0343.

[3] Yairi E, Ambrose N. Epidemiology of stuttering: 21st century advances. Journal of Fluency Disorders 2013;38(2):66-87. DOI: 10.1016/j.jfludis.2012.11.002.

[4] Starkweather CW. The epigenesis of stuttering. Journal of Fluency Disorders 2002;27(4):269-288. DOI: 10.1016/s0094-730x(02)00144-4.

[5] Diamond A. Executive functions. Annual Review of Psychology 2013;64:135-168. DOI: 10.1146/annurev-psych-113.011.143750.

[6] Anderson JD, Wagovich SA. Relationships among linguistic processing speed, phonological working memory, and attention in children who stutter. Journal of Fluency Disorders 2010;35(3):216-234. DOI: 10.1016/j.jfludis.2010.04.003.

[7] Anderson JD, Ofoe LC. The role of executive function in developmental stuttering. Seminars in Speech and Language 2019;40(4):305-319. DOI: 10.1055/s-0039.169.2965.

[8] Gökler B, Ünal F, Pehlivantürk B, Kültür EÇ, Akdemir D, Taner Y. Okul çağı çocukları için duygulanım bozuklukları ve şizofreni görüşme çizelgesi-şimdi ve yaşam boyu şekli-Türkçe uyarlamasının geçerlik ve güvenirliği. Çocuk ve Gençlik Ruh Sağliği Dergisi 2004; 11(3):109-116 (Turkish)

[9] Gioia GA, Isquith PK, Guy SC, Kenworthy L. Behavior rating inventory of executive function: BRIEF: Psychological Assessment Resources Odessa, FL; 2000. DOI:10.1076/chin.6.3.235.3152

[10] Koppitz EM. The visual aural digit span test with elementary school children. Journal of Clinical Psychology 1970;26(3):349-353. DOI: 10.1002/1097-4679(197007)26:3<349::AID-JCLP227.026.0329>3.0.CO;2-6

[11] Weintraub S, Mesulam MM. Right cerebral dominance in spatial attention: Further evidence based on ipsilateral neglect. Archives of Neurology 1987;44(6):621-625. DOI:10.1001/archneur.1987.005.20180043014.

[12] Batan SN, Öktem-Tanör Ö, Kalem E. Reliability and validity studies of Behavioral Rating Inventory Of Executive Function (BRIEF) in a Turkish normative sample. Elementary Education Online 2011;10(3):894-904

[13] Kılıç B, Koçkar A, Irak M, Şener Ş, Karakaş S. Görsel işitsel sayı dizileri testi B formu kullanılarak ölçülen bellek uzamının Türk ilkokul çocuklarında gelişimi. Psikiyatri Psikoloji Psikofarmakoloji Dergisi 2002;3:243-254 (Turkish)

[14] Kılıç BG, Irak M, Koçkar Aİ, Şener Ş, Karakaş S. İşaretleme testi türk formu'nun 6-11 yaş grubu çocuklarda standardizasyon çalışması. Klinik Psikiyatri Dergisi 2002;5(4):213-228 (Turkish)

[15] Hakim HB, Ratner NB. Nonword repetition abilities of children who stutter: An exploratory study. Journal of Fluency Disorders 2004;29(3):179-199. DOI: 10.1016/j.jfludis.2004.06.001.

[16] Pelczarski KM, Yaruss JS. Phonological memory in young children who stutter. Journal of Communication Disorders 2016;62:54-66. DOI: 10.1016/j.jcomdis.2016.05.006

[17] Sasisekaran J, Byrd C. Nonword repetition and phoneme

elision skills in school-age children who do and do not stutter. International Journal of Language & Communication Disorders 2013;48(6):625-639. DOI: 10.1111/1460-6984.12035.

[18] Smith A, Goffman L, Sasisekaran J, Weber-Fox C. Language and motor abilities of preschool children who stutter: Evidence from behavioral and kinematic indices of nonword repetition performance. Journal of Fluency Disorders 2012;37(4):344-358. DOI: 10.1016/j.jfludis.2012.06.001

[19] Anderson JD, Wagovich SA, Brown BT. Phonological and semantic contributions to verbal short-term memory in young children with developmental stuttering. Journal of Speech, Language, and Hearing Research 2019;62(3):644-667. DOI: 10.1044/2018_JSLHR-S-18-0039.

[20] Sasisekaran J, Basu S, Weathers EJ. Movement kinematics and speech accuracy in a nonword repetition task in school-age children who stutter. Journal of Communication Disorders 2019;81:105916. DOI: 10.1016/j.jcomdis.2019.105916

[21] Sugathan N, Maruthy S. Nonword repetition and identification skills in Kannada speaking school-aged children who do and do not stutter. Journal of Fluency Disorders 2020;63:105745. DOI: 10.1016/j.jfludis.2019.105745.

[22] Kaganovich N, Wray AH, Weber-Fox C. Non-linguistic auditory processing and working memory update in pre-school children who stutter: An electrophysiological study. Developmental Neuropsychology 2010;35(6):712-736. DOI: 10.1080/87565.641.2010.508549.

[23] Ofoe LC, Anderson JD, Ntourou K. Short-term memory, inhibition, and attention in developmental stuttering: A meta-analysis. Journal of Speech, Language, and Hearing Research 2018;61(7):1626-1648. DOI: 10.1044/2018_JSLHR-S-17-0372.

[24] Aydin A, Ahsen E. The comparison of working memory performance in children with and without stuttering. Ankara University Faculty of Educational Sciences Journal of Special Education 2021;22(4):827-845. https://doi.org/10.21565/ozelegitimdergisi.795687.(Turkish)

[25] Doneva SP. Adult stuttering and attentional ability: A meta-analytic review. International Journal of Speech-language Pathology 2020;22(4):444-453. DOI: 10.1080/17549.507.2019.1665710.

[26] Costelloe S, Davis S, Cavenagh P, Doneva SP. Attention levels in young children who stutter. Applied Neuropsychology: Child 2019;8(4):355-365. DOI:10.1080/21622.965.2018.1493996.

[27] Karrass J, Walden TA, Conture EG, Graham CG, Arnold HS, Hartfield KN, Schwenk KA, Relation of emotional reactivity and regulation to childhood stuttering. Journal of Communication Disorders 2006;39(6):402-423. DOI: 10.1016/j.jcomdis.2005.12.004.

[28] Anderson JD, Pellowski MW, Conture EG, Kelly EM. Temperamental characteristics of young children who stutter. Journal of Speech, Language, and Hearing Research 2003; 46(5):1221-1233. DOI: 10.1044/1092-4388(2003/095).

[29] Eggers K, Luc F, Van den Bergh BR. The efficiency of attentional networks in children who stutter. Journal of Speech, Language, and Hearing Research 2012;55(3):946-959. DOI: 10.1044/1092-4388(2011/10-0208).

[30] Eggers K, Luc F, Van den Bergh BR. Inhibitory control in childhood stuttering. Journal of Fluency Disorders 2013;38(1):1-13. DOI: 10.1016/j.jfludis.2012.10.001.

[31] Piispala J, Starck T, Jansson-Verkasalo E, Kallio M. Decreased occipital alpha oscillation in children who stutter during a visual Go/Nogo task. Clinical Neurophysiology 2018;129(9):1971-1980. DOI: 10.1016/j.clinph.2018.06.022.

[32] Eggers K, Jansson-Verkasalo E. Auditory attentional set-shifting and inhibition in children who stutter. Journal of Speech, Language, and Hearing Research 2017;60(11):3159-3170. DOI: 10.1044/2017_JSLHR-S-16-0096.

[33] Piispala J, Kallio M, Bloigu R, Jansson-Verkasalo E. Delayed N2 response in Go condition in a visual Go/No go ERP study in children who stutter. Journal of Fluency Disorders 2016;48:16-26. DOI: 10.1016/j.jfludis.2016.02.001.

[34] Harrewijn A, Schel M, Boelens H, Nater C, Haggard P, Crone E. Children who stutter show reduced action-related activity in the rostral cingulate zone. Neuropsychologia 2017;96:213-221. DOI: 10.1016/j.neuropsychologia.2017.01.022.

[35] Paphiti M, Jansson-Verkasalo E, Eggers K. Complex response inhibition and cognitive flexibility in school-aged Cypriot-Greek-speaking children who stutter. Frontiers in Psychology 2022;18:13. DOI: 10.3389/fpsyg.2022.991138.

[36] Ntourou K, Anderson JD, Wagovich SA. Executive function and childhood stuttering: Parent ratings and evidence from a behavioral task. Journal of Fluency Disorders 2018;56:18-32. DOI: 10.1016/j.jfludis.2017.12.001.