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Relationship of Autistic Traits with Cognitive Flexibility and Other Executive Functions in Adolescents with Social Anxiety Disorder

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ABSTRACT

Objective: The aim of this study was to compare cognitive flexibility and executive functions in adolescents diagnosed with social anxiety disorder (SAD) who have autistic traits with those who do not, and to investigate whether there is a significant difference compared to healthy controls.

Method: The study included 36 adolescents diagnosed with SAD and 36 healthy controls. All participants completed the Cognitive Flexibility Scale (CFS), and the Liebowitz Social Anxiety Scale was administered to the SAD group. Neuropsychological tests including the Stroop Test TBAG Form, the Wisconsin Card Sorting Test (WCST), Raven's Standard Progressive Matrices Test, and Visual-Auditory Digit Span Test-B were applied. Autistic traits were assessed using the Autism Spectrum Quotient-Adolescent's Version (AQ-Adolescent) and the Childhood Autism Rating Scale.

Results: There was no statistically significant difference in CFS scores between the social anxiety disorder and control groups. The SAD group showed poorer performance in the subdomains of the WCST. Additionally, in all subtestes of the Stroop test, the SAD group took significantly longer to complete the test. The AQ-Adolescent scores were significantly higher in the SAD group compared to the controls. In 25% (n=9) of the cases, autistic traits were above the cutoff. There were no significant difference in neuropsychological test results between the groups who have and do not have autistic traits within the case group. A weak negative correlation was found between the Liebowitz total and avoidance subscale scores and the AQ-imagination and attention to detail scores, while no correlation was found between the Liebowitz dimensions and CFS scores.

Conclusion: This is the among the first studies to examine autistic traits and executive functions among adolescents with SAD. While no difference was found in cognitive flexibility scale scores between the SAD and control groups, the SAD group showed poorer performance in tests measuring other executive functions. However, this difference was not significantly influenced by the presence of autistic traits.

Keywords: Adolescent, autistic traits, cognitive flexibility, executive function, neuropsychological test, social phobia

INTRODUCTION

Social Anxiety Disorder (SAD) is a psychiatric condition characterized by a marked and persistent fear of social situations where the individual may be scrutinized or be the focus of attention, typically accompanied by anticipatory anxiety related to negative evaluation by others, and often resulting in avoidance of such situations (American Psychiatric Association. DSM-5 Task Force., 2013). Autism Spectrum Disorder (ASD) is a neurodevelopmental condition typically emerging in early childhood, characterized by impairments in social interaction and communication, alongside restricted and repetitive behaviors and generally limited interests (American Psychiatric Association. DSM-5 Task Force., 2013). Although classified under separate diagnostic categories, Social Anxiety Disorder (SAD) and

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Autism Spectrum Disorder (ASD) share overlapping features such as impairments in social interactions, reduced eye contact, and deficits in theory of mind and empathy skills (Tyson and Cruess, 2012; Kadak et al. 2013; Nikolic et al. 2019; Öztürk et al. 2022). While Social Anxiety Disorder (SAD) is among the most common psychiatric comorbidities in children and adolescents with ASD (Simonoff et al. 2008), high levels of autistic traits have also been reported in children (Puleo and Kendall, 2011) and adults (Carpita et al. 2023) diagnosed with SAD. Studies have shown that children diagnosed with high-functioning autism/ Asperger's syndrome exhibit higher levels of social anxiety symptoms compared to community samples (Kuusikko et al. 2008). Similarly, another study reported that 49% of adolescents with high-functioning autism scored above the suggested cutoff for elevated social anxiety (Bellini, 2004). On the other hand, the relationship between autistic traits and anxiety disorders as well as depression has also been examined. Research conducted among university students found that autistic traits are associated not only with social anxiety but also with depression and aggression (White et al. 2011), and that social competence mediates the relationship between autistic traits and social anxiety symptoms (Liew et al. 2015). Collectively, these studies highlight the strong association between autistic traits and SAD.

Although executive functions (EF) encompass a wide range of cognitive processes, core components include inhibition and interference control, cognitive flexibility, and working memory (Diamond, 2013). According to Stevens, cognitive flexibility refers to the ability to shift between thoughts or the capacity to develop strategies to adapt to specific situations (Stevens, 2009). Several studies have indicated that lower cognitive flexibility skills may be associated with increased symptom severity in SAD (Arlt et al. 2016; Gadassi Polack et al. 2023; Jain et al. 2024; Özdemir and Akkuş, 2025). Both SAD and ASD are characterized by impairments in social functioning, and existing literature has linked social deficits to poorer EF performance (Topcuoglu et al. 2009; Lieb and Bohnert, 2017). In autism, specifically, metacognitive executive functions such as initiation, working memory, planning, organization, and monitoring have been shown to be associated with social symptoms (Leung and ark., 2016).

Symptoms of SAD may lead to impairments in various domains of EF. For instance, hypervigilance related to social evaluation may affect EF components such as emotional control or working memory (Baumel et al. 2022). In a study conducted with university students, a significant negative correlation was found between social anxiety symptoms and cognitive flexibility scores (Çakmak Tolan and Kara, 2023). The impact of social anxiety on EF may also vary depending on context. In Luş's study, among children and adolescents diagnosed with Attention-Deficit/ Hyperactivity Disorder (ADHD), increasing social anxiety symptoms were associated with greater EF impairments particularly in shifting, initiation, planning/organization, and metacognition based on parent ratings; conversely, in teacher ratings, lower levels of social anxiety were linked to greater impairments in planning/organization and behavioral regulation (Luş, 2022). This suggests that the relationship between symptoms and EF may differ between home and school settings. A recent study found that among children and adolescents with ASD, better facial expression recognition was associated with higher levels of social anxiety and better EF-based updating skills (Lievore et al. 2025). Taken together, these findings indicate that beyond symptom overlap, SAD and ASD may influence each other through executive functioning mechanisms. In a longitudinal study examining the impact of EF on anxiety and depressive symptoms in typically developing in young people, as well as those with ADHD and ASD, improvements in EF predicted reductions in anxiety symptoms, while improvements in cognitive flexibility specifically predicted reductions in depressive symptoms (Orm et al. 2024). These findings suggest that cognitive flexibility and other aspects of EF may influence the course of anxiety and depressive symptoms in children and adolescents with neurodevelopmental disorders.

Previous research has identified a relationship between autistic traits and SAD (Freeth et al. 2013; White et al. 2011). However, to the best of our knowledge, it remains unexplored whether the presence of autistic traits in adolescents diagnosed with SAD leads to differences in cognitive flexibility and other executive functions. The primary aim of the present study is to evaluate executive functions, including cognitive flexibility, in adolescents with SAD comparing those with and without autistic traits and to contrast these findings with healthy controls.

Based on the current literature, the following hypotheses were examined:

1. The executive functions of the SAD group are more impaired compared to the healthy control group.
2. Adolescents diagnosed with SAD exhibit higher levels of autistic traits compared to healthy controls.
3. There is a negative correlation between the severity of social anxiety symptoms and cognitive flexibility scores.
4. Within the SAD group, adolescents with higher levels of autistic traits will demonstrate lower cognitive flexibility and greater impairments in other executive functions compared to those without autistic traits and to the control group.

METHOD

Sample

Participants who applied to the Child Psychiatry Outpatient Clinics at Aydın Adnan Menderes University between February 1, 2023, and September 1, 2024, were included in the study. Adolescents aged 12–18 years diagnosed with Social Anxiety Disorder (SAD) according to the Schedule for Affective Disorders and Schizophrenia for School-Age Children Present and Lifetime Version (K-SADS-PL), with no additional psychiatric diagnoses, clinically normal intelligence, and no history of psychotherapy or pharmacotherapy, were recruited as the case group. The Liebowitz Social Anxiety Scale was administered to measure the severity of social anxiety symptoms.

The control group consisted of age- and gender-matched adolescents aged 12–18 years with clinically normal intelligence, who had no psychiatric diagnoses according to the K-SADS-PL and who had presented to child and adolescent psychiatry clinics for reasons other than psychiatric disorders.

Parents of all participants were asked to complete the Autism Spectrum Quotient Adolescent's Version (AQ-Adolescent) to assess autistic traits in the adolescents.

To evaluate various domains of executive functions, both scales and neuropsychological test batteries were administered. All participants completed the Cognitive Flexibility Scale (CFS) to assess cognitive flexibility. The Wisconsin Card Sorting Test (WCST) was used to assess perseveration, working memory, conceptualization, abstract thinking, and complex attention. The Raven's Progressive Matrices Test evaluated working memory, abstraction, and reasoning abilities. The Stroop Test TBAG form assessed response inhibition, interference control, information processing speed, and focused/selective attention. The Visual Aural Digit Span Test-B (VADST-B) was used to measure attention span and short-term memory capacity. All neuropsychological assessments were conducted by certified clinicians trained in neuropsychological test administration.

Data Collection Tools

Sociodemographic Data Form

A form created by the researchers was used to collect demographic characteristics and clinical information of the participants.

Schedule for Affective Disorders and Schizophrenia for School-Age Children Present and Lifetime Version, DSM-5 Turkish Adaptation (K-SADS-PL)

The K-SADS-PL, a semi-structured interview schedule based on DSM-5 criteria, was administered by the researchers to diagnose psychiatric disorders. The interview consists of three parts. The first part is an unstructured introductory interview. The second part includes screening questions and diagnostic criteria aimed at evaluating specific psychiatric symptoms. The third part is a general assessment scale used to determine the adolescent's level of functioning at the time of assessment. The interview is conducted separately with the parent(s) and the adolescent, and the final scoring is based on information gathered from all sources (parent, child, school). In cases of discrepancy, the clinician makes a judgment based on clinical expertise (Kaufman et al, 2016). Turkish validity and reliability was conducted by Ünal et al. (Ünal et al. 2019).

Liebowitz Social Anxiety Scale

Developed by Michael Liebowitz in 1987, the scale assesses fear and/or avoidance in social interaction and performance situations (Liebowitz, 1987). The scale consists of 24 items, with 11 items assessing social interaction and 13 items assessing performance situations. Scoring is based on a 4-point Likert scale, with severity rated from 1 to 4. The Turkish validity and reliability study was conducted in the 15–65 age group (Soykan et al. 2003). Cutoff scores have been suggested as 25 for subscales and 50 for the total scale score. Cronbach's alpha values were reported as 0.96 for the anxiety subscale, 0.95 for the avoidance subscale, and 0.98 for the total scale score.

Cognitive Flexibility Scale (CFS)

Developed by Bilgin, the CFS consists of 19 items, with total scores ranging from 19 to 95 (Bilgin, 2009). Higher total scores indicate greater cognitive flexibility. The scale's internal consistency coefficient was calculated as 0.92. The Turkish validity and reliability study for the adolescent age group was conducted by Çelikkaleli. (Çelikkaleli, 2014).

Autism Spectrum Quotient Adolescent's Version (AQ-Adolescent)

The AQ-Adolescent was developed to assess autistic traits or the broader autism phenotype in typically intelligent adult individuals (Baron-Cohen et al. 2006). The scale's items and structure are identical to the adult version but adapted for completion by parents. It evaluates five domains, each consisting of 10 items: communication, social skills, imagination, attention to detail, and attention switching. Responses range from 'definitely agree,' 'slightly agree,' 'slightly disagree,' to 'definitely disagree.' The maximum total score is 50. Regarding cutoff scores, 24 has been suggested as a potential threshold. The Turkish validity and reliability study in adolescents was conducted by Çetinoğlu and Aras (Cetinoglu and Aras, 2022).

In this study, the AQ-Adolescent form was used to assess autistic traits and was completed by the parents.

Childhood Autism Rating Scale (CARS)

The CARS was developed by Schopler et al. in 1980 as an aid in the diagnosis of autism (Schopler et al. 1980). It is a 15-item Likert-type scale based on behavioral observation, with each item rated from 1 to 4. The clinician assesses the child's relationships with others, use of body and objects, adaptability to change, verbal and nonverbal communication and imitation skills, as well as sensory features, fears, and activity levels. A score of 1 indicates normal behavior, while a score of 4 indicates abnormal or inappropriate behavior. According to the scale, scores between 37 and 60 indicate severe autism, scores between 30 and 36.5 indicate mild to moderate autism, and scores between 15 and 29.5 indicate no autistic symptoms. The Turkish validity and reliability study for ages 4 to 18 was conducted by İncekaş-Gassaloğlu et al. (İncekaş-Gassaloğlu et al. 2016).

In this study, in addition to psychiatric examination, clinical history, and the K-SADS-PL, the CARS was used to exclude autism diagnosis among participants scoring above the cutoff (24) on the AQ-Adolescent form. Patients with a CARS score below the cutoff of 30 were included in the study.

Neuropsychological Tests

Stroop Test TBAG Form

The Stroop Test primarily assesses the ability to focus and sustain attention over time and task demands, resist interfering stimuli, and inhibit inappropriate stimuli and response tendencies (Lowe and Mitterer, 1982). It has been standardized in Turkish for both children and adult populations (Karakaş et al. 1999; Günay Kılıç et al. 2002). The test consists of four cards, each containing six rows with four items per row. The test is divided into five parts. In the first two parts, participants are asked to read the words on the first and second cards. In the subsequent parts, participants are required to name the colors of the words on the third, fourth, and again the second card.

Visual Aural Digit Span Test (VADST-B)

Developed by Koppitz (1970) for differential diagnosis of learning disabilities in children (Koppitz, 1970), the Visual Aural Digit Span Test is a revised version designed to assess short-term memory, visual-auditory attention, serial learning, sequencing, and sensory-motor integration. The test comprises four subtests: Auditory Verbal (AV), Visual Verbal (VV), Auditory Written (AW), and Visual Written (VW). Each subtest involves the repetition of sequences of digits with increasing length, thereby measuring the capacity-limited short-term memory. The minimum total score obtainable is 0, and the maximum is 36. Eleven scores are calculated from the test, including four basic scores (AV, VV, AW, VW), six combined scores, and one total score (sum of AV + VV + AW + VW). The test was standardized for ages 6 to 96 by Karakaş et al. (Karakaş ve Doğutepe Dinçer, 2011).

Wisconsin Card Sorting Test (WCST)

The Wisconsin Card Sorting Test was originally developed by Berg (1948) to assess abstract reasoning abilities in a normal adult sample (Berg, 1948). The modern version of the test was refined by Heaton et al. (Heaton et al. 1993). It is widely used to evaluate executive functions. Standardization for the Turkish population is included within the BİLNOT battery (Karakaş and Doğutepe Dinçer, 2011). Cognitive functions assessed by this test prominently include complex attention, cognitive flexibility, and conceptual learning/reasoning. Studies conducted with Turkish samples have demonstrated that WCST scores primarily measure two core aspects: cognitive flexibility/perseveration and conceptual learning/reasoning (Yalçın ve Karakaş, 2007). In our study, the computerized version of the test was used (WCST-CV4 PAR Inc.). Previous research has shown that results from the computerized WCST version align well with those from the manual version (Bekçi et al. 2006; Karakaş and Doğutepe Dinçer, 2011). The computerized version used involves sorting 128 response cards according to four stimulus cards that vary in color, shape, and number of symbols. Participants must deduce the sorting rule independently, which changes throughout the test.

Raven Standard Progressive Matrices Test (RSPM)

Developed by Raven et al. the RSPM is a general ability test that measures analytic reasoning, problem-solving, organized thinking, and mental processing speed, independently of academic achievement and verbal skills (Raven et al. 1993). The test consists of five sections (A, B, C, D, E), each containing 12 items. Each item presents a sequence of patterns arranged according to a logical system, and participants are asked to identify the missing pattern. The difficulty progresses from easy to difficult, with options ranging from 6 to 8 choices per item. The Turkish validity, reliability, and norm studies were conducted as part of the BİLNOT Battery research and development project (Karakaş and Doğutepe Dinçer, 2011).

Ethics Approval

Ethical approval for the study was obtained from the Non-Interventional Clinical Research Ethics Committee of Aydın Adnan Menderes University Faculty of Medicine, with protocol number 2023/19. Both verbal and written informed consent were obtained from the adolescents and their parents. The study was conducted in accordance with the Declaration of Helsinki.

Statistical Analysis

Data were analyzed using SPSS version 29.0 (IBM Corp.). Sample size calculation was performed using the G*Power software. Based on the study by İpek Baş, with a power of 0.8, an alpha level of 0.05, and an effect size of 0.6, the required sample size was calculated as 72 (İpek Baş, 2020). The normality of continuous variables was assessed through visual methods (histograms and probability plots) and the Kolmogorov-Smirnov test. Descriptive statistics were presented as counts, percentages, means, standard deviations, medians, minimums, maximums, and mean ranks. Chi-square tests were used to determine differences between categorical variables. For comparisons of continuous variables between independent groups, Student's t-test was applied for parametric data, while the Mann-Whitney U test or Kruskal-Wallis analysis of variance was used for non-parametric data. Post-hoc Dunn tests were performed for pairwise comparisons when Kruskal-Wallis tests showed statistically significant differences. Pearson's correlation coefficient was used for correlation analyses. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Sociodemographic Findings

The total sample consisted of 72 participants with a mean age of 15.18 ± 1.67 years. Regarding gender distribution, 52 participants (72.2%) were female and 20 (27.7%) were male. The sociodemographic characteristics of the clinical and control groups are presented in Table 1. In the case group, the mean age of symptom onset was 11.3 ± 2.09 years, and the mean duration without treatment was 4.07 ± 2.41 years. The mean scale scores of the case group are presented in Table 2.

Table 1. Comparison of Sociodemographic Characteristics Between the Social Anxiety Disorder (SAD) Group and Control Group

	SAD (n=36)		Control (n=36)		
Gender	**n**	**%**	**n**	**%**	**p**
Female	25	69.5	27	75	0.605
Male	11	30.5	9	25	
Education Level					
Middle School	8	22.2	8	22.2	1
High School	28	77.8	28	77.8	
Parental Marital Status					
Married	26	72.2	31	86.1	0.055
Divorced/Separated	10	27.8	5	13.9	
Mother's Education Level					
Illiterate	1	2.8	0	0	0.557
Primary School Graduate	12	33.3	18	41.7	
Middle School Graduate	4	11.1	6	11.1	
High School Graduate	12	33.3	6	22.2	
University Graduate	7	19.4	6	22.2	
Mother's Employment Status					
Employed	10	27.8	13	36.1	0.354
Unemployed	26	72.2	22	61.1	
Retired	0	0	1	2.8	
Father's Education Level					
Primary School Graduate	16	44.4	15	41.7	0.555
Middle School Graduate	4	11.1	2	5.5	
High School Graduate	10	27.8	13	36.1	
University Graduate	6	16.7	6	16.7	
Father's Employment Status					
Employed	29	80.6	34	94.5	0.157
Unemployed	3	8.3	0	0	
Retired	4	11.1	2	5.5	
Household Income vs. Expenses					
Income < Expenses	10	27.8	5	13.9	0.428
Income = Expenses	18	50	19	52.8	
Income > Expenses	8	22.2	12	33.3	
Family History of Anxiety Disorders					
Yes	7	19.4	2	5.5	0.151

Table 2. Clinical Characteristics and Scale Scores of the Social Anxiety Disorder Group

Variables	With Autistic Traits (n=9) (Mean±SD)	Without Autistic Traits (n=27) (Mean±SD)	Total SAD Group (n=36) (Mean±SD)
Age	15±1.85	15.55±1.57	15.47±1.62
Age at Symptom Onset	10.37±2.77	11.37±1.96	11.3±2.09
Duration Without Treatment (years)	4.62±2.66	4.18±2.13	4.07±2.41
Liebowitz Total Score	126±36.71	133.55±22.95	131.77±25.9
Liebowitz Anxiety Subscore	63.37±17.26	66.66±10.69	65.88±12.1
Liebowitz Avoidance Subscore	62.62±19.7	66.88±21.02	65.8±20.22
CFS	45.75±5.75	47.29±3.95	47.11±4.43
AQ-Total	27.5±2.92	19.48±3.35	21.47±4.72
AQ- Communication	4.5±1.3	3.4±1.64	3.75±1.69
AQ-Social Skills	6.87±2.1	3.92±2.11	4.66±2.42
AQ-Imagination	4.5±1.85	2.92±1.32	3.27±1.56
AQ- Attention to Detail	5.62±1.92	4.37±2.4	4.63±2.3
AQ- Attention Switching	6±0.75	4.18±1.52	4.63±1.57

CFS: Cognitive Flexibility Scale, AQ: Autism Spectrum Quotient

Comparison of Executive Functions between Social Anxiety Disorder (Clinical) and Control Groups

In the comparison of executive function tests between the clinical and control groups, the number of trials administered in the WCST, total number of errors, total error percentage, number and percentage of perseverative responses, number and percentage of errors, and number and percentage of non-perseverative errors were all significantly higher in the SAD group compared to the control group ($p < 0.001$). The case group completed fewer categories than the control group ($p < 0.001$), required more trials to complete the first category correctly ($p = 0.004$), and showed a significantly higher rate of failures ($p < 0.001$). The case group also took significantly longer to complete the RSPM test compared to controls ($p = 0.039$).

Analysis of the Stroop test measurements revealed that the SAD group required significantly more time than the control group to complete parts 1 ($p = 0.004$), 2 ($p = 0.025$), 3 ($p = 0.001$), 4 ($p = 0.006$), and 5 ($p < 0.001$). Additionally, the SAD group showed significantly higher correction counts in part 2 and error counts in parts 3 and 4. No statistically significant difference was found between groups in mean Cognitive Flexibility Scale scores. Comparisons of the CFS and neuropsychological test battery scores between the clinical and control groups are presented in Table 3.

Comparison of Executive Functions Among Social Anxiety Disorder Subgroups with and without Autistic Traits and Controls

According to the comparison of AQ-Adolescent scores between the clinical and control groups, significantly higher autistic traits were observed in the SAD group ($p < 0.001$) (Table 3). Based on AQ-Adolescent total scores, 9 patients (25%) in the case group scored above the cutoff of 24, while no participants in the control group scored above this threshold. The case group was divided into those with autistic traits ($AQ > 24$) and those without autistic traits ($AQ \leq 24$), and their CFS and neuropsychological test battery scores were compared, with results presented in Table 4.

No significant difference in CFS scores was found among the groups with autistic traits, without autistic traits, and controls. However, WCST measures including number of trials administered ($p < 0.001$), total errors ($p < 0.001$), error percentage ($p < 0.001$), perseverative responses (count and percentage, both $p < 0.001$), total errors and error percentage ($p < 0.001$), non-perseverative errors and error percentage ($p < 0.001$), conceptual level response percentage ($p < 0.001$), number of categories completed ($p < 0.001$), and failure rates ($p < 0.001$) differed significantly between groups. These differences originated from comparisons between the control group and both clinical subgroups (with and without autistic traits).

No statistically significant differences were found between groups in the VADST-B and Raven's scores. Regarding Stroop test results, total completion time in part 1 differed significantly between the control group and the clinical subgroup without autistic traits ($p = 0.005$), and correction counts in part 2 differed between the control group and the clinical subgroup with autistic traits ($p = 0.02$). Total completion times for parts 3, 4, and 5, as well as error counts in parts 3 and 4, were significantly different in comparisons between the control group and both clinical subgroups (with and without autistic traits), with p-values as follows: part 3 time ($p = 0.008$ and 0.006), part 4 time ($p = 0.01$ and 0.034), part 5 time (both $p < 0.001$), part 3 errors ($p = 0.002$ and 0.004), and part 4 errors ($p < 0.001$ and 0.012) (Table 4). No statistically significant differences were observed between the clinical subgroups with and without autistic traits in any neuropsychological subtest.

Table 3. Comparison of Cognitive Flexibility and Neuropsychological Battery Scores Between Social Anxiety Disorder and Control Groups

	SAD Group (n=36)	Control Group (n=36)	p
AQ Total Score[a]	21.47±4.72	17.27±3.36	<0.001
Cognitive Flexibility Scale[a]	47.11±4.43	48.44±3.39	0.157
WCST-Number of Trials[b]	100 (68-129)	77.5 (70-124)	<0.001
WCST-Total Correct Responses[a]	74.16±13.81	69.8±17.16	0.239
WCST-Total Errors[b]	26 (15-59)	11.5 (6-50)	<0.001
WCST-Total Error Percentage[b]	25.5 (15-48)	14 (5-47)	<0.001
WCST-Perseverative Responses[b]	13 (7-24)	6 (4-15)	<0.001
WCST-Perseverative Response Percentage[b]	13 (5-23)	8 (4-15)	<0.001
WCST-Perseverative Errors[b]	13 (8-22)	6.5 (4-13)	<0.001
WCST-Perseverative Error Percentage[a]	13.12±3.21	8.36±3.00	<0.001
WCST-Non-perseverative Errors**	12 (6-37)	5 (2-37)	<0.001
WCST-Non-perseverative Error Percentage[b]	12 (5-31)	7 (2-33)	0.001
WCST-Conceptual Level Responses[b]	63.5 (35-84)	65 (61-78)	0.420
WCST-Conceptual Level Response Percentage[b]	64 (30-92)	83 (52-110)	<0.001
WCST-Number of Categories[b]	5 (3-6)	6 (6-6)	<0.001
WCST-Trials to Complete First Category**	12.5 (10-60)	11 (7-24)	0.004
WCST-Failure[b]	1 (0-3)	0 (0-2)	<0.001
WCST-Learning to Learn[b]	-3.6 (-152-12.62)	-0.125 (-3.08-2.8)	0.071
VADST-Auditory-Verbal[b]	6 (4-9)	6 (4-8)	0.533
VADST-Visual-Verbal[b]	6 (3-8)	5 (4-7)	0.312
VADST-Auditory-Written[b]	6 (4-9)	7 (4-9)	0.188
VADST-Visual-Written[b]	6 (3-8)	6 (3-9)	0.551
VADST-Auditory Stimulus[b]	13 (9-17)	13 (10-17)	0.272
VADST-Visual Stimulus[b]	11 (6-15)	11 (8-14)	0.797
VADST-Verbal Expression[b]	12 (8-16)	12 (10-14)	0.513
VADST-Written Expression[a]	11.86±1.98	12.58±2.4	0.169
VADST-Intra-sensory Integration[a]	12.08±1.82	12.3±1.8	0.605
VADST-Inter-sensory Integration[b]	12 (7-16)	12 (8-15)	0.547
VADST-Raven's Score[a]	23.97±3.2	24.41±2.99	0.545
Raven's Score[a]	40.91±8.89	42.27±6.45	0.460
Raven's Time (min)[b]	21 (10-32)	18.75±4.9	0.039
Stroop Part 1 - Total Time (sec)[b]	15 (8-83)	11.64±8.38	0.004
Stroop Part 1 - Errors[b]	(0-1)	0	0.317
Stroop Part 1 - Corrections[b]	0 (0-1)	0	0.079
Stroop Part 2 - Total Time (sec)[b]	15 (8-60)	12±8.27	0.025
Stroop Part 2 - Errors[b]	0 (0-1)	0	0.317
Stroop Part 2 - Corrections[b]	0 (0-1)	0	0.021
Stroop Part 3 - Total Time (sec)[b]	17.5 (10-80)	15.5±12.94	0.001
Stroop Part 3 - Errors[b]	0 (0-2)	0	<0.001
Stroop Part 3 - Corrections[b]	1 (0-2)	0.28±0.46	0.1
Stroop Part 4 - Total Time (sec)[b]	22 (13-90)	17.35±12.57	0.006
Stroop Part 4 - Errors[b]	0 (0-2)	0	0.001
Stroop Part 4 - Corrections[b]	0 (0-2)	0.5±0.51	0.909
Stroop Part 5 - Total Time (sec)[b]	34 (18-100)	24.07±12.97	<0.001
Stroop Part 5 - Errors[b]	0 (0-3)	0.42±0.64	0.536
Stroop Part 5 - Corrections[b]	1 (0-7)	0.92±0.99	0.544

[a]Student's t-test (mean ± SD); [b]Mann-Whitney U Testi, (median [min–max]). SAD: Social Anxiety Disorder, AQ: Autism Spectrum Quotient, WCST: Wisconsin Card Sorting Test, VADST: Visual Aural Digit Span Test

Table 4. Comparison of Cognitive Flexibility Scale and Neuropsychological Battery Scores Between Individuals with High vs. Low AQ Scores in the Social Anxiety Disorder Group and the Control Group

	SAD Group				
Tests	**With Autistic Traits (n=9) (a) (mean rank)**	**Without Autistic Traits (n=27) (b) (mean rank)**	**Control Group (n=36) (c) (mean rank)**	**p[a]**	**Pairwise Comparisons[b]**
Cognitive Flexibility Scale	31.89	34.33	39.28	0.503	
WCST-Total no. of trials administered	52.94	44.7	26.24	<0.001	a-c, b-c
WCST-Total Correct Responses	45.72	38.15	32.96	0.229	
WCST-Total Errors	54.33	48.17	23.29	<0.001	a-c, b-c
WCST-Total Error Percentage	51.94	46.56	25.10	<0.001	a-c, b-c
WCST-Perseverative Responses	56.39	48.35	22.64	<0.001	a-c, b-c
WCST-Perseverative Response Percentage	52.33	46.24	25.24	<0.001	a-c, b-c
WCST-Perseverative Errors	55.33	50.63	21.19	<0.001	a-c, b-c
WCST-Perseverative Error Percentage	50.72	48.78	23.74	<0.001	a-c, b-c
WCST-Non-perseverative Errors	51.11	46.07	25.67	<0.001	a-c, b-c
WCST-Non-perseverative Error Percentage	46.94	43.91	28.33	0.004	a-c, b-c
WCST-Conceptual Level Responses	45.06	31	38.49	0.157	
WCST-Conceptual Level Response Percentage	25.44	24.44	48.31	<0.001	a-c, b-c
WCST-Number of Categories	27	26.33	46.5	<0.001	a-c, b-c
WCST-Trials to Complete First Category	41.78	44.09	29.49	0.016	b-c
WCST-Failure	49	44.89	27.08	<0.001	a-c, b-c
WCST-Learning to Learn	43.28	28.31	40.94	0.035	b-c
VADST-Auditory-Verbal	31.83	36.13	37.94	0.701	
VADST-Visual-Verbal	42.83	37.56	34.13	0.474	
VADST-Auditory-Written	33.22	33.37	39.67	0.421	
VADST-Visual-Written	36.56	34.57	37.93	0.811	
VADST-Auditory Stimulus	32.39	34.3	39.18	0.531	
VADST-Visual Stimulus	39.56	34.65	37.13	0.799	
VADST-Verbal Expression	37.56	38.24	34.93	0.804	
VADST-Written Expression	34.56	32.39	40.07	0.332	
VADST-Intra-sensory Integration	34.83	36.07	37.24	0.944	
VADST-Inter-sensory Integration	35.83	34.78	37.96	0.827	
VADST-Total Score	34.5	35.02	38.11	0.804	
Raven's Score	32.33	34.7	38.89	0.598	
Raven's Time (min)	35.22	43.69	31.43	0.068	
Stroop Part 1 - Total Time (sec)	41.28	44.28	29.47	0.016	b-c
Stroop Part 1 - Errors	40	36	36	0.030	
Stroop Part 1 - Corrections	39	37.67	35	0.191	
Stroop Part 2 - Total Time (sec)	43.83	41.39	31	0.078	
Stroop Part 2 - Errors	36	37.33	36	0.435	
Stroop Part 2 - Corrections	42	38	34	0.037	a-c
Stroop Part 3 - Total Time (sec)	49	43	28.5	0.004	a-c, b-c
Stroop Part 3 - Errors	46.33	40.56	31	0.001	a-c, b-c
Stroop Part 3 - Corrections	37.61	40.85	32.96	0.233	
Stroop Part 4 - Total Time (sec)	49.78	41.06	29.76	0.013	a-c, b-c
Stroop Part 4 - Errors	47.39	39.54	31.5	0.001	a-c, b-c
Stroop Part 4 - Corrections	40.44	34.85	36.75	0.730	
Stroop Part 5 - Total Time (sec)	53.61	44.09	26.53	<0.001	a-c, b-c
Stroop Part 5 - Errors	37.61	34.41	37.79	0.739	
Stroop Part 5 - Corrections	38.61	37.7	35.07	0.826	

[a]Kruskal-Wallis test, [b]post-hoc Dunn Test, SAD: Social Anxiety Disorder, WCST: Wisconsin Card Sorting Test, VADST: Visual Aural Digit Span Test

Table 5. Correlation Analysis[a] Results Between Liebowitz Scale Subscales and Cognitive Flexibility and Autism Spectrum Quotient Subscales in the Social Anxiety Disorder Group (n=36)

	Cognitive Flexibility Scale	AQ- Total Score	AQ- Communication	AQ- Social Skills	AQ- Imagination	AQ- Attention to Detail	AQ- Attention Switching	Liebowitz Total Score	Liebowitz Anxiety
Liebowitz Total Score	0.318	-0.097	-0.053	0.243	-0.380*	-0.405*	0.136	1	0.651**
Liebowitz Anxiety	0.191	-0.137	-0.154	0.072	-0.195	-0.253	0.067	0.651**	
Liebowitz Avoidance	0.294	-0.042	0.025	0.269	-0.370*	-0.368*	0.134	0.891**	0.236

[a]Pearson correlation coefficient, *<0.05, **<0.01, AQ: Autism Spectrum Quotient

Correlation Analysis Results

Correlation analyses between AQ-Adolescent subscales, CFS, and Liebowitz Social Anxiety Scale scores in the case group are presented in Table 5. A weak negative correlation was found between the Liebowitz total score and the AQ subscales of imagination ($r = -0.380$, $p < 0.05$) and attention to detail ($r = -0.405$, $p < 0.05$), as well as between the Liebowitz avoidance subscale and the AQ subscales of imagination ($r = -0.370$, $p < 0.05$) and attention to detail ($r = -0.368$, $p < 0.05$). No significant correlations were found between Liebowitz scores and the CFS.

DISCUSSION

In this study comparing adolescents diagnosed with SAD and healthy controls in terms of cognitive flexibility and other executive functions using a neuropsychological test battery, no significant differences were found between the groups in self-reported cognitive flexibility scores. However, the SAD group exhibited a significantly higher number of perseverative errors and responses on the WCST. Additionally, the SAD group showed poorer performance on other WCST subtests. Furthermore, in all subtests of the Stroop Test, the SAD group completed the tasks in significantly longer durations. While autistic traits were found to be higher in the SAD group compared to controls, no significant differences were observed in neuropsychological test results between SAD participants with and without autistic traits.

When the limited number of studies conducted with adolescents were examined, it was found that adolescents diagnosed with Social Anxiety Disorder (SAD) had significantly higher scores than healthy controls in total responses and errors on the Wisconsin Card Sorting Test (WCST), number and percentage of perseverative and non-perseverative errors, and failure to maintain set (İpek Baş, 2020); working memory impairment was also observed in the SAD group (Hosseini Ramaghani et al. 2015). Similarly, in our study, the SAD group showed poorer executive function performance compared to the control group. Perseverative errors and responses on the WCST are used to assess cognitive flexibility, and these findings indicate cognitive rigidity in SAD. Although no significant difference was found between the SAD and control groups in the Cognitive Flexibility Scale scores, the WCST findings raise the question of which test method self-report or objective performance-based is more reliable. In the study by Demetriou et al. it was reported that while executive functions in adults with SAD did not appear impaired on objective performance tests, impairments were reported on self-report measures, and self-report was the strongest predictor of disability (Demetriou et al. 2018). Another point to consider is how discriminative the scale items are when they include content related to the disorder being investigated. The items of the Cognitive Flexibility Inventory used in this study include elements such as avoidance of social situations, developing alternative behavior patterns in social contexts, or considering others' perspectives.

In a review examining the relationship between attention and social phobia, several mechanisms potentially responsible for positive change during treatment have been proposed. These include reduced arousal, reduced avoidance, decreased self-focused attention, increased awareness, improved attentional control, and enhanced self-esteem (Bogels and Mansell, 2004). In young adults with SAD, studies using the Stroop test to assess the executive function of response inhibition have found greater impairments in groups with higher SAD severity (Liang, 2018). In contrast, a more recent study that assessed three executive function domains working memory, response inhibition, and cognitive flexibility reported that young adults with SAD performed well in terms of response inhibition (Whitsitt, 2022). In line with our findings, the SAD group demonstrated significantly longer total completion times across all Stroop subtests compared to the control group. Additionally, the number of corrections and errors in certain Stroop sections was significantly higher in the SAD group than in controls. The Stroop test primarily measures focused attention, sustained attention, and the suppression of interfering stimuli. In our study, adolescents in the SAD group performed worse on the Stroop test.

Autistic traits have been found to be significantly higher in adults diagnosed with SAD compared to control groups, and these traits have been shown to play a predictive role in the severity of SAD symptoms (Carpita et al. 2023). In a study conducted with adolescents, autistic traits in those diagnosed with SAD were found to be higher than in the general population but lower than in individuals with ASD (Kleberg et al. 2017).

Consistent with the literature, our study also found significantly higher levels of autistic traits in the SAD group compared to the control group. Additionally, among adolescents with SAD, 9 individuals (25%) scored above the clinical cutoff for autistic traits, a pattern not observed in the control group. Our findings align with the limited number of studies investigating autistic traits in adolescents with SAD. However, contrary to expectations, correlation analysis in our study revealed no significant association between the severity of social anxiety symptoms and overall autistic trait severity within the SAD group. Only two subscales of autistic traits imagination and attention to detail were found to be negatively correlated with social anxiety symptom severity. In other words, as social anxiety symptoms increased, the scores related to heightened attention to detail a characteristic associated with autistic traits decreased.

According to the cognitive model of SAD, abnormally heightened self-focused attention in socially threatening situations is considered a core feature of the disorder (Clark and Wells, 1995). This may be related to SAD symptoms redirecting attention from external stimuli toward the self. Whether the relationship between autism and social anxiety symptom severity varies with age remains an important topic for future research. Considering the potential bidirectional effects of the two conditions, studies aimed at clarifying the causal relationship between them are needed.

In adult samples, the SAD group has been reported to show executive function impairments similar to those found in the ASD group (Demetriou et al. 2018). Contrary to our expectations, when we divided the SAD group based on the presence or absence of autistic traits, no significant differences in executive function outcomes were found between the two subgroups. As this may be the first study to investigate this issue in adolescents, no direct comparison with previous literature could be made. Nonetheless, the findings should be interpreted with caution, as the number of participants with autistic traits was limited to nine, increasing the risk of a Type II error. We recommend replicating these tests with a larger sample size to better evaluate whether the presence of autistic traits in adolescents with SAD influences cognitive flexibility and other executive functions.

Limitations

This study has several limitations. First, the participants with SAD were recruited by help-seeking individuals. This may have influenced the severity of SAD and limits the generalizability of the findings to all adolescents with SAD. Second, although participants were clinically assessed to have normal intelligence, not all were administered a standardized intelligence test. Another limitation is the relatively small number of individuals with autistic traits within the SAD group. We recommend that future studies investigate autistic traits in larger SAD samples to replicate these findings. Based on our results, the impact of autistic traits on cognitive flexibility and other executive functions should be interpreted with caution due to the limited sample size.

CONCLUSION

Most studies in the literature examining executive functions in individuals with SAD have focused on adult populations. With this study, we aimed to evaluate the executive functions of adolescents diagnosed with SAD. To increase the reliability of our results, we administered a comprehensive battery of neuropsychological tests that assess various executive functions and are associated with different brain regions. Considering that comorbidities, psychotherapies, and pharmacotherapy may influence executive functioning, we selected our participants by excluding comorbid psychopathologies using the K-SADS-PL diagnostic interview.

According to our findings, adolescents with SAD demonstrated poorer performance in executive functions. However, the presence of autistic traits in these individuals did not lead to a significant difference in executive functioning outcomes. Given the continuity of SAD symptoms into adulthood, future studies are needed to investigate how executive function impairments identified during adolescence may change with treatment, the impact of comorbidities, and the long-term relationship between autistic traits, SAD severity, and executive functioning across developmental stages.

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