ORIGINAL ARTICLE

Sluggish cognitive tempo is associated with autistic traits and anxiety disorder symptoms in children with attention-deficit/hyperactivity disorder

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Objective: To investigate the association of sluggish cognitive tempo (SCT) with autistic traits (ATs) and anxiety disorder symptoms among children with attention-deficit/hyperactivity disorder (ADHD).
Methods: A total of 195 children with a DSM-5 diagnosis of ADHD were included. The Barkley Sluggish Cognitive Tempo Scale (BSCTS) was used to measure SCT symptoms. Other study measures included the Autism Spectrum Quotient (AQ), Screen for Child Anxiety and Related Disorders (SCARED), Turgay DSM-IV Disruptive Behavior Disorders Rating Scale (T-DSM-IV-S), and Conners' Teacher Rating Scale (CTRS-R).
Results: The frequency of SCT was 30.3% (n=59) in the whole group. Those with SCT had higher total AQ and SCARED scores. Significant associations and correlations were also found between SCT and certain subscores of AQ and SCARED. According to the linear regression model, the total score and social skills, attention switching, and imagination scores of AQ, as well as generalized anxiety and panic/somatic scores of SCARED and the total and inattention scores of parent T-DSM-IV, were predictive of SCT total score (p < 0.05).
Conclusions: SCT is associated with ATs and anxiety disorders. Children with ADHD and SCT symptoms should be screened for such conditions.

Keywords: Sluggish cognitive tempo; ADHD; autism

Introduction

The term "sluggish cognitive tempo" (SCT) was first introduced in the 1980s when a third factor named "sluggish tempo" emerged in factor analytic studies of attention-deficit/hyperactivity disorder (ADHD).[1] SCT is characterized by daydreaming, mental fogginess, confusion, hypoactivity, sluggishness or slow movement, lethargy, apathy, and sleepiness,[2] although almost one-third of children with ADHD also demonstrate elevated levels of SCT symptoms.[3,4] SCT has been suggested as a distinct phenomenon from ADHD. The available research indicates that there is strong evidence for the internal and external validity of SCT as a distinct construct.[2]

There is growing interest in the relationship between autism spectrum disorders (ASD) and SCT. Specifically, the clinical correlates of SCT in ASD and the related functional impairment have been examined. To date, three studies in children and adolescents and one study in adults investigated SCT among patients with ASD. According to these studies, SCT + ASD was found to be associated with a higher degree of social and global impairment than ASD alone; mixed results were reported on comorbid psychopathology and executive functioning deficits.[5-8] It appears that additional research is warranted

to examine the phenomenology of SCT in ASD across different developmental periods.

Clinical and population-based studies have shown that many children display symptoms of both ADHD and ASD. Milder behavioral and cognitive characteristics of autism, referred to as autistic traits (ATs), are also common in ADHD. Symptoms of autism or ATs have been reported to appear in 20 to 30% of children with ADHD.[9] There is evidence that the comorbidity of ADHD and ATs is associated with generally worse functioning.[10] Children with ADHD and ATs are more impaired in the domains of interpersonal communication, empathy, social relatedness, school functioning, and family relations.[10,11] Studies on the association of ADHD presentations (subtypes according to the DSM-IV) with ATs are largely limited. It has been shown that ATs may be linked with a greater likelihood of combined presentation of ADHD[12] and hyperactive-impulsive symptoms.[13]

Many cognitive functions, which are also interlinked, are crucial for initiating and maintaining reciprocal social interactions. Among these, attention skills are essential due to their marked impact on various aspects of relationships, e.g., social awareness, perception of social cues, engagement, and sustaining conversations. SCT, beyond being a different aspect of attention problems,

may be among the key correlates between ADHD and impaired social functioning. In line with this assumption, Becker et al.[14] have shown that, controlling for other psychopathology symptoms, SCT was associated with lower social engagement, including starting conversations and joining activities. A laboratory-based study also found SCT symptoms to be associated with fewer responses made during a chat room task and poorer perception of subtle social cues, after controlling for ADHD diagnosis.[15] Given the well-described high frequency of SCT in ADHD, research data linking SCT to social dysfunction, and the recent studies reporting a link between ASD and SCT, the investigation of these two concepts in non-autistic children with ADHD appears to be valuable.

In light of the well-documented high risk of anxiety disorders in ADHD, a number of studies have demonstrated a link between SCT and anxiety symptoms across different developmental periods. Skirbekk et al.[16] found that SCT was specifically associated with ADHD-anxiety disorder comorbidity. Although SCT symptoms are empirically distinct from anxiety symptoms, they are also strongly interlinked and associated. Mounting evidence suggests that, besides being an ADHD-related construct, SCT may be conceptualized as falling under the umbrella of internalizing psychopathology, including anxiety. SCT has been reported to be associated with neuroticism, which is widely considered the core of internalizing psychopathology.[17] Longitudinal co-occurrence of SCT with anxiety disorders has also been investigated. It has been suggested that SCT symptoms, and the related impairments such as academic difficulties and poorer social skills, may confer risk for subsequent internalizing symptoms. In line with this assumption, studies have found SCT to predict subsequent depressive symptoms and, to a lesser extent, anxiety symptoms.[18-20] More recently, Becker et al.[21] found that SCT symptoms predicted later teacher-rated anxiety, and child-rated anxiety predicted later SCT. The findings of these studies may suggest a bidirectional relationship between anxiety and SCT, which also changed according to the informant.

The main aim of the present study is to investigate the association between SCT and ATs in a clinical sample of children with ADHD. To adopt a broad perspective on the clinical meaning of SCT in ADHD, the relationship between SCT and comorbid anxiety symptoms will also be examined. The rationale for this approach is that both high levels of anxiety and reciprocal social interaction deficits may result in social difficulties, and the independent impacts of both conditions should be investigated to clarify the relationship between SCT and social dysfunction.

We hypothesized that: 1) children with SCT would have higher ATs scores; and 2) children with SCT would have higher anxiety disorder symptom scores.

Methods

Participants

This study was a cross-sectional cohort survey of children with ADHD who were seen at the Child and Adolescent Psychiatry Clinic of the Istanbul University of Health Sciences Erenkoy Research Hospital. The inclusion criteria were: 1) age 6-12 years; 2) no known diagnosis of chronic medical or neurological disease; 3) diagnosis of primary ADHD according to Kiddie Schedule for Affective Disorders and Schizophrenia-Present and Lifetime Version (K-SADS-PL) interview; 4) no other psychiatric diagnosis (only comorbid oppositional defiant disorder and anxiety disorder were allowed); 5) no DSM-5 diagnosis autism spectrum disorder; 6) normal intelligence based on either a Wechsler Intelligence Scale for Children-Revised (WISC-R) full-scale intelligence quotient (IQ) score above 80 or on average/above average academic performance as documented by final school grades for the preceding year. Normal intelligence was confirmed by at least one faculty member specializing in child psychiatry. Children with motor and visual handicaps were excluded.

A total of 195 children completed the study requirements and were included in the study. The sample consisted of both newly diagnosed, drug-naive children (n=95) and children who had been receiving medication for ADHD for at least 3 months (n=100).

Procedures

The study lasted 12 months (December 1, 2017 to December 1, 2018).

Measures

Study measures included the Turgay DSM-IV Disruptive Behavior Disorders Rating Scale (T-DSM-IV-S), Conners' Teacher Rating Scale-Revised (CTRS-R), Barkley Sluggish Cognitive Tempo Scale (BSCTS), Autism Spectrum Quotient-Children's Version (AQ-Child), and Screen for Child Anxiety and Related Disorders (SCARED).

T-DSM-IV-S parent and teacher forms

T-DSM-IV-S parent and teacher forms were developed by Turgay[22] and translated by Ercan et al.[23] into Turkish. The T-DSM-IV-S is based on DSM-IV diagnostic criteria and assesses hyperactivity/impulsivity, inattention, opposition-defiance, and conduct disorder. Symptoms are scored on a four-point Likert scale (0 = not at all; 1 = just a little; 2 = quite a bit; and 3 = very much).

CTRS-R

The CTRS-R is a commonly used teacher rating scale for diagnosing behavioral problems in children.[24] The 28-item CTRS-R provides a total score and three subscale scores: attention deficit; hyperactivity; and conduct problems. Sener et al.[25] reported that the CTRS-R-Turkish Version is valid and reliable for use in the Turkish population.

AQ-Child

The AQ-Child is a 50-item parent-report questionnaire developed to detect ATs in children at 4-11 years of age.[26] Items were worded to produce an approximately equal agree/disagree response in order to avoid response

bias. The AQ-Child consists of a series of descriptive statements designed to assess five areas associated with autism and the broader phenotype: social skills (items 1, 11, 13, 15, 22, 36, 44, 45, 47, 48), attention switching (items 2, 4, 10, 16, 25, 32, 34, 37, 43, 46), attention to detail (items 5, 6, 9, 12, 19, 23, 28, 29, 30, 49), communication (items 7, 17, 18, 26, 27, 31, 33, 35, 38, 39), and imagination (items 3, 8, 14, 20, 21, 24, 40, 41, 42, 50), each represented by 10 items. The minimum AQ score (0) indicates no ATs; the maximum score (150) suggests full endorsement on all autistic items. The AQ-Child-Turkish Version is valid and reliable for use in the Turkish population.[27]

BSCTS

The BSCTS includes 14 items reflecting SCT and rated identically to those for ADHD. These symptoms were chosen from those most often identified by experts and that have been used in prior studies of SCT.[28] They included the following: 1) prone to daydreaming; 2) has trouble staying alert or awake; 3) mentally foggy or easily confused; 4) stares a lot; 5) spacey, their mind seems to be elsewhere and not paying attention to what is going on around them; 6) lethargic, more tired than others; 7) underactive compared to other children; 8) slow-moving or sluggish; 9) doesn't seem to understand or process questions or explanations as quickly or as accurately as others; 10) seems drowsy or has a sleepy appearance; 11) apathetic or withdrawn, seems less engaged in activities than others; 12) gets lost in his or her thoughts; 13) slow to complete tasks, needs more time than others; and 14) lacks initiative to complete work or their effort fades quickly after getting started. All items have four Likert-type responses (1 = never or rarely; 2 = sometimes; 3 = usually; 4 = often). In factor analysis of these 14 items, the last two symptoms (13, 14) loaded more highly on the ADHD in list than on the SCT factors; thus, they were not used in determining SCT symptoms. The final scale consisted of the remaining 12 items (1-12). Barkley[3] suggests that, if parents endorse three or more of the 12 SCT items as occurring often or more frequently (scores of 3-4), this will place a child above the 93rd percentile for the population, the traditional index of statistical deviance. In this study, if the parents score 3 or 4 points in any item, that item is considered to be present. In total, the presence of three or more items is considered diagnostic of SCT. The validity and reliability study of the scale in Turkey was conducted by Fırat et al.[29] in 2018.

SCARED

The SCARED[30] is a 41-item measure of pediatric anxiety symptoms divided into five factors: panic/somatic (SOM; 13 items, e.g., "when I get frightened, my heart beats fast"); generalized anxiety (GAD; nine items, e.g., "I am a worrier"); social phobia or social anxiety (SoAD; seven items, e.g., "I feel shy with people I don't know well"); separation anxiety (SeAD; eight items, e.g., "I worry that something bad might happen to my parents"); and school phobia (SCH; four items, e.g., "I worry about going to

school"). In this study, we used the self-report version of the instrument. Children score each item on a three-point scale (0 = not true or hardly ever true; 1 = sometimes true; 2 = true or often true). Total scores range from 0 to 82, with higher scores reflecting higher anxiety levels. The validity and reliability of the Turkish version were reported by Çakmakçı.[31]

Statistical analysis

The collected data were analyzed in SPSS version 21.0. Demographic variables were presented as descriptive statistics. The Shapiro-Wilk test confirmed the normal distribution of sociodemographic and clinical data. Chi-square and likelihood ratio tests were used for the comparison of categorical variables. Parametric variables were compared between groups by using an independent-samples t test. In the study, associated factors of SCT were examined in the following steps. Firstly, binary comparisons were performed between the sample with and without SCT. Then, partial correlations were performed between SCT total score and all of the variables deemed significant on between-group analyses. To control for possible impact of medication, treatment status was taken as a covariate in the partial correlations. Finally, those factors with significant correlation coefficients were entered into a linear regression model to evaluate which were independently associated with SCT total score. A p-value < 0.05 was accepted as statistically significant.

Ethics statement

The parents of the whole sample were informed about the study procedure in detail and informed consent was obtained. The study protocol was approved by the Istanbul University of Health Sciences Erenkoy Research Hospital ethics committee.

Results

The mean age of the sample was 101.5 months (standard deviation = 19), and 78.5% (n=153) of participants were males. The frequency of ADHD-inattentive presentation was 23.1% (n=45), while the frequency of ADHD-combined presentation was 76.9% (n=150). The frequency of SCT was 30.3% (n=59) in the whole sample: 30.5% (n=29) of the newly diagnosed children and 30% (n=30) of the children receiving treatment had SCT (p > 0.05). Among those receiving treatment, 88% (n=88) were on stimulants and 5% (n=5), on atomoxetine. Risperidone was the most commonly used additional medication in both groups.

Demographic and psychiatric findings of the study sample with and without SCT are shown in Table 1. As seen in the table, the frequency of anxiety disorder diagnosis was higher in children with SCT (p < 0.05). Regarding the ADHD rating scale scores, the total (p < 0.01), inattention (p < 0.01), and oppositional defiance scores (p < 0.05) of parent T-DSM-IV-S were significantly higher in those with SCT. The total scores of teacher T-DSM-IV-S and

Table 1 Demographic and psychiatric findings of the study sample, stratified by presence or absence of SCT

	Sample with SCT symptoms (n=59)	Sample without SCT symptoms (n=136)	p-value
Age (months), mean (SD)	103.6 (20.4)	100.8 (18.2)	0.33
Gender (male)	45 (76.2)	107 (78.6)	0.64
ADHD subtype			0.15
Combined	41 (69.4)	109 (80.1)	
Inattentive	18 (30.5)	27 (19.8)	
Treatment status			0.89
Newly diagnosed	29 (49.1)	66 (48.5)	
Receiving treatment	30 (50.8)	70 (51.4)	
Comorbid diagnoses			
Anxiety disorder	12 (20.3)	11 (8.0)	< 0.05
Oppositional defiant disorder	6 (10.2)	21 (15.4)	0.31
Additional drug treatment			
Risperidone	5 (8.5)	12 (8.8)	0.91
Aripiprazole	2 (3.4)	1 (0.7)	0.17
SSRI	4 (6.8)	5 (3.7)	0.35
Others	1 (1.7)	1 (0.7)	
No additional treatment	47 (79.7)	117 (86.0)	
Parent T-DSM-IV-S score, mean (SD)			
Total	50.2 (17.9)	39.3 (17.9)	< 0.01
Inattention	19.2 (4.9)	13.5 (5.8)	< 0.01
Hyperactivity-impulsivity	15.8 (7.7)	14.8 (7.6)	0.40
Conduct disorder	4.6 (5.6)	4.0 (5.5)	0.50
Oppositional defiance	10.2 (6.9)	6.8 (6.1)	< 0.05
Teacher T-DSM-IV total score, mean (SD)	30.3 (18.4)	39.8 (19.7)	0.18
CTRS total score, mean (SD)	29.7 (15.2)	36.1 (13.8)	0.26

Data presented as n (%), unless otherwise specified.
ADHD = attention-deficit/hyperactivity disorder; CTRS = Conners' Teacher Rating Scale; SCT = sluggish cognitive tempo; SD = standard deviation; SSRI = selective serotonin reuptake inhibitor; T-DSM-IV-S = Turgay DSM-IV Disruptive Behavior Disorders Rating Scale.

Table 2 AQ-Child and SCARED scores in the study sample, stratified by presence or absence of SCT

	Sample with SCT symptoms (n=59)	Sample without SCT symptoms (n=136)	p-value
AQ-Child total	62.2 (15.3)	55.6 (12.9)	< 0.01
Social skills	10.3 (4.7)	8.0 (3.6)	< 0.01
Attention switching	13.5 (3.6)	11.7 (3.9)	< 0.01
Attention to details	11.5 (4.3)	13.3 (4.3)	0.01
Communication	13.5 (5.1)	11.1 (4.8)	< 0.01
Imagination	12.3 (4.8)	9.9 (3.8)	< 0.01
SCARED total	7.9 (3.7)	5.1 (3.6)	< 0.01
Panic/somatic	4.2 (4.0)	2.4 (2.8)	< 0.01
Generalized anxiety	5.8 (4.0)	3.9 (3.4)	< 0.01
Separation anxiety	6.9 (4.6)	5.6 (3.2)	< 0.05
Social phobia	7.9 (3.7)	5.1 (3.6)	< 0.01
School phobia	1.7 (1.6)	1.0 (1.2)	< 0.01

Data presented as mean (standard deviation).
AQ-Child = Autism Spectrum Quotient-Children's Version; SCARED = Screen for Child Anxiety and Related Disorders; SCT = sluggish cognitive tempo.

CTRS were not significantly different between children with and without SCT.

Table 2 shows the comparison of AQ and SCARED scores between children with and without SCT. As seen in the table, the total score (p < 0.01) and social skills (p < 0.01), attention switching (p < 0.01), communication (p < 0.01), and imagination (p < 0.01) scores of AQ were found to be higher in children with SCT. Significant differences were also found in SCARED scores. The total score (p < 0.01) and panic-somatic (p < 0.01), school phobia (p < 0.01), separation anxiety (p < 0.05), generalized anxiety (p < 0.01), and social phobia (p < 0.01) scores of the scale were significantly higher in those with SCT. Of note, in contrast with other AQ scores, the attention to details score of AQ was found to be higher in children without SCT. In light of the study findings, this association was interpreted as coincidental.

In addition to the above-mentioned comparisons, partial correlations were performed between SCT total score and AQ, SCARED, and parent T-DSM-IV-S scores.

To control for the possible impact of medication treatment, treatment status was taken as a covariate in partial correlations. Significant correlations were found between SCT total score and social skills ($r = 0.349$, $p < 0.01$), attention switching ($r = 0.333$, $p < 0.01$), communication ($r = 0.253$, $p < 0.01$), imagination ($r = 0.293$, $p < 0.01$), and total scores of AQ ($r = 0.291$, $p < 0.01$). Significant correlations were also found between SCT total score and school phobia ($r = 0.417$, $p < 0.01$), generalized anxiety ($r = 0.436$, $p < 0.01$), panic/somatic ($r = 0.452$, $p < 0.01$), separation anxiety ($r = 0.190$, $p = 0.008$), social phobia ($r = 0.430$, $p < 0.01$), and total scores ($r = 0.514$, $p < 0.01$) of SCARED, as well as with the inattention ($r = 0.488$, $p < 0.01$), oppositional defiance ($r = 0.166$, $p < 0.05$), and total scores ($r = 0.246$, $p = 0.01$) of parent T-DSM-IV.

A linear regression analysis of the predictors of SCT total score in the study sample is shown in Table 3. All of the significant AQ, SCARED, and parent T-DSM-IV scores from both the above-mentioned between-group analyses and correlations were entered in the model. As seen in the table, the total score and social skills, attention switching, and imagination scores of AQ, generalized anxiety and panic/somatic scores of SCARED, and total and inattention scores of parent T-DSM-IV were predictive of SCT total score.

Discussion

This study investigated the association of SCT with ATs and anxiety symptoms in a clinical sample of children with ADHD. We found that children with SCT were more likely to have ATs and anxiety symptoms than those without SCT. Moreover, these findings were still evident when controlling for the possible impact of medication treatment. The link between SCT and anxiety symptoms in ADHD has been documented previously.[19,32] However, to the best of our knowledge, the association between SCT and ATs in non-autistic children with ADHD had not been shown to date. Several factors should be taken into account to interpret our findings.

In the present study, all scores (total and subscale) of SCARED, including panic/somatic, generalized anxiety, separation anxiety, social phobia, and school phobia, were found to be higher in children with SCT, indicating an association with a broad spectrum of anxiety symptoms. Moreover, the frequency of anxiety disorder diagnosis was higher in those with SCT. A linear regression model showed that panic/somatic and generalized anxiety scores were predictive of SCT total score. These findings suggest a general tendency to anxiety symptoms in various domains. Few studies have investigated the association of SCT with specific anxiety domains. Harrington & Waldman[33] reported increased rates of generalized anxiety and social phobia symptoms in children with severe SCT when compared to those with low SCT. Mikami et al.[15] also found that children with SCT had higher levels of anxiety in social interactions. The use of a self-report scale to measure anxiety and the investigation of various anxiety dimensions may be considered as strengths of our study.

The complex relationship between ADHD, SCT, and impaired social functioning has been the topic of a handful of recent studies.[14,34] Becker et al.[14] showed that social difficulties associated with SCT are primarily due to withdrawal, isolation, and low initiative in social situations in a sample of children, 87% of whom had a diagnosis of ADHD. However, ATs were not mentioned as a possible underlying condition by the authors. More recently, McFayden et al.[7] used the social communication and interaction subscales of the Social Responsiveness Scale (SRS-2) to compare children and adolescents diagnosed with ADHD, ASD, and ASD + ADHD. The found those with ASD + ADHD and SCT had greater social impairment, and the frequency of SCT did not differ among the diagnostic groups. In the present study, the total score and communication, social skills, imagination, and attention switching scores of AQ were higher in children with ADHD and SCT. Regarding these subscales, attention switching and imagination scores deserve special attention, since these categories include traits associated with ASD, independent of social functioning. The attention switching category consists of items on insistence on sameness, narrow interests, and inability to understand humoristic social behaviors, while the imagination category measures imagination ability, pretend play, and the perception of emotions and intentions. When all of the significant AQ and SCARED scores were entered in the linear regression model, including those on social functioning, attention switching and imagination still persisted as predictors of SCT. Taken together, the AQ scores of our participants with SCT appear to reflect a milder form of ASD symptomatology, which is not limited to social withdrawal and isolation.

The link of SCT with both ATs and anxiety disorders may not be considered surprising, as all of these three constructs have developmental overlaps and shared

Table 3 Linear regression model on the predictors of SCT total score

		95%CI for beta		
	Beta	Lower	Upper	p-value
AQ-Child				
Social skills	0.22	0.09	0.58	< 0.01
Attention switching	0.17	0.01	0.54	< 0.05
Communication	0.10	-0.07	0.34	0.21
Imagination	0.25	0.13	0.60	< 0.01
Total	-0.37	-0.31	-0.02	< 0.05
SCARED				
Social phobia	0.11	-0.03	0.38	0.09
Panic/somatic	0.21	0.12	0.68	< 0.01
School phobia	0.06	-0.29	0.85	0.33
Generalized anxiety	0.17	0.03	0.52	< 0.05
Separation anxiety	-0.06	-0.30	0.08	0.25
Parent T-DSM-IV-S				
Inattention	0.52	0.35	0.69	< 0.01
Oppositional defiance	0.15	-0.01	0.29	0.06
Total	-0.44	-0.22	-0.07	< 0.01

95%CI = 95% confidence interval; AQ-Child = Autism Spectrum Quotient-Children's Version; SCARED = Screen for Child Anxiety and Related Disorders; SCT = sluggish cognitive tempo; T-DSM-IV-S = Turgay DSM-IV Disruptive Behavior Disorders Rating Scale).

external correlates. In the case of anxiety symptoms, it is widely known that children and adolescents with ASD experience higher rates of comorbid anxiety disorders (up to 40%) than the general population.[35] Reinvall et al.[6] have shown that SCT was related to higher internalizing scores, including anxiety symptoms, in adolescents with ASD. Duncan et al.[5] also examined adolescents with ASD and found that SCT symptoms were associated with ASD, ADHD, and internalizing symptoms. In contrast, a more recent study in adults with ASD reported that co-occurring SCT may not pose a heightened risk for anxiety symptoms.[8]

Temperamental traits of certain anxiety dimensions may also shed light on the link between SCT and anxiety. For instance, social anxiety is usually accompanied by marked behavioral inhibition, and said inhibition may partly explain the SCT characteristics of hypoactivity and lower engagement in social situations. To investigate the possible association between SCT and personality, Becker et al.[17,36] conducted two studies. One, in a community sample of children, found that fear/shyness (representing the fight-flight-freeze system, or FFFS), was a strong predictor of SCT symptoms.[36] More recently, in a sample of college students, they found that SCT was significantly associated with higher behavioral inhibition system (BIS).[17] Taken together, the association between anxiety and SCT appears to extend beyond a sole comorbidity to include certain personality characteristics and the possible impacts of ADHD and ASD.

The association between SCT and ATs may be interpreted in several ways. First, SCT may be partly responsible for the clinical picture of ATs in ADHD. It has been previously suggested that some symptoms of ATs in ADHD may reflect the pervasiveness of inattention symptoms. For instance, those children with high levels of hypoactivity, daydreaming, mental fogginess, and confusion may be less aware of the social cues and may be too slow in interactive communication. All of these factors may result in a more socially withdrawn temperament. Second, the association between SCT and ATs may be explained from a developmental perspective. Since ASD symptoms and/or ATs develop mainly in the first 3 years of life, SCT may be secondary to ATs in the developmental order. Third, there may be a bilateral relationship between ATs and SCT, with each of these clinical conditions representing a risk factor for the development of the other. Finally, shared brain regions and neurocognitive deficits may be responsible for the emergence of both conditions. One of the suggested regions is the superior parietal lobule (SPL), which has been specifically linked with SCT in adolescents with ADHD.[37] Hypoactivity in the SPL was shown to be related to impaired reorienting, shifting of attention, and deficits in behavioral learning.[37] Specifically in patients with ASD, a previous study has found decreased activation in the right SPL.[38] The authors of this study suggested that SPL may play an important role in motor learning and repetitive behavior in individuals with ASD. In a recent study, Baytunca et al.[39] compared the neurocognitive scores of ADHD children with and without SCT, and showed that cognitive flexibility was more severely impaired in those with SCT. Deficits in cognitive flexibility are also common in ASD, and related with impairments in daily life.[40] Future prospective studies, preferably including the early stages of development, neurocognitive evaluation and neuroimaging, are needed to clarify the complex relationship between ATs, SCT, and ADHD.

In the present study, beside ATs and anxiety dimension scores, the total, inattention, and oppositional defiance scores of parent T-DSM-IV were found to be higher in children with SCT. Amongst these, the total and inattention scores of parent T-DSM-IV were also found to be associated with SCT total score. The relationship between SCT and ADHD, especially inattention symptoms, has been widely documented in previous studies.[2] Of note, teacher-rated ADHD scale scores were not found to be associated with SCT symptoms in our sample. This discrepancy between parent- and teacher-rated tools is common in ADHD.[41] Since SCT was rated by parents in our study, the association of SCT with parent-rated ADHD symptoms may be considered a reliable finding.

This study has several major limitations, including the small sample size and cross-sectional design. Investigation of SCT based on both parent and teacher ratings would increase our reliability, since marked differences may exist between home and school settings. Although we controlled for medication treatment in the study analyses, the inclusion of both drug-naive children and those who were receiving medication may be considered a major drawback. The use of cross-informant measures on SCT and anxiety symptoms is also another major limitation, since rater-specific effects may decrease the reliability of some findings. Finally, the lack of the investigation of depression symptoms is a major limitation. The investigation of a broad range of internalizing symptoms, including depressive symptoms, might reveal additional findings.

The findings of the present study have several clinical implications for the assessment and management of children with ADHD. Although the investigation of core symptoms is a gold standard in ADHD, the screening of SCT and social deficits is also crucial for an overall evaluation of impairment. According to our findings, which warrant replication in future studies, a link between SCT and ATs appears to be evident. From a diagnostic perspective, clinicians should screen the signs of ATs in children with overt SCT symptoms. It should be kept in mind that some children with ADHD and SCT symptoms may have ATs and/or missed diagnosis of a mild form of ASD. On the other hand, some children with ADHD and marked social difficulties, who are labeled as having ATs, may also be experiencing SCT symptoms. Lastly, the management of those with ADHD and SCT should include comprehensive interventions to improve social skills in school and daily life – e.g., support in peer interactions, hobby training, and group-based school activities – and overcome social difficulties.

Disclosure

The authors report no conflicts of interest.

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