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Autistic Traits and Their Relationship with Internalization-Externalization Symptoms in ADHD and SLD

DEHB ve ÖÖB'de Otizm Spektrum Özellikleri ve İçselleştirme Dışsallaştırma Belirtileri ile İlişkisi

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ABSTRACT

Objectives: Neurodevelopmental disorders (NDDs) show frequent comorbidities and often contain overlapping symptom clusters. This study aims to investigate the autistic traits (ATs) in children with attention deficit hyperactivity disorder (ADHD), specific learning disorder (SLD), and comorbid patients, and it hypothesizes that increased autistic features are associated with increased internalization and externalization symptoms.

Materials and Methods: Data from 49 ADHD, 58 SLD, 48 ADHD+SLD, and 56 typically developing children were included in this study. A semi-structured clinical interview was used for diagnosis. The Social Responsiveness Scale and Strengths and Difficulties Questionnaire were administered to families of children.

Results: The study determined that ATs were more common in children with ADHD or SLD than in their typically developing peers and more common in the ADHD+SLD group than in the single-diagnosis groups. ATs are associated with increased internalization and externalization symptoms in NDDs.

Conclusion: ATs are more likely to be seen in NDDs other than autism compared to healthy controls, and psychopathologies are more common in people with ATs. Comprehensive assessments considering clusters of symptoms may be important for exploring common etiologic backgrounds and patient-based treatments.

Keywords: ADHD, autistic traits, neurodevelopmental disorders, SLD

ÖZ

Amaç: Nörogelişimsel bozukluklar (NGB) sıklıkla komorbidite gösterir ve sıklıkla örtüşen semptom kümeleri içerir. Bu çalışmanın amacı, dikkat eksikliği ve hiperaktivite bozukluğu (DEHB), özgül öğrenme bozukluğu (ÖÖB) ve komorbid tanıları olan çocuklarda otistik özellikleri (AT) ve artan AT'nin içselleştirme ve dışsallaştırma semptomları ile ilişkisini araştırmaktır.

Gereç ve Yöntem: Bu çalışmaya 49 DEHB, 58 ÖÖB, 48 DEHB+ÖÖB ve 56 tipik gelişen çocuktan elde edilen veriler dahil edilmiştir. Tanı için yarı yapılandırılmış klinik görüşme kullanılmıştır. Çocukların ailelerine Sosyal Duyarlılık Ölçeği ve Güç ve Güçlükler Anketi uygulanmıştır.

Bulgular: Çalışma, DEHB veya ÖÖB olan çocuklarda AT tipik gelişim gösteren akranlarına ve DEHB+ÖÖB grubuna kıyasla tek tanılı gruplara göre daha yaygın olduğunu belirlemiştir. AT'ler NGB'de artan içselleştirme ve dışsallaştırma semptomlarıyla ilişkili bulunmuştur.

Sonuç: AT'lerin otizm dışındaki NGB'de görülme olasılığı sağlıklı kontrollere kıyasla daha yüksektir ve AT'leri olan kişilerde psikopatolojiler daha yaygındır. Semptom kümelerini dikkate alan kapsamlı değerlendirmeler, ortak etiyolojik arka planları ve hasta temelli tedavileri araştırmak için önemli olabilir.

Anahtar Kelimeler: DEHB, otistik özellikler, nörogelişimsel bozukluklar, ÖÖB

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Introduction

Neurodevelopmental disorders (NDDs) are lifelong, common disorders that can affect the lives of children, families, and society in many ways.[1] Close to 10% of children are defined as having one or more NDDs.[2] Clinically, they show heterogeneous presentations. Attention deficit hyperactivity disorder (ADHD), specific learning disorder (SLD), and autism spectrum disorder (ASD) are among the most common disorders included in the NDDs section of Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-5).[1] The high comorbidity rates of these disorders have given rise to the possibility of a common neurobiological basis. Discussion of NDDs in relation to neurodiversity has come to the forefront of the current literature.[3] Neurodiversity is discussed on the basis that these disorders have similar etiological origins, overlap in symptom clusters, and involve developmental changes that are lifelong.[4] In this context, autistic traits (ATs), which can be seen frequently in other NDDs despite being below the ASD diagnostic threshold have been the subject of many studies in recent years.[5-8] ATs may include difficulties with social communication and interaction, along with repetitive behaviors and interests, which can be seen at varying levels without meeting the diagnostic requirements for ASD.[7] For instance, studies comparing children with autism and their siblings to neurotypical peers highlight higher levels of depression and hyperactivity, along with greater restrictions in social relationships.[9] Having an autistic sibling can lead to an increase in behavioral and emotional adjustment problems in children.[10]

ASD, ADHD, and SLD may have varying degrees of attention problems, challenges in peer communication, impulsiveness, and hyperactivity. Significant academic, behavioral, emotional, and adaptive problems may occur at home, at school, and in other settings.[11,12] In a study comparing social skills between ADHD cases and cases with SLD comorbidity, no difference was found.[13] ADHD and ASD are linked to additional difficulties in specific learning and development, particularly reading difficulties and motor problems, including developmental coordination disorder.[14-16] In addition, speech and language problems common in ASD often accompany ADHD and SLD. ASD and ADHD show very high comorbidity between them concerning traits and complete disorders, both in clinical samples and general population cross-sectional samples.[17-19] While the exact neurobiological mechanisms of NDDs are not completely understood, genetic and imaging studies provide evidence suggesting that these conditions might share underlying neurobiological dysfunction.[20,21] Population-based twin studies have shown an increased prevalence of autism-like symptoms in children with ADHD and suggested that up to 50% of ASD and ADHD symptoms are inherited together.[19,22]

The coexistence of ATs with psychopathologies is a frequently occurring topic in the literature. There is a relationship between autism characteristics and problems in many areas, such as attention, behavior, social communication, and learning.[23] In research by Tsuji et al.,[24] it was shown that ATs are associated with internalization problems and that sensory differences may mediate this relationship. In a twin study, autistic-like communication disorders and repetitive/restricted behaviors were most strongly associated with internalizing disorders such as generalized anxiety and negative affect, both in terms of phenotypical and genetic factors.[18] In a study involving 522 children aged 4-16 years, Social Responsiveness Scale (SRS) total scores positively correlated with anxiety/depression, behavioral problems, and ADHD.[25] Similarly, research by Katsuki et al.[26] revealed a higher rate of ATs in the "high internalization/externalization" group in 314 ADHD children aged 4-15 years. It has been shown that ADHD symptoms account for 48% of the variance in predicting SRS scores when ADHD does not accompany ASD. ADHD problems explain 40% of the variance when ASD is co-diagnosed.[27] In a population-based study on adult Australian twins, the association was discussed as potentially being linked with susceptibility to psychopathologies and emphasizes the relationship between ASD and ADHD traits.[8]

In this study, we seek answers to the following questions:

1) Do children with SLD or ADHD have more ATs than healthy peers?

2) Do children with ADHD+SLD have more ATs than peers with only ADHD or only SLD?

3) Is there a relationship between the ATs of these children in the NDDs spectrum and the increase in internalization and externalization symptoms?

Materials and Methods

Study Sample and Procedure

Children aged 8 to 15 years who applied to the İstanbul University-Cerrahpaşa, Cerrahpaşa Faculty of Medicine, Department of Child and Adolescent Psychiatry outpatient clinic in 2020-2021 were included in the study. This included children diagnosed with ADHD, SLD, both, and neurotypically developing children. ADHD and SLD diagnoses were made by the clinician based on DSM-5 criteria, and the semi-structured interview the Kiddie Schedule for Affective Disorders and Schizophrenia (K-SADS). After the Wechsler Intelligence Scale for Children-Revised version assessment, children with a total intelligence quotient >85 were included in the sample. Children who were reported to have chronic physical diseases (e.g., visual or hearing impairments, neurological, and metabolic diseases) by their parents were not included. As a result of the K-SADS-Present and Lifetime (PL) version evaluation, children with comorbid anxiety disorders, mood disorders, ASDs, eating disorders, or psychotic disorders were excluded. Parents of the remaining children were asked to fill in sociodemographic data forms, the SRS, and the Strengths and Difficulties Questionnaire (SDQ).

Five patients with chronic physical illness, 62 patients with additional psychiatric comorbidity, 12 patients with cognitive impairment, were not included in the study, and 19 patients were excluded due to missing data. Statistical evaluations were conducted among 211 children whose data were not missing.

Ethics committee approval of the study was obtained from İstanbul University-Cerrahpaşa, Cerrahpaşa Faculty of Medicine Clinical Research Ethics Committee (approval no: 117836, date: 10.09.2020) and written informed consent was obtained from the caregivers of the children.

Schedule for Affective Disorders and Schizophrenia for School-Aged Children, Present and Lifetime Version

K-SADS-PL is a semi-structured interview form used to determine the psychopathology of children and adolescents according to DSM-5 diagnostic criteria.[28] The Turkish version of the interview schedule for DSM-5 was published by Ünal et al.[29]

Social Responsiveness Scale (SRS)

SRS consists of a total of 65 items, 39 related to observable reciprocal social behavior, 6 related to the social use of language, and 20 related to stereotypical behaviors.[30] The total score obtained from the scale reflects the severity of social deficiencies. Higher scores indicate more severe social impairment. Although there is no study on the validity and reliability published in Turkish, the scale was used in a study with a large sample of school-age children.[31] Using data from this study, the internal consistency (Cronbach's alpha) of the scale was reported as 0.86. As a result of the factor analysis, it was decided to consider the test as a singular factor. The test-retest reliability of the Turkish version of the SRS was also found to be high (Pearson's; r=0.53, p<0.01). In our study, the reliability coefficient of the total scale was found to be 0.94.

Strengths and Difficulties Questionnaire (SDQ)

The questionnaire consists of five sub-dimensions (emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems, and prosocial behavior), each containing five questions, totaling 25 questions. Internalizing and externalizing subscales represent types of broadband scales. The scale was developed by Goodman,[32] and the Turkish study of validity and reliability was conducted by Güvenir et al.[33] Cronbach's alpha values were found to be between 0.37 and 0.84. While Cronbach's alpha value for the peer relationship subscale score was 0.37, the values for the other subscales were greater than 0.65. In our study, the reliability coefficients of internalization, externalization, and total score scales were found to be 0.67, 0.82, and 0.84, respectively.

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA). A p-value <0.05 was considered statistically significant, and findings included exact p-values to indicate the precise level of significance in the results. The descriptive data were compared using the chi-square test and ANOVA by forming 4 groups: ADHD, SLD, SLD+ADHD, and typical development (TD). The Kolmogorov-Smirnov test and Kurtosis-Skewness values were used to assess normality. Pearson correlation analysis was first performed between SRS and internalization and externalization scores in children with SLD, ADHD, and ADHD+SLD groups. Afterward, while the SRS score was included in the analysis as an independent variable, internalization, externalization, and total SDQ scores were also included as dependent variables in the linear regression analysis. The relationship between internalization, externalization, total problems, and SRS scores in the total sample was analyzed by Pearson correlation analysis. The differences between internalization, externalization, and total SDQ scores between the four groups were tested with ANCOVA by adding the medication use, age, and gender variable as a covariate.

Participants with more than 12 missing SRS items were excluded from the study (n=19).[19]

Results

Sample Characteristics

Data from 211 children aged 8-15 years (10.19±1.80 years) were analyzed. One hundred fifty-five of these children have NDDs (age: 10.07±1.76). In the study, no significant differences were found between the groups in terms of gender [$\chi^2(3)=5.192$, p=0.158] and age [F(3,207)=0.138, p=0.937] (Table 1). A statistical difference was found between the groups in terms of medication use [$\chi^2(3)=90.102$, p<0.001].

Correlation of Internalizing Externalizing Symptoms with Autistic Traits

In children with NDDs, SRS scores were significantly related by total problems (r=0.750, p<0.01), internalization problems (r=0.681, p<0.01), externalization problems (r=0.645, p<0.01) scores (Table 2).

Regression Analysis

Simple regression analysis has revealed that SRS scores predicted total problems [$R^2=0.550$, F(2,148)=92.551, p<0.01], internalization problems [$R^2=0.456$, F(2,148)=62.141, p<0.01], and externalization problems [$R^2=0.407$, F(2,148)=50.793, p<0.01] (Table 3).

Comparison of Internalizing Externalizing and Social Responsiveness Scores in SLD, ADHD and ADHD+SLD

A one-way ANCOVA was conducted to determine a statistically significant difference between SLD, TD, ADHD, and ADHD+SLD on the social responsiveness, total problems, internalization problems, and externalization problems, controlling for age, gender and medication use (Table 4). There was a significant effect of the groups on the severity of social responsiveness after controlling for age, gender, and medication (F=12.422, p<0.001). Pairwise comparisons indicated that the mean score of ADHD+SLD was significantly greater than SLD (p<0.001), ADHD (p<0.001), and TD (p<0.001). Additionally, the mean score of the TD group was significantly lower than that of the SLD (p<0.023), ADHD (p=0.017), and ADHD+SLD (p<0.001).

There is a significant effect of the groups on the scores of internalization problems after controlling for age, gender, and medication (F=9.145, p<0.001) (Table 4). Pairwise comparisons

Table 1. Comparison of the groups in terms of age, gender, and medical treatment

	TD	SLD	ADHD	SLD+ADHD	p-value	Children with NDDs
n	56	58	49	48		155
Age	10.21±1.89	10.06±1.63	10.0±1.87	10.14±1.85	0.937	10.07±1.76
Gender (male)	38	41	42	37	0.158	120, 77.4%
Medication	0	0	31	17	0.000	48, 31.8%

TD: Typical development, SLD: Specific learning disorder, ADHD: Attention deficit hyperactivity disorder, NDDs: Neurodevelopmental disorders

Table 2. Association between total problems, internalization problems, externalization problems, and social responsiveness in children with NDDs

	M±SD	1	2	3
1. Total problems	15.683±6.457	1		
2. Internalization	6.683±3.401	0.863**	1	
3. Externalization	9±3.921	0.899**	0.553**	1
4. Social responsiveness	69.458±29.397	0.750**	0.681**	0.645**

**p<0.01, NDDs: Neurodevelopmental disorders, M: Mean, SD: Standard deviation

Table 3. Regression analysis

DV	IV	B	SE	R	B	F
Total problems	**Social responsiveness**	0.181	0.013	0.550	0.744	92.551
Internalization		0.087	0.008	0.456	0.675	62.141
Externalization		0.094	0.009	0.407	0.635	50.793

DV: Dependent variable, IV: Independent variable, SE: Standard error

Table 4. One-way ANCOVA analysis

	SLD+ADHD mean (SD)	SLD mean (SD)	ADHD mean (SD)	TD mean (SD)	p-value
Externalizing scores	14.096 (4.158)	11.179 (3.999)	10.909 (4.418)	8.115 (4.051)	**<0.001**
Internalizing scores	13.909 (5.039)	9.444 (5.150)	8.555 (3.565)	6.415 (5.039)	**<0.001**
Social responsiveness score	93.578 (28.095)	56.100 (18.450)	59.562 (19.711)	43.055 (17.041)	**<0.001**

ANCOVA: Analysis of covariance, SLD: Specific learning disorder, ADHD: Attention deficit hyperactivity disorder, TD: Typical development, SD: Standard deviation

indicated that the mean score of ADHD+SLD was significantly greater than SLD (p=0.003), ADHD (p<0.001), and TD (p<0.001). Additionally, scores of internalization problems in SLD were significantly higher than those in TD (p=0.018).

There is a significant effect of the groups on the scores of externalization problems after controlling for age, gender, and medication (F=7.986, p<0.001) (Table 4). Pairwise comparison tests showed that ADHD+SLD was significantly higher than ADHD (p<0.011) and TD (p<0.001). Additionally, scores of externalization problems in SLD were significantly higher statistically than in TD (p=0.002).

There is a significant effect of the groups on the severity of total problems after controlling for age, gender and medication (F=10.223, p<0.001) (Table 4). Pairwise comparisons indicated that the mean score of ADHD+SLD was significantly greater than SLD (p=0.035), ADHD (p=0.001), and TD (p<0.001). Additionally, total problem scores in SLD were significantly higher than in TD (p<0.001).

Discussion

Our findings revealed that ATs were higher in children with ADHD and SLD, than their typically developing peers. More ATs were seen in the comorbid ADHD+SLD group, those with more neurodevelopmental symptoms, than in the single-diagnosis group. This study also shows that ATs may be associated with more psychopathological symptoms in children on the neurodevelopmental spectrum who are not diagnosed with ASD.

The study results are consistent with the literature showing that attention deficits are higher in ADHD and SLD groups.[6,34,35] ATs are thought to occur in 20% to 30% of children with ADHD, and research has found that such children are more impaired than other children with ADHD alone, particularly in the areas of interpersonal communication and empathy.[6,36,37] Evidence from twin and family studies suggests that ADHD and ASD share certain inherited causes, implying that these conditions stem from overlapping familial and genetic factors. Furthermore, genome-wide association studies (GWAS) investigating

clinical phenotypes have identified several potential shared genetic factors.[36,38,39] Abnormalities in catecholaminergic and serotonergic neurotransmission are commonly reported in both ADHD and ASD. Serotonin-related genes like *SLC6A4 (serotonin transporter gene)* influence serotonin levels and have shown associations with both disorders, although findings are not consistently replicated. Catechol-O-methyltransferase and Monoamine Oxidase A variants affect dopamine regulation in the brain, potentially influencing symptomatology in both ADHD and ASD, though evidence remains mixed. Rare mutations in genes such as *FMR1*, *15q13.2-q13.3* duplications, and *22q11* deletions are implicated in combined ADHD-ASD diagnoses, often presenting with distinct physical and neurological features.[38] Family and twin studies indicate significant shared genetic factors underlying both disorders, influencing their heritability and suggesting common origins for symptomatology across genders and age groups. Linkage studies and GWAS have identified potential pleiotropic genes and single nucleotide polymorphism overlaps, although ongoing research is needed to establish comprehensive genetic links between ADHD and ASD.[39] GWAS have also found rare copy number variants shared between these two disorders.[40]

In a study comparing groups diagnosed with SLD and ADHD, peers with ASD, and a control group in terms of SRS scores and social cognition, it is observed that both SLD and ADHD groups differ from the typical group with regard to autism-like features.[41] Studies show that children with SLD have difficulty with social communication, cues, and emotions.[42] Consistent with previous findings, our study detected higher levels of ATs in children with comorbid ADHD+SLD compared to those with a single diagnosis of SLD or ADHD. Although there are opinions in the literature that ATs may increase as other symptoms increase in the neurodevelopmental field,[25] we could not source a study comparing two diagnoses and a single diagnosis as in our study.

While it was emphasized in the literature that social difficulties were related to impulsivity in children with ADHD, studies on assistive technologies introduce new aspects to this understanding. Social difficulties often persist after ADHD symptoms have been treated.[43] Additionally, an adult study reported that attention-shifting difficulties, and repetitive routines and behaviors, showed a particularly strong genetic overlap with ADHD characteristics.[22,44] Although there are studies on ADHD, the literature on SLD is limited; our findings in cases with SLD alone may contribute to the relatively understudied field.

To our knowledge, no studies have specifically examined the relationship between ATs and internalizing and externalizing symptoms in children with SLD. However, in both the comorbid group and ADHD, there are studies in which ATs are associated with anxiety disorder, depression, and behavioral disorders, in line with our findings.[45] Studies indicate that ATs in children with ADHD may be associated with higher psychopathology, which may predict a riskier clinical presentation. Although children with ADHD and ATs are not different from other ADHD children in the primary symptoms of ADHD, they show more severe clinical symptoms.[41,45]

Social cognition results from a combination of various neurocognitive processes, including executive functions.[46] In our study, we have used a scale to assess the social responsiveness aspect; however, research focused on executive functions has yielded similar results. Executive function deficits are observed in ADHD, SLD and ASD.[47,48] Similar to our results, a study showed that executive function problems increase in ADHD comorbidity with SLD compared to SLD alone.[47] While comorbidity of ASD between ADHD could not be diagnosed until DSM-5, recent research has led to a paradigm shift, and a more inclusive approach. Although it is necessary to diagnose individuals in terms of appropriate intervention and treatment, it is recommended to adopt a holistic, biopsychosocial model when approaching neurodiverse individuals. We hope that the identification of ATs in our study involving children diagnosed with ADHD and/or SLD, without concurrent psychiatric comorbidities, will contribute valuable insights to the field and advance our understanding.

The findings in this study support the growing literature on the existence and importance of common symptom clusters in NDDs. More research is needed to better understand the role of ATs. Study designs containing information in areas such as emotion regulation and executive functions will be useful in this context. Studies, investigating specific learning disabilities are insufficient. Further studies may be useful to understand the common structural, functional, and genetic connections and to elucidate the etiology of NDDs.

Study Limitations

The study has some limitations. Our sample was drawn from a single center; however, multicenter studies may better represent the community sample. The presence of a group diagnosed with ASD among our diagnostic groups would have more strongly supported our hypotheses. One of our most important limitations is that we have scale-based data. It should be kept in mind that the scales used in our study are parent-based and subjective, and may not accurately reflect the real-life performance of children. It is important to distinguish whether the high correlation between the scales is related to a true neurobiological overlap or whether it is due to measurement technique or other parameters to understand the nature of the relationship. Future studies may help us better understand the nature of this relationship by using more objective and clinical observation-based measures.

Conclusion

Our study revealed that ATs were more common in children diagnosed with ADHD+SLD, ADHD, and SLD, compared to the typically developing group, and these features were associated with increased internalizing and externalizing problems. This situation draws attention to the importance of ATs in children with NDDs excluding ASD. Patient-centered approaches that adopt a transdiagnostic perspective may be useful for clinicians'

individualized intervention and treatment plans, working in the field of NDDs. In addition, investigations of symptom clusters may be essential to enhance understanding and elucidate the etiopathogenesis of the disorders in this diagnostic group by addressing the commonalities and differences.

Ethics

Ethics Committee Approval: Ethics committee approval of the study was obtained from İstanbul University-Cerrahpaşa, Cerrahpaşa Faculty of Medicine Clinical Research Ethics Committee (approval no: 117836, date: 10.09.2020).

Informed Consent: Written informed consent was obtained from the caregivers of the children.

Footnotes

Authorship Contributions

Surgical and Medical Practicies: Z.S.A., N.S., M.S.Y., Concept: Z.S.A., N.S., M.T.K., B.D., Design: Z.S.A., M.T.K., B.D., Data Collection or Processing: Z.S.A., N.S., M.S.Y., Analysis or Interpretation: Z.S.A., B.Ö.A., D.D.S., Literature Search: Z.S.A., N.S., M.S.Y., Writing: Z.S.A., B.Ö.A., D.D.S.

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