After one year in university; a robust decrease in autistic traits reporting among autistic students

Gil Zukerman[1]*, Gili Yahav[1] and Ester Ben-Itzchak[1,2]

[1]Department of Communication Disorders, Ariel University, Ariel, Israel, [2]Bruckner Center for Autism Research, Ariel University, Ariel, Israel

Background: Previous research on autistic students enrolled in university support programs has reported moderate improvement in anxiety/depression or adaptive behavior. However, alterations in autistic traits have not been examined.

Methods: This longitudinal study evaluated changes in university students' autistic trait and state/trait anxiety levels. Participants were 24 neurotypically developed (ND) students with high levels of social anxiety symptoms (High SA), 30 ND students with low levels of SA symptoms (Low SA), and 41 autistic students (the primary focus of this study) residing with an ND peer student mentor as part of participating in the university's integration support program. Autism spectrum quotient [AQ and State Trait Anxiety Inventory STAI] data were collected during the first semester of two consecutive academic years (T1, T2), as well as baseline (T1) levels of social anxiety, depression, and obsessive−compulsive symptoms.

Results: Significant interaction between group and time was observed, denoting a sharp decrease (2.9 SD) from T1 to T2 in the overall autistic trait level among the autistic group (AQ "attention switching" subscale demonstrating the most robust decrease), and a moderate decrease (0.5 SD) among the high SA group. Only for the autistic students were more compulsive symptoms at T1 associated with a lesser decrease in AQ scores (T1-T2), which in turn was negatively correlated with their T1 year-end grade point average.

Conclusion: The findings suggest that attending post-secondary education (while partaking in a support/transition program) is followed by a profound change of the individual's subjective experience of autism, characterized by a sharp decline in the level of autistic traits, particularly attention switching. This change is independent of alterations in well-being indices, such as anxiety, that are known to characterize students attending university.

KEYWORDS

autism traits, post-secondary education, anxiety symptoms, autism support programs, attention alterations

1. Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by social communication/interaction impairment and restricted/repetitive behaviors, interests, or activities [DSM 5, (1–3)]. Autism is estimated to occur in 1 in 44 people [U.S.; (4)] and approximately 67–70% have no intellectual disability (4, 5).

In recent years, individuals with autism are increasingly enrolling in higher education (6), the matriculation to which can be a complex experience. Indeed, autistic students attending university have reported elevated personal distress (6–10) along with high rates of anxiety and depressive symptoms, in particular social anxiety and obsessive–compulsive symptoms (11–15). The relatively high rates of comorbid psychiatric symptoms, specifically anxiety, may have a profound effect on their acclimation to university: previous studies have reported a negative association between anxiety (especially social anxiety and obsessive compulsive symptoms) on adaptive behavior and academic performance among young undergraduate autistic students (10, 14–16) as well as autistic children and adolescents (17, 18).

In light of the rapid increase in university students with autism (19), the necessity of developing appropriate support programs has been acknowledged (20, 21). However, few programs have been described in the literature, and efficacy research is even more scarce. The majority of the existing studies have focused on well-being and functional indices such as anxiety and depression (16, 22–25), satisfaction (25), self-efficacy (23), and adaptive behavior (16): moderate improvement in these well-being and functional indices has been reported. However, the possibility of change in autistic characteristics during university attendance in the context of support program participation has yet to be examined.

Higher education integration support programs may have a fundamental effect on autism trajectories and outcomes, as suggested by the effect of intensive intervention efforts during other developmental stages (usually early intervention among toddlers) that has resulted in reported gains in cognitive and adaptive functioning, as well as decreased ASD symptom severity (26–28). It has been suggested that use of multisensory and multidomain teaching approaches can alter core deficits in social-communication domains by providing recurring experiences that promote increased complexity in neural networks and connectivity (29, 30). Thus, it is highly relevant to study whether the experience of attending university (whether or not partaking in a specialized transition program) may serve as a window of opportunity to alter autism trajectories and enhance functioning later in life.

Support programs should also take into consideration the specific characteristics associated with autism. Autistic traits, defined as a set of personality characteristics, have been associated with the phenotypic expression of autism (31), and often include social skill impairment, a strong preference for routine, difficulties with attention switching, and impaired imagination (32). Significantly higher in autism (33), these traits are conceptualized as representing a normally distributed continuum of autistic features among the general population. The Autism Spectrum Quotient [AQ, (1)] is one of the most widely used quantitative measures of the levels of autistic traits reflecting the broader autistic phenotype spectrum (34). Several studies have examined the association between high levels of autistic traits, as measured by the AQ, and various factors. One line of research examined the association between AQ scores and mental health/personality factors, finding high levels of autistic traits among ND students associated with mental distress, particularly anxiety (35–38); this has led to the suggestion that AQ reporting is affected by the individual's mental state (39). However, changes among autistic students may be less associated with anxiety alteration while other factors contributing to change may occur.

The current study's primary aim, therefore, was to explore whether there is change in autistic students' self-reported autistic traits during 1 year of attending university. The autistic students in our cohort were participating in the university's integration program, which included facilitated social interaction with an ND peer-mentor with whom the vast majority of autistic students resided, as well as extensive focused opportunities for socializing via various program activities. Since social anxiety has been reported as the most frequent type of comorbid anxiety among autistic individuals (40, 41) and, like autism, it also significantly impacts social abilities (14, 42), ND students with high and low levels of social anxiety served as control groups.

We hypothesized that a year of participating in the university's integration program would be followed by reports of lower levels of autistic traits. We also hypothesized that changes in levels of general anxiety over that year would be associated with changes in autistic traits. A secondary aim of the study was to examine whether reduction in AQ scores after one academic year would correlate with students' baseline levels of psychiatric symptoms (social anxiety, depression, and obsessive–compulsive symptoms). We hypothesized that lower baseline levels of psychiatric symptoms would be associated with greater AQ reduction one academic year later. Previous study findings have demonstrated positive or negative associations (38, 43) between autistic traits and academic performance. Accordingly, we hypothesized that changes in the level of autistic traits and academic achievement (annual grade point average at the end of the academic year) would be significantly associated. However, no direction of that association was assumed.

2. Materials and methods

2.1. Participants

The study included 95 full-time undergraduate university students (11 females; $M_{age} = 24.19$ years, $SD = 2.65$), who were assigned to one of three groups: (1) Students diagnosed with autism spectrum disorder (Autism group; $n = 41$). (2) ND students with high social anxiety symptom levels (High SA; $n = 24$); and (3) ND students with low social anxiety symptom levels (Low SA; $n = 30$). As students with autism tend to gravitate toward science, technology, and mathematics fields (44), the vast majority of the autistic students were enrolled in exact sciences and engineering departments; accordingly, advertisements soliciting ND student participation in the study were mainly posted in exact sciences facilities.

Formal diagnoses for the autistic students were collected from the university integration program's files (with participant consent) and the inclusion criteria consisted of an Autism Spectrum Disorder (ASD) diagnosis based on DSM-5 or ICD-10 criteria from a licensed neurologist/psychiatrist/psychologist. All Autism group participants had attended mainstream schools prior to attending university, had met standard university requirements for the department to which they were accepted, and were participating in the university's integration program. They were quite independent and required no assistance in activities of daily living. Table 1 presents participant demographics, year-end Grade Point Average (GPAs), and psychiatric comorbidities (Low SA symptoms group participants were asked to specify any previous psychiatric diagnoses).

TABLE 1 Demographics and academic affiliation among the study groups.

	ASD (n =41)	High SA (n =24)	Low SA (n =30)
Mean age (SD)*	23.46 (2.89)	24.33 (1.81)	25.07 (2.88)
Race (%)			
Caucasian	100%	100%	100%
Sex (%)(n)			
Female	4.87% (2)	8.33% (2)	23/33% (7)
Academic affiliation[a] (n)			
Exact sciences	21	24	2
Engineering	5	0	8
Life sciences	1	0	0
Health sciences	0	0	3
Architecture	0	0	1
Communications	0	0	2
Humanities	4	0	9
Grade point average (SD) (year-end)	76.12 (18.11)	77.09 (11.39)	83.07 (7.03)
Psychiatric comorbidities[b] (%)(n)			
ADHD*	19.5% (8)	–	10% (3)
Learning disability**	24.3% (10)	–	3% (1)
Anxiety disorder**	14.63% (6)	–	0
Depressive disorder	2.4% (1)	–	0
OCD*	9.7% (4)	–	0
Disruptive, impulse control, and conduct disorder	2.4% (1)	–	0
Personality disorder	2.4% (1)	–	0
Psychiatric medication (%)(n)	2.4% (1)	–	0

ADHD, attention deficit hyperactivity disorder; ASD, autism spectrum disorder; OCD, obsessive compulsive disorder; SA, social anxiety. [a]Academic affiliation data available for 34/41 participants of the Autism group, 24/24 of the High SA group, and 29/30 of the Low SA group. [b]Psychiatric comorbidities were excerpted from students' files with their consent. *$p < 0.05$, **$p < 0.01$.

Participants from all three groups completed the Liebowitz Social Anxiety Scale [LSAS; (45)]. ND participants with LSAS scores ≥30 [considered the optimal cutoff signifying the presence of Social Anxiety Disorder; (46, 47)] were included in the high social anxiety symptom (High SA) group; those with scores <30 were included in the low social anxiety symptoms (Low SA) group. Significant group differences in age were observed, $F(2, 94) = 3.26$, $p = 0.043$. Post-hoc (Bonferroni) testing indicated that the Autism group was significantly younger than the Low SA group. Male predominance was observed, with significant difference observed between groups, $\chi^2(2,95) = 6.09$, $p = 0.048$.

2.2. Integration support program

The university's integration program primarily included: (1) Mentoring each autistic student was matched with a ND student (peer–mentor). The vast majority (83%) of autistic students resided with their peer-mentor in the university dormitories for at least one academic year (in which the study took place), while the remaining students resided either at home with their parents (13%) or in rented apartments near the university (~4%). The autistic students regularly met with their mentors over the same period. Peer-mentors provided daily support to their mentees and encouraged social interaction. (2) Tutoring – the autistic students attended a weekly half-hour personal session with a program coordinator that included information and assistance regarding academic procedures. (3) Structured social activities - all autistic students and their mentors had once-weekly (~25 times per academic year) two-hour social events. Additionally, the autistic students attended separate lectures (e.g., topics such as sexuality, employment opportunities, etc.). Overall, autistic students spent about 3 h weekly on program-related activities.

2.3. Measures

2.3.1. Autism spectrum quotient

The autism spectrum quotient (AQ) quantifies autistic traits among adults with average IQs (1), tapping into an individual's agreement with 50 statements on a 4-point Likert scale. The AQ includes five subscales (Social Skills, Attention Switching, Attention to Detail, Communication, Imagination) and can be used as a screening tool for autism (48). Relatively good test–retest reliability and internal consistency have been reported (1).

FIGURE 1
Reduction in AQ subscales scores (T1-T2) among the study's groups.
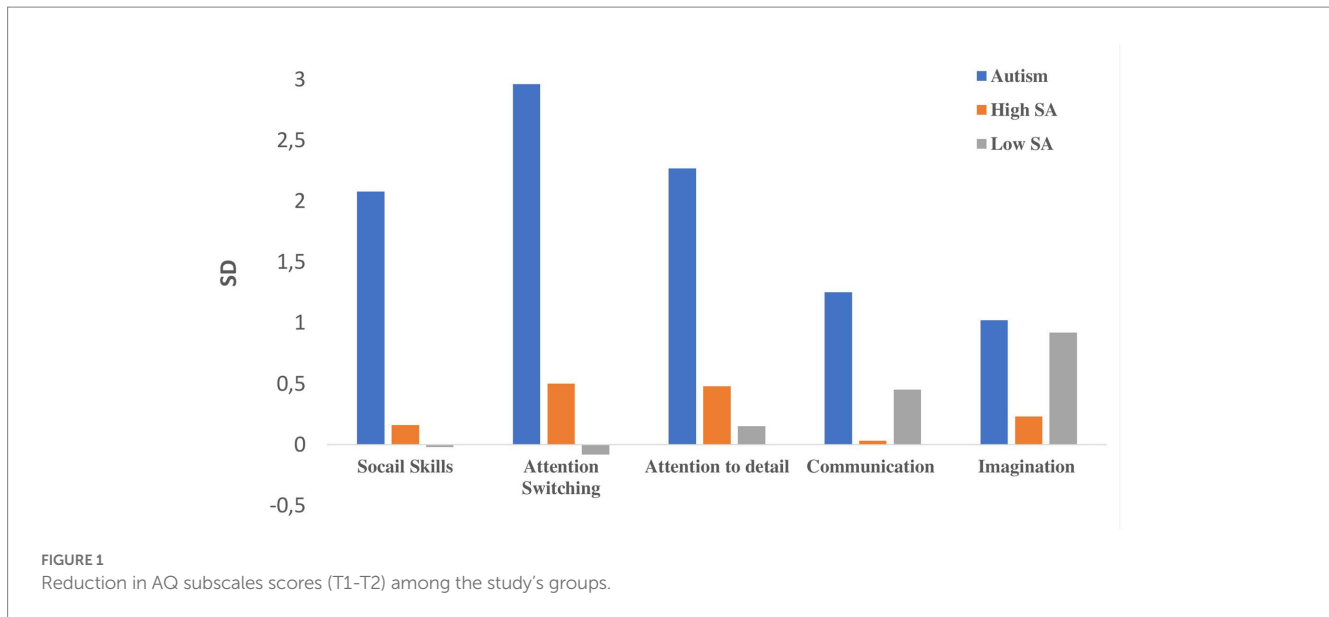
2.3.2. Liebowitz social anxiety scale

Assesses social interaction and performance anxiety by presenting 24 Likert scale items (range: 0–3) querying experienced fear and avoidance (49, 50). A total score, and fear and avoidance subscale scores, are generated (49). High reliability and validity have been reported for the self-report version used in this study (51).

2.3.3. Beck depression inventory

A 21-item self-report measure assessing cognitive, affective, and behavioral outcomes of depression (52). High reliability and validity, expressed in high correlations with other depression-related self-rating scales ($r = 0.66$), have been reported (52, 53).

2.3.4. Yale−Brown obsessive−compulsive scale II

Measures obsessive–compulsive disorder (OCD) symptom severity (54), yielding a total score (range: 0–40) and subscores for obsessions and compulsions (range: 0–20 for each). Moderate to high reliability and significant correlation with other OCD clinical symptom scales have been reported (55).

2.3.5. State trait anxiety inventory

The state trait anxiety inventory (STAI) produces two scores: trait and state anxiety (2, 56). High internal consistency coefficients (0.86–0.95), acceptable validity and moderate validity were reported (2).

2.3.6. Grade point average

The participants' year-end grade point average was obtained from an official university-generated report. GPAs were in numeric values, ranging from 0 to 100 (Table 1).

2.4. Procedure

The study was approved by the university research ethics committee. All procedures were in accordance with ethical standards of the responsible committee on human experimentation (institutional and national) and the Helsinki Declaration (1975, revised in 2000). All participants provided signed informed consent to participate. The AQ,

Beck depression inventory (BDI-II), LSAS, and STAI were self-completed a research assistant was available for questions, while the Yale–Brown Obsessive–Compulsive Scale II (Y-BOCS-II) was administered by a licensed clinical psychologist. Completion of the instruments took place in this order at the start of the 1st academic year (T1 = Time 1), and over about 1.5 h. The AQ and STAI were also administered (in that order) at the start of the 2nd academic year (T2 = Time 2).

2.5. Data analysis

Analyses were conducted using SPSS version 25 (57). AQ total and subscale scores and year-end GPA were transformed to normal distribution in accordance with Templeton (57, 58). Transformed AQ scores and grade point averages were examined for normality, in accordance with Kim (59). Chi square analyses were conducted to assess group differences in sex and rates of previous psychiatric diagnoses (see Table 1). Univariate analyses were used to assess group differences in psychiatric symptoms levels (LSAS, BDI-II, Y-BOCS-II) at T1. To assess change over time for autism traits, AQ total score and AQ subscale scores (Social Skills, Attention Switching, Attention to Detail, Communication, Imagination) were entered as dependent variables in two separate analyses that included a 3×2 (3 groups×2 time points) multivariate analysis of variance with repeated measures for time, and 3×2 doubly multivariate analysis of variance with repeated measures for time, respectively.

All analyses were conducted with/without Sex and Age as covariates. We used SD's taken from Baron-Cohen et al. (1) for presentation of the difference in AQ subscale scores (T2-T1) (see Figure 1). An additional MANOVA was conducted to assess change over time in anxiety levels (STAI State and Trait scores) among the study groups. Correlation analyses with False Discovery Rate corrections for multiple comparisons [FDR, (60)] were conducted between changes in AQ subscale scores (T1-T2), general anxiety (STAI T1-T2 trait and state subscales), and year-end GPAs.

Five linear regression analyses were conducted to examine the contribution of psychiatric symptoms to the variance in AQ subscale score change (T1-T2) over 1 year of university attendance. Sex and age

were entered in the first step, ASD diagnosis (yes/no) and social anxiety symptom level (T1 LSAS total score) in the second step, depression symptom level (T1 BDI-II) and compulsion level (T1 Y-BOCS-II score) in the third step. The interactions of ASD Diagnosis (yes/no) with Depression level (ASD diagnosis* T1 BDI-II) and ASD Diagnosis and Compulsion level (ASD diagnosis*T1 Y-BOCS-II compulsion) were entered in the fourth step, in a stepwise manner. Due to the high correlation between obsession and compulsion scores ($r = 0.84$) only the latter was entered into the regression models. Continuous variables were standardized for regression analyses according to Dawson. All independent variables in the regression analysis were examined for multicollinearity.

3. Results

All the study's transformed outcome variables (total and subscale AQ scores, GPA) were normally distributed. At T1, significant group differences were found in the social anxiety symptom levels (higher LSAS scores in the Autism and High SA groups compared to the Low SA group), as well as higher levels of depression symptoms (although BDI-II scores were in the subclinical range for all groups) and higher obsessive and compulsive symptoms (Y-BOCS-II scores) among the Autism group compared to the other groups (Table 2).

3.1. AQ and STAI score change

3.1.1. AQ total score change

The change (T1-T2) in AQ total score after one year of university attendance was examined for all groups. The 2×3 univariate ANOVA with repeated measures for time yielded a significant Group $\times$ Time interaction [$F(2, 91) = 26.09$, $p < 0.00$, $\eta^2_p = 0.36$]. This effect remained significant when using Age and Sex as covariates. Separate analyses for each group yielded a significant Time effect for the Autism group

[$F(1, 40) = 103.62$, $p < 0.00$, $\eta^2_p = 0.72$], (T1 $M = 42.11$, $SD = 8.33$; T2 $M = 23.29$, $SD = 6.59$) and for the High SA group, [$F(1, 22) = 5.91$, $p = 0.02$, $\eta^2_p = 0.21$] (T1 $M = 19.05$, $SD = 9.73$; T2 $M = 15.68$, $SD = 10.08$). Lower AQ total scores were noted at the start of the second academic year as compared to the start of the first year, for both the Autism and High SA groups. The findings also indicate a significant Time effect [$F(1, 91) = 63.63$, $p < 0.00$, $\eta^2_p = 0.41$, with lower AQ total scores at T2 ($M = 17.51$, $SE = 0.75$) compared to T1 ($M = 26.13$, $SE = 0.03$)]. Additionally, a significant Group effect was observed [$F(2, 91) = 82.23$, $p < 0.00$, $\eta^2 = 0.64$], indicating significantly higher AQ scores among the Autism group ($M = 32.70$, $SD = 7.46$) compared to the High SA ($M = 17.44$, $SD = 9.91$) and Low SA ($M = 15.32$, $SD = 6.76$) groups. The Time effect was not significant when using Age as a covariate.

3.1.2. AQ subscale change

For AQ subscale changes, the 2×3 MANOVA with repeated measures for time yielded a significant Group $\times$ Time interaction [$F(10, 172) = 20.23$, $p < 0.00$, $\eta^2_p = 0.54$]. This effect remained significant even when using Age and Sex as covariates. Univariate tests indicated a significant interaction in all AQ subscale domains ($p < 0.000$ for all). Separate analysis for each group yielded a significant Time effect for the Autism group [$F(5, 36) = 93.15$, $p < 0.00$, $\eta^2_p = 0.92$]. Univariate analyses for each separate AQ subscale indicated a significant Time effect for all subscales; a robust decrease in AQ scores was evident for all AQ subdomains following one academic year (see Table 3). In addition, a significant Time effect was noted for the High SA group [$F(5, 18) = 3.78$, $p = 0.01$, $\eta^2_p = 0.50$], However, univariate analyses indicated that the decrease in AQ scores was significant only for the Attention Switching, Attention to Detail, and Imagination subscales (Table 3). A significant Time effect was also noted for the Low SA group [$F(5, 25) = 5.44$, $p < 0.00$, $\eta^2_p = 0.52$], however univariate analyses revealed a significant decrease only for the Communication and Imagination subdomain scores (see Table 3).

TABLE 2 Psychiatric symptoms among the study's groups at T1.

	Autism (SD)	High SA (SD)	Low SA (SD)
LSAS total score**	45.54 (25.65)	54.43 (15.69)	19.15 (7.92)
BDI-II*	10.78 (7.89)	6.66 (5.76)	6.83 (6.31)
Y-BOCS-II obsession score**	7.60 (3.74)	3.08 (3.83)	3.13 (3.47)
Y-BOCS-II compulsion score**	7.36 (3.23)	2.04 (3.37)	2.56 (3.47)

LSAS, Liebowitz Social Anxiety Scale; BDI–II, Beck Depression Inventory II; Y-BOCS-II, Yale-Brown Obsessive–Compulsive Scale II. *$p < 0.05$, **$p < 0.01$.

TABLE 3 Time effects on AQ subscales in each of the study's groups.

AQ subscale	Autism			High SA			Low SA		
	$F(1, 40)$	p	η^2	$F(1, 22)$	p	η^2	$F(1, 29)$	p	η^2
Social skills	87.87	0.00	0.68	1.18	0.28	0.05	0.21	0.88	0.00
Attention switching	401.47	0.00	0.90	12.28	0.00	0.35	0.13	0.71	0.00
Attention to detail	207.11	0.00	0.83	6.45	0.01	0.22	0.77	0.37	0.02
Communication	23.68	0.00	0.37	0.08	0.77	0.00	5.79	0.02	0.16
Imagination	26.61	0.00	0.40	11.15	0.00	0.33	24.12	0.00	0.45

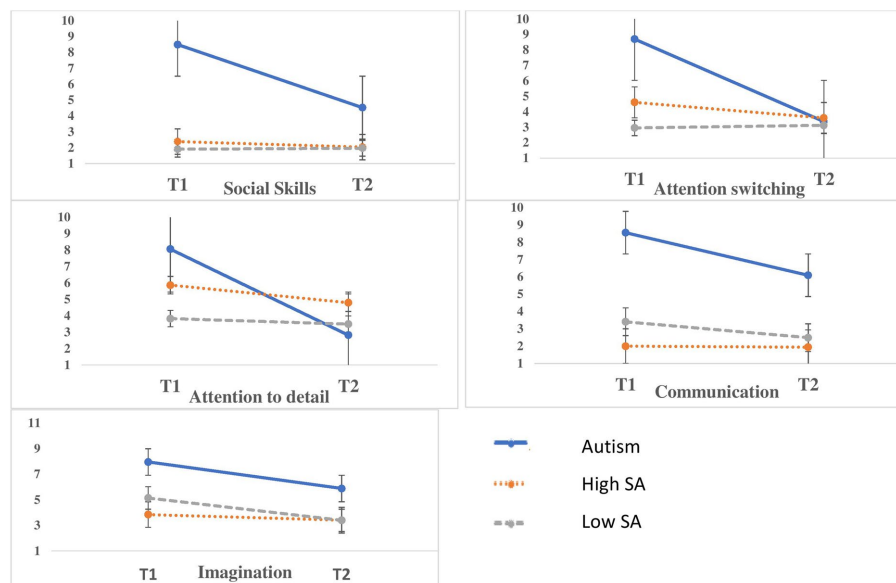Bold values in table represent $p < 0.05$.

FIGURE 2
AQ subscales scores among the study's groups at T1 (beginning of the academic year) and T2 (beginning of the consecutive academic year). SA, social anxiety.

TABLE 4 Correlation between grade point average (GPA) at the end of first year and change in AQ subscales after 1year of university attendance (T1-T2).

		AQ – social skills T1-T2	AQ – attention switching T1-T2	AQ- attention to detail T1-T2	AQ- communication T1-T2	AQ- imagination T1-T2
ASD	GPA	**−0.31***	−0.02	0.01	**−0.35***	**−0.29***
	n	35	35	35	35	35
High SA	GPA	−0.03	0.07	0.19	0.19	−0.10
	n	21	21	21	21	21
Low SA	GPA	0.15	0.26	0.01	−0.14	−0.16
	n	27	27	27	27	27

Bold values in table represent *p* <0.05.

Figure 2 presents AQ subscale scores at T1 and T2 for the study groups. Figure 1 presents the reduction in AQ scores from T1 to T2 for the study groups in standard deviations (norms for SD's were taken from (1)).

Additionally, the 2×3 MANOVA for AQ subscales yielded a significant Time and a significant Group effect for all AQ subscales. However, the Time effect did not remain significant when using Age as a covariate and remained significant only for Attention Switching and Attention to Detail when using Sex as a covariate.

Anxiety scores change. A main effect of Time on anxiety scores was evident [$F(2, 76) = 5.44$, $p < 0.05$, $\eta^2_p = 0.09$]. Univariate analyses indicated a significant Time effect for both State Anxiety [$F(1, 77) = 6.91$, $p = 0.01$, $\eta^2_p = 0.08$] and Trait Anxiety [$F(1, 77) = 7.08$, $p = 0.09$, $\eta^2_p = 0.08$], demonstrating lower levels at T2 ($M = 36.67$, $SD = 10.57$; $M = 38.41$ $SD = 9.60$) compared to T1 ($M = 40.11$ $SD = 9.05$; $M = 41.91$ $SD = 10.82$) for both state and trait anxiety, respectively, among the entire sample. The reduction in STAI scores in standard deviations was 0.29 and 0.30 for State and Trait anxiety scores, respectively [norms taken from (61)]. No significant correlations were observed between STAI indices and AQ subscale score change among any of the study groups. Comparing the year-end GPAs between the groups revealed no significant differences (see Table 1).

3.2. AQ and academic performance

A correlation analysis between change in AQ subscale scores (T1-T2) and year-end GPA was conducted separately for each group (Table 4). Only for the Autism group was a significant negative association observed between GPA and a reduction in AQ Social Skills, Communication, and Imagination subscale scores, meaning that a larger decrease from T1 to T2 in these AQ subscale scores were associated with a lower GPA.

3.3. Predictive values of participant characteristics and baseline levels of psychiatric symptoms

Finally, we examined the predictive value of participant characteristics on change in the AQ subdomain scores (T1-T2) after one academic year. No multicollinearity was observed between the regression predictive variables (all VIF's < 1.8). The regression analysis with T1-T2 AQ Communication subscale scores as the dependent variable is presented in Table 5. In the final model, explaining 27.8% of the variance, older age and an autism diagnosis

TABLE 5 Linear regression analysis for AQ Communication subscale score.

Variable	B	SE	β	R²	ΔR²
Step 1					
Age	0.39	0.23	0.20	0.04	
Sex	0.07	0.77	0.10		
Step 2					
Age	**0.56**	**0.22**	**0.29***	0.17*	0.13*
Sex	1.08	0.75	0.16		
Autism diagnosis	**1.64**	**0.51**	**0.37****		
T1 LSAS	−0.18	0.26	−0.08		
Step 3				. 20*	0.02
Age	**0.57**	**0.22**	**0.30***		
Sex	1.03	0.75	0.15		
Autism diagnosis	**1.98**	**0.63**	**0.44****		
T1 LSAS	−0.06	0.27	−0.02		
T1 BDI-II	−0.30	0.28	0.13		
T1 Y-BOCS II Comp	−0.15	0.32	−0.07		
Step 4				0.28**	0.09**
Age	**0.67**	**0.21**	**0.35***		
Sex	0.93	0.71	0.14		
Autism diagnosis	**2.56**	**0.64**	**0.59****		
T1 LSAS	−0.02	0.26	−0.00		
T1 BDI-II	−0.34	0.27	−0.15		
T1 Y-BOCS-II Comp	0.41	0.36	0.20		
Autism diagnosis * T1 Y-BOCS-II Comp	**−1.67**	**0.59**	**−0.48****		

T1 LSAS, Time 1 Liebowitz Social Anxiety Scale total score; T1 BDI–II, Time 1 Beck Depression Inventory II; T1 Y-BOCS-II Comp, Time 1 Yale–Brown Obsessive–Compulsive Scale II Compulsion score. *$p < 0.05$, **$p < 0.01$.

were associated with greater reduction in AQ Communication scores (T1-T2).

Additionally, a T1 Y-BOCS-II Compulsion*Autism Diagnosis interaction was negatively associated with AQ Communication score decrease, such that a higher level of compulsive symptoms at T1 among autistic students was associated with a lesser reduction in AQ communication scores at T2. The interaction according to the regression equation is depicted in Figure 3.

In addition, two significant regression models were obtained for AQ Attention Switching ($R^2 = 0.64$ $p < 0.001$) and Attention to Detail ($R^2 = 0.66$, $p < 0.001$) subdomain scores as dependent variables. For both subscales in the final model, older age and an autism diagnosis were associated with greater reduction in these AQ subscale scores after one academic year at the university. No other significant models were observed.
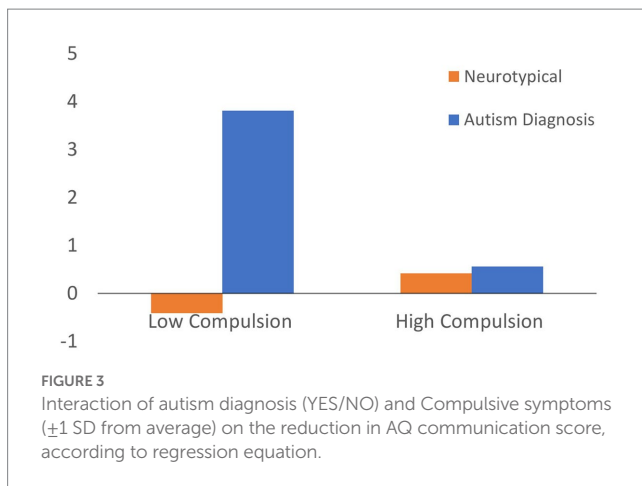
4. Discussion

The main aim of this study was to explore whether there is change in autistic students' self-reported autistic traits while attending university. We observed a robust decrease (over two standard deviations in three out of five AQ subscales) in autism trait levels as reported by the autistic students after attending

university for one academic year. Autistic trait reporting is considered reliable and has demonstrated relative stability over time among autistic individuals as well as among the general population (1, 62–65).

While previous research has linked AQ scores and other mental factors such as anxiety (66, 67), depressive symptoms (36, 37), or mental distress (39), the reduction in autism traits found in this study cannot be explained by alteration in these factors, anxiety in particular. This conclusion is derived from the following study findings: (1) changes in trait and state anxiety did not correlate with any AQ subscale score change; (2) anxiety and depression levels at T1 were not associated with reduced AQ scores at T2; and (3) among autistic students, the decrease in their AQ scores (~2.0 SD) was far more striking than their reduction in state/trait anxiety (~0.30 SD in STAI scores).

Our finding of a robust reduction in autistic traits among students with autism could be explained by changes in cognitive factors, in particular attention. Among the Autism group (as well as the entire sample) the effect size for the change over time in the AQ Attention Switching subscale was the largest. Both the AQ Attention Switching and Attention to Detail subscales are measured through items that directly relate to attentional abilities ("In a social group I can easily keep track of several different people conversations"; "I often notice small sounds when others

FIGURE 3
Interaction of autism diagnosis (YES/NO) and Compulsive symptoms (± 1 SD from average) on the reduction in AQ communication score, according to regression equation.

do not"). Thus, a possible interpretation of the robust autistic trait reduction is that it actually reflects change in cognitive abilities (attention in particular) expressed in the individual's self-reported AQ score. Indeed, atypical attention patterns are common among autistic individuals (68) particularly in deploying attention from one stimulus to another (attention switching) (69–73). Accordingly, repeated elevated levels of social interaction afforded during 1 year of participating in the university's integration program may have demanded more attention switching and were followed by improved attentional abilities, reflected in the students' reports on the AQ. However, changes in other domains of autism traits were also reported by the students, perhaps indicating that change in the reported levels of autism traits cannot be explained solely by improved attention switching. Another plausible explanation relates to reduced meta-cognition in autism, particularly meta-cognition regarding self-representation (74): possibly, the autistic students' self-perceptions of their level of autistic traits (as opposed to an objective assessment of their autism trait levels) simply changed following the intense social interactions inherent to attending university. However, the notion that the change reflects only a subjective, possibly biased perception is undermined by the finding of a significant association between autism trait reduction and GPA, a more objective measure of performance. Future studies should methodically and directly examine these possibilities, as they were not directly examined in this study.

The extensive reduction observed in the Communication subdomain of the AQ was associated with an autism diagnosis. However, this reduction was less profound among autistic students reporting high baseline levels of compulsion. The moderating effect of compulsion could be related to impaired extinction processes or, alternatively, to reduced social cognition, both previously associated with obsessive compulsive symptoms (75, 76).

As noted above, autistic students' self-reported decrease in AQ scores was correlated with an objective measure, namely their grade point average at the end of the academic year. Previous studies have reported contrasting findings, with one study reporting a positive association (43) while another reporting a negative association (38) between autism traits and academic performance. Future studies should further examine these issues.

Although a statistically significant effect of time on autism traits was found for the ND groups, a close inspection of the findings suggests this reduction had small meaning in the clinical sense. According to Baron-Cohen et al. (1) the average AQ score for male student is 18.6 (SD 6.6) In this study, AQ scores reduced from 17.08 to 13.56 and from 19.20 to 15.68 from T1 to T2 in the Low and High social anxiety symptoms groups, respectively. This finding indicated the existence of small fluctuations in AQ scores among ND students, but this reduction was relatively small and within the normal range of AQ scores. For both ND groups, the AQ scores at both timepoints were within non-clinical range. Previous research has demonstrated such reductions and associated them with reduction in anxiety, among ND students (39). Future studies should examine changes in AQ scores among ND students.

This study, one of a small number of follow-up studies on university students with autism, has various strengths, including the participation of a relatively large group of university students with autism, a population with the highest potential for achieving independent living yet rarely examined in research. The use of standardized measures of psychopathology symptoms is an additional study strength. The novelty of this study includes its two control groups of ND students, and the comparison between autistic trait levels and self-reported psychopathology symptoms among university students over a relatively prolonged period (one academic year).

Notwithstanding the novel findings, the study has limitations. These include the infeasibility of a control group of autistic students not participating in the university's integration program, as all students identifying as autistic chose to participate in it. Accordingly, it is difficult to isolate the major factor affecting the decrease in autism traits among the autistic students. Thus, to a certain extent, the generalizability of the findings may compromised, making them more applicable to autistic students participating in a university support/transition programs. Future studies should compare autistic students participating in support/transition programs to those who do not, and to those attending alternative post-secondary vocational or academic pursuits. Additionally, since it is also possible that behavioral changes (more social interaction) may underlie the reduction in autism traits, future studies are advised to monitor such changes. Another study limitation relates to the fact that measures of autism traits, anxiety, and depression were obtained by self-report questionnaires; diagnostic interviews conducted by mental health professionals are preferable for future studies. Further, participants in the high social anxiety group demonstrated what may be considered moderate levels of social anxiety symptoms and future studies are encouraged to study participants with even higher levels of social anxiety symptoms. Lastly, the male to female ratio of 39:2 among the autistic students is higher than the typically reported 4:1 male to female ratio in autism (77, 78), so future studies should attempt to include higher rates of females and achieve more balanced male/female ratios in all study groups.

The current study findings have important theoretical and clinical implications. Previous autism research and clinical effort reporting improvement in outcomes among toddlers was interpreted as due to increased brain plasticity during early development (79, 80). However, the current finding suggests the possibility of robust change during the young adulthood of autistic individuals too. The potentially dramatic lifestyle changes evoked by entering post-secondary education may lead to greater mental health problems (81) but simultaneously may also facilitate processes that accelerate acclimation and improvement

in core symptoms. Our findings suggest that autism traits, as measured by the AQ, may be more malleable than conventionally thought. Further studies are needed to better characterize possible alterations in autistic traits over time, as an expression of the broader autistic phenotype, when autistic individuals transition to university and generally over their lifetime.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by The University of Ariel Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

References

1. Baron-Cohen S, Wheelwright S, Skinner R, Martin J, Clubley E. The autism-spectrum quotient (AQ): evidence from Asperger syndrome/high-functioning autism, males and females, scientists and mathematicians. *J Autism Dev Disord*. (2001) 31:5–17. doi: 10.1023/a:1005653411471

2. Spielberger CD, Gorsuch RL. *Manual for the state trait anxiety inventory*. *Rev.* ed. Palo Alto, CA: Consulting Psychologists Press (1983).

3. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders*. Washington, DC: American Psychiatric Association. 5th ed (2013).

4. Maenner MJ, Shaw KA, Baio J, EdS1Washington A, Patrick M, et al. Prevalence of autism Spectrum disorder among children aged 8 years — autism and developmental disabilities monitoring network, 11 sites, United States, 2016. *MMWR Surveill Summ*. (2020) 69:1–12. doi: 10.15585/mmwr.ss6904a1

5. Christensen DL, Bilder DA, Zahorodny W, Pettygrove S, Durkin MS, Fitzgerald RT, et al. Prevalence and characteristics of autism spectrum disorder among 4-year-old children in the autism and developmental disabilities monitoring network. *J Dev Behav Pediatr*. (2016) 37:1–8. doi: 10.1097/DBP.0000000000000235

6. Gurbuz E, Hanley M, Riby DM. University students with autism: the social and academic experiences of university in the UK. *J Autism Dev Disord*. (2019) 49:617–31. doi: 10.1007/s10803-018-3741-4

7. Cage E, Howes J. Dropping out and moving on: a qualitative study of autistic people's experiences of university. *Autism*. (2020) 24:1664–75. doi: 10.1177/1362361320918750

8. Jackson SLJ, Hart L, Volkmar FR. Preface: special issue-college experiences for students with autism Spectrum disorder. *J Autism Dev Disord*. (2018) 48:639–42. doi: 10.1007/s10803-018-3463-7

9. Jansen D, Emmers E, Petry K, Mattys L, Noens I, Baeyers D. Functioning and participation of young adults with ASD in higher education according to the ICF framework. *J Furth High Educ*. (2016) 42:259–75. doi: 10.1080/0309877X.2016.1261091

10. Lei J, Calley S, Brosnan M, Ashwin C, Russell A. Evaluation of a transition to university Programme for students with autism Spectrum disorder. *J Autism Dev Disord*. (2020) 50:2397–411. doi: 10.1007/s10803-018-3776-6

11. Howlin P, Magiati I. Autism spectrum disorder: outcomes in adulthood. *Curr Opin Psychiatry*. (2017) 30:69–76. doi: 10.1097/YCO.0000000000000308

12. Lever AG, Geurts HM. Psychiatric co-occurring symptoms and disorders in young, middle-aged, and older adults with autism Spectrum disorder. *J Autism Dev Disord*. (2016) 46:1916–30. doi: 10.1007/s10803-016-2722-8

13. Moss P, Howlin P, Savage S, Bolton P, Rutter M. Self and informant reports of mental health difficulties among adults with autism findings from a long-term follow-up study. *Autism*. (2015) 19:832–41. doi: 10.1177/1362361315585916

14. Zukerman G, Yahav G, Ben-Itzchak E. Increased psychiatric symptoms in university students with autism spectrum disorder are associated with reduced adaptive behavior. *Psychiatry Res*. (2019) 273:732–8. doi: 10.1016/j.psychres.2019.01.098

15. Zukerman G, Yahav G, Ben-Itzchak E. Diametrically opposed associations between academic achievement and social anxiety among university students with and without autism spectrum disorder. *Autism*. (2019) 12:1376–85. doi: 10.1002/aur.2129

16. Zukerman G, Yahav G, Ben-Itzchak E. Adaptive behavior and psychiatric symptoms in university students with autism: one-year longitudinal study. *Psychiatry Res*. (2022) 315:114701. doi: 10.1016/j.psychres.2022.114701

17. Hossain B, Bent S, Hendren R. The association between anxiety and academic performance in children with reading disorder: a longitudinal cohort study. *Dyslexia*. (2021) 27:342–54. doi: 10.1002/dys.1680

18. Negreiros J, Belschner L, Selles RR, Lin S, Stewart SE. Academic skills in pediatric obsessive-compulsive disorder: a preliminary study. *Ann Clin Psych*. (2018) 30:185–95.

19. Eagan K, Stolzenberg EB, Zimmerman HB, Aragon MC, Whang Sayson H, Rios-Aguilar C. *The American freshman: National Norms Fall 2016*. *Expanded* ed UCLA's Higher Education Research Institute (2016). https://www.heri.ucla.edu/monographs/TheAmericanFreshman2016.pdf

20. Barnhill GP. Supporting students with Asperger syndrome on college campuses: current practices. *Focus Autism Other Dev Disabil*. (2016) 31:3–15. doi: 10.1177/1088357614523121

21. Nachman BR, McDermott CT, Cox BE. Brief report: autism-specific college support programs: differences across geography and institutional type. *J Autism Dev Disord*. (2022) 52:863–70. doi: 10.1007/s10803-021-04958-1

22. Capriola-Hall NN, Brewe AM, Golt J, White SW. Anxiety and depression reduction as distal outcomes of a college transition readiness program for adults with autism. *J Autism Dev Disord*. (2021) 51:298–306. doi: 10.1007/s10803-020-04549-6

23. Gillespie-Lynch K, Bublitz D, Donachie A, Wong V, Brooks PJ, D'Onofrio J. "for a long time our voices have been hushed": using student perspective to develop support for neurodiverse college students. *Front Psychol*. (2017) 8:544. doi: 10.3389/fpsyg.2017.00544

24. Hillier A, Goldstein J, Murphy D, Trietsch R, Keeves R, Mandes E, et al. Supporting university students with autism spectrum disorders. *Autism*. (2018) 22:20–8. doi: 10.1177/1362361317699584

25. White SW, Elias R, Capriola-Hall NN, Smith IC, Conner CM, Asselin SB, et al. Development of a college transition and support program for students with autism Spectrum disorder. *J Autism Dev Disord*. (2017) 47:3072–8. doi: 10.1007/s10803-017-3236-8

26. Ben-Itzchak E, Watson LR, Zachor DA. Cognitive ability is associated with different outcome trajectories in autism spectrum disorders. *J Autism Dev Disord*. (2014) 44:2221–9. doi: 10.1007/s10803-014-2091-0

27. Sinai-Gavrilov Y, Gev T, Mor-Snir I, Vivanti G, Golan O. Integrating the early start Denver model into Israeli community autism spectrum disorder preschools: effectiveness and treatment response predictors. *Autism*. (2020) 24:2081–93. doi: 10.1177/1362361320934221

28. Dawson JF. Moderation in management research: what, why, when, and how. *J Bus Psychol*. (2014) 31:3–15. doi: 10.1177/1088357614523121

29. Johnson MH, Munakata Y. Processes of change in brain and cognitive development. *Trends Cogn Sci*. (2005) 9:152–8. doi: 10.1016/j.tics.2005.01.009

30. Zwaigenbaum L, Bauman ML, Choueiri R, Kasari C, Carter A, Granpeesheh D, et al. Early intervention for children with autism Spectrum disorder under 3 years of age: recommendations for practice and research. *Pediatrics*. (2015) 136:S60–81. doi: 10.1542/peds.2014-3667E

31. Hurley RSE, Losh M, Parlier M, Reznick JS, Piven J. The broad autism phenotype questionnaire. *J Autism Dev Disord*. (2007) 37:1679–90. doi: 10.1007/s10803-006-0299-3

32. Polderman TJC, Hoekstra RA, Vinkhuyzen AAE, Sullivan PF, van der Sluis S, Posthuma D. Attentional switching forms a genetic link between attention problems and autistic traits in adults. *Psychol Med*. (2013) 43:1985–96. doi: 10.1017/S0033291712002863

33. Zhang L, Sun Y, Chen F, Wu D, Tang J, Han X, et al. Psychometric properties of the autism-Spectrum quotient in both clinical and non-clinical samples: Chinese version for mainland China. *BMC Psychiatry*. (2016) 16:213. doi: 10.1186/s12888-016-0915-5

34. Lundqvist LO, Lindner H. Is the autism-Spectrum quotient a valid measure of traits associated with the autism Spectrum? A Rasch validation in adults with and without autism Spectrum disorders. *J Autism Dev Disord*. (2017) 47:2080–91. doi: 10.1007/s10803-017-3128-y

35. Horder J, Wilson CE, Mendez MA, Murphy DG. Autistic traits and abnormal sensory experiences in adults. *J Autism Dev Disord*. (2014) 44:1461–9. doi: 10.1007/s10803-013-2012-7

36. Kunihira Y, Senju A, Dairoku H, Wakabayashi A, Hasegawa T. "Autistic" traits in non-autistic Japanese populations: relationships with personality traits and cognitive ability. *J Autism Dev Disord*. (2006) 36:553–66. doi: 10.1007/s10803-006-0094-1

37. Kurita H, Koyama T. Autism-Spectrum quotient Japanese version measures mental health problems other than autistic traits. *Psychiatry Clin Neurosci*. (2006) 60:373–8. doi: 10.1111/j.1440-1819.2006.01516.x

38. Suzuki T, Wada K, Muzembo BA, Ngatu NR, Yoshii S, Ikeda S. Autistic and attention deficit/hyperactivity disorder traits are associated with suboptimal performance among Japanese university students. *JMA Journal*. (2020) 3:216–31. doi: 10.31662/jmaj.2020-0001

39. Kitazoe N, Inoue S, Izumoto Y, Kumagai N, Iwasaki Y. The autism-Spectrum quotient in university students: pattern of changes in its scores and associated factors. Asia Pac. *Psychiatry*. (2015) 7:105–12. doi: 10.1111/appy.12094

40. Kuusikko S, Pollock-Wurman R, Jussila K, Carter AS, Mattila ML, Ebeling H, et al. Social anxiety in high-functioning children and adolescents with autism and Asperger syndrome. *J Autism Dev Disord*. (2008) 38:1697–709. doi: 10.1007/s10803-008-0555-9

41. Spain D, Zıvralı Yarar E, Happé F. Social anxiety in adults with autism: a qualitative study. *Int J Qual Stud Health Well-being*. (2020) 15:1–15. doi: 10.1080/17482631.2020.1803669

42. Kraper CK, Kenworthy L, Popal H, Martin A, Wallace GL. The gap between adaptive behavior and intelligence in autism persists into young adulthood and is linked to psychiatrics co-morbidities. *J Autism Dev Disord*. (2017) 47:3007–17. doi: 10.1007/s10803-017-3213-2

43. Huang W, Zhang L, Sun Y, Chen F, Wang K. The prediction analysis of autistic and schizotypal train attentional networks. *Psychiatry Investig*. (2021) 18:417–25. doi: 10.30773/pi.2020.0251

44. Wei X, Yu JW, Shattuck P, McCracken M, Blackorby J. Science, technology, Engineering & Mathematics (STEM) participation among college students with autism Spectrum disorder. *J Autism Dev Disord*. (2013) 43:1539–46. doi: 10.1007/s10803-012-1700-z

45. von Glischinski M, Willutzki U, Stangier U, Hiller W, Hoyer J, Leibing E, et al. Liebowitz social anxiety scale (LSAS): optimal cut points for remission and response in a German sample. *Clin Psychol Psychother*. (2018) 25:465–73. doi: 10.1002/cpp.2179

46. Mennin DS, Fresco DM, Heimberg RG, Schneier FR, Davies SO, Liebowitz MR. Screening for social anxiety disorder in the clinical setting: using the Liebowitz social anxiety scale. *J Anxiety Disord*. (2002) 16:661–73. doi: 10.1016/s0887-6185(02)00134-2

47. Rytwinski NK, Fresco DM, Heimberg RG, Coles ME, Liebowitz MR, Cissell S, et al. Screening for social anxiety disorder with the self-report version of the Liebowitz social anxiety scale. *Depress Anxiety*. (2009) 26:34–8. doi: 10.1002/da.20503

48. Woodbury-Smith MR, Robinson J, Wheelwright S, Baron-Cohen S. Screening adults for Asperger syndrome using the AQ: a preliminary study of its diagnostic validity in clinical practice. *J Autism Dev Disord*. (2005) 35:331–5. doi: 10.1007/s10803-005-3300-7

49. Beard C, Rodriguez BF, Moitra E, Sibrava NJ, Bjornsson A, Weisberg RB, et al. Psychometric properties of the Liebowitz social anxiety scale (LSAS) in a longitudinal study of African Americans with anxiety disorders. *J Anxiety Disord*. (2011) 25:722–6. doi: 10.1016/j.janxdis.2011.03.009

50. Liebowitz MR. Social phobia. Mod. Probl. *Pharmacopsychiatry*. (1987) 22:141–73. doi: 10.1159/000414022

51. Baker SL, Heinrichs N, Kim HJ, Hofmann SG. The Liebowitz social anxiety scale as a self-report instrument: a preliminary psychometric analysis. *Behav Res Ther*. (2002) 40:701–15. doi: 10.1016/s0005-7967(01)00060-2

52. Beck AT, Steer RA, Brown GK. *Manual for the Beck depression inventory-II*. San Antonio, TX: Psychological Corporation (1996).

53. Dozois DJA, Dobson KS, Ahnberg JL. A psychometric evaluation of the Beck depression inventory–II. *Psychol Assess*. (1998) 10:83–9. doi: 10.1037/1040-3590.10.2.83

54. Goodman WK, Price LH, Rasmussen SA, Mazure C, Delgado P, Heninger GR, et al. The Yale-Brown obsessive compulsive scale II. *Validity Arch Gen Psychiatry*. (1989) 46:1012–6. doi: 10.1001/archpsyc.1989.01810110054008

55. Deacon BJ, Abramowitz JS. Patients' perceptions of pharmacological and cognitive-behavioral treatment for anxiety disorders. *Behav Ther*. (2005) 36:139–45. doi: 10.1016/S0005-7894(05)80062-0

56. Gustafson LW, Gabel P, Hammer A, Lauridsen HH, Petersen LK, Andersen B, et al. Validity and reliability of state-trait anxiety inventory in Danish women aged 45 years and older with abnormal cervical screening results. *BMC Med Res Methodol*. (2020) 20:89. doi: 10.1186/s12874-020-00982-4

57. IBM Corp. (2013). IBM SPSS Statistics for Windows. *IBM Corp*. Canberra.

58. Templeton GF, Burney LL. Using a two-step transformation to address non-normality from a business value of information technology perspective. *J Inf Syst*. (2017) 31:149–64. doi: 10.2308/isys-51510

59. Kim H-Y. Statistical notes for clinical researchers: assessing normal distribution (2) using skewness and kurtosis. *Restor Dentist Endodon*. (2013) 38:52–4. doi: 10.5395/rde.2013.38.1.52

60. Benjamini Y, Hochberg Y. Controlling the false discovery rate: a practical and powerful approach to multiple testing. *J R Statis Soc Series B (Methodol.)*. (1995) 57:289–300. doi: 10.1111/j.2517-6161.1995.tb02031.x

61. Kontoangelos K, Tsiori S, Koundi K, Pappa X, Sakkas P, Papageorgiou CC. Greek college students and psychopathology: new insights. *Int J Environ Res Public Health*. (2015) 12:4709–25. doi: 10.3390/ijerph120504709

62. Constantino JN, Abbacchi AM, Lavesser PD, Reed H, Givens L, Chiang L, et al. Developmental course of autistic social impairment in males. *Dev Psychopathol*. (2009) 21:127–38. doi: 10.1017/S095457940900008X

63. Robinson EB, Munir K, Munaf MR, Hughes M, McCormick MC, Koenen KC. Stability of autistic traits in the general population: further evidence for a continuum of impairment. *J Am Acad Child Adolesc Psychiatry*. (2011) 50:376–84. doi: 10.1016/j.jaac.2011.01.005

64. Taylor MJ, Gillberg C, Lichtenstein P, Lundström S. Etiological influences on the stability of autistic traits from childhood to early adulthood: evidence from a twin study. *Mol Autism*. (2017) 8:1–9.

65. Whitehouse AJO, Hickey M, Ronald A. Are autistic traits in the general population stable across development? *PLoS One*. (2011) 6:e23029. doi: 10.1371/journal.pone.0023029

66. Amos GA, Byrne G, Chouinard PA, Godber T. Autism traits, sensory over-responsivity, anxiety, and stress: a test of explanatory models. *J Autism Dev Disord*. (2019) 49:98–112. doi: 10.1007/s10803-018-3695-6

67. Austin EJ. Personality correlates of the broader autism phenotype as assessed by the autism Spectrum quotient (AQ). *Pers Individ Dif*. (2005) 38:451–60. doi: 10.1016/j.paid.2004.04.022

68. Mottron L, Dawson M, Soulières I, Hubert B, Burack J. Enhanced perceptual functioning in autism: an update, and eight principles of autistic perception. *J Autism Dev Disord*. (2006) 36:27–43. doi: 10.1007/s10803-005-0040-7

69. Abu-Akel A, Testa RR, Jones HP, Ross N, Skafidas E, Tonge B, et al. Attentional set-shifting and social abilities in children with schizotypal and comorbid autism spectrum disorders. *Aust N Z J Psychiatry*. (2018) 52:68–77. doi: 10.1177/0004867417708610

70. Crivello C, Grossman S, Poulin-Dubois D. Specifying links between infants' theory of mind, associative learning, and selective trust. *Infancy*. (2021) 26:664–85. doi: 10.1111/infa.12407

71. Reed P, McCarthy J. Cross-modal attention-switching is impaired in autism spectrum disorders. *J Autism Dev Disord*. (2012) 42:947–53. doi: 10.1007/s10803-011-1324-8

72. Skewes JC, Kemp T, Paton B, Hohwy J. How are attention, learning, and social cognition related on the non-clinical autistic spectrum? *Acta Psychol*. (2020) 210:103157. doi: 10.1016/j.actpsy.2020.103157

73. Skripkauskaite S, Slade L, Mayer J. Attentional shifting differences in autism: domain general, domain specific or both? *Autism*. (2021) 25:1721–33. doi: 10.1177/13623613211001619

74. Zinck A, Frith U, Schönknecht P, White S. Knowing me, knowing you: spontaneous use of mentalistic language for self and other in autism. *Autism*. (2021) 25:164–75. doi: 10.1177/1362361320951017

75. Cooper SE, Dunsmoor JE. Fear conditioning and extinction in obsessive-compulsive disorder: a systematic review. *Neurosci Biobehav Rev*. (2021) 129:75–94. doi: 10.1016/j.neubiorev.2021.07.026

76. Tulacı RG, Cankurtaran EŞ, Özdel K, Öztürk N, Kuru E, Özdemir İ. The relationship between theory of mind and insight in obsessive-compulsive disorder. *Nord J Psychiatry*. (2018) 72:273–80. doi: 10.1080/08039488.2018.1436724

77. Fombonne E, Quirke S, Hagen A. Epidemiology of pervasive developmental disorders In: DG Amaral, G Dawson and DH Geschwind, editors. *Autism Spectrum disorders*. Oxford, USA: Oxford University Press (2011). 90–111.

78. Loomes R, Hull L, Mandy WPL. What is the male to female ratio in autism Spectrum disorder? A systematic review and meta-analysis. *J Am Acad Child Adolesc Psychiatry*. (2017) 56:466–74. doi: 10.1016/j.jaac.2017.03.013

79. Dawson G. Early behavioral intervention, brain plasticity, and the prevention of autism spectrum disorder. *Dev Psychopathol*. (2008) 20:775–803. doi: 10.1017/S0954579408000370

80. Fuller EA, Oliver K, Vejnoska SF, Rogers SJ. The effects of the early start Denver model for children with autism Spectrum disorder: a meta-analysis. *Brain Sci*. (2020) 10:368. doi: 10.3390/brainsci10060368

81. Bruffaerts R, Mortier P, Kiekens G, Auerbach RP, Cuijpers P, Demyttenaere K, et al. Mental health problems in college freshmen: prevalence and academic functioning. *J Affect Disord*. (2018) 225:97–103. doi: 10.1016/j.jad.2017.07.044