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The mediating effect of trauma and stressor related symptoms and ruminations on the relationship between autistic traits and mood spectrum

Liliana Dell'Osso[a], Barbara Carpita[a,*], Ivan Mirko Cremone[a], Dario Muti[a], Elisa Diadema[a], Filippo Maria Barberi[a], Gabriele Massimetti[a], Natascia Brondino[b], Beatrice Petrosino[c], Pierluigi Politi[b], Eugenio Aguglia[c], Primo Lorenzi[d], Claudia Carmassi[a], Camilla Gesi[a]

[a] Department of Clinical and Experimental Medicine, University of Pisa, Italy
[b] Department of Brain and Behavioral Sciences, University of Pavia, via Bassi 21, Pavia 27100, Italy
[c] Department of Clinical and Experimental Medicine, Psychiatry Unit, University of Catania, Catania, Italy
[d] Clinical Psychology and Psychotherapy, University of Florence, Careggi Hospital, Florence, Italy

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ABSTRACT

An increasing number of studies highlighted significant correlations between autistic traits (AT) and mood spectrum symptoms. Moreover, recent data showed that individuals with high AT are likely to develop trauma and stressor-related disorders. This study aims to investigate the relationship between AT and mood symptoms among university students, focusing in particular on how AT interact with ruminations and trauma-related symptomatology in predicting mood symptoms. 178 students from three Italian Universities of excellence were assessed with The Structured Clinical Interview for DSM-5 (SCID-5), the Adult Autism Subthreshold Spectrum (AdAS Spectrum), the Ruminative Response Scale (RRS), the Trauma and Loss Spectrum (TALS) and the Moods Spectrum (MOODS). Considering the AdAS Spectrum total scores, 133 subjects (74.7%) were categorized as "low scorers" and 45 subjects (25.3%) as "high scorers". Students in the high scorer group showed significantly higher scores on RRS, TALS-SR and MOOD-SR total scores. Total and direct effects of AdAS Spectrum total score on MOODS-SR total score were both statistically significant. AdAS Spectrum total score also showed a significant indirect effect on MOODS-SR total score through TALS and RRS total scores. Results showed a significant relationship between AT and mood spectrum, which is partially mediated by ruminations and trauma/stressor-related symptomatology.

1. Introduction

The Broad Autism Phenotype (Billeci et al., 2016; Dell'Osso et al., 2016a, b; Losh et al., 2009; Losh et al., 2008; Taylor et al., 2017) has been conceptualized to describe milder manifestations of autism, such as impaired social and communication skills, unusual aloof personality, repetitive and stereotyped behaviors, frequently found among unaffected relatives of people with Autism Spectrum Disorder (ASD). Parallel, subthreshold manifestations of autism have been shown to be variously distributed in some high risk groups from the general populations (Choteau et al., 2016; Dell'Osso et al., 2017; Skylark and Baron-Cohen, 2017; Suzuki et al., 2017), as well as highly prevalent in a broad variety of clinical groups, including patients with eating disorders, major depression, suicidal behavior, borderline personality disorder (Dell'Osso et al., 2018a, b, 2015a; Takara and Kondo, 2014a; Tchanturia et al., 2013), where they are usually referred to as autistic traits (AT).

The specific interest in exploring AT lies in the fact that they seem to interfere with overall functioning, and they may be, according to a growing number of studies, a significant risk factor for developing clinical symptoms, as well as suicidal ideation (Dell'Osso et al., 2016a, b). While the role of AT in affecting the development of personality has been long debated in literature (Anckarsäter et al., 2006), several data suggest that they may also represent a vulnerability factor for developing many other disorders. In particular, robust data highlight a significant correlation between AT and mood disorders (Kanne et al., 2009; Kunihira et al., 2006; Liu et al., 2017; Matsuo et al., 2015; Pine et al., 2008; Towbin et al., 2005) which is also consistent with findings about the clinical forms of ASD, that show a high prevalence of depressive disorders among ASD patients (Hofvander et al., 2009) as well as a significant caseness for ASD among patients referring for depression (Takara and Kondo, 2014b). Parallel, subjects with ASD have been

* Corresponding author.
E-mail address: barbara.carpita1986@gmail.com (B. Carpita).

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shown to have high levels of adjustment disorder, which may also relate to greater suicidality (Kato et al., 2013), and recent data showed an association between AT and Post-Traumatic Stress Disorder (PTSD) (Roberts et al., 2015), suggesting that the autistic dimension may also relate to the entire spectrum of trauma and stress-related conditions. Interestingly, some authors also pointed out a crucial role of rumination, which typically occurs within AT (Dell'Osso et al, 2016a, b), in the development of PTSD in the aftermath of a traumatic event, due to the impairment caused by repetitive thinking in processing stressful experiences (Ben-Sasson et al., 2008; Carmassi et al., 2017; Ehlers and Clark, 2000; Foley Nicpon et al., 2010; Lecavalier et al., 2011). In this framework, a possible explanation of the relationship between AT and mood disorders might be that subjects with AT may be prone to developing affective symptoms following the exposure to life stressors, due their impaired ability to cope with environmental changes and to stressful situations (APA, 2013; Kanne et al., 2009). Along with this hypothesis, subjects with high AT could be likely to develop mood symptoms as part of a stress response, with life stressors and their related symptoms mediating the association with mood symptoms. Stress/trauma-related symptoms may be involved also in the reported increased prevalence of suicidal ideation in subjects with AT (Kato et al., 2013). Some authors highlighted in fact the presence of an unrecognised adjustment disorder in patients with high levels of AT and with suicidal behaviours (Takara and Kondo, 2014a). Moreover, in a study by Storch et al. (2013), conducted in a sample of young patients with ASD, authors reported a 11% prevalence of suicidal thoughts and behaviours, which were associated with the presence of PTSD and depressive disorders.

Despite the raising attention to AT in recent literature, no study has so far investigated the relationship between AT and mood spectrum symptoms, paying attention to post-traumatic dimension and to rumination. Clarifying this relationship may add knowledge to both ASD and mood psychopathology, and in particular may shed some light on how AT could act as a risk factor for developing other psychiatric conditions, as suggested by previous literature (Dell'Osso et al., 2016a, b). University students may represent a convenience population to evaluate the relationship between AT and other psychopathological dimensions. According to a large amount of data, in fact, AT are highly distributed among university students, especially those enrolled in high ranking universities, which use selective admission standards to enroll students with great academic aptitude (Baron-Cohen et al., 2001; Choteau et al., 2016; Dell'Osso et al., 2018c, 2016c; Pisula et al., 2013; Shi et al., 2017; Sierro et al., 2016; Stevenson and Hart, 2017; Trevisan and Birmingham, 2016; Wakabayashi et al., 2006). Moreover, university students are exposed to great levels of stress (Garlow et al., 2008) and mostly belong to the age range in which many mental disorders have first onset or peak in prevalence (Blanco et al., 2008; Eisenberg et al., 2013; Tupler et al., 2015). Of note, students have often shown a high prevalence of social anxiety symptoms, which can be the most prominent and/or a frequent associated feature of ASD, especially in female gender (Attwood, 2006; Attwood et al., 2006; Clark, 2010; Dell'Osso et al., 2015b; Dell'Osso et al., 2014, 2002a; Jobe and White, 2007; Marazziti et al., 2015, 2014; White et al., 2011).

The aim of the present study is thus to investigate the relationship between autistic traits and mood symptoms in a university student population, with a special focus on how autistic traits interact with rumination and trauma/stressor-related symptomatology in predicting mood symptoms. Based on previous research (Carmassi et al., 2015; Dell'Osso et al., 2012; Takara and Kondo, 2014b; Roberts et al., 2015; Stratta et al., 2016), we hypothesize (1) that a strong link will exist between autistic traits and mood symptoms, and (2) that trauma and stressor-related symptoms will be a mediating factor between autistic traits and mood symptoms.

2. Methods

A sample of 178 students was recruited from three Universities of excellence in Italy: the “Scuola Superiore Sant'Anna” (Pisa), the “Collegio Universitario di Merito” (Pavia) and the “Scuola Superiore di Catania” (Catania). All the three schools are included among the “Superior Graduate Schools” of Italy, that offer advanced training and research through university-type courses after passing highly selective entry tests. All students that agreed to participate were assessed with The Structured Clinical Interview for DSM-5 (SCID-5) to evaluate the presence of mental disorders according to DSM-5 criteria; in addition, students were asked to fulfill the following questionnaires in self-report: the Ruminative Response Scale (RRS), the Trauma and Loss spectrum (TALS), the Moods Spectrum (MOODS) and the Adult Autism Subthrehsold Spectrum (AdAS Spectrum). All participants received clear information about the study and had the opportunity to ask questions before they provided a written informed consent. The study was conducted in accordance with the Declaration of Helsinki; the Ethics Committee of the Azienda Ospedaliero-Universitaria of Pisa approved all recruitment and assessment procedures.

2.1. Measures

In addition to the Structured Clinical Interview for DSM-5 (First et al., 2015), in this study we employed a set of instruments (namely the AdAS Spectrum, the MOODS-SR and the TALS-SR) developed and validated in the framework of the international research network called Spectrum Project (Carmassi et al., 2013; Cassano et al., 1999; Dell' Osso et al., 2016a, b, d; Dell'Osso et al., 2014, 2011, 2002b; Fagiolini et al., 1999; Frank et al., 1998). Applying a spectrum approach to psychopathology, the spectrum instruments are devised to assess not only the presence of a disorder according to standard psychiatric classification systems, but also the broader spectrum of symptoms, behavioral characteristics and associated features, that may occur to subjects who do not conform to the formal diagnosis. From this perspective, spectrum instruments are not meant to be used as diagnostic tools, but to provide a dimensional assessment of psychopathology, including prodromal, residual and subthreshold conditions.

2.1.1. The adult autism subthreshold spectrum (AdAS spectrum)

The AdAS Spectrum questionnaire has been developed by Dell'Osso et al. (2017), and devised to assess the presence of a broad range of ASD symptoms in adults with normal intelligence and without language impairment. It allows to evaluate a wide array of features, from threshold level ASD to subthreshold and partial forms, down to isolated autistic traits. It is composed of 160 dichotomous items, grouped in seven domains. In the validation study (Dell'Osso et al., 2017) the questionnaire showed an excellent reliability, with a Kuder-Richardson's coefficient of 0.964. Moreover, the AdAS Spectrum demonstrated high correlation with widely used measures of autism, such as the Autism-Spectrum Quotient (Pearson's r correlation = 0.77) and the Ritvo Autism and Asperger Diagnostic Scale 14-item version (Pearson's r correlation 0.83).

2.1.2. Mood spectrum self-report (MOODS-SR), lifetime version

The MOODS-SR is a 161-item questionnaire which assesses a broad spectrum of mood symptoms, from symptom criteria and clinical level mood disorders, to mild manifestations as expressions of subclinical, prodromic, residual and atypical syndromes (Dell'Osso et al., 2002b; Frank et al., 1998). Items are grouped in 3 manic/hypomanic and 3 depressive domains (exploring, in each case, the areas of mood, energy, and cognition). A further domain explores disturbances in rhythmicity and vegetative functions. The questionnaire showed good internal consistency, with a Kuder-Richardson's coefficient ranging from 0.79 to 0.92 among single domains.

Table 1
Comparisons between AdAS Spectrum high and low scorers.

	AdAS Spectrum High scorers (N = 45)	AdAS Spectrum low scorers (N = 133)	t	sig.
TALS total, *(mean ± SD)*	38.86 ± 16.6	23.18 ± 14.5	$t = -5.97$	$p < 0.001$
RRS total, *(mean ± SD)*	54.93 ± 12.08	43.44 ± 10.09	$t = -6.13$	$p < 0.001$
MOODS-SR				
total score, *(mean ± SD)*	96.98 ± 26.6	66.48 ± 24.94	$t = -6.95$	$p < 0.001$
depressive score, *(mean SD)*	54.6 ± 18.86	40.22 ± 17.17	$t = -4.17$	$p < 0.001$
manic score, *(mean ± SD)*	29.68 ± 10.68	18.23 ± 10.18	$t = -6.42$	$p < 0.001$

2.1.3. The trauma and loss spectrum (TALS-SR)

The TALS-SR questionnaire is composed of 116 dichotomous items (grouped in nine domains), assessing stress response symptoms across 3 different dimensions: (1) the dimension of loss events and potentially traumatic events, even of mild/moderate severity; (2) the dimension of the peritraumatic and acute reactions; (3) the dimension of the post-traumatic symptoms(Dell'Osso et al., 2009; Dell'Osso et al., 2008). Using a dimensional approach, the questionnaire is aimed to evaluate not only the full-blown trauma and stressor-related disorders, but also the wide spectrum of symptoms that may follow stressful experiences across the lifetime. In the validation study, all Kuder-Richardson coefficients for TALS-SR exceeded the minimum standard of 0.50, and the instrument demonstrated positive correlations between domains, with Pearson's r ranging from 0.46 to 0.76.

2.1.4. The ruminative response scale (RRS)

The RRS is a 22-item scale assessing the tendency to ruminative thinking. Items are rated on a 4-point Likert scale and investigate ruminations along three dimensions: brooding, reflection and depression. The instrument showed an excellent internal consistency, with a Crombach's alpha of 0.89 (Nolen-Hoeksema and Morrow, 1991). The scale has been widely employed to assess the presence and quality of ruminations, in both the original and the short form (Parola et al., 2017).

2.2. Statistical analyses

To perform statistical analysis, we considered the quartiles of AdAS Spectrum score, splitting the sample in two groups: "low scorers" (below the 3rd quartile, Q3 = 65) and "high scorers" (above the 3rd quartile, Q4 > 65). The Chi-square test was utilized to compare the rates of males and females in the two groups. We also used the independent sample *t*-test to compare mean total and domain scores of TALS-SR, RRS and MOODS-SR between the two groups. The Pearson's correlation was used to evaluate the association between AdAS Spectrum, TALS-SR, RRS and MOODS-SR scores. Subsequently, in order to control for the confounding effects of independent variables (AdAS Spectrum, TALS-SR and RRS scores) associated with the dependent variable (MOODS-SR score) and clarify whether AdAS Spectrum, TALS-SR and RRS scores predict the MOODS-SR score, a multiple linear regression analysis was performed. Since all the three independent variables were significantly associated with the total MOODS-SR score, we then performed a mediation analysis providing AdAS total score as predictor, MOOD-SR total score as dependent variable and TALS-SR total score and RRS total score as mediators. The Hayes's PROCESS tool was utilized; bootstrap confidence intervals and Sobel test for indirect effect were computed. All analyses were performed using SPSS version 24 (IBM Corp., 2016).

3. Results

The study sample included 178 subjects, 93 males (52.2%) and 85 females (47.8%), (age ± SD = 21.24 ± 1.85) recruited at three University Schools in Italy. Specifically, 63 (35.4%) participants were enrolled at the "Scuola Superiore Sant'Anna", 47 (26.4%) at the "Collegio Universitario di Merito" and 68 (38.2%) at the "Scuola Superiore di Catania", from the faculties of Engineering, Biotechnologies, Medicine and Surgery, Law, Political science, Economy, Physics, Classics. However, most of the students chose to not disclose their university course.

Mean AdAS Spectrum score in the overall sample was 50.2 ± 21.5 with no significant differences between males and females (50.3 ± 21.8 vs 50.1 ± 21.3, t = 0.078, p = 0.549). 133 subjects (74.7%) were categorized as "low scorers" (total AdAS Spectrum score ≤ 65) and 45 (25.3%) as "high scorers (total AdAS spectrum score > 65). The two groups did not significantly differ for age (mean age = 21.24 ± 1.85) and gender distribution (93 males, 85 females, $\chi^2 = 0.36$, p = 0.55).

Considering the SCID-5, no subjects reported a full-blown diagnosis of Major depressive disorder (MDD), Obsessive-compulsive disorder (OCD) or Post-traumatic stress disorder (PTSD). Two subjects (1.1%) reported a diagnosis of Bipolar disorder (BD), both included in the high scorers group. Two subjects (1.1%) were diagnosed with Panic disorder (PD) and 50 (28.1%) with Generalized anxiety disorder (GAD), with no significant differences between AdAS high and low scorers. The rate of suicidal ideation was higher among AdAS high than low scorers (25% vs 10.2%; p = 0.032). In the former group two subjects also reported a suicide attempt.

Students in the high scorers group, versus low scorers group, showed significantly higher scores on the RRS, the TALS-SR and the MOODS-SR total score, as well as on the MOODS-SR depressive component and manic component score (all $p < 0.001$) (see Table 1). A Pearson's correlation matrix of scale scores is presented in Table 2. Statistically significant correlations were found among all scales, with the strongest correlation emerging between AdAS Spectrum and MOODS total scores ($r = 0.660$, $p = 0.001$).

A multiple linear regression was performed using MOODS-SR total score as dependent variable and RRS, TALS and AdAS Spectrum total scores as independent variables. A significant regression equation was found ($F(3.164) = 61.096$, $p < 0.001$), with R2 = 0.528. Results are shown in *Table 3*. All the independent variables were identified to significantly predict the level of MOODS-SR, with the AdAS Spectrum showing the highest standardized coefficient (β = 0.41).

The mediation analysis (Fig. 1) showed that both total and direct effect of AdAS Spectrum total score on MOODS-SR total score were statistically significant (total effect: b = 0.88, $p < 0.001$; direct effect: b = 0.55, $p < 0.001$). AdAS Spectrum total score also showed a significant indirect effect on MOODS-SR total score through TALS and RRS

Table 2
Pearson's Correlation between spectrum instruments in the sample.

	TALS total	RRS total	MOODS-SR total	MOODS-SR depr	MOODS-SR man
AdAS total	0.529*	0.550*	0.660*	0.498*	0.607*
TALS total	–	0.494*	0.583*	0.405*	0.543*
RRS total	–	–	0.560*	0.449*	0.437*

Abbreviations: MOODS-SR dep: MOODS-SR depressive-related total score; MOODS-SR man: MOODS-SR manic-related total score.
*$p < 0.001$.

Table 3
Multiple linear regression with MOODS total score as dependent variable.

MOxDEL	b	β	IC95%	*t*	*p*
K	10.93	–	–	1.73	0.085
AdAS Spectrum	0.55	0.41	0.37–0.73	5.89	< 0.001
RRS	0.53	0.22	0.20–0.54	3.21	0.002
TALS	0.42	0.24	0.19–0.66	3.54	0.001

total scores (b = 0.33), 95% bootstrapped CI [0.21, 0.48]. Sobel test showed b = 0.18, Z = 3.25, $p = 0.001$ for TALS total score and b = 0.16, Z = 2.99, $p = 0.003$ for RRS total score.

4. Discussion

Our study aimed to investigate the relationship between AT and mood symptoms in a university student population, and how autistic traits interact with rumination and trauma/stressor-related symptomatology in predicting mood symptoms. We found that high levels of AT are associated with greater mood symptoms and, to a lesser extent, with greater trauma and stressor-related symptoms and rumination. Furthermore, as expected, results showed that the relationship between autistic traits and mood symptoms is in part mediated by rumination and trauma/stressor–related symptomatology.

The relatively high mean score reported on AdAS Spectrum (50.2), with a 25.3% of the sample scoring higher than 65, is in line with previous literature that identifies university students as a group at risk for the presence of AT (Baron-Cohen et al., 2001; Choteau et al., 2016; Dell'Osso et al., 2018c, 2016c; Pisula et al., 2013; Shi et al., 2017; Sierro et al., 2016; Stevenson and Hart, 2017; Trevisan and Birmingham, 2016; Wakabayashi et al., 2006). The association between AT and mood spectrum symptoms has been previously highlighted in several studies conducted in children and adolescents (Kunihira et al., 2006; Pine et al., 2008; Towbin et al., 2005) and, more recently, also in adult populations (Abu-Akel et al., 2017; Liu et al., 2017; Matsuo et al., 2015). In particular, our findings are pretty consistent with those by Kanne and colleagues (2009), who reported that university students with greater levels of AT also have greater psychiatric difficulties across a broad range of psychopathological dimensions, including depression. Higher levels of depressive symptoms in individuals with AT may be variously explained. One hypothesis may be that AT prevent subjects from adapting to the changing environment and from getting involved in significant social relationships, making them more vulnerable to isolation, loneliness and depression (Hoekstra et al., 2007). However, since most data are provided by cross-sectional studies, the inverse relationship is also possible, as AT might also be a consequence (or associated feature) of depression. For instance, social withdrawal, that is quite common in many mental disorders, may mimic autism-related social deficits and, so that, raise the scores of questionnaires assessing AT. Such an interpretation seems consistent with the study of Matsuo et al. (2015) who found that subjects with unipolar depression display high AT during the acute phase, but not when they recovery from depressive symptoms, while patients with bipolar disorder show high AT independently from the phase of the disorder. Interestingly, our findings showed that subjects with high versus low levels of AT have greater mood symptoms of both polarity, with manic symptoms showing an even stronger correlation with AT than depressive ones. This may corroborate the hypothesis that autistic dimensions and bipolar mood spectrum are tightly interwoven, implying a possible pathophysiological overlap and/or common genetic underpinnings (Khanzada et al., 2017). Accordingly, the only two students with bipolar disorder in our sample were included in the high scorers group.

However, a further hypothesis may be put forward to explain the association between AT and mood symptoms. The result of the mediation analysis, in fact, showed that besides a direct effect there is also an indirect effect of AdAS Spectrum on MOODS-SR scores through TALS-SR and RRS, indicating that rumination and trauma/stressor related symptoms may partially act as mediating factors in the relationship between AT and mood spectrum symptoms. Such a mediating role is in line with data indicating that individuals with high levels of AT may show impaired coping strategies (Kanne et al., 2009) and, so that, reduced ability to adapt to stressful situation, that in turn may raise proneness to trauma and stressor-related spectrum disorders. Consistently with this hypothesis, recent research have found that individuals with high versus low AT have fairly high levels of adjustment disorder with depressive mood as well as of PTSD (Roberts et al., 2015; Takara and Kondo, 2014b). On the other hand, our findings seem to disagree with Liu and colleagues (2017), who found that childhood abuse and neglect do not mediate the relationship between AT and depression. This discrepancy could be explained taking into account that the TALS-SR is aimed to assess the broad array of symptoms following not only great traumatic events, but also milder stressful life situations. This may suggest that also minor stressful life events could facilitate the onset of latent psychiatric symptoms, when coping strategies are reduced, which is the case of subject with AT (Dell'Osso, 2016a, b; Kanne et al., 2009). Rumination, that also was shown to mediate the relationship between AdAS Spectrum and MOODS-SR scores, may further explain the pathway between AT and mood symptoms. Interestingly, according to the cognitive model of PTSD, excessive rumination over traumatic or highly distressing experiences may lead to faulty processing of them and to the development of post-traumatic stress symptoms (Ehlers et al., 2000). Overall, our finding may suggest that subjects with high AT may experience poorer coping strategies, reduced abilities of effective processing of stressful events, and greater likelihood of suffering from trauma and stressor-related symptoms and other accompanying negative effects such as depression. In this framework, it is noteworthy that the relationships between ASD and other psychopathological dimensions seem to be corroborated also from a neurobiological point of view. While neuroimaging studies pointed out a continuity between ASD and BAP (Billeci et al., 2016), and genetic studies stressed possible common genetic underpinnings between ASD and mood disorders (Ragunath et al., 2011), results from biochemical studies have highlighted an involvement of pro-inflammatory cytokines and neurotrophins, as well as immune system dysregulations, in ASD as

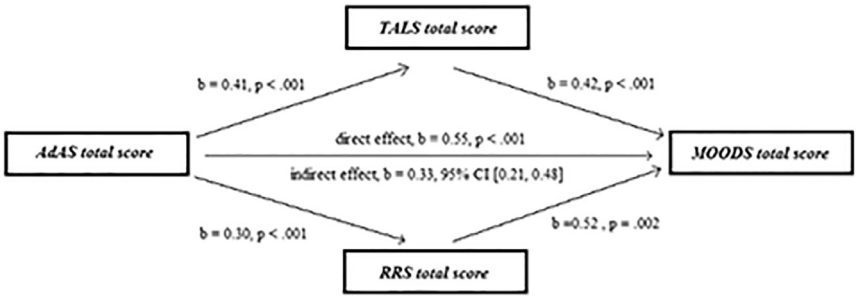

Fig. 1. Mediation Analysis results.

well as in PTSD and in mood disorders (Angelucci et al., 2014; Jiang et al., 2018; Rowland et al., 2018; Siniscalco et al., 2018; Zheng et al., 2016).

The prevalence of mood disorders in our sample was low: no comparisons could be made for major depressive disorder given the absence of caseness, while two subjects (1.1% of the sample) reported a bipolar disorder. Of note, both subjects with bipolar disorder were in the high scorers group and the suicidal ideation was significantly higher among high vs low scorers (25% vs 10.2%), with also two cases of suicide attempt in the former group. Despite our study was based on a small sample, the latter result is especially interesting in the light of recent literature, as growing data are showing the predictive role of autistic symptoms on suicide risk in several clinical populations, suffering either from ASD (Dell'Osso et al., 2015c; Richa et al., 2014) or other mental disorders (Roberts et al., 2015; Takara and Kondo, 2014a). In particular, our study adds to recent data from Pelton and Cassidy (2017) that found an association between AT and increased suicide risk in a non clinical group, suggesting that the continuity between the general and the clinical population with ASD with regard to the core autistic dimensions may also apply to some clinically significant correlates of AT. Similarly, the association between AT and mood symptoms that we are reporting confirms and extends the tight relationship found between mood disorders and ASD, which could involve not only full-blown conditions but also the wide spectrum of manifestations of both disorders, as demonstrated by the strong correlation between MOODS-SR and AdAS Spectrum questionnaires. As previously proposed (Dell'Osso et al., 2016a; Kanne et al., 2009), such findings corroborate the feasibility of using a subthreshold autism model as a proxy for ASD, which may be particularly important for future research. Of note, no student showed a diagnosis of Substance use disorder, notwithstanding the broad literature reporting the significant prevalence of alcohol or other substance abuse among students (Kračmarová et al., 2001; Martinotti et al., 2015), and despite recent data suggesting a close relationship between autism and Substance use disorder (Butwicka et al., 2017; Dell'Osso et al., 2018d). It is possible that this finding has been underestimated due to students' fear of being stigmatized, especially considering the very selective academic setting.

Our findings should be considered in light of some obvious limitations. First, the assessment was cross-sectional preventing us from evaluating the temporal relationship between AT, stressful events and mood symptoms. Another limitation is the relatively small size of the sample and the recruitment of a high risk population, that does not allow to generalize our results to different groups. Third, the assessment included several self-report instruments, which may be prone to over and/or understatement of symptoms. Fourth, depression and autistic traits can confound one another, at least to some extent. Subjects with high levels of AT, in fact, often show high levels of repetitive thinking and rumination, that have been suggested to act as a maintenance factor of depressive symptoms (Nolen-Hoeksema and Morrow, 1991). Fifth, a significant selection bias can not be ruled out, since subjects with the highest levels of AT and/or depressive symptoms could have avoided entering the study.

In the context of the above limitations, our study confirms the importance of AT as a risk factor for developing full-blown mental disorders and highlights the possible role of life stressors as a promoting factor in vulnerable individuals, ultimately helping to improve the identification of AT in both general and clinical populations. As already stressed in literature (Innamorati et al., 2016; Pompili et al., 2016), greater attention should be paid to detect high-risk individuals in particular among young students, as a first step to prevent the onset and the chronic course of psychiatric conditions. A better recognition of AT in clinical settings, which is often associated with drug resistance, may also allow to improve therapeutic strategies (Dell'Osso et al., 2016a, b). Still, further studies in wider samples and with longitudinal design are warranted to corroborate our findings and to clarify the relationship between autistic traits, traumatic events and other psychopathological dimensions.

References

Abu-Akel, A., Clark, J., Perry, A., Wood, S.J., Forty, L., Craddock, N., et al., 2017. Autistic and schizotypal traits and global functioning in bipolar I disorder. J. Affect. Disord. 207, 268–275. https://doi.org/10.1016/j.jad.2016.09.059.

American Psychiatric Association, 2013. Diagnostic and Statistical Manual of Mental Disorders: DSM-5. American Psychiatric Association, Washington, DC.

Anckarsäter, H., Stahlberg, O., Larson, T., Hakansson, C., Jutblad, S.B., Niklasson, L., et al., 2006. The impact of ADHD and autism spectrum disorders on temperament, character, and personality development. Am. J. Psychiatry 163, 1239–1244. https://doi.org/10.1176/appi.ajp.163.7.1239.

Angelucci, F., Ricci, V., Gelfo, F., Martinotti, G., Brunetti, M., Sepede, G., et al., 2014. BDNF serum levels in subjects developing or not post-traumatic stress disorder after trauma exposure. Brain Cogn. 84 (1), 118–122. https://doi.org/10.1016/j.bandc.2013.11.012.

Attwood, T., 2006. The pattern of abilities and development for girls with Asperger's syndrome. In Asperger's and Girls Eds. Future Horizons Inc., Arlington, TX.

Attwood, T., Grandin, T., Faherty, C., Wagner, S., Wrobel, M., Bolick, T., et al., 2006. Asperger's and Girls. Future Horizons, Arlington, TX.

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

Ben-Sasson, A., Cermak, S.A., Orsmond, G.I., Tager-Flusberg, H., Kadlec, M.B., Carter, A.S., 2008. Sensory clusters of toddlers with autism spectrum disorders: differences in affective symptoms. J. Child. Psychol. Psychiatry. 49 (8), 817–825. https://doi.org/10.1111/j.1469-7610.2008.01899.x.

Billeci, L., Calderoni, S., Conti, E., Gesi, C., Carmassi, C., Dell'Osso, L., et al., 2016. The broad autism (Endo)Phenotype: neurostructural and neurofunctional correlates in parents of individuals with autism spectrum disorders. Front. Neurosci. 10, 346. https://doi.org/10.3389/fnins.2016.00346.

Blanco, C., Okuda, M., Wright, C., Hasin, D.S., Grant, B.F., Liu, S.M., et al., 2008. Mental health of college students and their non-college-attending peers: results from the national epidemiologic study on alcohol and related conditions. Arch. Gen. Psychiatry. 65 (12), 1429–1437. https://doi.org/10.1001/archpsyc.65.12.1429.

Butwicka, A, Långström, N, Larsson, H, Lundström, S, Serlachius, E, Almqvist, C, Frisén, L, Lichtenstein, P, 2017. Increased risk for substance use-related problems in autism spectrum disorders: a population-based Cohort study. J Autism Dev Disord 47 (1), 80–89 Jan.

Carmassi, C., Bertelloni, C.A., Gesi, C., Conversano, C., Stratta, P., Massimetti, G., et al., 2017. New DSM-5 PTSD guilt and shame symptoms among Italian earthquake survivors: impact on maladaptive behaviors. Psychiatry Res. 251, 142–147. https://doi.org/10.1016/j.psychres.2016.11.026.

Carmassi, C., Antonio Bertelloni, C., Massimetti, G., Miniati, M., Stratta, P., Rossi, A., et al., 2015. Impact of DSM-5 PTSD and gender on impaired eating behaviors in 512 Italian earthquake survivors. Psychiatry Res. 225 (1-2), 64–69. https://doi.org/10.1016/j.psychres.2014.10.008.

Carmassi, C., Akiskal, H.S., Yong, S.S., Stratta, P., Calderani, E., Massimetti, E., et al., 2013. Posttraumatic stress disorder in DSM-5: estimates of prevalence and criteria comparison versus DSM-IV-TR in a non-clinical sample of earthquake survivors. J. Affect. Disord. 151 (3), 843–848. https://doi.org/10.1016/j.jad.2013.07.020.

Cassano, G.B., Dell'Osso, L., Frank, E., Miniati, M., Fagiolini, A., Shear, K., et al., 1999. The bipolar spectrum: a clinical reality in search of diagnostic criteria and an assessment methodology. J. Affect. Disord. 54, 319–328. https://doi.org/10.1016/S0165-0327(98)00158-X.

Choteau, L., Raynal, P., Goutaudier, N., Chabrol, H., 2016. Psychopathological traits in college students from top-ranking french schools: do autistic features impair success in science when associated with schizotypal traits? Psychiatry Res 237, 218–223. https://doi.org/10.1016/j.psychres.2016.01.038.

Clark, J., 2010. Asperger's in pink: Pearls of Wisdom from Inside the Bubble of Raising a Child With Asperger's. Future Horizons, Arlington, TX.

Dell'Osso, L., Carpita, B., Gesi, C., Cremone, I.M., Corsi, M., Massimetti, E., et al., 2018a. Subthreshold autism spectrum disorder in patients with eating disorders. Compr. Psychiatry 81, 66–72. https://doi.org/10.1016/j.comppsych.2017.11.007.

Dell'Osso, L., Cremone, I.M., Carpita, B., Fagiolini, A., Massimetti, G., Bossini, L., et al., 2018b. Correlates of autistic traits among patients with borderline personality disorder. Compr. Psychiatry 83, 7–11. https://doi.org/10.1016/j.comppsych.2018.01.002.

Dell'Osso, L., Carpita, B., Muti, D., Cremone, I.M., Massimetti, G., Diadema, E., et al., 2018c. Prevalence and characteristics of orthorexia nervosa in a sample of university students in Italy. Eat Weight Disord. 23 (1), 55–65. https://doi.org/10.1007/s40519-017-0460-3.

Dell'Osso, L., Conversano, C., Corsi, M., Bertelloni, C.A., Cremone, I.M., Carpita, B., et al., 2018d. Polysubstance and behavioral addictions in a patient with bipolar disorder: role of lifetime subthreshold autism spectrum. Case Rep. Psychiatry, 1547975. https://doi.org/10.1155/2018/1547975. 2018.

Dell'Osso, L., Gesi, C., Massimetti, E., Cremone, I.M., Barbuti, M., Maccariello, G., et al., 2017. Adult autism subthreshold spectrum (AdAS Spectrum): validation of a questionnaire investigating subthreshold autism spectrum. Compr. Psychiatry 73, 61–83. https://doi.org/10.1016/j.comppsych.2016.11.001.

Dell'Osso, L., Luche, R.D., Gesi, C., Moroni, I., Carmassi, C., Maj, M., 2016a. From Asperger's Autistischen Psychopathen to DSM-5 autism spectrum disorder and beyond: a subthreshold autism spectrum model. Clin. Pract. Epidemiol. Ment. Health.

12, 120–131. https://doi.org/10.2174/1745017901612010120.
Dell'Osso, L., Dalle Luche, R., Maj, M., 2016b. Adult autism spectrum as a transnosographic dimension. CNS Spectr. 21 (2), 131–133. https://doi.org/10.1017/S1092852915000450.
Dell'Osso, L., Abelli, M., Carpita, B., Massimetti, G., Pini, S., Rivetti, L., et al., 2016c. Orthorexia nervosa in a sample of Italian university population. Riv. Psichiatr. 51 (5), 190–196. https://doi.org/10.1708/2476.25888.
Dell'Osso, L., Abelli, M., Carpita, B., Pini, S., Castellini, G., Carmassi, C., et al., 2016d. Historical evolution of the concept of anorexia nervosa and relationships with orthorexia nervosa, autism, and obsessive-compulsive spectrum. Neuropsychiatr. Dis. Treat. 12, 1651–1660. https://doi.org/10.2147/NDT.S108912.
Dell'Osso, L., Dalle Luche, R., Cerliani, C., Bertelloni, C.A., Gesi, C., Carmassi, C., 2015a. Unexpected subthreshold autism spectrum in a 25-year-old male stalker hospitalized for delusional disorder: a case report. Compr. Psychiatry 61, 10–14. https://doi.org/10.1016/j.comppsych.2015.04.003.
Dell'Osso, L., Abelli, M., Pini, S., Carpita, B., Carlini, M., Mengali, F., et al., 2015b. The influence of gender on social anxiety spectrum symptoms in a sample of university students. Riv. Psichiatr. 50 (6), 295–301. https://doi.org/10.1708/2098.22688.
Dell'Osso, L., Dalle Luche, R., Carmassi, C., 2015c. A new perspective in post-traumatic stress disorder: which role for unrecognized autism spectrum? Int. J. Emerg. Ment. Health 17, 436–438. https://doi.org/10.4172/1522-4821.1000e188.
Dell'Osso, L., Abelli, M., Pini, S., Carlini, M., Carpita, B., Macchi, E., et al., 2014. Dimensional assessment of DSM-5 social anxiety symptoms among university students and its relationship with functional impairment. Neuropsychiatr. Dis. Treat. 10, 1325–1332. https://doi.org/10.2147/NDT.S59348.
Dell'Osso, L., Carmassi, C., Musetti, L., Socci, C., Shear, M.K., Conversano, C., et al., 2012. Lifetime mood symptoms and adult separation anxiety in patients with complicated grief and/or post-traumatic stress disorder: a preliminary report. Psychiatry Res. 198 (3), 436–440. https://doi.org/10.1016/j.psychres.2011.12.020.
Dell'Osso, L., Carmassi, C., Massimetti, G., Conversano, C., Daneluzzo, E., Riccardi, I., et al., 2011. Impact of traumatic loss on post-traumatic spectrum symptoms in high school students after the L'Aquila 2009 earthquake in Italy. J. Affect. Disord. 134 (1–3), 59–64. https://doi.org/10.1016/j.jad.2011.06.025.
Dell'Osso, L., Carmassi, C., Rucci, P., Conversano, C., Shear, M.K., Calugi, S., et al., 2009. A multidimensional spectrum approach to post-traumatic stress disorder: comparison between the structured clinical interview for trauma and loss spectrum (SCI-TALS) and the self-report instrument (TALS-SR). Compr. Psychiatry 50 (5), 485–490. https://doi.org/10.1016/j.comppsych.2008.11.006.
Dell'Osso, L., Shear, M.K., Carmassi, C., Rucci, P., Maser, J.D., Frank, E., et al., 2008. Validity and reliability of the structured clinical interview for the trauma and loss spectrum (SCI-TALS). Clin. Pract. Epidemiol. Ment. Health 4, 2. https://doi.org/10.1186/1745-0179-4-2.
Dell'Osso, L., Rucci, P., Cassano, G.B., Maser, J.D., Endicott, J., Shear, M.K., et al., 2002a. Measuring social anxiety and obsessive-compulsive spectra: comparison of interviews and self-report instruments. Compr. Psychiatry 43 (2), 81–87. https://doi.org/10.1053/comp.2002.30795.
Dell'Osso, L., Armani, A., Rucci, P., Frank, E., Fagiolini, A., Corretti, G., et al., 2002b. Measuring mood spectrum: comparison of interview (SCI-MOODS) and self-report (MOODS-SR) instruments. Compr. Psychiatry 43 (1), 69–73. https://doi.org/10.1053/comp.2002.29852.
Ehlers, A., Clark, D.M., 2000. A cognitive model of posttraumatic stress disorder. Behav. Res. Ther 38 (4), 319–345. https://doi.org/10.1016/S0005-7967(99)00123-0.
Eisenberg, D., Hunt, J., Speer, N., 2013. Mental health in American colleges and universities: variation across student subgroups and across campuses. J. Nerv. Ment. Dis. 201 (1), 60–67. https://doi.org/10.1097/NMD.0b013e31827ab077.
Fagiolini, A., Dell'Osso, L., Pini, S., Armani, A., Bouanani, S., Rucci, P., et al., 1999. Validity and reliability of a new instrument for assessing mood symptomatology: the structured clinical interview for mood spectrum (SCI MOODS). Int. J. Meth. Psych. Res. 8 (2), 71–81. https://doi.org/10.1002/mpr.58.
First, M.B., Williams, J.B., Karg, R.S., Spitzer, R.L., 2015. SCID-5-CV: Structured Clinical Interview for DSM-5 Disorders, Clinician Version. American Psychiatric Association, Arlington, VA.
Foley Nicpon, M., Doobay, A.F., Assouline, S.G., 2010. Parent, teacher, and self perceptions of psychosocial functioning in intellectually gifted children and adolescents with autism spectrum disorder. J. Autism Dev. Disord. 40 (8), 1028–1038. https://doi.org/10.1007/s10803-010-0952-8.
Frank, E., Cassano, G.B., Shear, M.K., Rotondo, A., Dell'Osso, L., Mauri, M., et al., 1998. The Spectrum model: a more coherent approach to the complexity of psychiatric symptomatology. CNS Spectr. 3, 23–34. https://doi.org/10.1017/S1092852900005836.
Garlow, S.J., Rosenberg, J., Moore, J.D., Haas, A.P., Koestner, B., Hendin, H., et al., 2008. Depression, desperation, and suicidal ideation in college students: results from the American foundation for suicide prevention college screening project at Emory University. Depress. Anxiety 25 (6), 482–488. https://doi.org/10.1002/da.20321.
Hoekstra, R.A., Bartels, M., Verweij, C.J., Boomsma, D.I., 2007. Heritability of autistic traits in the general population. Arch. Pediatr. Adolesc. Med. 161 (4), 372–377. https://doi.org/10.1001/archpedi.161.4.372.
Hofvander, B., Delorme, R., Chaste, P., Nydén, A., Wentz, E., Ståhlberg, O., et al., 2009. Psychiatric and psychosocial problems in adults with normal-intelligence autism spectrum disorders. BMC Psychiatry 9, 35. https://doi.org/10.1186/1471-244X-9-35.
IBM Corp, 2016. IBM SPSS Statistics for Windows. IBM Corp, Armonk, NY Version 24.0.
Innamorati, M., Erbuto, D., Venturini, P., Fagioli, F., Ricci, F., Lester, D., et al., 2016. Factorial validity of the childhood trauma questionnaire in Italian psychiatric patients. Psychiatry Res. 245, 297–302. https://doi.org/10.1016/j.psychres.2016.08.044.
Jiang, D., Jiang, S., Gong, F., Yuan, F., Zhao, P., He, X., et al., 2018. Correlation between depression, posttraumatic stress disorder, and inflammatory factors in patients with severe burn injury. Am. Surg. 84 (8), 1350–1354.
Jobe, L.E., White, S.W., 2007. Loneliness, social relationships, and a broader autism phenotype in college students. Pers. Individ. Diff. 42 (8), 1479–1489. https://doi.org/10.1016/j.paid.2006.10.021.
Kanne, S.M., Christ, S.E., Reiersen, A.M., 2009. Psychiatric symptoms and psychosocial difficulties in young adults with autistic traits. J. Autism Dev. Disord. 39 (6), 827–833. https://doi.org/10.1007/s10803-008-0688-x.
Kato, K., Mikami, K., Akama, F., Yamada, K., Maehara, M., Kimoto, K., et al., 2013. Clinical features of suicide attempts in adults with autism spectrum disorders. Gen. Hosp. Psychiatry. 35 (1), 50–53. https://doi.org/10.1016/j.genhosppsych.2012.09.006.
Khanzada, N.S., Butler, M.G., Manzardo, A.M., 2017. Gene analytics pathway analysis and genetic overlap among autism spectrum disorder, bipolar disorder and schizophrenia. Int. J. Mol. Sci. 18 (3), E527. https://doi.org/10.3390/ijms18030527. pii.
Kračmarová, L., Klusoňová, H., Petrelli, F., Grappasonni, I., 2001. Tobacco, alcohol and illegal substances: experiences and attitudes among Italian university students. Rev. Assoc. Med. Bras. 57 (5), 523–528. https://doi.org/10.1590/S0104-42302011000500009.
Kunihira, Y., Senju, A., Dairoku, H., Wakabayashi, A., Hasegawa, T., 2006. 'Autistic' traits in non-autistic Japanese populations: relationships with personality traits and cognitive ability. J. Autism Dev. Disord. 36 (4), 553–566. https://doi.org/10.1007/s10803-006-0094-1.
Lecavalier, L., Gadow, K.D., Devincent, C.J., Houts, C.R., Edwards, M.C., 2011. Validity of DSM-IV syndromes in preschoolers with autism spectrum disorders. Autism 15 (5), 527–543. https://doi.org/10.1177/1362361310391115.
Liu, J., Gong, J., Nie, G., He, Y., Xiao, B., Shen, Y., et al., 2017. The mediating effects of childhood neglect on the association between schizotypal and autistic personality traits and depression in a non-clinical sample. BMC Psychiatry 17 (1), 352. https://doi.org/10.1186/s12888-017-1510-0.
Losh, M., Adolphs, R., Poe, M.D., Couture, S., Penn, D., Baranek, G.T., et al., 2009. Neuropsychological profile of autism and the broad autism phenotype. Arch. Gen. Psychiatry 66 (5), 518–526. https://doi.org/10.1001/archgenpsychiatry.2009.34.
Losh, M., Childress, D., Lam, K., Piven, J., 2008. Defining key features of the broad autism phenotype: a comparison across parents of multiple- and single-incidence autism families. Am. J. Med. Genet. B Neuropsychiatr. Genet. 147B (4), 424–433. https://doi.org/10.1002/ajmg.b.30612.
Marazziti, D., Abelli, M., Baroni, S., Carpita, B., Ramacciotti, C.E., Dell'Osso, L., 2015. Neurobiological correlates of social anxiety disorder: an update. CNS Spectr. 20 (2), 100–111. https://doi.org/10.1017/S109285291400008X.
Marazziti, D., Abelli, M., Baroni, S., Carpita, B., Piccinni, A., Dell'Osso, L., 2014. Recent findings on the pathophysiology of social anxiety disorder. Clin. Neuropsychiatry 11, 91–100.
Martinotti, G., Lupi, M., Carlucci, L., Cinosi, E., Santacroce, R., Acciavatti, T., et al., 2015. Novel psychoactive substances: use and knowledge among adolescents and young adults in urban and rural areas. Hum. Psychopharmacol. 30 (4), 295–301. https://doi.org/10.1002/hup.2486.
Matsuo, J., Kamio, Y., Takahashi, H., Ota, M., Teraishi, T., Hori, H., et al., 2015. Autistic-like traits in adult patients with mood disorders and schizophrenia. PLoS One 10 (4), e0122711. https://doi.org/10.1371/journal.pone.0122711.
Nolen-Hoeksema, S., Morrow, J., 1991. A prospective study of depression and posttraumatic stress symptoms after a natural disaster: the 1989 Loma Prieta Earthquake. J. Pers. Soc. Psychol. 61 (1), 115–121. https://doi.org/10.1037/0022-3514.61.1.115.
Parola, N., Zendjidjian, X.Y., Alessandrini, M., Baumstarck, K., Loundou, A., Fond, G., et al., 2017. Psychometric properties of the Ruminative response scale-short form in a clinical sample of patients with major depressive disorder. Patient Prefer. Adherence 11, 929–937. https://doi.org/10.2147/PPA.S125730.
Pelton, M.K., Cassidy, S.A., 2017. Are autistic traits associated with suicidality? A test of the interpersonal-psychological theory of suicide in a non-clinical young adult sample. Autism Res. 10 (11), 1891–1904. https://doi.org/10.1002/aur.1828.
Pine, D.S., Guyer, A.E., Goldwin, M., Towbin, K.A., Leibenluft, E., 2008. Autism spectrum disorder scale scores in pediatric mood and anxiety disorders. J. Am. Acad. Child. Adolesc. Psychiatry 47 (6), 652–661. https://doi.org/10.1097/CHI.0b013e31816bffa5.
Pisula, E., Kawa, R., Szostakiewicz, Ł., Łucka, I., Kawa, M., Rynkiewicz, A., 2013. Autistic traits in male and female students and individuals with high functioning autism spectrum disorders measured by the Polish version of the Autism-Spectrum Quotient. PLoS One 8 (9), e75236. https://doi.org/10.1371/journal.pone.0075236.
Pompili, M., Murri, Belvederi, M., Patti, S., Innamorati, M., Lester, D., Girardi, et al., 2016. The communication of suicidal intentions: a meta-analysis. Psychol. Med. 46 (11), 2239–2253. https://doi.org/10.1017/S0033291716000696.
Ragunath, P., Chitra, R., Mohammad, S., Abhinand, P., 2011. A systems biological study on the comorbidity of autism spectrum disorders and bipolar disorder. Bioinformation 7 (3), 102–106. https://doi.org/10.6026/97320630007102.
Richa, S., Fahed, M., Khoury, E., Mishara, B., 2014. Suicide in autism spectrum disorders. Arch. Suicide Res. 18 (4), 327–339. https://doi.org/10.1080/13811118.2013.824834.
Roberts, A.L., Koenen, K.C., Lyall, K., Robinson, E.B., Weisskopf, M.G., 2015. Association of autistic traits in adulthood with childhood abuse, interpersonal victimization, and posttraumatic stress. Child. Abuse Negl. 45, 135–142. https://doi.org/10.1016/j.chiabu.2015.04.010.
Rowland, T., Perry, B.I., Upthegrove, R., Barnes, N., Chatterjee, J., Gallacher, D., et al., 2018. Neurotrophins, cytokines, oxidative stress mediators and mood state in bipolar disorder: systematic review and meta-analyses. Br. J. Psychiatry 213 (3), 514–525. https://doi.org/10.1192/bjp.2018.144.

Shi, L.J., Liu, W.H., Shi, H.S., Yan, C., Wang, Y., Wang, Y., et al., 2017. Co-occurrence of autistic and schizotypal traits and its association with emotional and psychosocial function in Chinese college students. Psychiatry Res. 248, 64–70. https://doi.org/10.1016/j.psychres.2016.12.021.

Sierro, G., Rossier, J., Mohr, C., 2016. Validation of the French Autism Spectrum Quotient scale and its relationships with schizotypy and Eysenckian personality traits. Compr. Psychiatry 68, 147–155. https://doi.org/10.1016/j.comppsych.2016.03.011.

Siniscalco, D., Schultz, S., Brigida, A.L., Antonucci, N., 2018. Inflammation and neuro-immune dysregulations in autism spectrum disorders. Pharmaceuticals (Basel) 11 (2), 56. https://doi.org/10.3390/ph11020056.

Skylark, W.J., Baron-Cohen, S., 2017. Initial evidence that non-clinical autistic traits are associated with lower income. Mol. Autism 8, 61. https://doi.org/10.1186/s13229-017-0179-z.

Stevenson, J.L., Hart, K.R., 2017. Psychometric properties of the autism-spectrum quotient for assessing low and high levels of autistic traits in college students. J. Autism Dev. Disord. 47 (6), 1838–1853. https://doi.org/10.1007/s10803-017-3109-1.

Storch, E.A., Sulkowski, M.L., Nadeau, J., Lewin, A.B., Arnold, E.B., Mutch, P.J., et al., 2013. The phenomenology and clinical correlates of suicidal thoughts and behaviors in youth with autism spectrum disorders. J. Autism Dev. Disord. 43, 2450–2459. https://doi.org/10.1007/s10803-013-1795-x.

Stratta, P., Sanità, P., Bonanni, R.L., De Cataldo, S., Angelucci, A., Rossi, R., et al., 2016. Clinical correlates of plasma brain-derived neurotrophic factor in post-traumatic stress disorder spectrum after a natural disaster. Psychiatry Res. 244, 165–170. https://doi.org/10.1016/j.psychres.2016.07.019.

Suzuki, T., Miyaki, K., Eguchi, H., Tsutsumi, A., 2017. Distribution of autistic traits and their association with sociodemographic characteristics in Japanese workers. Autism 1, 1362361317716605. https://doi.org/10.1177/1362361317716605.

Takara, K., Kondo, T., 2014a. Comorbid atypical autistic traits as a potential risk factor for suicide attempts among adult depressed patients: a case-control study. Ann. Gen. Psychiatry 13 (1), 33. https://doi.org/10.1186/s12991-014-0033-z.

Takara, K., Kondo, T., 2014b. Autism spectrum disorder among first-visit depressed adult patients: diagnostic clues from backgrounds and past history. Gen. Hosp. Psychiatry 36 (6), 737–742. https://doi.org/10.1016/j.genhosppsych.2014.08.004.

Taylor, M.J., Gillberg, C., Lichtenstein, P., Lundström, S., 2017. Etiological influences on the stability of autistic traits from childhood to early adulthood: evidence from a twin study. Mol. Autism 8, 5. https://doi.org/10.1186/s13229-017-0120-5.

Tchanturia, K., Smith, E., Weineck, F., Fidanboylu, E., Kern, N., Treasure, J, et al., 2013. Exploring autistic traits in anorexia: a clinical study. Mol. Autism 4 (1), 44. https://doi.org/10.1186/2040-2392-4-44.

Towbin, K.E., Pradella, A., Gorrindo, T., Pine, D.S., Leibenluft, E., 2005. Autism spectrum traits in children with mood and anxiety disorders. J. Child. Adolesc. Psychopharmacol. 15 (3), 452–464. https://doi.org/10.1089/cap.2005.15.452.

Trevisan, D., Birmingham, E., 2016. Examining the relationship between autistic traits and college adjustment. Autism 20 (6), 719–729. https://doi.org/10.1177/1362361315604530.

Tupler, L.A., Hong, J.Y., Gibori, R., Blitchington, T.F., Krishnan, K.R., 2015. Suicidal ideation and sex differences in relation to 18 major psychiatric disorders in college and university students: anonymous web-based assessment. J. Nerv. Ment. Dis. 203 (4), 269–278. https://doi.org/10.1097/NMD.0000000000000277.

Wakabayashi, A., Baron-Cohen, S., Wheelwright, S., Tojo, Y., 2006. The Autism-Spectrum Quotient (AQ) in Japan: a cross-cultural comparison. J. Autism Dev. Disord. 36 (2), 263–270. https://doi.org/10.1007/s10803-005-0061-2.

White, S.W., Ollendick, T.H., Bray, B.C., 2011. College students on the autism spectrum: prevalence and associated problems. Autism 15 (6), 683–701. https://doi.org/10.1177/1362361310393363.

Zheng, Z., Zhang, L., Zhu, T., Huang, J., Qu, Y., Mu, D., 2016. Peripheral brain-derived neurotrophic factor in autism spectrum disorder: a systematic review and meta-analysis. Sci. Rep. 6, 31241. https://doi.org/10.1038/srep31241.