Ambivalent effects of highly estimated personal strengths on adaptive functioning and internalizing symptoms in non-clinical autistic females

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Abstract

Recently, individuals with autistic traits, especially female, have been known to use compensatory strategies (e.g. hiding their autistic traits or compensatory learning) for better adaptation. Though these strategies are predicted to be relevant with the non-clinical undiagnosed autistic people, their adaptive status and the factor contributing to it remain largely unexplored, especially the influence of gender. We explored the strengths of non-clinical adults with high autistic traits (high, N = 89, scored 19 or higher on Autism Spectrum Screening Questionnaire: ASSQ, self- and/or other-ratings) who were respondents to an online survey recruited from all over Japan, using items of the personal strengths in the Adult Self Report (ASR) and Adult Behavior Checklist (rating by others). We compared the high group with the low autistic traits group (low, N = 408, less than 19 on both ASSQ self- and other- ratings on the online survey) and the autism spectrum disorder group (ASD, N = 50, initial visit to hospital), as well as by gender. Personal strengths estimated by others were significantly higher than those by self in the high group, especially in females, but were opposite in the ASD group and equivalent in the low group, respectively. Multiple regression analysis revealed that personal strengths estimated by others increased adaptive functioning, with worsening of internalizing symptoms in high group females, both of which were assessed using ASR. Thus, non-clinical autistic females appeared to have unique adaptation styles.

Keywords Achenbach System of empirically based Assessment · Autism spectrum disorder · Compensation · Gender difference · General population · Over-adaptation

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Introduction

Autism Spectrum Disorder (ASD) is diagnosed more often in men than in women across all ages (Loomes et al., 2017). To understand this discrepancy, some researchers have suggested that traditional assessment prevents females from being diagnosed and more severe autistic symptoms and greater cognitive and behavioral problems were required to reach the ASD diagnosis in females (Dworzynski et al., 2012; Kopp & Gillberg, 2011). Moreover, females with ASD but without intellectual disability are more likely to "camouflage" their traits for better adaptation than males with the same condition (Lai et al., 2017). Research on this concept has been fast-growing in recent years.

The exploration for adaptive strategies of the individuals with autistic traits has recently begun to target not only for those with ASD diagnosis but also the undiagnosed in the general population. As is evident from the previous studies

on the distribution of the general population of autistic traits, there are many undiagnosed individuals in the general population with high autistic traits (e.g., Baron-Cohen et al., 2001). Large body of previous literature on them has mainly focused on their relatively strong social adaptive difficulties and psychiatric symptoms, that is the negative aspects attributed to autistic traits (e.g., Kanne et al., 2009; Deisinger, 2015). Their subclinical course may have traditionally been understood as the consequences of milder disorder and associated milder difficulties than being diagnosed with ASD. Interestingly, positive correlations between autistic traits and the acquisition of social psychological skills in the general population have recently been reported (Gollwitzer et al., 2019). Examining individuals with autistic traits including those in the general population whose autistic traits were not significantly different from those with the ASD diagnosis, Livingston et al., (2019) qualitatively identified wide range of their compensative strategies for better adaptation from "camouflage" to the "acquisition of psychosocial knowledge." Even with the same degree of autistic traits, whether they interfere with daily life at a clinically significant level and whether they cause the need to be clinically refereed to,varies greatly by individuals (Honda, 2017). In addition, autistic traits that have been present since childhood are sometimes masked until social demands exceed the limits of one's abilities or because of coping strategies learned as they grow up, as explicitly noted in the Diagnostic and Statistical Manual of Mental Disorders 5th edition, DSM-5 (American Psychiatric Association, 2013) .There is still no empirically grounded explanation for such individual differences in the manifestation of autistic traits or clinically impaired symptoms, across the lifespan. Based on the assumption that compensation as an individual coping mechanism contributes to such heterogeneity, Livingston & Happé (2017) suggested that the compensation may be most successfully used by such as the undiagnosed individuals and females who reported high autistic traits in the general population. Exploring the adaptive strategies developed or the factors that contribute to maintaining the adaptation of these non-clinical populations with autistic traits, may provide an important reference not only for understanding the population but also for long-term intervention in ASD.

In the current study, we focus on individual strength as a factor that may contribute to adaptive status of these non-clinical autistic populations. Strength is an extraction of positive aspects of individuals' abilities, traits, and environmental conditions for better adaptation, which is currently widely shared among professionals of mental health and social work (Rapp & Goscha, 2006). In addition, in the context of positive psychology, extracted individuals' strengths have been utilized along with the assessment of deficits or disorders using the Values in Action Inventory of Strengths (VIA-IS; Seligman et al., 2004), which is a self-rating measure of individuals' strengths. Regarding the relationship with autistic traits, despite having recognized the value of strength assessment clinically, empirical research is limited to two contexts—1) ability, skill, and coping methods related to special interests (Kirchner & Dziobek, 2014; Teti et al., 2016) and 2) positive aspects related to personality and character (Kirchner et al., 2016). Particularly in the second context, intellectual strengths (open-mindedness, theological power, and self-control) have been shown to be the most frequently assessed strengths among adults with ASD using the VIA-IS (Kirchner et al., 2016). However, the above study is limited as it is unclear whether the extracted strengths actually contribute to adaptations. Moreover, the difficulty related to autistic traits, self-referential cognition, which influences self-insight and metacognition, can occasionally cause discrepancies between self-evaluations and evaluations by others using various measures (Johnson et al., 2009; Lombardo & Baron-Cohen, 2010; Griffin et al., 2016). Self-report measures are broadly used for the assessment of adults with ASD, but consideration must be given to which domains these discrepancies are more apparent (Sandercock et al., 2020). Moderate correlations with ratings by others such as parental evaluation have been observed in self-ratings of autistic traits, daily living skills (Sandercock et al., 2020), psychiatric symptoms (Gotham et al., 2015), and quality of life (QOL) (Hong et al., 2016). Self-assessment of strengths in this population has not been adequately examined to date and the use of both self-ratings and ratings by others seems to be essential. Strength assessments with self- and others-rated adult versions are available as the personal strengths in the Achenbach System of Empirically Based Assessment (ASEBA; Achenbach & Rescorla 2003), which mainly include prosocial items as strengths. We used the personal strengths, together with other measures of psychiatric problems and adaptive functioning in the ASEBA (Achenbach, 2015), to investigate the individual strengths and contribution of the extracted strengths to a subjective adaptive status.

Another important point related to the strength is the possibility of gender differences in adaptive strategies among non-clinical individuals with autistic traits, as we mentioned above (Lai et al., 2017; Livingston & Happé, 2017). Though some previous studies retrospectively clarified on the pre-diagnostic status of females diagnosed with ASD, as exhibited exhaustion and prolonged psychiatric symptoms (Bargiela et al., 2016; Leedham et al., 2020), there are few gender-specific reports on the individuals with autistic traits in the general population who have not manifested clinical symptoms leading to a medical consultation. Therefore, we include gender factor to be considered in the current study.

The aim of the current study was two-fold. The first was to identify the personal strengths and adaptive status, including the adaptive functioning, QOL, and internalizing symptoms of individuals with high autistic traits without medical consultation in the general population (=the high group). In order to clarify the features of the high group, we made comparisons with the low autistic traits group. Comparisons were also made with the group diagnosed with ASD to examine the differences between those with autistic traits but with or without clinical manifest. The second was to examine whether the strengths of the high group contribute to their adaptive status if we found the strengths specific to the high group. For both purposes, gender comparisons were added to explore whether gender specificity exists. Based on the existing literature reviewed above, we hypothesized that the high group has the specific strengths, especially female, which contribute to their better adaptive status (adaptive functioning, QOL, and internalizing symptoms).

Methods

Study design

This retrospective observational study was based on data obtained both from a large registrant bank pool for online survey and a retrospective medical chart review.

Participants and Procedure

Participants from the general population were recruited from the study of the standardization of the Japanese version of the ASEBA (Funabiki & Murai, 2015) via a research company (Cross Marketing Inc. https://www.cross-m.co.jp/en/), which has a large registrant bank pool for online survey inquiries to gain as sufficient representative samples of the Japan population in terms of age, gender, and residential area as possible. Each participant was required to nominate someone whom they knew well and evaluate each other in pairs on each URL without knowing the other's answer. They also had to agree to the informed consent form on the prepared web pages of this study before answering questionnaires—the Adult Self Report (ASR; Achenbach & Rescorla 2003), Autism Spectrum Screening Questionnaire (ASSQ; Ehlers et al., 1999), and World Health Organization Quality of Life-BREF (WHOQOL-BREF; The WHOQOL Group, 1998) for self-rating answers and Adult Behavior Checklist (ABCL; Achenbach & Rescorla 2003) and ASSQ for others-rated answers. We included paired respondents who had no history of physical or mental illness or neurodevelopmental disorders and answered all questions honestly as participants in the general population. A total of 497

participants, matched for age and gender to the ASD group noted below, were divided into two groups on the basis of the standard cut-off score of the ASSQ, those who scored ≥ 19 on either self-rating or others rating of the ASSQ were categorized into the "high group," while those who scored < 19 on either rating were categorized into the "low group." The high group consisted of 89 people aged 19–48 years (49 males, mean age = 30.9 ± 8.5 years; 40 females, mean age = 30.2 ± 8.3 years), and the low group consisted of 408 people aged 19–43 years (208 males, mean age = 30.9 ± 5.6 years; 200 females, mean age = 31.0 ± 5.7 years).

Participants with diagnosed ASD were outpatients from our hospital and they were recruited through retrospective medical chart reviews using our hospital's clinical archive. Although sampling is different from the above general population, we included data at the first visit of our outpatients to better represent the features of the clinical groups. Trained psychiatrists diagnosed the patients based on the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV-TR; American Psychiatric Association, 2000). The ASD group consisted of 50 people aged 18–47 years (32 males, mean age = 30.6 ± 7.5 years; 18 females, mean age = 26.7 ± 5.3 years). To test their intelligence quotient (IQ), we applied the Wechsler Adult Intelligence Scale, Third Edition (WAIS-III) on 48 of them, and the Wechsler Adult Intelligence Scale-Revised (WAIS-R) on the remaining two patients. We also assessed the severity of ASD-associated features and the need to support all participants in the ASD group, using the Multidimensional Scale for Pervasive Developmental Disorders and Attention Deficit Hyperactivity Disorder (MSPA; Funabiki et al., 2011). In this group, four ASD-related core items in the MSPA were > 3, indicating that the severity level requires individual daily environmental considerations (communication, 3.45; social adaptation, 3.41; empathy, 3.30; restricted interests and behaviors, 3.44; see supplementary data). They underwent self-assessment using the ASR and ASSQ and were assessed by others using the ABCL and ASSQ. The exclusion criteria were a diagnosis of mental retardation or an IQ of < 70. The IQ of the ASD group did not show gender differences. Ethical approval for this study protocol was obtained from the medical ethics committee of our institution.

Measures

Autism spectrum screening questionnaire (ASSQ)

The ASSQ (Ehlers et al., 1999) consists of 27 items rated on a 3-point Likert scale, inquiring about social interaction (11 items), communication problems (six items), restricted and repetitive behaviors (five items), and motor clumsiness and

other associated problems (five items). The Japanese version translated by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) research group with the original authors' permission, has confirmed adequate reliability and validity for preschool children and adolescents, with a cutoff score of 19, which is also recommended by the parent evaluation of the original version. Cronbach's alphas(α) of previous studies were 0.84–0.92 and showed good internal consistency (Ii et al., 2003; Ito et al., 2014; Adachi et al., 2018). To measure autistic traits that existed in childhood, we converted the sentences of items to reflect the past tense, retaining their original meanings (e.g., item 17: "*lacks* best friend" was converted to "*lacked* best friend" in Japanese), with an additional introduction, such as "Please recall your childhood as far back as possible and choose the one of the options that best describes it—'Yes,' 'Somewhat,' or 'No'." Questions regarding collaterals were asked in a similar manner. Higher scores indicated higher levels of autistic traits. In the current study, both self and other ratings had excellent reliability (both Cronbach's α = 0.94).

World health organization quality of life assessment-brief version (WHOQOL-BREF)

The WHOQOL-BREF (The WHOQOL Group, 1998) is a 26-item subjective assessment that asks how satisfied individuals are with the four subscales: physical, psychological, social, and environmental domains. Each question was rated on a 5-point Likert scale for "how much," "how often," "how good," or "how satisfied" based on the impressions of the past 2 weeks, with examples being questions such as "*Do you have enough energy for everyday life? (physical)*" or "*How satisfied are you with yourself? (psychological)*". Higher scores indicated better QOL. The Japanese version of WHOQOL-BREF (Tazaki & Nakane, 1997) has been tested for content equivalence with the original English version and confirmed its validity and reliability. The previous studies showed adequate consistency with Cronbach's alpha for each sub-domain: physical 0.70–0.84, psychological 0.76–0.77, social 0.61–0.69 and environmental 0.76–0.80 (Tazaki & Nakane, 1997; Yoshitake et al., 2015). In the current study, adequate reliability was confirmed for physical, psychological, social, environmental, and the total score (Cronbach's α = 0.61, 0.78, 0.66, 0.81, and 0.92, respectively).

Adult self report (ASR) and adult Behavior Checklist (ABCL)

ASEBA provides standardized forms for obtaining self-rating and others rating reports, which have been translated into more than 100 cultural languages. The versions for individuals aged 18–59 are the ASR and the ABCL, both of which include the mean adaptive scale, internalizing symptom scale, and personal strengths, with adequate reliability and validity (Achenbach & Rescorla, 2003). We measured adaptive functioning and psychiatric symptoms using the mean adaptive scale and the internalizing symptom scale in the ASR. We also measured individuals' strengths using the personal strengths in the ASR and ABCL. We referred to the ASR for gender and age, and to both the ASR and ABCL to minimize the possibility of underreporting for educational level and presence or absence of history of physical or mental illness or neurodevelopmental disorders. Previous international studies including Japan and the standardization study of the Japanese version (Rescorla et al., 2016; Funabiki & Murai 2015) showed acceptable to good internal consistency for each scale: Mean adaptive scale (Cronbach's α = 0.69–0.71, 0.74, 0.75–0.78, 0.60, and 0.51 for friends, family, spouse/partner, job, and education, respectively), Internalizing symptoms (Cronbach's α = 0.80–0.89), and Personal strengths (Cronbach's α = 0.76).

Mean adaptive scale

The mean adaptive scale of the ASR assesses self-rating adaptive functioning in five adaptive areas—friends, family, spouse/partner, job, and education. All participants answered scales of friends and family, and each scale of spouse/partner, job, and education was answered only when it was reported to be relevant during the preceding 6 months. The friends scale consisted of four items asking about the number of close friends, frequency of contact, and quality of relationships, each rated on a scale of 0–3, with the total score being the sum of the four items. The family scale included questions about the relationship with the father, mother, brother, sister, and children, including adopted and stepchildren; only relevant items were answered from 0 to 2, and the total was divided by the number of answered items. Each scale of spouse/partner, job, and education consisted of 8, 8, and 5 items respectively, with 2–4 positive and 4–6 negative content items. Each total score was the sum of the positive items minus that of negative items. The mean adaptive scale was the quotient of the sum of the scores divided by the number of scales answered. In the current study, acceptable reliability was obtained with each Cronbach's alpha: 0.77, 0.94, 0.66, 0.74 and 0.55 for friends, family, spouse/partner, job, and education, respectively.

Internalizing symptoms

Since depression and anxiety are particularly prevalent psychiatric problems in adults with ASD (Gillott & Standen, 2007) and self-assessment of these symptoms has sufficient validity compared to assessment by others in adults with

ASD (Gotham et al., 2015), we used the internalizing problems scale of the ASR. Participants were asked to self-assess regarding the frequency of each problematic behavior on a 3-point Likert scale ranging from 0 to 2 (not true, sometimes true, often true). Syndrome scales consisting of 18 items of anxious/depressed, nine items of withdrawn, and 12 items of somatic complaints were summed up to form the internalizing problems scale. We used raw ASR scores in the analyses, as recommended by Achenbach and Rescorla (2003). In the current study, good reliability was obtained with 0.91, 0.83, 0.80 and 0.80 for the subscales of anxious/depressed, withdrawn, somatic complains, and the Internalizing symptoms of the Cronbach's alphas, respectively.

Personal strengths

The personal strengths of the ASR and ABCL consist of 11 items each for self-rating and ratings by others to assess individual positive aspects. We used 10 of the 11 items of personal strengths. No. 80 (*I stand up for my rights)* of the ASR items and No. 110 (*Makes good decisions*) of the ABCL items were excluded because they are not identical in the ASR and ABCL. Each inquiry was rated on a 3-point Likert scale ranging from 0 to 2 (not true, sometimes true, often true). In the current study, good reliability was obtained with 0.79 and 0.81 for total self-rating and others rating of the Cronbach's alphas, respectively.

Statistical analysis

We examined the normality of each distribution of all variables and used non-parametric tests if they were not normally distributed. Percentage calculations, chi-square tests, and analyses of variances (ANOVAs) were performed for differences in age and gender distribution by group. We also performed another chi-square test to examine differences in education level (high school diploma/junior college or vocational college/bachelor's degree/master's or doctoral degree) among the three groups. On the mean adaptive scale and each of the five adaptive areas, the internalizing symptoms and each of the three component symptoms, and WHOQOL-BREF, we performed 2×3 ANOVAs with the factors of gender and group. For the personal strengths, we performed $2 \times 3 \times 2$ repeated measures ANOVAs with the factors of gender, group, and rater (self/other). As post hoc tests, Bonferroni-adjusted p-values were reported for multiple comparisons. Furthermore, for self-evaluation and/or evaluation by others, in which we found significant results in the high group by the above-mentioned three-way ANOVA on the total score of personal strengths, we performed multiple regression analyses to examine the contributions of the total score of personal strengths and the

autistic traits (high or low group) to each of the mean adaptive scales, QOL, and internalizing symptoms. We included an interaction between personal strengths and autistic traits in the regression models to examine whether personal strengths moderated the relationship between autistic traits and the dependent variables. We analyzed them by gender to examine the gender-specific contributions of personal strengths. Prior to these analyses, we transformed the binary categorical variables of the high and low groups to 1 and −1 by effect coding, respectively, and the other independent variable of the personal strengths to be mean-centered by centering within cluster and then computed the interaction using those variables. Multicollinearity was evaluated using the variance inflation factor (VIF).

We used IBM SPSS Statistics version 27.0 (SPSS Japan Inc.) for all statistical analyses. Statistical significance was set at $p < 0.05$.

Results

Details of the descriptive statistics of all participants are shown in Table 1. The proportions of genders were similar among the groups (χ^2 (2) = 3.24, $p = 0.198$, Cramer's V = 0.077). The 2×3 ANOVA on age with factors of gender and group showed no main effects or interaction (gender: F (1,541) = 3.76, $p = 0.053$; group: F (2,541) = 2.69, $p = 0.069$; and gender×groups: F (2,541) = 2.10, $p = 0.123$). The education levels (high school diploma/junior college or vocational college/bachelor/master's or doctoral degree) among the three groups were similar (χ^2 (6) = 10.92, $p = 0.091$, Cramer's V = 0.100), and all participants had a high school diploma or higher. Regarding the composition of the attributes of other raters, no significant difference was found between the low and high groups ($p = 0.635$), and spouse/partner, parent/sibling, and friends were 80.9% ($n = 72$), 12.4% ($n = 11$), and 6.7% ($n = 6$), respectively, in the high group and 83.8% ($n = 342$), 9.1% ($n = 37$), and 7.1% ($n = 29$), respectively, in the low group. However, the distributions in the ASD group differed from those in the other two groups (χ^2 (4) = 208.43, $p < 0.001$, Cramer's V = 0.436), with 90% ($n = 45$) of other raters in the ASD group being a parent/sibling and 10% ($n = 5$) being a spouse/partner.

Confirmation of autistic traits, adaptive functioning, internalizing symptoms, QOL, and personal strengths

All variables were normally distributed, except for the others rating of the ASSQ. Therefore, on both self-rating and others rating of the ASSQ, we performed the Kruskal–Wallis test with the group factor, followed by multiple comparisons

Table 1 Group and gender differences between the ASSQ, ASR, and WHOQOL-BREF

	Low (N=408)		High (N=89)		ASD (N=50)		Significant differences
	Male (N=208)	Female (N=200)	Male (N=49)	Female (N=40)	Male (N=32)	Female (N=18)	
	Mean (SD)		Mean (SD)		Mean (SD)		
Age	30.9(5.6)	31.0(5.7)	30.9(8.5)	30.2(8.3)	30.6(7.5)	26.7(5.3)	
Range	19–42	19–43	19–46	19–48	18–47	20–39	
IQ	–		–		103.4(13.2)	103.6(16.6)	
Range					78–128	74–134	
ASSQ							
Self–rating [a] [0 to 54,α=0.94]	5.7(4.7)	4.6(3.7)	24.2(7.3)	22.1(10.3)	26.7(10.1)	23.1(10.7)	L<H.A, F<M
Others rating [a] [0 to 54,α=0.94]	3.3(3.9)	2.4(2.9)	13.0 (9.0)	16.2(9.8)	18.5(12.8)	21.4(9.5)	L<H.A
ASR							
Mean adaptive scale [0 to 7.3]	3.2(1.4)	3.9(1.5)	3.1(1.5)	2.9(1.5)	1.0(1.4)	1.4(1.2)	M:A<H.L F:A<H<L,L:M<F
Friends [0 to 12,α=0.77]	5.9(3.0)	7.4(2.8)	6.9(3.4)	6.1(2.5)	3.1(3.1)	4.3(3.0)	M:A<H.L F:A.H<L, L:M<F
Family [0 to 2,α=0.94]	1.45(0.5)	1.57(0.5)	1.21(0.7)	1.26(0.6)	0.93(0.4)	1.25(0.6)	A.H<L M<F
Spouse/Partner [b] [8 to +8,α=0.66]	N=165 4.7(2.9)	N=157 4.2(3.2)	N=32 3.5(2.8)	N=28 3.6(3.1)	N=5 3.2(3.5)	N=2 0	c
Job [b] [-12 to +4,α=0.74]	N=179 0.8(2.3)	N=97 1.0(2.2)	N=38 0.1(2.4)	N=26 –0.5(2.6)	N=17 –3.3(3.9)	N=8 –3.9(4.1)	A<H<L
Education [b] [-4 to +6,α=0.55]	N=30 1.9(2.0)	N=15 2.7(1.8)	N=9 1.7(1.3)	N=11 2.3 (2.3)	N=8 0.4(2.7)	N=7 0.3(1.3)	A<H.L
Internalizing symptoms [0 to 78,α=0.80]	9.0(9.3)	10.4(8.1)	18.3(13.8)	23.5(14.1)	37.8(9.9)	36.0(15.1)	L<H<A
Anxious/Depressed [0 to 36,α=0.91]	4.9(5.3)	5.9(4.9)	9.2 (7.6)	13.0(7.3)	20.9(6.3)	18.4(8.6)	H:M<F M&F:L<H<A
Withdrawn [0 to18,α=0.83]	2.5(3.0)	2.5(2.6)	5.0(4.0)	5.7(3.8)	10.8(2.1)	9.2 (4.2)	L<H<A
Somatic Complaints [0 to 24,α=0.80]	1.6(2.2)	2.1(2.3)	4.1(4.7)	4.7(4.5)	6.1(4.3)	8.4(6.2)	L<H<A, M<F
WHOQOL-BREF [0 to 130,α=0.92]	85.4(12.7)	80.5(12.5)	87.3(12.1)	77.9(15.2)	–	–	H<L

ASSQ, Autism Spectrum Screening Questionnaire; ASR, Adult Self Report; WHOQOL-BREF, World Health Organization Quality of Life Assessment-Brief version; N, number of participants; SD, standard deviation; L, low traits group; H, high traits group; A, ASD group; M, male; F, female; α, Cronbach's alpha. In square brackets, the score range and Cronbach's alphas are shown. All variables, except the ASSQ, were analyzed by two-way ANOVAs and the Bonferroni adjusted post hoc test. Only significant results are shown

[a] The ASSQ was analyzed using a non-parametric test (Kruskal–Wallis test for group and Mann–Whitney test for gender) due to the assumption of a non-normal distribution of other-rated ASSQ.

[b] Only for those who reported relevance during the preceding 6 months

[c] Although the main effect of the group was significant, the post hoc test did not show significant differences

(Bonferroni's correction) and the Mann–Whitney test with the gender factor. For both self-rating and others rating of the ASSQ, group differences were found between the low group and each of the other two groups (low<high, low<ASD, both adjusted $p<0.001$), but not between the high and ASD groups (self: adjusted $p=1.000$, others: adjusted $p=0.687$). Gender differences were found only in self-rated ASSQ (female<male, $p=0.002$) and not in the others rated ASSQ ($p=0.174$). Table 1 shows the status of the high group regarding all measures used in the current study, compared to that of the low and ASD groups.

On the mean adaptive scale, 2×3 ANOVA with factors of gender and group showed a significant group difference ($F(2,541)=56.89$, $p<0.001$, $\eta p^2=0.174$) and an interaction effect ($F(2,541)=4.156$, $p=0.016$, $\eta p^2=0.015$). The following simple main effect tests showed significant group differences by gender (male: ASD<high, low, both adjusted $p<0.001$; female: ASD<high, $p=0.001$, high<low, $p<0.001$), indicating that the high group males adapted better than the ASD males and equally well as the low group males. We also found similar results of the high group male in "friend," one of the five adaptive areas, a main effect

in the group factor (friend: $F(2,541)=21.37$, $p<0.001$, $\eta p^2=0.073$) and an interaction effect $F(2,541)=5.67$, $p=0.004$, $\eta p^2=0.021$). The subsequent post hoc analysis showed the differences by gender (male: ASD < low, high, both adjusted $p<0.001$; female: ASD < low, adjusted $p<0.001$, high < low, adjusted $p=0.027$). On the other adaptive areas, we found main effects in the group factor (family: $F(2,541)=20.98$, $p<0.001$, $\eta p^2=0.072$; partner/spouse: $F(2,383)=4.26$, $p=0.015$, $\eta p^2=0.022$; job: $F(2,359)=36.02$, $p<0.001$, $\eta p^2=0.167$; education: $F(2,74)=5.59$, $p=0.005$, $\eta p^2=0.131$) without interaction, and each subsequent multiple comparison analysis showed varied extents of adaptive functioning across areas in the high group. In "family," the high group had significantly lower adaptation than the low group (adjusted $p<0.001$), but it was similar to that in the ASD group (adjusted $p=0.322$). In "job," the scores of the high group were significantly higher than those of the ASD group (adjusted $p<0.001$) and lower than those of the low group (adjusted $p=0.013$). In "education," the values were similar between the high and low groups, while the high group had significantly higher adaptive scores than the ASD group (adjusted $p=0.047$). In "spouse/partner," post hoc analysis showed no significant differences among the groups. We found a main effect of gender only in family ($F(1,541)=6.42$, $p=0.012$, $\eta p^2=0.012$). The high group also appeared to retain the response percentages of selective adaptive areas. The rate of having a spouse/partner was 67.4% in the high group (males 65.3%; females 70.0%) and 78.9% in the low group (males 79.3%; females 78.5%). The rate of having a job was 71.9% in the high group (males 77.6%; females 65.0%) and 67.6% in the low group (males 86.0%; females 48.5%). The ASD group had the lowest rates in partner/spouse (14%) and job (50%), but in education, the ASD group had the highest rates (30%), followed by the high group (22.4%) and the low group (11.0%).

Regarding internalizing symptoms, we found a main effect of the group factor ($F(2,541)=177.01$, $p<0.001$, $\eta p^2=0.396$) and significant differences among groups (low < high, high < ASD, both adjusted $p<0.001$). No significant interaction effects were observed. Details of every composite symptom scales of "anxious/depressed," "withdrawn," and "somatic complaints," are shown in Table 1.

We compared the QOL data between the low and high groups and found a main effect of groups ($F(1,493)=22.99$, $p<0.001$, $\eta p^2=0.045$), showing that the high group had lower scores than the low group ($p<0.001$).

On the total personal strengths, the $2\times2\times3$ three-way repeated measures ANOVA with the factors gender, group, and rater revealed a main effect of group ($F(2,541)=3.53$, $p=0.030$, $\eta p^2=0.013$) and a three-way interaction ($F(2,541)=3.46$, $p=0.032$, $\eta p^2=0.013$) (Table 2).We found

a simple interaction effect of rater×gender only in the high group (low: $p=0.309$, high: $p=0.027$, ASD: $p=0.364$) and simple–simple main effects on females in the high group (self < others, $p=0.001$) and on males in the ASD group (others < self, $p=0.045$). We also found a simple interaction of rater×group only in females (male: $p=0.099$; female: $p=0.001$), but the simple–simple main effects of others rating of personal strengths were revealed in both genders (male: $p=0.003$; female: $p=0.004$). The post hoc tests showed group differences in others rating of personal strengths, being rated higher in the low and high groups than in the ASD group in males (ASD < high, adjusted $p=0.004$; ASD < low, adjusted $p=0.005$), while being rated higher in the high group than in the low group in females (low < high, adjusted $p=0.003$) (Fig. 1). In terms of self-rating of personal strengths, no differences were found among groups in either gender (male: $p=0.172$; female: $p=0.179$). There were no other simple interactions or simple–simple main effects.

As supplementary explorative analyses, the results of the same three-way repeated measures ANOVA on the 10 components of personal strengths are also shown in Table 2. The differences between self-evaluation and evaluation by others in the high group, which were seen in the total score, were also seen in item No. *2: I make good use of my opportunities/Makes good use of his/her opportunities* and No. *49: I can do certain things better than others/Can do certain things better than other people* ($p<0.001$ for each, self < others) by the significant two-way interactions (rater×group) and the subsequent simple main effect tests. Similar results to the total score were also shown in item No. *98: I like to help others/Like to help others*; females in the high group were highly rated by others than those in the low group (adjusted $p=0.023$) and males with ASD were highly rated by themselves than by others ($p<0.001$).

Implications of highly rated personal strengths by others in the high group

We examined the contribution of uniquely observed highly rated total score of personal strengths by others in females in the high group with respect to their adaptive state, and multiple regression analyses by each gender revealed the gender-specific models as shown in Table 3; Fig. 2 with each scatter plot. In males, interaction terms (autistic traits×others rating of personal strengths) were not significant in any model. Others rating of personal strengths provided significant main effects in the model predicting QOL (β [95% confidence interval {CI}] = 0.353 [0.164 to 0.543], $p<0.001$) and adaptive functioning (β [95% CI] = 0.220 [−0.022 to 0.417], $p=0.029$). Autistic traits had a negative main effect in predicting QOL (β [95%

Table 2 Group, gender, and rater differences between self- and others-rated personal strengths

	Low (N=408)		High (N=89)		ASD (N=50)		Interaction[a]	Post hoc analysis[a]
	Male (N=208)	Female (N=200)	Male (N=49)	Female (N=40)	Male (N=32)	Female (N=18)		
	Mean (SD)		Mean (SD)		Mean (SD)			
2. I make good use of my opportunities	0.93 (0.61)	0.82 (0.62)	0.86(0.68)	0.68 (0.66)	0.22 (0.42)	0.67 (0.77)	Rater×Group** Gender×Group*	H: S<O***, L: S<O**
2. Makes good use of his/her opportunities	1.01 (0.70)	0.94 (0.75)	1.00(0.71)	1.13 (0.76)	0.22 (0.49)	0.44 (0.51)		S: A<H*A<L***, O:A<H*** A<L***, M:A<H***A<L*** F: A<L*, A: M<F*
4. I work up to my ability	1.15 (0.63)	0.90 (0.63)	1.18(0.60)	1.00 (0.72)	0.91 (0.73)	1.11 (0.90)	Gender×Group**	M: A<H** A<L*** L: F<M***
4. Works up to ability	1.09 (0.77)	0.89 (0.78)	1.10(0.71)	1.15 (0.74)	0.05 (0.67)	0.94 (0.64)		
15. I am pretty honest	1.12 (0.69)	1.26 (0.62)	1.18(0.70)	1.20 (0.69)	1.44 (0.62)	1.39 (0.61)		L<A** S<O**
15. Is pretty honest	1.20 (0.73)	1.23 (0.74)	1.24(0.72)	1.48 (0.60)	1.50 (0.67)	1.72 (0.46)		
49. I can do certain things better than other people	0.76 (0.71)	0.61 (0.63)	0.76(0.66)	0.73 (0.64)	0.91 (0.73)	1.28 (0.83)	Rater×Group*** Gender×Group**	H: S<O***, S: L<A*** H<A* O: L<H*** L<A*
49. Can do certain things better than other people	0.72 (0.77)	0.52 (0.70)	1.04(0.71)	1.33 (0.62)	0.78 (0.61)	1.11 (0.68)		F: L<A*** L<H***, L: F<M**, A: M<F*
73. I meet my responsibilities to my family	0.82 (0.70)	0.74 (0.66)	0.80(0.67)	0.62(0.71)	0.31 (0.54)	0.33 (0.60)		S<O*** A<L***, A<H***
73. Meets responsibilities to his/her family	0.98 (0.85)	0.86 (0.81)	0.96(0.82)	1.15 (0.66)	0.62 (0.75)	0.67 (0.69)		
88. I enjoy being with people	0.96 (0.76)	1.06 (0.71)	0.96(0.74)	1.00 (0.72)	0.78 (0.71)	0.83 (0.71)		
88. Enjoys being with people	1.02 (0.77)	0.98 (0.78)	1.02(0.63)	1.02 (0.77)	0.69 (0.69)	1.00 (0.69)		
98. I like to help others	0.68 (0.66)	0.80(0.63)	0.80(0.71)	0.85 (0.77)	0.97 (0.78)	0.94 (0.64)	Rater×Group×Gender* Male: Rater×Group** ASD: Rater×Gender* Low: Rater×Gender**	A M: O<S*** F L: O<S** F O: L<H*
98. Likes to help others	0.70 (0.73)	0.62 (0.73)	0.73(0.64)	0.95 (0.78)	0.41 (0.62)	0.67 (0.77)		
106. I try to be fair to others	0.77 (0.68)	0.70 (0.69)	1.00(0.74)	0.87 (0.69)	1.16 (0.72)	1.39 (0.61)		O<S** L<H*** L<A***
106. Tries to be fair to others	0.64 (0.76)	0.58 (0.74)	0.86(0.71)	1.02 (0.80)	0.91 (0.89)	1.00 (0.77)		
109. I like to try new things	0.73 (0.73)	0.66 (0.71)	1.10(0.71)	0.87 (0.69)	0.56 (0.67)	1.22 (0.73)	Rater×Group ** Gender×Group**	H&A: O<S***, L: O<S* S: L<H** M: L<H*
109. Likes to try new things	0.62 (0.72)	0.61 (0.69)	0.73(0.76)	0.63 (0.77)	0.22 (0.55)	0.72 (0.83)		A<H***A<L*, A:M<F**
123. I am a happy person	0.72 (0.64)	0.75 (0.69)	0.86(0.74)	0.85 (0.74)	0.56 (0.67)	0.94 (0.80)	Rater×Group***	L: S<O*** O: A<L*** A<H*
123. He/she is a happy person	1.10 (0.74)	1.11 (0.77)	0.94(0.78)	1.10 (0.71)	0.50 (0.62)	0.78 (0.81)		
Total Self–rating [α=0.79]	8.63 (4.18)	8.31 (3.99)	9.49(3.92)	8.67 (3.85)	7.81 (3.20)	10.11(4.16)	Rater×Group×Gender* Female: Rater×Group** High: Rater×Gender*	H F: S<O**, A M: O<S*
Total Others rating [α=0.81]	9.08 (4.89)	8.33 (4.72)	9.63(3.46)	10.95(4.18)	6.34 (2.68)	8.78 (3.52)		F O: L<H** M O: A<L** A<H**

*** p<0.001 ** p<0.01 * p<0.05. N, number of participants; SD, standard deviation; L, Low traits group; H, High traits group; A, ASD group; M, Male; F, Female; S, Self-rating; O, Others rating; α, Cronbach's alpha. The upper row of each item shows self-evaluation and the lower row shows evaluation by others

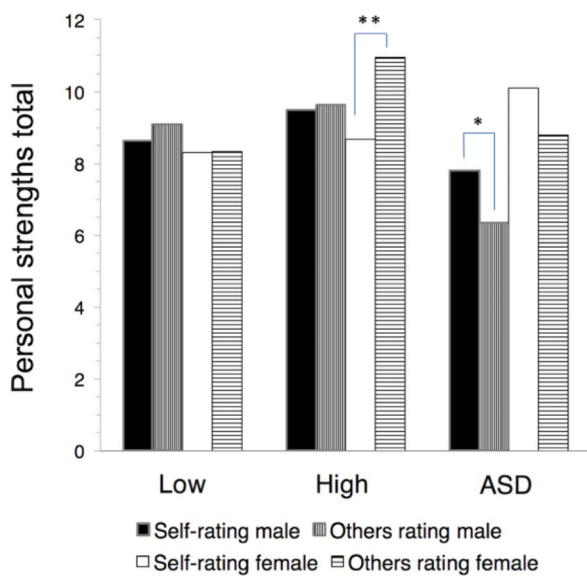[a] Only significant results by three-way repeated measures ANOVA are shown

Fig. 1 Group, gender, and rater differences in personal strengths by ANOVA

** $p < 0.01$ * $p < 0.05$. Low, the group with low autistic traits; High, the group with high autistic traits; ASD, the group with diagnosis of autism spectrum disorder

CI] $= -0.150$ [-0.266 to -0.034] $p = 0.011$) and a positive main effect in predicting internalizing symptoms (β [95% CI] $= 0.336$ [0.219 to 0.452], $p < 0.001$). In females, the interaction terms were significant in the model predicting internalizing symptoms (β [95% CI] $= 0.179$ [0.014 to 0.345], $p = 0.034$). For the interpretation of the interaction, a simple slope test according to the method proposed by Aiken & West (1991) showed a significant simple slope of 0.374 ($p = 0.017$). In females, autistic traits provided negative main effects in predicting adaptive functioning (β [95% CI] $= -0.263$ [-0.382 to -0.144], $p < 0.001$) and QOL (β [95% CI] $= -0.267$ [-0.387 to -0.148], $p < 0.001$) and a positive main effect in predicting internalizing symptoms (β [95% CI] $= 0.462$ [0.350 to 0.574], $p < 0.001$). Others rating of personal strengths provided significant main effects in the

model predicting adaptive functioning (β [95% CI] $= 0.245$ [0.070 to 0.420], $p = 0.006$) and internalizing symptoms (β [95% CI] $= 0.195$ [0.030 to 0.360], $p = 0.021$), suggesting that in females, others rating of personal strengths contributed to an increase not only in adaptive functioning but also in internalizing symptoms, especially in the high group. We confirmed that all VIFs were below 2.165, indicating that multicollinearity was not a problem.

Discussion

We first aimed to investigate the adaptive status (adaptive functioning, QOL, and internalizing symptoms) and personal strengths of the high autistic traits group in the general population. Considering together the result that the high group had as high autistic traits as the ASD group and the fact the high group did not include those who reported any history of illness or neurodevelopmental disorders, indicated that the high group could be considered as an undiagnosed group with autistic traits without clinically significant symptoms. We also showed that the high group was intermediate in adaptive functioning, QOL, and internalizing symptoms, worse than the low group and better than the ASD group. These results are consistent with previous studies showing that high autistic traits can cause relatively poor adaptability compared to those with low autistic traits or typical development (Kanne et al., 2009; Deisinger, 2015).

With regard to adaptive functioning, previous studies showing poor adaptation of the non-clinical autistic population have focused on specific adaptive areas, such as friends or romantic relationships (Pollmann et al., 2010; Wainer et al., 2013), hence the overall adaptive functioning or utilization of each adaptive area of that population has not been well examined. The high group had a comparable number of adaptive areas to the low group and showed an intermediate degree of overall adaptive functioning with varied degrees across adaptive areas, from relatively better adaptation in friends and education to poorer adaptation

Table 3 Multiple regression analyses predicting adaptive status by others rating of personal strengths and autistic traits

	Independent variables	QOL			Adaptive functioning			Internalizing symptoms		
		Adj R²	β	p	Adj R²	β	p	Adj R²	β	p
Male	Autistic traits (High1/Low–1)	0.116	-0.150	**0.011**	0.042	-0.021	0.734	0.104	0.336	**< 0.001**
	Others rating PS		0.353	**< 0.001**		0.220	**0.029**		0.035	0.720
	Interaction		0.042	0.667		-0.014	0.892		-0.015	0.878
Female	Autistic traits (High1/Low–1)	0.116	-0.267	**< 0.001**	0.132	-0.263	**< 0.001**	0.223	0.462	**< 0.001**
	Others rating PS		0.105	0.240		0.245	**0.006**		0.195	**0.021**
	Interaction		-0.147	0.101		-0.035	0.650		0.179	**0.034**

The categorical variables of the groups (high and low) were effect-coded and transformed into 1 and −1. P-values below 0.05 are in bold font. Adj R², adjusted R-squared; PS, personal strengths
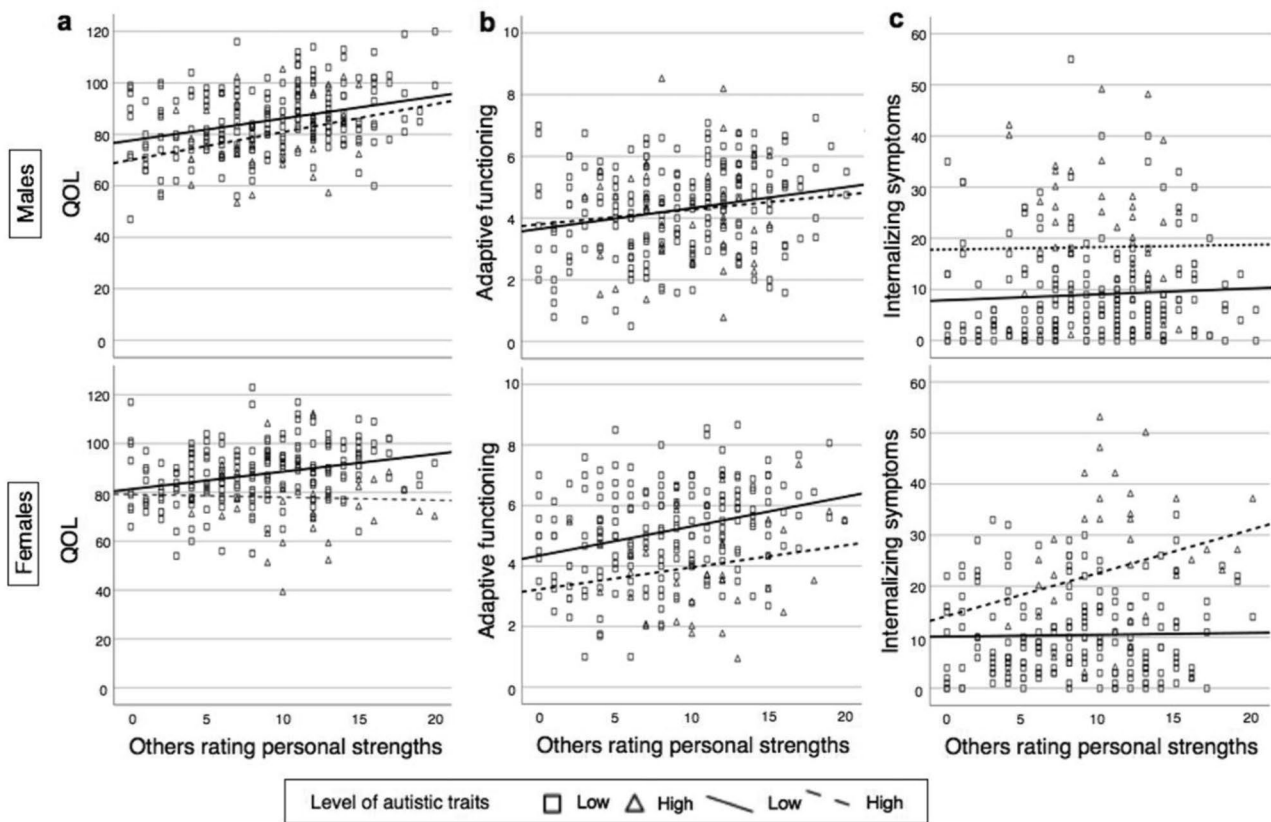
Fig. 2 Regression lines for adaptive status by others rating of personal strengths and autistic traits
 Low, the group with low autistic traits; High, the group with high autistic traits; WHOQOL-BREF, World Health Organization Quality of Life Assessment-Brief Version. Males are shown in the upper panels, and females are shown in the lower panels. Contributions of personal strengths by others and autistic traits (low/high) to each adaptive status of (a) QOL, (b) adaptive functioning, and (c) internalizing symptoms

in family. Non-clinical autistic people may compensate for poor adaptation in primary relationships, such as family, by developmentally shifting to other adaptive areas where opportunities and comfort are easier to find. A future elaborate investigation of these issues is needed.

In terms of personal strengths, although there were no striking features in the high group's self-rating, we found that the discrepancies between self-rating and others rating of personal strengths were common in the high and ASD groups both with autistic traits, whereas no discrepancies were found in the low group, which may be due to autism-related deficiencies in the processing of self-referenced information (Lombardo & Baron-Cohen, 2010). Remarkably, these discrepancies were in opposite directions—highly estimated by others than by self in the high group, whereas highly estimated by self than by others in the ASD group. The results of the ASD group were consistent with those of previous studies, indicating that individuals with ASD reported significantly less about their own autistic traits and symptoms than others (Johnson et al., 2009; Griffin et al., 2016). To further support our findings, individuals

with ASD portrayed themselves more favorably than others (parents) (Schriber et al., 2014). These might be discussed in terms of the effect of "arrogant egocentrism" (Attwood, 2007) or "naïve egocentrism" (Frith & de Vignemont, 2005) in ASD to overcompensate for one's inadequacy in social situations, which is limited by the fact that we found no significant difference among groups in the self-rating of personal strengths in the current study. Another possible explanation is in terms of the harshness of parents' evaluations, which are prone to being rated with sensitivity to the autism-related deficits of their own children (Lee et al., 2008). We cannot exclude these effects as most of the other evaluators in the ASD group were parents or siblings in our study. Since such a situation is often unavoidable in the clinical population, it should be considered when interpreting the results.

The opposite discrepancy of personal strengths highly rated by others in the high group was observed in females, which is generally consistent with those reported in a child study by Dworzynski et al. (2012). The researchers showed the significantly higher scores of the subclinical girls with

autistic traits in the others (teacher)-rating prosocial individual strengths items of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997) compared to that of boys and children with diagnosed ASD, which was not a major outcome of their study and only interpreted as follows without further analysis: the subclinical girls with autistic traits are likely to cope and adapt better. Whether the subclinical girls with autistic traits are actually better at coping and adapting is a question that needs to be considered along with the secondary aim of the current study. Interestingly, others rating of personal strengths of females in the high group actually contributed to an increased overall adaptive functioning as we expected and worsened internalizing symptoms contrary to our prediction. The combination of these ambivalent contributions in the high group females, which are not found in those of males or other groups, reminds us of the concepts of "over-adaptation", which has been widely recognized in mental health and educational fields for several decades in Japan and defined as the pro-active attitude to meet the environment demands while suppressing internal own needs (Ishizu & Ambo, 2008). "Over-adaptation" is more prevalent in females, and has a temporary positive effect on adaptation, but can also lead to clinical problems such as exhaustion and depression (Sugawara et al., 2013). These discussed points are in common with those in the concepts of "compensation" or "camouflaging" which are conscious or unconscious adaptive strategies to minimize the effect of autistic traits (Livingston et al., 2019; Lai et al., 2017). In line with literature, our results of females in the high group could be considered an excessive pursuit of meeting the demand of the environment or as the result of compensatory learning of socially desirable manner and behavior, which has not been well investigated in relation to the high others-rated strength. Further investigation of qualitative research or evaluation of its correlations with measurement of over-adaptation or compensation/camouflage (e.g., CAT-Q (Hull.et.al., 2019)) is needed. Given the traditional value of attuning others' expectations and unique sensitivity to the surrounding situation for adaptation in Japanese culture (Morling et al., 2002), our findings might be culturally limited and further examination across cultures is also required.

Our expectation in focusing on the positive aspect of the personal strength was to explore something that the individuals with autistic traits who do not impair current functioning to a clinically meaningful level have developed for better adaptation. As we predicted, the high group females tended to be highly evaluated by others for their strengths, which contributed to their better adaptative functioning. In the supplementary analysis of the personal strength items, such higher evaluation by others in the high group than in the low group was noticeable in the items such as "Can do

certain things better than other people," or "Likes to help others," suggesting that some abilities or trends associated with autistic traits (e.g., special interest, result-oriented morality) may have been utilized. These perspectives of understanding the individuals who have autistic traits without clinically significant impairment in the general population might be the important reference for effective clinical support across the lifespan of the ASD diagnosed (Honda., 2017).

Given the likelihood that females with autistic traits who developed compensatory strategies such as camouflage/compensation are easily overlooked in the daily clinical settings, various clues are needed to recognize, understand and intervene with them. Our findings may provide an opportunity to recognize individuals who are seemingly well-adjusted but are struggling with persistent problems related to their high autistic traits, in pre-clinical settings, such as educational and working environments. They may manage to maintain stability by contributing their own traits to their adaptation, which tend to be evaluated positively by others. But their excessive tendencies are actually inextricably linked to the enhancement of the internal symptoms and other distress. Environmental considerations must be made based on understanding this inextricable link. At the same time, it is necessary to assess whether their adaptive strategies are working or failing and to prompt clinical intervention when appropriate. To understand these populations and to examine the clinical intervention process further in detail, it is essential to accumulate findings on the factors that contribute to the adaptation of the individuals with autistic traits in the general population.

Limitation

We aimed to present the characteristics of the high group prominently by comparing with the low and ASD groups. In particular, we explored the strengths of the high group, which remained non-clinical despite having the same autistic traits as those of the ASD group. Due to concerns that ASD respondents who could convene online might be biased toward milder forms of symptoms and may be closer to the high group than to the clinical group, we used the data from the first hospital visit for the ASD group. However, the possible effects of these different samplings cannot be ruled out and must be considered when interpreting the results.

Conclusion

This study explored the adaptation and strength of a non-clinical autistic population. We have shown that non-clinical autistic individuals, the high group, retained intermediate adaptive

functioning between the low and ASD groups with sufficient choice in each adaptive area showing those varied degrees. Furthermore, in the high group, especially in females, personal strengths were evaluated highly by others, which appeared to lead to not only better adaptive functioning but also increased internalizing symptoms. Exploring the styles of adaptation and strengths of the subclinical autistic population from a gender-specific perspective may provide useful suggestions not only for screening for those who may be missed under the current autism diagnostic criteria but also for long-term interventions for individuals with ASD.

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