

Factor analysis of the Chinese version of the Autism Spectrum Quotient 10 and its association with schizotypal traits in adolescents and young adults in Hong Kong

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CME

Abstract

Background: There is evidence suggesting that autistic traits are associated with schizotypal traits. This study examined the factor structure of the Autism Spectrum Quotient 10 (AQ-10) and its associations with schizotypal traits (measured by the Schizotypal Personality Questionnaire-Brief [SPQ-B]) in a cohort of Chinese adolescents and young adults.

Methods: Invitation letters, stratified by locations and housing types, were randomly sent to individuals aged 15 to 24 years for participation. Assessments were made using face-to-face or online interviews. Autistic traits were assessed using the Chinese version of the AQ-10. Schizotypal personality traits were assessed using the Chinese version of the 22-item SPQ-B.

Results: In total, 395 male and 536 female participants (mean age, 19.93 years) were recruited between July 2020 and May 2021. Exploratory factor analysis of the AQ-10 yielded three factors (theory of mind, task switching, and attention deficits) explaining 55.11% of the total variance. Autistic traits were positively correlated with schizotypal traits of disorganised features ($r = 0.21$, $p < 0.001$), interpersonal relationship deficits ($r = 0.19$, $p < 0.001$), and cognitive-perceptual deficits ($r = 0.11$, $p = 0.001$).

Conclusion: In Chinese adolescents and young adults, autistic traits, especially task switching and attention deficits (compared with theory of mind) are more closely correlated with schizotypal personality traits. Disentangling the overlapping and diametrical structure of autistic traits and schizotypal traits may help understand their aetiologies, assessment, and interventions.

Key words: Adolescent; Autistic disorder; Autism spectrum disorder; Schizotypal personality disorder; Young adult

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Introduction

Autism spectrum disorder (ASD) and schizotypal personality disorder (SPD) have wide-reaching effects on not only the patients but also their families and the healthcare system.^{1,2} There is evidence suggesting an association between these two neurodevelopmental disorders.³ ASD is characterised by deficits in interpersonal relationships, theory of mind, attention, and task switching,⁴ whereas SPD is characterised by ideas of reference, social anxiety, odd/magical beliefs, unusual perceptions, odd/eccentric behaviour, a lack of close friends, disorganised speech, constricted affect, and suspiciousness.⁵ Understanding the overlapping and differential features of the two disorders at the subclinical level may help understand their aetiologies and development.

The 10-item Autism Spectrum Quotient (AQ-10) is a validated, culture-free, self-report tool for screening individuals aged ≥ 16 years for traits of autism (attention to detail, task switching, communication, imagination, and social aspects).⁷ Individuals who score >6 should undergo a full diagnostic assessment. The AQ-10 is more feasible to be implemented in large-scale studies and performs well in identifying individuals with ASD.⁶ However, findings

regarding its robustness in the general population have been mixed. In a study of 6595 adults, the psychometric properties of the AQ-10 supported a four-factor, rather than unifactorial, structure comprising cognitive and affective aspects of autistic trait.⁸ The AQ-10 has poor internal reliability, probably owing to cultural or sex differences in autistic traits.^{9,10} Its total score is correlated with the performance of social psychological skill.¹¹ Similarly, the AQ-10 has convergent validity for measuring autistic traits in the general population.¹² However, whether the factor structure and validity of the AQ-10 are applicable to the Chinese youth population warrants investigation.

Schizotypy, or schizotypal personality traits, is a multidimensional construct that comprises attenuated schizophrenia-spectrum disorder symptoms. It is conceptualised as an endophenotype for the development of schizophrenia.¹³ Both the positive and negative types of schizotypy share similar neurological, psychological, and behavioural characteristics, including interpersonal impairment, cognitive-perceptual deficits, and disorganised speech and behaviours.^{13,14} The 22-item Schizotypal Personality Questionnaire-Brief (SPQ-B) has a three-factor structure (cognitive-perceptual deficits, interpersonal relationship deficits, and disorganised features) and is widely used to assess schizotypal characteristics among different age groups and cultures.¹⁵⁻¹⁷

Autistic traits are closely associated with schizotypal traits,^{3,10} and they have common genetic and non-genetic risk factors.¹⁸ Disentangling the overlapping and diametrical structure of both traits may help elucidate their aetiologies and improve diagnosis and treatment. Individuals with ASD or SPD may display similar social and communication impairments.³ It is important to differentiate the two and ensure that appropriate interventions are implemented.

In a meta-analysis,³ autistic traits are correlated with negative schizotypal traits ($r = 0.536$) and disorganisation ($r = 0.355$) and positive schizotypal traits ($r = 0.256$). Autism and schizophrenia share common genetic¹⁹ and environmental risk factors²⁰ but differ in developmental neurobiology.²¹ Social cognitive deficits in ASD and SPD are associated with different brain mechanisms.²² Children with comorbid ASD and SPD outperform children with either ASD or SPD in attentional set-shifting and social-pragmatic abilities; this suggests attenuated impairment and a compensatory effect.²³ However, whether there is a compensatory effect across age groups and the underlying mechanism between the two disorders requires further investigation.

Among the general population, interpersonal aspects of autistic traits are positively associated with negative schizotypal traits,²⁴ whereas disorganisation schizotypal traits have a moderate-to-weak association with autistic-like social and communicative impairments.²⁵ However, other studies found very weak or no associations between the two disorders.^{26,27} Autistic and positive schizotypal traits may have opposing effects on perspective-taking abilities²⁸ and saliency cost.²⁹ These mixed findings may be due to the

use of different measurement tools and non-homogenous samples (eg, a sex effect).⁹

In addition, cultural differences might play a role in autistic traits; for example, Japanese children scored 5 points lower on average than Western children,¹⁰ whereas Japanese adults scored approximately 6 points higher on average than British adults.³⁰

The validity of the AQ-10 has not been examined in the Chinese population, especially in adolescents and young adults. There have been no studies investigating the relationship between different dimensions of autistic traits and schizotypal traits using the AQ-10 and SPQ-B. Previous studies have treated the AQ-10 as a unidimensional construct.³¹ This study examined the factor structure of the AQ-10 and its associations with schizotypal traits (measured by the SPQ-B) in a cohort of Chinese adolescents and young adults. It was hypothesised that the AQ-10 would be a multidimensional construct and each AQ-10 subscale would be associated with each SPQ-B subscale. The findings of this study can facilitate clinicians in the administration of assessments and interventions for ASD and SPD.

Methods

Participants were recruited from the ongoing Hong Kong Youth Epidemiological Study of Mental Health. This is a territory-wide, household-based epidemiological study of mental disorders in young people in Hong Kong. The study adopts a stratified multi-stage cluster sampling design to ensure a representative sample.³² Young people living in the community were recruited from April 2019. Randomly selected addresses, stratified by locations and housing types, were provided by the Census and Statistics Department. Invitation letters were sent to individuals aged 15 to 24 years for participation. Assessments were made using face-to-face or online interviews, depending on the COVID-19 control measures at the time of assessment.

Autistic traits were assessed using the Chinese version of the AQ-10, which consists of three dimensions: theory of mind, task switching ability, and attention deficits. Each item is rated using a four-point Likert scale from 1 ('definitely disagree') to 4 ('definitely agree'). The total raw and factor scores are computed by summation of the score of individual items. A standardised scoring method is also applied to compute the summation of the binary item scores.⁶ Higher total scores (raw and standardised) indicate higher levels of autistic traits.

Schizotypal personality traits were assessed using the Chinese version of the 22-item SPQ-B,^{17,33} which is a short version of the 74-item SPQ.¹⁵ The SPQ-B construct comprises three factors: cognitive-perceptual deficits, interpersonal relationship deficits, and disorganised features^{16,34} and has been validated in Chinese children and adolescents.¹⁷ Each item is rated as 1 ('yes') or 0 ('no') based on the patient's experience in the previous 6 months. Higher total and factor scores indicate higher levels of schizotypy.

Statistical analyses were performed using SPSS (Windows version 25.0; IBM Corp, Armonk [NY], United States). Exploratory factor analysis was performed for the AQ-10. Descriptive data analysis and Pearson correlational analyses were performed for the AQ-10, SPQ-B, and sociodemographic variables.

Results

In total, 395 male and 536 female participants (mean age, 19.93 years) were recruited between July 2020 and May 2021. Of these, 65.5% had completed secondary school and 34.0% had a higher level of education.

The Cronbach's alphas of the AQ-10 were fair for the total raw score ($\alpha = 0.52$) and the three subscores ($\alpha = 0.76$ for theory of mind, $\alpha = 0.66$ for task switching, and $\alpha = 0.33$ for attention deficits), whereas the Cronbach's alphas of the SPQ-B were acceptable in terms of overall schizotypal traits ($\alpha = 0.86$) and subscales of cognitive-perceptual deficits ($\alpha = 0.66$), interpersonal relationship deficits ($\alpha = 0.79$), and disorganised features ($\alpha = 0.71$).

An exploratory factor analysis of the AQ-10 was conducted using principal axis factoring and varimax rotation. Three factors were identified in the scree plot and explained 55.11% of the total variance. The first factor (theory of mind) explained 24.68% of the variance (eigenvalue = 2.76); the second factor (task switching) explained 15.42% of the variance (eigenvalue = 1.59); and the third factor (attention deficits) explained 15% of the

variance (eigenvalue = 1.16). Items 5, 6, 9, and 10 loaded on factor 1 (theory of mind), with item 10 cross-loading on attention; items 3 and 4 loaded on factor 2 (task switching); and items 1, 2, 7, and 8 loaded on factor 3 (attention deficits) [Table 1]. Scores of the AQ-10 and the SPQ-B among the 931 participants are shown in Table 2.

For the AQ-10, theory of mind score was positively correlated with task switching score and negatively correlated with attention deficits score, total standardised score, and total raw score (Table 3). The task switching score was positively correlated with theory of mind score and negatively correlated with total standardised score and total raw score. Attention deficits score was positively correlated with total standardised score and total raw score and negatively correlated with theory of mind score. Task switching score was not correlated with attention deficits score.

The total standardised and raw scores of the AQ-10 were positively correlated with the total and all subscale scores of the SPQ-B; correlation of the SPQ-B was stronger with autistic traits of tasking switching and attention deficits than with theory of mind (Table 3).

The AQ-10 theory of mind score was negatively correlated with SPQ-B cognitive-perceptual deficits score and SPQ-B interpersonal relationship deficits score and was positively correlated with SPQ-B disorganised features score (Table 3). The AQ-10 task switching score was negatively correlated with SPQ-B cognitive-perceptual deficits score and SPQ-B interpersonal relationship deficits

Table 1. Exploratory factor analysis of the Chinese version of the Autism Spectrum Quotient 10

Item	Loading		
	Factor 1 (theory of mind)	Factor 2 (task switching)	Factor 3 (attention deficits)
1. I often notice small sounds when others do not	0.395	-0.283	0.623
2. I usually concentrate more on the whole picture, rather than the small details	0.143	0.175	0.486
3. I find it easy to do more than one thing at once	0.172	0.801	0.159
4. If there is an interruption, I can switch back to what I was doing very quickly	0.178	0.817	0.059
5. I find it easy to 'read between the lines' when someone is talking to me	0.765	0.263	-0.032
6. I know how to tell if someone listening to me is getting bored	0.783	0.080	0.026
7. When I am reading a story, I find it difficult to work out the characters' intentions	-0.327	0.072	0.585
8. I like to collect information about categories of things (eg, types of car, types of bird, types of train, types of plant, etc)	-0.050	0.107	0.489
9. I find it easy to work out what someone is thinking or feeling just by looking at their face	0.805	0.152	0.017
10. I find it difficult to work out people's intentions	-0.524	-0.083	0.513

score. The AQ-10 attention deficits score was positively correlated with SPQ-B cognitive-perceptual deficits score, SPQ-B interpersonal relationship deficits score, and SPQ-B disorganised features score.

Discussion

In the exploratory factor analysis, the AQ-10 had a three-factor structure (theory of mind, tasking switching, and attention deficits) explaining 55.11% of the total variance.

Table 2. Scores of the Autism Spectrum Quotient 10 and the Schizotypal Personality Questionnaire-Brief among 931 participants

Tool	Mean ± standard deviation (range) score
Schizotypal Personality Questionnaire-Brief	
Cognitive-perceptual problems	2.22 ± 1.91 (0-8)
Interpersonal relationship deficits	2.84 ± 2.31 (0-8)
Disorganised feature	1.22 ± 1.51 (0-6)
Total	6.29 ± 4.76 (0-22)
Autism Spectrum Quotient 10	
Theory of mind	11.79 ± 2.22 (4-16)
Task switching	4.90 ± 1.33 (2-8)
Attention deficits	9.30 ± 1.71 (4-15)
Summation of binary item score	3.66 ± 1.90 (0-10)
Summation of raw item score	22.60 ± 3.50 (11-37)

Overall autistic traits were positively correlated with overall and individual schizotypal personality traits; correlation of schizotypal traits was stronger with autistic traits of task switching and attention deficits than with theory of mind. The autistic trait of task switching was not correlated with the autistic trait of attention deficits. These findings are consistent with the existing literature.^{3,24,25,27} Importantly, these findings suggest that there is an overlapping and diametrical structure of autistic traits and schizotypal traits; understanding the aetiologies of the two neurodevelopmental disorders may help in their assessment and intervention.

No significant correlation between the autistic traits of task switching and attention deficits is probably because of the low internal reliability for attention deficits ($\alpha = 0.33$), which might have affected the predictive power of the attention deficits scores. One possible explanation is the differences between Chinese and Western cultures, for instance, East Asians are found to allocate their attention more broadly than Americans.³⁵ The timing difference in the development of theory of mind between Chinese and North American children is ≥ 2 years.³⁶ These findings suggest that there may be specific experiential factors in the development of theory of mind and attention across cultures. In addition, the AQ-10 has poor internal reliability.⁸ In future studies, the Chinese version of the AQ-10 subscale of attention deficits may be modified to address the cultural differences.

Overall autistic traits were positively correlated with overall and individual schizotypal traits; this suggests shared aetiological mechanisms.¹⁸ Identifying similarities and differences between autistic traits and schizotypal traits can facilitate better assessment and intervention for both conditions. The three autistic traits were differentially correlated with the three schizotypal traits; correlation of schizotypal traits was stronger with autistic traits of tasking

Table 3. Correlations between Autism Spectrum Quotient 10 (AQ-10) and Schizotypal Personality Questionnaire-Brief (SPQ-B)

AQ-10	SPQ-B				AQ-10				
	Total	Cognitive-perceptual deficits	Interpersonal relationship deficits	Disorganised features	Theory of mind	Task switching	Attention deficits	Summation of binary item score	Summation of raw item score
Theory of mind	$r = -0.03$, $p = 0.31$	$r = -0.10$, $p = 0.002$	$r = -0.07$, $p = 0.05$	$r = 0.09$, $p = 0.01$	-	$r = 0.31$, $p < 0.001$	$r = -0.11$, $p = 0.001$	$r = -0.67$, $p < 0.001$	$r = -0.81$, $p < 0.001$
Task switching	$r = -0.15$, $p < 0.001$	$r = -0.17$, $p < 0.001$	$r = -0.15$, $p < 0.001$	$r = -0.06$, $p = 0.08$	$r = 0.31$, $p < 0.001$	-	$r = 0.01$, $p = 0.80$	$r = -0.55$, $p < 0.001$	$r = -0.58$, $p < 0.001$
Attention deficits	$r = 0.21$, $p < 0.001$	$r = 0.22$, $p < 0.001$	$r = 0.13$, $p < 0.001$	$r = 0.18$, $p < 0.001$	$r = -0.11$, $p = 0.001$	$r = 0.01$, $p = 0.80$	-	$r = 0.48$, $p < 0.001$	$r = 0.55$, $p < 0.001$
Summation of binary item score	$r = 0.20$, $p < 0.001$	$r = 0.11$, $p = 0.001$	$r = 0.19$, $p < 0.001$	$r = 0.21$, $p < 0.001$	-	-	-	-	-
Summation of raw item score	$r = 0.18$, $p < 0.001$	$r = 0.08$, $p = 0.02$	$r = 0.19$, $p < 0.001$	$r = 0.19$, $p < 0.001$	-	-	-	-	-

switching and attention deficits than with theory of mind. This indicates distinct associations between specific autistic traits and specific schizotypal traits. Specifically, cognitive or executive functioning deficits (found in individuals with autistic traits) are associated with cognitive and social problems (found in individuals with schizotypal traits). These findings suggest shared underlying neurocognitive mechanisms between the two conditions, particularly in the domains of higher-order cognitive control and information processing in social contexts. Also, task switching and disorganised features are found to be distinct features of autism and schizotypy, respectively.^{25,27} Attention deficits (found in individuals with autistic traits) are associated with cognitive-perceptual deficits, interpersonal relationship deficits, and disorganised features (found in individuals with schizotypal traits).³ These findings highlight the importance of attentional and executive control processes as common areas of difficulty across the autism-schizotypy spectrum. In addition, higher theory of mind level (found in individuals with autistic traits) was associated with more disorganised features (found in individuals with schizotypal traits). This suggests that the ability to understand and reason about mental states, while often impaired in autism, may be related to the disorganised thinking and behaviour characteristic of schizotypy in a more complex way. This is in line with previous findings that autistic traits (particularly speech problems) found during childhood are associated with psychotic experiences in adolescence.³⁷ However, whether autistic traits are the early precursor of schizotypal traits is yet to be examined. All these findings suggest a dimensional and overlapping association between the core features of autism and schizotypy, with cognitive, attentional, and social-cognitive processes being key areas of intersection. This has important implications for understanding the shared and distinct neurobiological underpinnings of these mental health conditions.

Autistic traits and schizotypal traits may have common aetiological mechanisms. There is genetic, cognitive, and psychological evidence to support that autism and schizophrenia share similar neurodevelopmental deficits as well as genetic and non-genetic risk factors.¹⁸ As such, autistic traits may be risk factors for the development of schizotypal experiences.³⁷ Specifically, autistic traits can lead to stressors such as social rejection / isolation, peer victimisation, and stress from poor academic performance. These stressors may mediate an increased risk of subsequent schizotypal experiences. The neurodevelopmental delay in early childhood could be precursors of psychotic disorders.³⁷ The causal relationship between autistic and schizotypal traits could be in either direction, and both traits could coexist. Whether coexistence of both traits would exacerbate their symptoms is unclear. The present study provided a foundation for future longitudinal studies to examine the trajectory of autistic and schizotypal traits and their causal relationship. The findings of the present study suggest that individuals with autistic and schizotypal traits have overlapping deficits (eg, social and communication

difficulties)^{3,38} and that interventions (such as social skills training) may be beneficial.³⁹

There are limitations in the present study. Only adolescents and young adults aged 15 to 24 years were included; there may be an age effect on the association between autistic and schizotypal personality traits. Thus, our findings may not be generalisable to other age groups or the general population. Although the three-factor structure of the AQ-10 was validated in a cohort of Chinese adolescents and young adults, whether it is applicable across different cultures warrants further study. The AQ-10 is a self-report and abbreviated tool; tools with more psychometric properties or tools that use structured interview or tools rated by clinicians (eg, Childhood Autism Rating Scale and Autism Diagnostic Observation Schedule) should have been used. The present study did not include a formal clinical diagnosis or assessments of mental state-dependent measures such as depression and anxiety. The cross-sectional study design cannot establish a causal relationship between autistic traits and schizotypal traits; a longitudinal study design is warranted.

Conclusion

In Chinese adolescents and young adults, autistic traits, especially task switching and attention deficits (compared with theory of mind) are more closely correlated with schizotypal personality traits. Disentangling the overlapping and diametrical structure of autistic traits and schizotypal traits may help understand their aetiologies, assessment, and interventions.

Contributors

BYHL, EYHC, CLMH, and CSMW designed the study. BYHL and VKWC acquired and analysed the data and drafted the manuscript. All authors critically revised the manuscript for important intellectual content and had full access to the data, contributed to the study, approved the final version for publication, and take responsibility for its accuracy and integrity.

Conflicts of interest

EYHC has received speaker honoraria from Otsuka and DSK BioPharma, research funding from Otsuka, participated in paid advisory boards for Janssen and DSK BioPharma, and received funding to attend conferences from Otsuka and DSK BioPharma. As editors of the journal, CSMW, SKWC, EHML, CLMH, and EYHC were not involved in the peer review process. Other authors have disclosed no conflicts of interest.

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Data availability

All data generated or analysed during the present study are available from the corresponding author on reasonable request.

Ethics approval

This study was approved by the institutional review board (reference: is UW19-017). The patient was treated in accordance with the tenets of the Declaration of Helsinki. The patient provided written informed consent for all treatments and procedures and for publication.

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