**Beyond the interpersonal core of Schizotypal Personality and Autism:
Associations between autism and schizotypal traits
are not merely due to Social Anxiety.**

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Abstract

Several lines of research have established overlap between autistic and schizotypal traits but there have been limited attempts to identify variables that might explain this overlap. As both sets of traits are individually associated with social anxiety, we investigated whether social anxiety traits could explain the overlap between them. To this end, the Autism Quotient (AQ), Schizotypal Personality Questionnaire Brief-Revised (SPQ-BR) and Liebowitz Social Anxiety Scale-Self Report (LSAS-SR) were administered to a non-clinical population of 345 adults. Correlational analyses revealed strong, positive correlations between autistic, schizotypal, and social anxiety traits. After controlling for social anxiety, the association between total AQ and SPQ-BR scores remained modest and significant, suggesting that their association is not simply due to a shared association with social anxiety.

Keywords: Autistic traits, schizotypal traits, social anxiety.

Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder classified in the Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM-5; American Psychiatric Association, 2013) as a manifestation of persistent deficits in social communication and interaction, and restricted, repetitive patterns of behaviour, interests and activities. Complex interactions between genetic, epigenetic, and environmental factors (Chaste & Leboyer, 2012; Eapen, 2011; Persico & Bourgeron, 2006; Tordjman et al., 2014) are thought to lead to *distinct cognitive styles* (Adolphs, Sears, & Piven, 2001; Behrmann, Thomas, & Humphreys, 2006; Frith, Morton, & Leslie, 1991; Happé, 1999; Mottron, Dawson, Soulieres, Hubert, & Burack, 2006) and *neurophysiological differences* (e.g., Hadjikhani, Joseph, Synder, & Tager-Flusberg, 2006), among ASD sufferers (e.g., in the amygdala; Abdi & Sharma, 2004; Amaral, Schumann, & Nordahl, 2008; Kemper & Bauman, 1993; Baron-Cohen et al., 2000; Brambilla et al., 2003; Critchley et al., 2000; Nacewicz et al., 2006; Schumann & Amaral, 2006; Schumann et al., 2004; Sparks et al., 2002). Individuals within the general population have also been shown to exhibit characteristics of ASD, albeit at a non-clinically significant level. This phenomenon, namely, the '*broader autism phenotype*,' entails the endorsement of non-clinical levels on certain personality characteristics that closely resemble those of the ASD phenotype (Hoekstra, Bartels, Verweij, & Boomsma, 2007; Wheelwright, Auyeung, Allison, & Baron-Cohen, 2010).

Another diagnostic category within the DSM-5 (American Psychiatric Association, 2013), which also comprises socio-communicative difficulties akin to those of ASD, is the schizophrenia spectrum disorder (SSD). SSD is characterised by abnormalities in one or more of the following: delusions, hallucinations, disorganised speech (thinking), disorganised or abnormal motor behaviour, and negative symptoms (American Psychiatric Association, 2013). Similar to ASD, research has indicated that SSD also has major *genetic* (see Stefansson et al., 2008; The International Schizophrenia Consortium, 2008; Tsuang, 1999; Walsh et al., 2008), *environmental* (Brown, 2011; Tsuang, 1999; van Os, Kenis, & Rutten, 2010), and *epigenetic* (Akbarian, 2014; Oh & Petronis, 2008; Roth, Lubin, Soghi, & Kleinman, 2009; Shorter & Miller, 2015) components that contribute to its development. Moreover, and again similar to ASD, *cognitive biases* have been found to underlie the disorder (Aleman, Böcker, Hijman, de Haan, & Kahn, 2003; Bentall & Kaney, 1989; Bentall, Kinderman, & Kaney, 1994); as well as neurophysiological differences, again specifically in the amygdala (Aleman & Kahn, 2005; Pinkham, Brensinger, Kohler, Gur, & Gur, 2011; Reynolds, 1983; Velakoulis et al., 2006; Williams et al., 2004; Wright et al., 2000). Sub-clinical levels of SSD symptomatology have been termed '*schizotypal traits*' (Cohen & Matthews, 2010) and can be measured in the general population. SSD is comparable to ASD in that its negative symptoms (including anhedonia, alogia, decreased emotional expression, and asociality) parallel ASD's socio-communicative deficits (Shi et al., 2017). For example, due to characteristic and shared socio-communicative deficits, individuals with either autism or schizophrenia may exhibit social withdrawal and a lack of social interest, poverty of speech, restricted affect, poor eye contact, and differences in responding and interacting with others (American Psychiatric Association, 2013).

Although the DSM-5 (American Psychiatric Association, 2013) classifies autism and schizophrenia spectrum disorders as mutually exclusive diagnoses, research has demonstrated substantial phenotypic overlap between them (e.g., see Barneveld et al., 2011; Dinsdale, Hurd, Wakabayashi, Elliot, & Crespi, 2013; Hurst, Nelson-Gray, Mitchell, & Kwapil, 2007; Konstantareas & Hewitt, 2001; Mealey, Abbott, Byrne, & McGillivray, 2014; Nylander, Lugnegard, & Hallerback, 2008; Shi et al., 2017; Spek & Wouters, 2010), most of which being among their shared social cognition deficits (Couture, Penn, Losh, & Adolphs, 2010; Pilowsky, Yirmiya, Arbelle, & Mozes, 2000; Sasson, Pinkham, Carpenter, & Belger, 2011). Indeed, a growing corpus of data appears to point toward a shared ASD-SSD socio-cognitive dysfunction (Couture, Penn, & Roberts, 2006; Couture et al., 2010; Pinkham, Hopfinger, Pelphrey, Piven, & Penn, 2008; Pinkham & Penn, 2006; Sasson et al., 2011). In fact, even as early 1949, Kanner suggested that the putative relationship between the two disorders required consideration, due to resemblance in socio-communicative dysfunction; Asperger (1944) further acknowledged the similarities between autism and some negative schizophrenic symptoms.

The overlap between autistic and schizotypal traits has been established in both non-clinical populations (e.g., Dinsdale et al., 2013; Hurst et al., 2007) and clinical populations (Esterberg, Trotman, Brasfield, Compton, & Walker, 2008; Barneveld et al., 2011). For example, Esterberg et al. (2008) found autistic traits to be common in adolescents with SPD, and Barneveld et al. (2011) found schizotypal symptomology to be present in adolescents with ASD. The overlap between autistic and schizotypal traits has consistently been found to be strongest between the socio-communicative differences that characterise autism and the negative or ‘interpersonal’ symptoms of schizophrenia, which affect socio-communication (Barneveld et al., 2011; Claridge & McDonald, 2009; Del Giudice, Angeleri, Brizio, & Elena, 2010; Hurst et al., 2007; Konstantareas & Hewitt, 2001; Mealey et al., 2014; Russell-Smith et al., 2011; Spek & Wouters, 2010). The substantial phenotypic overlap found between autistic

and schizotypal traits is a prominent trend in the literature, to the extent that it has even acquired the endophenotypic term of '*social disorganisation*' (Ford & Crewther, 2014), leading some researchers to suggest that there should be changes to the diagnostic classification of the clinical disorders (see Craddock & Owen, 2011)—for example, that autism and early-onset schizophrenia should be unified as social-communication disorders (e.g., Tordjman, 2008). Interestingly, for such a dominant trend, there is a lack of research surrounding the possible 'confounding' variables that might account for this relationship between autistic and schizotypal traits (Mealey et al., 2014). Investigating this matter further may have implications for both research and clinical practice.

Nonetheless, given that anxiety and depression are often associated with both autism and schizophrenia (Braunstein-Bercovitz, 2000; White, Bray, & Ollendick, 2012), Mealey et al. (2014) investigated whether depression and anxiety could account for the association between autistic and schizotypal traits, but found that they could not. Given the strong associations between the socio-communicative aspects of schizotypal and autistic traits, it could be hypothesised that social anxiety would be a more likely candidate to explain their overlap. Indeed, social anxiety was shown to exhibit associations with both autistic and schizotypal traits; for example, Freeth, Bullock, & Milne (2013) found that UK students high in autistic traits also had higher levels of social anxiety. Furthermore, overlap between autism and social anxiety has been found in clinical populations, with research revealing SAD to be the most common anxiety disorder among adolescents and adults with high-functioning ASD (Bellini, 2004; Hurtig et al., 2009; Kuusikko et al., 2008; White et al., 2012) and Asperger's syndrome (Melfsen, Walitza, & Warnke, 2006). Similarly, studies have found that individuals diagnosed with SAD score significantly higher in measures of autistic traits (Cath, Ran, Smit, Van Balkom, & Comijs, 2008; Pine, Guyer, Goldwin, Towbin, & Leibenluft, 2008), and that individuals with ASD score significantly higher in measures of social anxiety traits (Bejerot,

Eriksson, & Mörtberg, 2014). Schizotypal traits are also associated with social anxiety (Brown, Silvia, Myin-Germeys, Lewandowski, & Kwapil, 2008; Meyer & Lenzenweger, 2009; Pallanti, Quercioli, & Hollander, 2004). For example, Brown et al. (2008) found that those with higher levels of schizotypal traits also scored highly in social anxiety traits, whereas Pallanti et al. (2004) found social anxiety to be highly prevalent in individuals diagnosed with schizophrenia. Further, Meyer & Lenzenweger (2009) found that schizotypy was associated with increased referential thinking, which is a characteristic cognitive style of socially-anxious individuals.

Given the prevalence of these associations, the present study aimed to investigate whether social anxiety's association to both autistic and schizotypal constructs could account for the overlap between them. Participants' levels of autistic, schizotypal, and social anxiety traits were measured by responses to three widely used and validated inventories: The Autism-Spectrum Quotient (AQ; Baron-Cohen et al., 2001), which measured autistic traits; the Schizotypal Personality Questionnaire-Brief Revised (SPQ-BR; Cohen et al., 2010), which measured schizotypal traits; and the Liebowitz Social Anxiety Scale-Self Report (LSAS-SR; Liebowitz, 1987), which measured social anxiety traits.

Method

Participants

345 members of the general adult population participated fully in the study (85 male, 260 female, mean age = 34.2, SD = 15.2, age range = 18-74), and were included in the final analysis. Participants were recruited via links posted on social media. There were no exclusion criteria. A clinical diagnosis of autism, schizophrenia, or social anxiety was disclosed by 4, 0, and 46 participants respectively.

Measures

Autism-Spectrum Quotient (AQ; Baron-Cohen et al., 2001) is a 50-item self-administered scale that measures the degree to which an individual within the non-clinical population has traits associated with the autism spectrum. The AQ contains five 10-item subscales assessing 5 different areas including social skill, attention-switching, attention to detail, communication, and imagination. The original researchers used a scoring system in which items that either mildly or strongly endorsed the autistic-like behaviour scored 1 point, and those that did not scored 0, with a response scale including “*definitely disagree*”, “*slightly disagree*”, “*slightly agree*”, and “*definitely agree*”. However, in the current study, the researchers were influenced by the scoring system used and suggested by Austin (2005) in which the response scale is treated as a 4-point Likert scale, so that each item scores on a scale from 1 to 4. This scoring method was used because, as concluded by Austin (2005), the degree of endorsement of each item was valuable in discriminating between participants. Therefore, the 25 positively worded items such as “*I tend to notice details that others do not*” scored 4 for “*definitely agree*” to 1 for “*definitely disagree*”, and the remaining 25 negatively worded items such as “*I enjoy social occasions*”, scored 4 for “*definitely disagree*” to 1 for “*definitely*

agree". Negative items specified in Baron-Cohen et al. (2001) were reverse-scored, as instructed by the original researchers. Items are randomised within the AQ in terms of their subscale and their expected response from a high-scorer. Scores on the total scale range from 0 to 200, with higher scores indicating increased levels of autistic traits. Cronbach's alpha coefficients for each of the five subscales were calculated, and these were all moderate to high, ranging from .63 to .77 (Baron-Cohen et al., 2001). Moreover, a subsequent study reported a high Cronbach's alpha coefficient of .82 for the total AQ score (Austin, 2005).

Schizotypal Personality Questionnaire-Brief Revised (SPQ-BR; Cohen et al., 2010) is a 32-item scale that measures schizotypal personality traits in non-clinical adults. The SPQ-BR is a refinement of the Schizotypal Personality Questionnaire-Brief (Raine & Benishay, 1995) which is a brief version of the Schizotypal Personality Questionnaire (Raine, 1991). The SPQ-BR contains seven subscales that measure subordinate factors including ideas of reference/suspiciousness (*"I often feel that others have it in for me"*), odd or eccentric behaviour (*"I have some eccentric (odd) habits"*), no close friends/restricted affect (*"I rarely laugh or smile"*), odd speech (*"I often ramble on too much when speaking"*), excessive social anxiety (*"I get anxious when meeting people for the first time"*), unusual perceptual experiences (*"I often hear a voice speaking my thoughts aloud"*), and odd beliefs/magical thinking (*"Do you believe in telepathy (mind-reading)?"*). There are also three superordinate factors determined by three subscales measuring interpersonal, disorganised, and cognitive-perceptual aspects of schizotypal personality. Items are rated on a 5-point Likert scale (0 = *"strongly disagree"*, 1 = *"disagree"*, 2 = *"neutral"*, 3 = *"agree"*, 4 = *"strongly agree"*). Scores on the total scale range from 0 to 128, with higher scores indicating higher levels of schizotypal traits. These subordinate subscales can be grouped into 3 superordinate cognitive-perceptual, interpersonal, and disorganized schizotypy domains—factors that map directly onto the

positive, negative and disorganised symptom domains of schizophrenia, respectively (Andreasen et al., 1995; Basso et al., 1998). The cognitive-perceptual factor of SPQ-BR contains three subscales: magical thinking, unusual perceptions, ideas of reference/suspiciousness. The interpersonal factor includes the subscales of constricted affect/no close friends and social anxiety. Lastly, the disorganised factor includes the eccentric behaviour and odd speech subscales.

Liebowitz Social Anxiety Scale-Self Report (LSAS-SR; Liebowitz, 1987) is a 24-item scale that measures fear and avoidance across different social situations, thus assessing social anxiety. For each situation, for example, “*going to a party*”, items are rated on their level of fear and avoidance, both on a different 4-point Likert scale. The fear scale ranges from 0 (“*no fear*”) to 3 (“*severe fear*”) whereas, although the avoidance ratings also range from 0 to 3, they are based on the percentage of time avoiding the situation; 0 = “*never (0%)*”, 1 = “*occasionally (10%)*”, 2 = “*often (33-67%)*”, 3 = “*usually (67-100%)*”. The LSAS-SR contains two subscales measuring social anxiety associated with social interaction (11 items) and performance (13 items). Therefore, total fear and avoidance ratings can be obtained from this scale, as well as fear and avoidance ratings for both subscales. Scores on the total scale range from 0 to 144. The total LSAS-SR has a high overall Cronbach’s alpha coefficient of .95 (Baker et al., 2002).

Procedure

Ethical approval was granted by the University of Sheffield Department of Psychology ethics committee. The above inventories were administered in a single survey via an online survey tool Qualtrics 2018. Subjects were recruited via links distributed on social media, including Facebook and LinkedIn. Participants were assured that their participation would be anonymous, and that to withdraw they should simply close their browser and their data would be discarded. Completion of the survey took approximately 15 minutes, which involved participants disclosing their age, gender, any past or present clinical diagnosis of autism, schizophrenia, or social anxiety, as well as their responses to the items of the AQ, the SPQ-BR, and the LSAS-SR. Participants were fully debriefed as to the aims and objectives of the study, and contact details for more information, and support, were provided.

Results

The mean AQ score was 105.8 ± 16.2 SD; the mean SPQ-BR score was 84.6 ± 22.07 ; and the mean LSAS-SR score was 39.9 ± 26.2 . These were similar to those previously reported (Freeth et al., Dinsdale et al, Austin). Cronbach's alpha coefficients were calculated for each inventory and their subscales (Table 1); these were all high or acceptable, indicating high levels of internal consistency across each scale. Although, the AQ imagination subscale had a lower value (0.587), this was similar to that of the original validation (Baron-Cohen et al., 2001)

Zero-order correlations indicated that there was a significant, moderate, and positive correlation between total AQ scores and total SPQ-BR scores ($r=0.658$, Table 2). There were also positive correlations between the majority of the pairs of AQ subscales and both the superordinate and subordinate subscales, with the exceptions being the AQ imagination subscale and the SPQ-BR subordinate scales magical thinking and eccentric behaviour; AQ Attention switching and SPQ-BR subordinate scales magical thinking.

Total AQ score was also correlated with total LSAS-SR score ($r=0.583$) and with both the performance ($r=0.526$) and interaction ($r=0.591$) LSAS-SR subscales (Table 3). All 5 AQ subscales were significantly correlated with both the total LSAS-SR score and the performance and interaction subscales (Table 2). Likewise, total SPQ-BR displayed similar correlations with LSAS-SR total ($r=0.601$) and the performance ($r=0.573$) and interaction LSAS-SR subscales ($r=0.584$, table 4). Similarly, all SPQ-BR superordinate and subscales correlated with LSAS total and subscales apart from SPQ-BR magical thinking and LSAS-interaction.

Thus, as both the AQ and SPQ-BR as well as their subscales were correlated with LSAS-SR scores, it may be that the association between AQ and SPQ-BR is simply due to their shared association with LSAS-SR. To assess this conjunction, the correlations with AQ and SPQ-BR were calculated after ‘controlling’ (partialling) for total LSAS-SR scores. After controlling for LSAS, the correlation between total AQ score and total SPQ-BR score remained moderate and significant (0.474 as compared to the zero-order correlation 0.658, table 5 versus table 2). The vast majority of correlations between pairs of the AQ subscales and both the superordinate and subordinate subscales of the SPQ-BR remained significant following partialling for total LSAS-SR scores. The exceptions were AQ social skills and SPQ-BR social anxiety and magical thinking; AQ attention to detail and SPQ-BR social anxiety, AQ imagination and all the 3 superordinate SPQ-BR subscales and subordinate subscales: social anxiety, ideas of reference/suspiciousness, unusual perceptions and odd speech.

Table 1: Internal Reliability (Cronbach's Alpha Coefficient) for AQ, SPQ, L-SAS scales and subscales

Scale	No. of Items	Alpha Coefficient
AQ	50	.869
AQ Social Skills	10	.786
AQ Attention Switching	10	.724
AQ Attention to Detail	10	.676
AQ Communication	10	.697
AQ Imagination	10	.587
SPQ	32	.930
SPQ Interpersonal	10	.884
SPQ Disorganized	8	.859
SPQ Cognitive-Perceptual	14	.869
SPQ Social Anxiety	4	.899
SPQ Eccentric Behaviour	4	.886
SPQ Magical Thinking	4	.788
SPQ Odd Speech	4	.786
SPQ Constricted Affect/ No close Friends	6	.814
SPQ Unusual Perceptions	4	.680
SPQ Ideas of Reference/ Suspiciousness	6	.866
L-SAS	24	.965
L-SAS Interaction	11	.910
L-SAS Avoidance	13	.887

Table 2: Zero-Order Correlations between AQ and SPQ

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. AQ total	.658**	.792**	.833**	.511**	.816**	.573**	.705**	.478**	.486**	.641**	.517**	.153**	.430**	.620**	.433**	.391**
2. SPQ total		.574**	.578**	.305**	.627**	.223**	.824**	.809**	.892**	.724**	.854**	.474**	.743**	.745**	.725**	.668**
3. AQ Social Skills			.601**	.179**	.662**	.329**	.759**	.323**	.365**	.716**	.411**	.124*	.276**	.644**	.307**	.247**
4. AQ Attention Switching				.327**	.639**	.347**	.595**	.440**	.434**	.604**	.487**	.076	.407**	.470**	.379**	.380**
5. AQ Attention to Detail					.215**	.045	.188**	.262**	.314**	.174**	.276**	.152**	.319**	.163**	.295**	.150**
6. AQ Communication						.370**	.629**	.535**	.447**	.540**	.484**	.165**	.357**	.579**	.459**	.466**
7. AQ Imagination							.303**	.119*	.140**	.203**	.151**	.017	.149**	.327**	.073	.135*
8. SPQ Interpersonal								.514**	.566**	.871**	.622**	.178**	.467**	.911**	.460**	.426**
9. SPQ Disorganized									.624**	.444**	.600**	.277**	.573**	.470**	.877**	.848**
10. SPQ Cognitive-Perceptual										.508**	.889**	.669**	.801**	.503**	.573**	.500**
11. SPQ Social Anxiety											.582**	.141**	.400**	.590**	.386**	.382**
12. SPQ Ideas of Reference/ Suspiciousness												.355**	.617**	.533**	.520**	.516**
13. SPQ Magical Thinking													.347**	.175**	.287**	.186**
14. SPQ Unusual Perceptions														.431**	.545**	.440**
15. SPQ Constricted Affect/ No close Friends															.431**	.378**
16. SPQ Eccentric Behaviour																.490**
17. SPQ Odd Speech																1

Note. * $p < .01$, ** $p < .001$.

Table 3: Zero-Order Correlations between L-SAS and AQ

	2	3	4	5	6	7	8	9
1. L-SAS Performance	.862**	.527**	.510**	.130*	.449**	.228**	.526**	.967**
2. L-SAS Interaction		.605**	.564**	.173**	.491**	.236**	.591**	.961**
3. AQ Social Skills			.601**	.179**	.662**	.329**	.792**	.595**
4. AQ Attention Switching				.327**	.639**	.347**	.833**	.559**
5. AQ Attention to Detail					.215**	.045	.511**	.160**
6. AQ Communication						.370**	.816**	.490**
7. AQ Imagination							.573**	.238**
8. AQ total								.583**
9. L-SAS total								1

Note. * $p < .01$, ** $p < .001$.

Table 4: Zero-Order Correlations between L-SAS and SPQ-BR

	2	3	4	5	6	7	8	9	10	11	12	13	14
1. SPQ total	.601**	.824**	.809**	.892**	.724**	.854**	.474**	.743**	.745**	.725**	.668**	.573**	.584**
2. L-SAS total		.680**	.360**	.463**	.721**	.545**	.112*	.360**	.511**	.305**	.318**	.967**	.961**
3. SPQ Interpersonal			.514**	.566**	.871**	.622**	.178**	.467**	.911**	.460**	.426**	.617**	.689**
4. SPQ Disorganised				.624**	.444**	.600**	.277**	.573**	.470**	.877**	.848**	.337**	.356**
5. SPQ Cognitive-Perceptual					.508**	.889**	.669**	.801**	.503**	.573**	.500**	.472**	.423**
6. SPQ Social Anxiety						.582**	.141**	.400**	.590**	.386**	.382**	.643**	.744**
7. SPQ Ideas of Reference/ Suspiciousness							.355**	.617**	.533**	.520**	.516**	.542**	.513**
8. SPQ Magical Thinking								.347**	.175**	.287**	.186**	.146**	.064
9. SPQ Unusual Perceptions									.431**	.545**	.440**	.353**	.343**
10. SPQ Restricted Affect/ No close Friends										.431**	.378**	.473**	.507**
11. SPQ Eccentric Behaviour											.490**	.281**	.301**
12. SPQ Odd Behaviour												.302**	.314**
13. L-SAS Performance													.862**
14. L-SAS Interaction													1

Note. * $p < .01$, ** $p < .001$.

Table 5: Partial Correlations between AQ and SPQ, controlling for L-SAS

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. AQ total	.474***	.681***	.752***	.521***	.749***	.551***	.518***	.354***	.299***	.391***	.292***	.108*	.291***	.461***	.330***	.267***
2. SPQ total		.337***	.365***	.264***	.478***	.104	.709***	.794***	.866***	.524***	.786***	.512***	.706***	.638***	.712***	.629***
3. AQ Social Skills			.402***	.106*	.529***	.241***	.601***	.145**	.125*	.515***	.128*	.072	.082	.493***	.165**	.076
4. AQ Attention Switching				.290***	.506***	.266***	.354***	.308***	.238***	.349***	.263***	.016	.266***	.259***	.265***	.257***
5. AQ Attention to Detail					.159**	.008	.110*	.222***	.274***	.086	.228***	.137*	.284***	.096	.262***	.106
6. AQ Communication						.300***	.463***	.441***	.285***	.309***	.297***	.127*	.223***	.439***	.373***	.375***
7. AQ Imagination							.199***	.037	.034	.047	.026	.010	.070	.246***	.000	.065
8. SPQ Interpersonal								.393***	.386***	.749***	.410***	.140**	.326***	.894***	.362***	.301***
9. SPQ Disorganized									.553***	.286***	.516***	.255***	.509***	.357***	.864***	.829***
10. SPQ Cognitive-Perceptual										.283***	.857***	.701***	.764***	.350***	.512***	.420***
11. SPQ Social Anxiety											.325***	.087	.218***	.372***	.251***	.232***
12. SPQ Ideas of Reference/ Suspiciousness												.353***	.539***	.354***	.443***	.431***
13. SPQ Magical Thinking													.331***	.138*	.267***	.160**
14. SPQ Unusual Perceptions														.308***	.490***	.368***
15. SPQ Constricted Affect/ No close Friends															.337***	.265***
16. SPQ Eccentric Behaviour																.435***
17. SPQ Odd Speech																1

Note. * $p < .05$, ** $p < .01$, *** $p < .001$.

Discussion

The aim of this study was to investigate whether (and to what extent) social anxiety may be able to explain the overlap between autistic and schizotypal traits. Our analyses revealed significant and strong positive correlations between autistic (AQ), schizotypal (SPQ-BR) and social anxiety traits (LSAS). After controlling for social anxiety traits, the relationship between autistic and schizotypal traits reduced but nonetheless remained significant.

Relationship between autistic and schizotypal traits

The finding that total AQ scores were strongly positively correlated with total SPQ-BR scores was consistent with findings of previous research (Barneveld et al., 2011; Couture et al., 2010; Dinsdale et al., 2013; Hurst et al., 2007; Konstantareas & Hewitt, 2001; Mealey et al., 2014; Nylander et al., 2008; Pilowsky et al., 2000; Shi et al., 2017; Spek & Wouters, 2010), which indicated significant overlap between autistic and schizotypal traits. In the present study, the strongest correlations were found between the scores of the interpersonal subscale (and associated subordinate subscales) of the SPQ-BR, and the social skills and communication subscales of the AQ, suggesting that there exists substantial overlap between the socio-communicative aspects of autistic and schizotypal traits. This, too, was in line with previous research that has consistently found the association between autism and schizophrenia, or their associated traits, to be strongest between negative schizotypy (reflected by the interpersonal subscales of the SPQ-BR) and the socio-communicative aspects of autism (reflected by the social skills and communication subscales of the AQ; Barneveld et al., 2011; Claridge & McDonald, 2009; Del Giudice et al., 2010; Hurst et al., 2007; Konstantareas & Hewitt, 2001; Mealey et al., 2014; Russell-Smith et al., 2011; Spek & Wouters, 2010).

Our analyses also revealed strong correlations between the scores of the AQ attention-switching- and the SPQ-BR-interpersonal-subscale. It is worth noting that the AQ's attention switching subscale reflects attention-switching difficulties unique to social situations, rather than general attention-switching difficulties *per se* (e.g. neurocognitive)—with items such as “*I frequently get so strongly absorbed in one thing that I lose sight of other things*”, “*I tend to have very strong interests, which I get upset about if I can't pursue*”, and “*I like to plan any activities I participate in carefully*” (Baron-Cohen et al., 2001). Deficits in attention switching in social situations likely reflect the characteristic strong preference for routine and pursuit of strong interests in ASD, as well as aspects of negative schizotypal symptomatology (American Psychiatric Association, 2013): since such aspects may negatively affect socio-communication through decreased attention-switching. Thus, the association between the SPQ-BR interpersonal subscale and the AQ attention to detail subscale may also reflect shared social communicative difficulties in the two sets of traits.

Relationship between autistic and social anxiety traits

Total AQ scores were strongly and positively correlated with total LSAS-SR scores, which is in line with previous research conducted in clinical (Bellini, 2004; Cath et al., 2008; Hurtig et al., 2009; Kuusikko et al., 2008; Melfsen et al., 2006; White et al., 2012) and non-clinical populations (Freeth et al., 2013). All AQ subscales exhibited significant correlations with the LSAS-SR total-scores and subscales. The highest correlations between AQ and LSAS-SR were found for the AQ social skills, attention switching and communication subscales. This is in line with Freeth et al. (2013) who also found that the AQ subscales attention switching, social skill, and communication were most strongly associated with social anxiety (LSAS-SR) scores. This is also in line with investigations in clinical samples suggesting that SAD patients exhibit similar AQ deficits in attention-switching and social skills (e.g., Cath et al., 2008).

Relationship between schizotypal and social anxiety traits

In line with previous research (e.g., Brown et al., 2008; Meyer & Lensenweger, 2009; Pallanti et al., 2004), total SPQ-BR scores were also strongly and positively correlated with total LSAS-SR scores. Inspection of correlations among the subscales from the two inventories indicated strong relationships between the SPQ-BR's interpersonal subscales scores and the LSAS-SR total and subscale scores, thereby reflecting shared negative symptomatology. This finding suggests that the relationship between schizotypal traits and social anxiety—similar to the relationship between autistic traits and social anxiety—could be due to similarities in the negative feedback or rejection experienced by such individuals in social situations, as a result of the unusual communication they exhibit (e.g., Angermeyer, Beck, & Matschinger, 2003; Stuart & Arboleda-Flórez, 2001). Finally, there were also significant correlations between all other subscales of the SPQ-BR and LSAS-SR, indicating that these psychopathologies do not merely share a core, negative (interpersonal) core.

***Relationship between autistic and schizotypal traits,
after controlling for social anxiety traits***

The present study found that after controlling for participants' social anxiety trait scores (LSAS-SR), the correlation between autistic (AQ) and schizotypal traits (SPQ-BR) remained significant and moderate, suggesting that the association between autism (AQ) and schizotypy (SPQ-BR) was not solely due to a shared association with social anxiety.

Indeed, the vast majority of correlations between pairs of the AQ subscales and both the superordinate and subordinate SPQ-BR subscales remained significant after controlling for total L-SAS-SR scores. The exceptions to this rule included: AQ social skills with SPQ-BR social anxiety and magical thinking; AQ attention to detail with SPQ-BR social anxiety, AQ imagination and all the 3 superordinate SPQ-BR subscales and subordinate subscales (that is, social anxiety, ideas of reference/suspiciousness, unusual perceptions and odd speech). This is unsurprising given their attenuated zero-order correlations compared to other subscale pairs. Furthermore, these AQ and SPQ-BR subscales shared the most similarity with social anxiety (e.g., AQ–social skills; SPQ-BR–Social anxiety), displaying the highest zero-order correlations with its respective measure (i.e., LSAS-SR). Since their content primarily reflects social and communication difficulties, it could be argued that the collection of these traits (e.g., AQ social skills and SPQ-BR reference/suspiciousness and social anxiety) form the interpersonal core of autism-schizotypy that is by and large underlied by social anxiety.

Recent evidence suggests that the phenotypic overlap between autistic and schizotypal constructs might be explained by underlying aetiological overlap, such as shared genes and biological pathways (Kushima et al., 2018). Several copy-number variants (CNVs) increase likelihood of both autism and schizophrenia diagnosis in *Caucasian* (Marshall et al., 2017; Pinto et al., 2014) and *Japanese* (Kushima et al., 2018) samples, and investigations have found significant overlap in these CNVs in ASD and *schizophrenia* spectrum disorders (Kushima et

al., 2018). Kushima et al. (2018) located several disorder-relevant genes that seemed to account for such overlap. Moreover, the researchers found multiple shared biological pathways in ASD and SSD, including differences in neuronal projection, increased oxidative stress, alterations in lipid metabolism, and defects in genomic integrity (Kushima et al., 2018).

Similar to the research regarding genetic or other biological underpinnings to ASD and SSD is the research that suggests shared neurological aetiology. For instance, Ford, Nibbs, & Crewther (2017) found that individuals high in '*social disorganisation*' (i.e., high in common autistic and schizotypal traits) showed an increased glutamate-to-GABA+ ratio in the right hemisphere superior temporal region. Given right hemisphere's responsibility for interpreting of prosody—and by extension the emotional content and meaning of speech—the researchers suggested that this neural characteristic may lead to the behavioural phenotype shared between those on the clinical or non-clinical autistic or schizotypal spectrum (Ford et al., 2017a). In line with this, Ford, Woods, & Crewther (2017) found that a delay in *mismatch field latency*—which has been associated with odd speech and behaviour, as well as constricted affect—was involved in the overlap between autistic and schizotypal traits (Ford et al., 2017b).

Adding to this literature, the current study indicated that there were significant, strong, and positive correlations between autistic, schizotypal, and social anxiety traits. Social Anxiety traits themselves had a small influence in controlling for the relationship between schizotypal and autistic traits. The present results support previous research suggesting a strong overlap between autistic and schizotypal traits. However, they also extend it by further suggesting that this overlap is not fully accounted for by social anxiety.

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