Confirmatory factor analysis of autism and schizophrenia spectrum traits

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ABSTRACT

The relationship between the Autism Spectrum Quotient (AQ) and Schizotypal Personality Questionnaire (SPQ) data has consistently shown overlap in the social and interpersonal domains. Factor analyses of the AQ and SPQ subscales support this overlap with the emergence of a shared AQ and SPQ subscale factor as the largest common element. This study investigated, at the item level, the factor structure of the AQ and SPQ. Exploratory and confirmatory factor analyses were conducted on the AQ and SPQ responses of 1670 participants (aged 18–40, 1243 females, 427 males). Seven factors cumulatively explained 40.56% of the data. Of these, four represented shared traits (named Odd Behaviour, Relationship Disinterest, Cue Interpretation, Social and Communication Discomfort), one was a more specific autistic tendency (named Fixation with Details), and two factors were more specific to the psychotic dimension of schizotypy (named Paranoia/Suspiciousness and Hallucination/Delusional Experiences). These findings demonstrate that a set of symptom traits is present in both the autism and schizophrenia spectra. The findings of this study have important clinical implications in terms of future research, diagnosis and treatment of autism and schizophrenia spectrum disorders.

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1. Introduction

It is becoming well understood that autism and schizophrenia exist on a spectrum that grades from psychopathology to normality. The Autism Spectrum Quotient (AQ; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001) and Schizotypal Personality Questionnaire (SPQ; Raine, 1991) are well-validated and reliable psychometric measures of autistic and schizotypal traits within the high-functioning population, respectively. These measures are employed extensively by the scientific research community to identify psychometric (Dinsdale, Hurd, Wakayabashi, Elliot, & Crespi, 2013; Kanai et al., 2011), psychophysical (Russell-Smith, Maybery, & Bayliss, 2011; Sutherland & Crewther, 2010) and neurological (Sasamoto et al., 2011) underpinnings of non-clinical symptoms that might inform the respective spectrum disorders.

The AQ was developed based on the DSM-IV-TR triad of autism spectrum symptoms (social skills deficits, communication deficits, and restricted and repetitive behaviours) (American Psychological Association, 1994) in order to identify the degree of autistic traits in adults of normal intelligence, and assess their effect in scientific studies. The AQ was also suggested as a screening tool prior to psychiatric assessment. The AQ quantifies autistic tendency through five theory-driven subscales based on the symptom triad: Social Skills, Communication, Attention Switching, Attention to Detail and Imagination (Baron-Cohen et al., 2001), with higher scores reflecting greater difficulty for each subscale.

The SPQ was developed in order to provide the first comprehensive assessment of specific trait-schizotypy symptoms in the high-functioning population; previous measures simply assessed the degree of the three core symptoms: positive, negative and disorganised. The scale was also suggested as a screening tool for schizotypal personality disorder (Raine, 1991). The SPQ quantifies the nine DSM-III-R criteria for schizotypal personality disorder, which are further classified within the three overarching schizophrenia spectrum dimensions (American Psychological Association, 1987): Ideas of Reference, Odd Belief, Unusual Perceptual Experiences and Suspiciousness (Cognitive-Perceptual/positive symptoms), Excessive Social Anxiety, No Close Friends and Constricted Affect (Interpersonal/negative symptoms), Odd Behaviour and Odd Speech (Disorganised features) (Raine, 1991; Raine et al., 1994).

In their development, the AQ and SPQ underwent an item analysis, and reliability and validity testing. However, neither was subject to factor analysis, which confirms specificity of the items to their assigned subscales. Subsequent studies have investigated the factor structure of the AQ and SPQ, reporting a three- (Austin, 2005; Hurst, Mitchell, Kimbrel, Kwapil, & Nelson-Gray, 2007), four- (Stewart & Austin, 2009) and five-factor structure for the AQ (Kloosterman, Keefer, Kelley, Summerfeldt, & Parker, 2011), and a seven-factor structure for the SPQ (Cohen, Matthews, Najolia, & Brown, 2010). Overall, these factors

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do not align with the original AQ and SPQ subscales, suggesting that the original subscales lack specificity.

Autism and schizophrenia are manifestly clinically distinct disorders, with differences in age of onset as well as several diagnostic categories such as the presence of restricted and repetitive behaviours, expressive language difficulties and psychosis (American Psychological Association, 2013). However, prodromal and negative symptoms of schizophrenia are strikingly similar to the pervasive social and communication abnormalities of autism (Spek & Wouters, 2010). Due to this similarity, the relationship between the AQ and SPQ subscales has been thoroughly explored, with the Interpersonal SPQ subscales, and Social Skills and Communication subscales of the AQ shown to be closely related (Barneveld et al., 2011; Dinsdale et al., 2013; Ford & Crewther, 2014; Russell-Smith et al., 2011). The relationships between the scales are not exclusive to the Interpersonal dimension however, with Disorganised SPQ subscales moderately related to the AQ subscale Attention to Detail (Spek & Wouters, 2010). Divergence of SPQ from AQ subscales appears within the Cognitive-Perceptual SPQ subscales (Barneveld et al., 2011; Spek & Wouters, 2010). These above-mentioned symptom and trait relationships have been reported in both clinical (Barneveld et al., 2011; Spek & Wouters, 2010) and non-clinical studies (Dinsdale et al., 2013; Ford & Crewther, 2014; Kanai et al., 2011; Russell-Smith et al., 2011).

The extensive overlap between autistic and schizotypal traits could reflect a similarity in symptomology between the two spectra, or indeed a true comorbidity of symptoms. That these scales, and several others, are used to measure "caseness" of their respective spectrum traits in scientific studies (Baron-Cohen et al., 2001), it is important to investigate the degree to which the questions that quantify the spectrum traits overlap—this is the focus of the current study.

To date, only the factor structure of the AQ and SPQ subscales have been investigated (Dinsdale et al., 2013; Ford & Crewther, 2014). Dinsdale et al. (2013), through principal component analysis of the AQ and a brief version of the SPQ, reported a combined autistic and schizotypal general social interest and aptitude phenotype (Cohen et al., 2010). Ford and Crewther (2014) conducted a factor analysis with the full versions of the AQ and SPQ, revealing a similar shared phenotype, comprised of social and communication AQ, and Interpersonal and Disorganised SPQ subscales. This phenotype was termed Social Disorganisation. Two scale specific factors also emerged from the factor analysis: Perceptual Oddities (SPQ) and Social Rigidity (AQ). These studies demonstrate substantial overlap between the subscales, raising the question of commonality or comorbidity at an item level. Furthermore, item analysis might reveal truer autistic and schizotypal traits.

This study investigated the adequacy of the AQ and SPQ questions in differentiating their respective spectrum disorder traits, while simultaneously investigating the presence of shared traits. It was predicted that confirmatory factor analysis of combined AQ and SPQ items would result in factors of shared traits, and disorder-specific traits. Specifically, three factors were predicted to resemble the original Social Disorganisation factor of Ford and Crewther (2014), representing social skills, communication and social isolation. Disorder specific factors of unusual perceptions and paranoia of the SPQ, and restricted interests and behaviour factor of the AQ were predicted to emerge.

2. Methods

2.1. Participants

A total of 1678 participants aged 18 to 40, 428 males (mean = 25.96, SD = 6.47) and 1250 females (mean = 26.49, SD = 6.79), completed the Autism Schizotypy Questionnaire (ASQ).

2.2. Procedure

Ethics approval was granted by the research institution's Human Research Ethics Committee. All participants provided informed consent to participate in the study. The ASQ, comprised of all items from the AQ, SPQ, and Coolidge Axis II Inventory (CATI+) Schizotypy and Schizoid scales, was presented on-line using the Opinio software interface (ObjectPlanet Inc., 1998–2013). Responses were recorded on a 4-point Likert scale from 1(strongly disagree) to 4(strongly agree). This study adopted a full-scale scoring system to provide higher item-item correlations and improve reliability (Austin, 2005; Ford & Crewther, 2014; Wuthrich & Bates, 2005).

2.3. Materials

The AQ (Baron-Cohen et al., 2001) is a 50-item assessment of autistic tendency across five dimensions with ten items representing each sub-scale: Social Skills (1), Communication (2), Attention Switching (3), Attention to Detail (4) and Imagination (5). Half the items are reverse scored and higher subscale scores indicate more autistic trait severity; total AQ score is out of 200. The reliability of the AQ was not disclosed in the original publication, while subscale Cronbach's α reliabilities were adequate with α(Social Skills) = 0.77, α(Communication) = 0.65, α(Attention Switching) = 0.67, α(Attention to Detail) = 0.63 and α(Imagination) = 0.65.

The SPQ (Raine, 1991) has 74 items, with three superordinate dimensions encapsulating its nine sub-scales: *Cognitive-Perceptual symptoms* [Ideas of Reference (1a), Odd Beliefs (1b), Unusual Perceptual Experiences (1c), and Suspiciousness (1d)]; *Interpersonal symptoms* [Social Anxiety (2a), No Close Friends (2b) and Constricted Affect (2c)]; *Disorganised features* [Odd Behaviour (3a) and Odd Speech (3b)]. The SPQ has a maximum score of 296, with higher scores indicating a higher degree of trait severity. Original Cronbach"s α reliability of the SPQ was 0.90, subscale α values are moderate to good, with α(Ideas of Reference) = 0.71, α(Odd Beliefs) = 0.81, α(Unusual Perceptual Experiences) = 0.71, α(Suspiciousness) = 0.78, α(Social Anxiety) = 0.72, α(No Close Friends) = 0.67, α(Constricted Affect) = 0.66, α(Odd Behaviour) = 0.76, α(Odd Speech) = 0.70.

The CATI+ (Coolidge & Merwin, 1992) Schizotypy subscale (CATI-St) consists of 22 items measuring odd beliefs and magical thinking, unusual perceptual experiences, suspiciousness, inappropriate or odd behaviour, and social anxiety, with good reliability (α = 0.73) and a total score out of 88. The Schizoid subscale (CATI-Sd) consists of 10 items assessing long term absence of social relationships, solitary activities, muted affect and withdrawal, with good reliability (α = 0.73) and a total score out of 40. Higher scores on both scales indicate greater severity.

2.4. Statistical analysis

The data consisting of 1678 observations was screened for univariate outliers and eight observations with missing values identified. These observations were deleted from the analysis leaving a sample size of 1670.

The first randomly selected half of the sample was used for an exploratory factor analysis (EFA) using the principal axis factoring method with an oblimin rotation. The complement of the sample was used for a confirmatory factor analysis (CFA) using maximum likelihood estimation. The EFA showed that seven factors explained 40.56% of the total variation in the data after items with communalities below 0.2 and items with cross-loading on two or more factors removed.

Redundant items from the EFA were removed from each factor in the CFA until acceptable goodness of fit statistics were obtained for each factor. Model fit was assessed with the Tucker-Lewis index (TLI), comparative fit index (CFI), and the root-mean-square error of approximation (RMSEA). TLI and CFI values >0.90 and RMSEA values >0.08 indicate acceptable model fit, whereas TLI and CFI values >0.95 and RMSEA values >0.06 indicate good model fit (these cut-offs are based on Hu & Bentler, 1999; Kline, 2005; Muthen, 2004). Discriminant validity was demonstrated for the seven factors using the Fornell and Larcker (1981) AVE approach. Appropriate names were assigned to each factor and