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The structure of the Autism-Spectrum Quotient (AQ): Evidence from a student sample in Scotland

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ABSTRACT

The Autism-Spectrum Quotient (AQ; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001) has been recently developed to assess how individuals of normal intelligence vary on autistic traits. The main objective of this study was to assess the factor structure of the AQ in a large Scottish University sample ($n = 536$). Group differences in the AQ were also assessed. The current study found four factors of 'Socialness', 'Pattern', 'Understanding Others/Communication' and 'Imagination'. Baron-Cohen, Wheelwright, Hill, Raste, and Plumb (2001) suggest five subscales, previous factor analytic studies find two- or three-factor models. However, all agree on a 'Socialness', and a 'Patterns/Attention to Detail' factor. In addition, a 'Communication' factor is largely agreed upon. Group differences were as expected, students enrolled in a mathematical science degree type scored higher than other students, and males scored higher than females. The AQ, in a UK population, appears to be reasonably reliable, however, it does require some revision.

1. Introduction

Autism Spectrum Disorders (ASDs) are characterised by impairments in socialisation, communication and the presence of restricted repetitive and stereotyped patterns of behaviour, interests, and activities (American Psychiatric Association, 1994). These are developmental disorders and diagnosis is made from behavioural criteria. Some researchers consider traits or features of ASD to be present in the general population without a diagnosis of ASD. These traits, otherwise known as the Broader Autism Phenotype have been studied in relatives of those with ASD and in the general population (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001; Dawson et al., 2007; Hurley, Losh, Parlier, Reznik, & Piven, 2007). The study of "autistic" traits in the general population is an important one. It may help in giving us insight into processing styles in individuals with ASD and also aid us in understanding predictors of processing preferences in the general population. In addition, recently some researchers have proposed that the triad of impairments that occur in ASD may not always cluster together and should be studied separately (Happé, Ronald, & Plomin, 2006). It is of much interest to assess how traits relate to each other in the general population and is therefore of great importance to evaluate the measures which assess "autistic" traits.

One of these is a self-report measure, developed to measure autistic traits in the general population, the Autism-Spectrum Quotient (AQ; Baron-Cohen, Wheelwright, Skinner, et al., 2001). It aims to quantitatively assess indices related to the triad of impairments, and to incorporate aspects of the cognitive impairment seen in ASD.

Traits as assessed by the AQ show high heritability (Hoekstra, Bartels, Verweij, & Boomsma, 2007) and are stable cross-culturally in both Dutch and Japanese samples (Hoekstra, Bartels, Cath, & Boomsma, 2008; Wakabayashi, Baron-Cohen, Wheelwright, & Tojo, 2006). The AQ has been used for a variety of purposes including assessing the broader phenotype of ASD and as a screening tool (Bishop et al., 2004; Ketelaars et al., 2008; Woodbury-Smith, Robinson, Wheelwright, & Baron-Cohen, 2005). In addition, the AQ has predicted performance on tests of social cognition such as the Reading the Mind in the Eyes (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001); on gaze preference to social or non-social stimuli (Bayliss & Tipper, 2005), on phonological tests (Stewart & Ota, 2008) and on an adapted block design (Stewart, Watson, Allcock, & Yaqoob, 2009).

Baron-Cohen, Wheelwright, Skinner, et al. (2001) assessed students from Cambridge University, members of the general population, individuals with Asperger syndrome (AS) or high-functioning autism (HFA) and winners of the Mathematics Olympiad. Both in Baron-Cohen, Wheelwright, Skinner, et al. (2001) sample and in more recent replications individuals with ASD score significantly higher than members of the general population (Kurita, Koyama, & Osada, 2005). In addition, Baron-Cohen, Wheelwright, Skinner, et al. (2001) found that students studying science scored higher than those studying humanities and social science.

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Baron-Cohen, Wheelwright, Skinner, et al. (2001) suggest five subscales: Social Skills, Communication, Imagination, Attention to Detail and Attention–Switching. Two studies to date have shown a three-factor structure of social skills, details/patterns and communication/mind reading (Austin, 2005; Hurst, Mitchell, Kimbrel, Kwapil, & Nelson-Gray, 2007). While Hoekstra et al. (2008) found a two-factor model, consisting of a "social interaction" factor and "attention to detail" factor in a Dutch sample. Interestingly, all three studies agree on a "social" factor and an "attention to detail" factor.

Reliability of the subscales has been assessed in only two UK samples (Austin, 2005; Baron-Cohen, Wheelwright, Skinner, et al., 2001) and the factor structure in only one (Austin, 2005). Austin's study was relatively small including only 201 individuals. Baron-Cohen, Wheelwright, Skinner, et al. (2001) sample was much larger comprising 840 students from Cambridge University (454 males, 386 females). Unfortunately, the factor structure was not assessed in this sample. It is important to gain an understanding of the reliability and validity of the AQ as a measure in different populations. The questionnaire was first assessed in one of the UK's most elite Universities, this study assesses the questionnaire in participants recruited from both Heriot-Watt University and the University of Edinburgh in order to both increase the sample size and have a more representative student sample. The current study aims to test the factor structure of the AQ in a large Scottish University sample and to assess score differences as a function of gender and course choice.

2. Method

2.1. Participants

The participants were 536 students recruited from Heriot-Watt University ($N = 384$) and the University of Edinburgh ($N = 152$). There were 303 males and 230 females; three participants did not state their gender. The mean age of the group was 24.3 years, standard deviation 10.5 years. All participants gave informed consent and ethical approval was obtained from the Ethics Committees of Heriot-Watt University and the University of Edinburgh.

2.2. Materials

Autism-Spectrum Quotient (AQ; Baron-Cohen, Wheelwright, Skinner, et al. (2001)): The Autism-Spectrum Quotient is a self-administered questionnaire comprised of 50 items. It consists of five subscales each of 10 questions assessing: Social Skills, Communication, Imagination, Attention to Detail and Attention–Switching and can also be scored according to the factor structure derived by Austin (2005), giving components of social skills, details/patterns and communication/mindreading. Half of the questions are worded to elicit an 'agree' response and the other half, a 'disagree' response. The test was administered as a pen-and-paper task. Participants were asked to answer each question as quickly as possible by circling their response on a 4-point scale ('strongly disagree', 'disagree', 'agree', 'strongly agree'). The items were scored on a continuous (Likert) scale (1–4) as this retains more information about the participants' responses than the 0/1 scoring which is sometimes used for this instrument (e.g., Baron-Cohen, Wheelwright, Skinner, et al. (2001)). Use of all the response option choice information also increases the inter-item correlations, scale reliability and validity coefficients (Muniz, Garcia-Cueto, & Lozano, 2005). A total AQ score is calculated by summing all of the scores for each of the items, with a maximum score of 200. In addition to completing the AQ, participants were asked to state their age, sex and degree subject.

2.3. Procedure

Participants were recruited as part of other ongoing projects. Participants either completed and returned the questionnaires immediately or returned the questionnaires to an investigator after completion.

3. Results

An initial exploratory factor analysis (EFA) was performed on the AQ items. Examination of the scree plot, shown in Fig. 1, suggested the extraction of four, six or eight factors, whilst a parallel analysis suggested that eight factors should be extracted. Examination of the eight-factor solution showed that several of the factors were difficult to interpret. In order to examine the issue of factor number in more detail the confirmatory factor analysis (CFA) approach described by Lynn, Allik, and Irwing (2004) was followed. As in the data of Lynn et al. (2004), it seemed likely that the parallel analysis solution was over-inclusive, i.e., it was suggesting a large number of poorly defined factors which would be unlikely to replicate in subsequent studies. The CFA approach provides a range of fit indices which can be compared for models with different numbers of factors, allowing a more informed choice of the number of factors to extract than is possible with EFA. EFA analyses for factor numbers in the range 1–8 were used as the basis of CFA models. Table 1 shows three fit indices for the models: the consistent Akaike information criterion (CAIC); root mean square error of approximation (RMSEA); and standardized root mean square residual (SRMR); following recommendations for fitting non-nested models (Jöreskog, 1993), the four-factor model was selected, as it had the lowest CAIC value. It should be noted that this model was not well-fitting according to the cut-off value of 0.05 generally used for the RMSEA and SRMR. It would have been possible to improve the fit statistics by modifying the model by allowing items to cross-load between the factors, but this was not done as there is no theoretical justification for such model changes.

The four-factor structure obtained using EFA was examined in detail. The four factors explained 29% of the variance. Since correlated factors would be expected, an oblique (direct oblimin) rotation was used; the items contributing strongly to the factors (pattern matrix elements of modulus above .3) are shown in Table 2. Internal reliabilities (Cronbach's alpha) are also shown; these reached acceptable values for the first three factors. Correlations amongst the factors are shown in Table 3. Factor scores were obtained by summing item scores, reverse-keying where necessary. Descriptive statistics for the factor scores and total AQ score

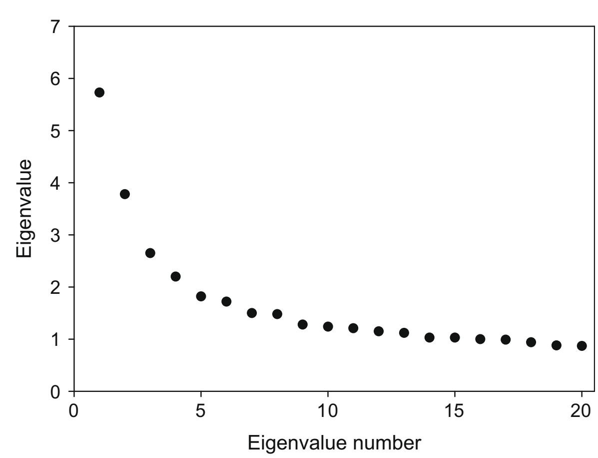

Fig. 1. Scree plot of principal components factoring of the AQ items.