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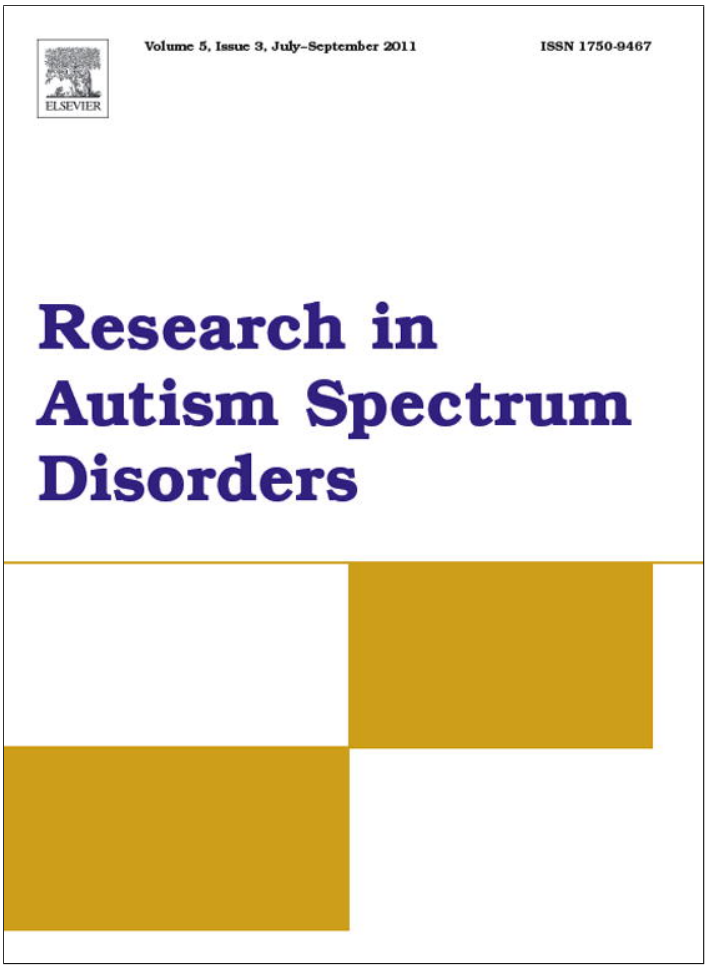


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# The use of the Autism-spectrum Quotient in differentiating high-functioning adults with autism, adults with schizophrenia and a neurotypical adult control group

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ABSTRACT

The present study compared 21 high functioning individuals with autism, 21 individuals with schizophrenia and 21 healthy individuals in self-reported features of autism, as measured by the Autism-spectrum Quotient (AQ). The individuals with autism reported impairment on all AQ subscales, compared to the neurotypical group. The schizophrenia group reported deficits on all subscales except Attention to Detail, compared to the neurotypical group.

The autism group reported more impairment than the individuals with schizophrenia in Social skill, Communication and Attention switching.

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## 1. Introduction

Recently, interest in autism spectrum disorders in adults has increased substantially. There is a growing need for knowledge about how autism can be distinguished validly from other psychiatric disorders. Therefore, it is important to use reliable screening instruments prior to the diagnostic process. The most widely used screening instrument in adult groups is the Autism-spectrum Quotient (AQ; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001). The AQ quantitatively assesses symptoms that are considered characteristic of autism spectrum disorders (ASD). The psychometric properties and validity of the AQ have been established by several publications (Baron-Cohen et al., 2001; Hoekstra, Bartels, Cath, & Boomsma, 2008; Kurita, Koyama, & Ossada, 2005). Baron-Cohen et al. (2001) suggested the following five subscales: Social skill, Communication, Imagination, Attention to detail and Attention switching. Although the subscales of the AQ are theoretically based, the five domain structure is still under debate (Austin, 2005; Hoekstra et al., 2008). In our study we chose to use the five domain version of the AQ to enable comparing our results with results of previous studies on the differential diagnostic ability of the AQ (Cath, Ran, Smit, van Balkom, & Comijs, 2008; Sizoo, van der Brink, Gorissen-van Eenige, Koeter, van Wijngaarden-Cremers, & van der Gaag, 2009).

Previous research indicated that the AQ, regardless of the number of subscales, can differentiate reasonably well between high functioning adults with autism and neurotypical individuals (Baron-Cohen et al., 2001; Hoekstra et al., 2008; Wakabayashi, Baron-Cohen, Wheelwright, & Tojo, 2006). Furthermore, research pointed out that the AQ can differentiate validly between autism and obsessive-compulsive disorder (OCD), social anxiety disorder (SAD), attention deficit disorder (ADHD) and schizophrenia (Cath et al., 2008; Hoekstra et al., 2008; Sizoo et al., 2009; Spek & Wouters, 2010).

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However, little is known about whether individuals with other psychiatric conditions have elevated scores on the AQ. To assess whether autistic features, as measured by the AQ, are unique for autism, it is important not only to investigate how other psychiatric conditions with autistic features relate to autism, but also to a neurotypical group as well. To our knowledge, only one study compared psychiatric conditions other than autism with a neurotypical group in their AQ performance (Cath et al., 2008). This study showed that on the subscales Attention switching and Social skill as well as on the total AQ, participants with OCD or SAD reported more impairment than neurotypical individuals, whereas on the subscales Communication, Imagination and Attention to detail the participants with OCD or SAD scored similar to neurotypical individuals.

Since recent studies indicated that autism and schizophrenia may arise from similar neurodevelopmental vulnerability (Burbach & van der Zwaag, 2009; Rapoport, Chavez, Greenstein, Addington, & Gogtay, 2009), the distinction between these two disorders is particularly important. The distinction between autism and schizophrenia becomes particularly unclear when little or no positive symptoms are present (Werry, 1992). Several studies reported overlap in negative symptoms between the two disorders (Dykens, Volkmar, & Glick, 1991; Konstantareas & Hewitt, 2001; Petty, Ornitz, Michelman, & Zimmerman, 1984; Sheitman, Bodfish, & Carmel, 2004; Spek & Wouters, 2010). The negative symptoms of schizophrenia (lack of emotion and thoughts, poverty of speech and apathy) behaviorally look similar to the symptoms that are characteristic for autism (disinterest, social withdrawal, difficulty in understanding social situations, lack of fantasy, reduced reciprocal social interaction).

It is important to know whether the AQ can differentiate well between individuals with schizophrenia and high functioning individuals with autism and how their performance on the AQ relates to a neurotypical control group.

Therefore, the present study aims to examine the usefulness of the AQ in differentiating between high functioning adults with autism, schizophrenia and a neurotypical adult control group.

## 2. Method

### 2.1. Participants

The participants with schizophrenia or autism were recruited at GGZ (mental health institution) in Eindhoven and in Oss and the study was approved by the regional Ethics Committees of both centers. The individuals were randomly selected from a larger group of patients in treatment programs for autism or schizophrenia. The neurotypical control subjects were recruited from the general population by advertisements in newspaper and by word of mouth. Healthy controls were not included in the present study if they had a history of psychiatric illness or if autism ran in the family.

Participants with genetic conditions or relevant neurodevelopmental conditions other than schizophrenia or autism (e.g. ADHD, Tourette syndrome) were excluded, as were participants who were institutionalized. Those participants who met the inclusion criteria were asked to participate in the present study. In total, 63 participants agreed to take part and signed informed consent forms prior to their inclusion in the present study. The individuals were all male and ranged in age from 18 to 65 years. The group comprises 21 adults with autism, 21 adults with schizophrenia and 21 neurotypical adults. To warrant the ability of the participants to understand the items of the questionnaires, they were only included when their Verbal Comprehension score of the Wechsler Adult Intelligence Scale III (WAIS III; Wechsler, 1997) was 80 or higher.

### 2.2. Assessment of disorders

The diagnoses in the individuals with autism were established preliminary, by evaluation of history and current symptoms. To gather developmental information, parents or an older brother or sister were interviewed using the Dutch version of Autism Diagnostic Interview, Revised version (ADI-R) (Lord, Rutter, & Le Couteur, 1994). The ADI-R was administered by psychologists who were trained in the administration and scoring of this instrument. The ADI-R yields excellent reliability and validity when used by trained examiners (Lord et al., 1994). To gather information of current symptoms, a semi-structured interview was administrated. This interview assesses the DSM-IV-TR criteria of autism (American Psychiatric Association [APA], 2000). For each diagnostic criterium, a standard primary question was asked, followed by questions to clarify whether the participant met the criteria of the given item. This semi-structured interview has been used for diagnostic classification in previous studies (Spek, Scholte, & van Berckelaer-Onnes, 2008; Spek, Scholte, & van Berckelaer-Onnes, 2009). Only those participants who met the DSM-IV-TR criteria of the autistic disorder were included in the present study.

The diagnoses of the participants with schizophrenia were established preliminary to the present study by psychiatric assessment following standard protocols. While the course of schizophrenia differs over time (Rabinowitz, Levine, Haim, & Häfner, 2007) the Structured Clinical Interview Schedule for DSM-IV has been administered (SCID-I; First, Spitzer, Gibbon, & Williams, 1997) to verify and confirm the diagnoses of the schizophrenia group at the present time. The reliability of the SCID-I in diagnosing specifically schizophrenia is high (Skre, Onstad, Torgersen, & Kringlen, 1991). Based on SCID-I criteria, all participants met the criteria for schizophrenia, paranoid type.

### 2.3. Instruments

#### 2.3.1. Autism-spectrum Quotient

To examine whether characteristics of autism are present in the participants, a Dutch translation of the Autism-spectrum Quotient (AQ) was used (Ponnet, Roeyers, & Buysse, 2001). The AQ is a 50 item self-administered questionnaire that assesses

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the degree to which an adult reports features of the core autistic phenotype (Baron-Cohen et al., 2001). Although the use of self-reports is controversial in individuals with autism, research has shown that adults with average verbal ability and a relatively high level of functioning are relatively able to describe their strengths and weaknesses adequately (Frith & Happé, 1999; Happé, 1991; Spek, Scholte, & Van Berckelaer-Onnes, 2009). In the present sample, 90.4% of the individuals with autism finished a middle or high level of education. Therefore adequate insight might be expected.

In schizophrenia, insight has also been questioned (for an overview, see: Osatuke, Ciesla, Kasckow, Zisook, & Mohamed, 2008), but was found positively related to compliance to treatment (Capdevielle et al., 2009; Lincoln, Lüllmann, & Rief, 2007) and the absence of substance abuse (Kamali et al., 2001). Therefore, only participants with high treatment compliance and without substance were included in the schizophrenia group.

The 50 items of the AQ were divided by the original authors into 5 theoretical subscales of 10 items each: Social skill, Communication, Imagination, Attention to detail, and Attention switching. The internal consistency and test–retest reliability of the AQ are satisfactory (Hoekstra et al., 2008). The internal consistency for the three groups in the present study is good for the autism group (standarized Crohnbach's alpha = .89), sufficient for the schizophrenia group (standarized Crohnbach's alpha = .73) and very good for the neurotypical group (standarized Crohnbach's alpha = .92).

#### 2.3.2. Verbal Comprehension (Wechsler Adult Iintelligence Scale III (WAIS III))

As part of the present study, general verbal skills have been assessed, using the Dutch version of the WAIS-III (Wechsler, 2000). Four factors can be derived from WAIS-III data: Verbal Comprehension, Perceptual Organization, Freedom from Distractibility and Processing Speed. Factor analytic studies indicate that the four factor scales give the best estimates of the factors underlying intelligence (Arnau & Thompson, 2000; Ryan & Paolo, 2001). Only the factor Verbal Comprehension was used in the present study. This factor scale consists of three subtests: Vocabulary, Information and Similarities. WAIS-III has excellent psychometric properties (Sattler & Ryan, 1999) and has been validated for the Dutch population (Wechsler, 2000).

### 2.4. Statistics

The three groups were matched according to age and verbal abilities. To match for verbal abilities, the WAIS-III factor scale 'Verbal Comprehension Index' (VCI) was used.

The assumptions for parametric tests were met. To test the hypotheses of differences in total AQ scores between the three groups, the average sum score of the total AQ was calculated per group and subsequently compared using an one-way between groups analysis of variance (ANOVA). To investigate which differences between the three diagnostic groups added to the main effects, post hoc Tukey HSD comparisons were performed. Finally, a Receiver Operating Characteristic analysis (ROC) was performed to examine sensitivity, specificity, cut-off scores and percentage correctly classified patients in the three groups.

To investigate differences in AQ subscales between the three groups, the average sum scores of the AQ subscales were calculated per group and subsequently compared with a multivariate analysis of variance (MANOVA). To investigate which differences between the three diagnostic groups added to the main effects, post hoc Tukey HSD comparisons were performed. To interpret the effect size of the differences between the three groups, the guidelines of Cohen (1988) were used. Except for the two-graph ROC analysis which was done in R, all statistical analyses were performed with SPSS 16.0 using two-tailed tests with $\alpha = 0.05$.

## 3. Results

### 3.1. Matching statistics

The three groups were normally distributed with regard to age and verbal abilities and therefore the assumptions of one-way analysis of variance (ANOVA) were met. The results of the ANOVA showed that the three groups did not differ in VCI and mean age (see Table 1).

### 3.2. Explanatory statistics

#### 3.2.1. Differences in the total AQ

The mean scores and standard deviations of the total AQ in the three groups are presented in Table 2. To test the hypothesis of differences in the total AQ score between the three groups, a one-way between groups analysis of variance

**Table 1**
Matching variables.

| | Autism | Schizophrenia | Neurotypical | Statistic | *p*-Value |
|---|---|---|---|---|---|
| Mean age | 44.1 (11.7) | 40.9 (8.1) | 40.8 (9.9) | $F(2, 60) = 0.76$ | .47 |
| VCI[a] | 110.5 (13.6) | 107.2 (11.4) | 114.0 (8.3) | $F(2, 60) = 1.89$ | .16 |

[a] VCI = Verbal Comprehension Index, measured by the WAIS-III.

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**Table 2**
Means and standard deviations for the Autism-spectrum Quotient.

| | Autism | Schizophrenia | Neurotypical | *p*-Value |
|---|---|---|---|---|
| Total AQ | 133.5 (16.9) | 115.6 (12.1) | 92.8 (17.3) | .00 |
| Social skill | 30.1 (4.5) | 23.6 (4.9) | 18.0 (4.6) | .00 |
| Attention switching | 28.4 (4.8) | 24.5 (4.0) | 18.5 (4.9) | .00 |
| Attention to detail | 24.5 (5.3) | 22.9 (4.4) | 20.4 (5.1) | .03 |
| Communication | 25.2 (4.3) | 20.7 (3.3) | 16.6 (3.0) | .00 |
| Imagination | 25.3 (4.5) | 24.0 (3.9) | 19.4 (4.8) | .00 |

(ANOVA) with Tukey HSD comparisons tests was performed. The diagnosis was used as the independent variable and the total AQ sum score as the dependent variable. The three groups were normally distributed with regard to the dependent variable and the assumption of homogeneity of variances was met. The analysis showed a statistically significant difference in total AQ score between the three diagnostic groups $F(2, 60) = 35.890$, $p < .001$. The actual difference in mean scores between the groups is large; the effect size, calculated using eta squared, is .54.

Post hoc comparisons using the Tukey HSD test indicated that the mean total AQ score was significantly higher in the individuals with autism than in the schizophrenia group ($p = .001$) and the neurotypical group ($p < .001$). Furthermore, the mean total AQ score in the schizophrenia group was significantly higher than in the neurotypical group ($p < .001$).

A Receiver Operating Characteristic analysis (ROC analysis) was conducted to assess the ability of the total AQ to discriminate between the three groups. To optimize sensitivity and specificity simultaneously, we indicated the points at which the percentages of wrongly classified patients is equally distributed over both groups at hand, cut-off points were determined using the two-graph ROC technique of Greiner, Pfeiffer and Smith (2000).

Regarding autism and neurotypicals, a ROC analysis for the total AQ showed an area under the curve of 0.905 which means that of all possible pairs of subjects in which one has autism and the other one is neurotypical, the AQ can highly accurate (90%) identify the status of both subjects (autism or neurotypical). A balanced cut-off score of 112 resulted in a sensitivity of 0.90, a specificity of 0.90, and a correct classification of 90%, which consisted for 50% of individuals with autism. Using the balanced cut-off score 112, in our sample we correctly identified 38 of the 42 individuals (19 with autism and 19 neurotypicals).

Regarding autism and schizophrenia, a ROC analysis for the total AQ showed an area under the curve of 0.751, which means that in almost all possible pairs of subjects in which one has autism and the other schizophrenia, the AQ can moderately accurate (75%) identify the status of both subjects (autism or schizophrenia). A balanced cut-off score of 123 resulted in a sensitivity of 0.71, a specificity of 0.76, and a correct classification of 74%, which consisted for 48% of individuals with autism. Using the balanced cut-off score 123, in our sample we correctly identified 31 of the 42 individuals (16 with autism and 15 with schizophrenia).

Finally, regarding schizophrenia and neurotypicals, a ROC analysis for the total AQ showed an area under the curve of 0.803, which means that in almost all possible pairs of subjects in which one has schizophrenia and the other one is neurotypical, the AQ can moderately accurate (80%) identify the status of both subjects (schizophrenia or neurotypical). A balanced cut-off score of 104 resulted in a sensitivity of 0.81, a specificity of 0.81, and a correct classification of 81%, which consisted for 50% of individuals with schizophrenia. Using the balanced cut-off score 104, in our sample, we correctly identified 34 of the 42 individuals (17 with schizophrenia and 17 neurotypical individuals).

### *3.2.2. Differences in the AQ subscales*

The mean scores and standard deviations of the AQ subscales for the three groups are presented in Table 2. To test the hypotheses of differences in the AQ subscales between the three groups, a multivariate analysis of variance (MANOVA) was performed. The diagnosis was used as the independent variable and the AQ subscales as the dependent variables. Preliminary assumption testing was conducted to check for normality, linearity, univariate en multivariate outliers, homogeneity of variance–covariance matrices and multicollinearity, with no violations noted. The analyses show a significant difference between the three groups in the combined dependent variables, $F(10, 114) = 5.518$, $p < .001$; Pillai's Trace = .65. The effect size, calculated using eta squared, was .33, which can be described as large.

When the results for the dependent variables were considered separately, all AQ subscales reached statistical significance at a $p < 0.05$ level.

Post hoc comparisons using the Tukey HSD test showed that the adults with autism reported significantly more impairment compared to the schizophrenia group on the subscales Social skill ($p < .001$), Attention switching ($p = .021$) and Communication ($p < .001$). No significant differences were found between these two groups on the subscales Attention to details ($p = .542$) and Imagination ($p = .595$).

In comparison with the neurotypical group the autism group scored significantly higher on the subscales Social skill ($p < .001$), Attention switching ($p < .001$), Attention to detail ($p = .023$), Communication ($p < .001$) and Imagination ($p < .001$).

Finally, the schizophrenia group reported significantly more autistic characteristics in comparison with the neurotypical group on the subscales Social skill ($p = .001$), Attention switching ($p < .001$), Communication ($p = .001$) and Imagination ($p = .004$). No significant difference between those two groups was found on the subscale Attention to detail ($p = .232$).

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## 4. Discussion

The aim of the present study was to examine how the performance of adults with autism or schizophrenia on the AQ relates to a neurotypical group. The results showed that the individuals with autism reported most autistic features, the neurotypical group the least. The individuals with schizophrenia could be positioned somewhere between the two other groups. Recent research indicates that autistic disability lies on a continuum depending on the severity of the symptoms. In this continuum, neurotypical individuals lie on one end and individuals with autistic disorder lie on the other end. As Fig. 1 illustrates, the individuals with schizophrenia can be placed approximately in the middle of this continuum.

With regard to the AQ subscales, the present study shows impairment in the autism group on all subscales, compared to the neurotypical group. The individuals with schizophrenia report impairment on all subscales except Attention to detail, compared to the neurotypical group. The autism group reported more impairment in Social skill, Communication and Attention switching than the individuals with schizophrenia. In the following paragraph, the findings on the different subscales of the AQ will be further discussed and related to previous findings of AQ performance in other psychiatric disorders.

Our results demonstrated impairment in Social skill and Communication in the autism and schizophrenia groups, compared to the neurotypical group. The results further showed that the impairment in both domains is larger in the autism group than in the schizophrenia group. With regard to Social skill this is in line with previous studies in which impaired Social skill has been reported in both autism (see Carter, Davis, Klin, & Volkmar, 2005, for an overview) and schizophrenia (Bellack, Morrison, Wixted, & Mueser, 1990; Mueser et al., 1996, and others). Our findings are also in agreement with the notion that in autism, impairment in Social skill is regarded a primary deficit (Carter et al., 2005) while in schizophrenia this is still unclear (Brüne, 2005). Similar results were found when ADHD and ASD were compared: social impairment in ASD appears larger than in ADHD (Sizoo et al., 2009). However, research comparing ASD with OCD and SAD yielded mixed results. Cath and colleagues reported no differences between the three groups, while Hoekstra et al. (2008) found more impairment in ASD than in OCD and SAD. Apparently, impairment in Social skill is not limited to individuals with ASD, although most evidence points to larger deficits in individuals with ASD. With regard to Communication research in autism (Tager-Flusberg, Paul, & Lord, 2005) and schizophrenia (Brüne, 2005) demonstrated that both disorder groups are impaired in applying conversational rules and conventions. Especially encoding and decoding messages with the objective to interpret seems to be difficult for both groups (Brüne, 2005). Previous research showed unimpaired functioning in Communication in OCD and SAD, compared to a neurotypical group (Cath et al., 2008). Furthermore, Sizoo et al. (2009) reported larger impairments on the AQ subscale Communication in autism than in ADHD. Our results and those of Sizoo et al. (2009) seem to indicate that impairment in Communication, as measured by the AQ, is not limited to ASD. However, the impairment seems larger in ASD than in other psychiatric disorders.

The results on the subscale Attention switching pointed to a deficit in attention shifting in autism and schizophrenia, compared to neurotypical individuals. The impairment was larger in the autism group. Attention switching refers to the ability to adjust the mental focus of attention to follow rapidly changing sensory cues which simultaneous enter different channels. Our findings are in line with previous research in autism (for an overview, see Ozonoff, South, & Provencal, 2005)

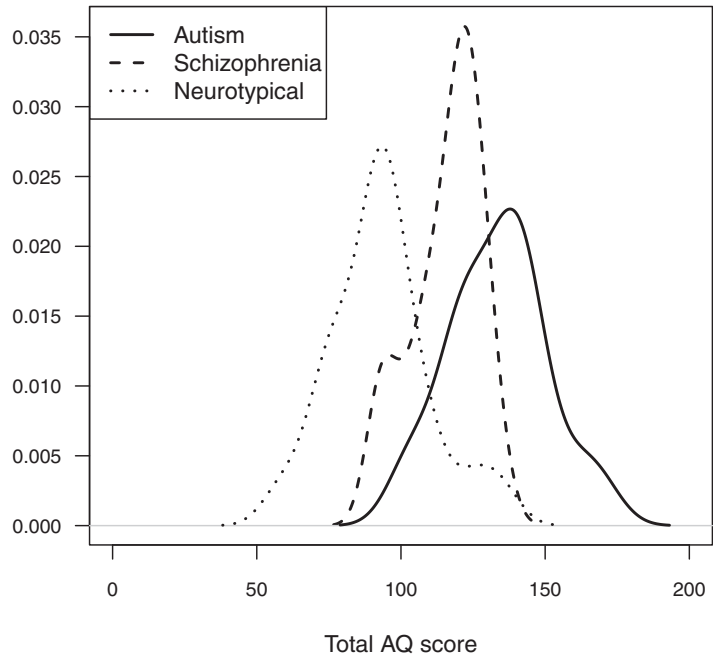


**Fig. 1.** Density plot of total AQ scores.

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and schizophrenia (Smith et al., 1998; Zubin, 1975), which demonstrated that both disorder groups are impaired in tasks that require shifting attention.

Previous research, in which OCD, SAD and ADHD were compared with ASD, showed similar results. Individuals with OCD and SAD were impaired in attention shifting, but in a lesser degree than individuals with autism (Cath et al., 2008). Although ADHD has not been compared with a neurotypical control group in this respect, the individuals with ASD did report more impairment than the ADHD group (Sizoo et al., 2009). The above suggests that impairment in attention shifting is not restricted to ASD, although the degree of impairment is larger in ASD than in other disorders.

With regard to imagination, both the autism and the schizophrenia groups were, in a similar degree, impaired in comparison to a neurotypical group. Previous studies reported more impairment in ASD than in ADHD, SAD and OCD in this respect (Cath et al., 2008; Sizoo et al., 2009). Our findings with respect to the schizophrenia group are in contrast with previous research, which showed enhanced imagination in individuals with schizophrenia (Sacks, van de Ven, Etschenberg, Schatz, & Linden, 2005). We can think of two possible explanations for this. First, it is possible that the schizophrenia group lacks the insight to recognize their imagination skills validly. We cannot exclude lack of insight in this group. However, the individuals with schizophrenia were carefully selected on the absence of substance abuse and high compliance to treatment, the two factors that are most predictable of adequate insight into the disorder (Capdevielle et al., 2009; Lincoln et al., 2007). Secondly, it may be due to the content of the subscale Imagination. In this respect, it is important to consider studies in which the factor analytic structure of the AQ has been examined. Two studies suggested three underlying factors: Social skill, Details/patterns and Communication/mindreading (Austin, 2005; Hurst, Mitchell, Kimbrel, Kwapil, & Nelson-Gray, 2007) and one study suggested a broad Social interaction subscale and a second subscale Attention to detail (Hoekstra et al., 2008). In the three existing factor analytic studies, the subscale Imagination was never established as a separate subscale. Apparently, the items that build up the subscale Imagination load on different subscales of the AQ. Therefore, it is possible that the unexpected results in the subscale Imagination can be attributed to the questionable validity of this particular subscale.

The results of the present study further show that adults with autism score higher on the subscale Attention to detail in comparison to the neurotypical subjects. Individuals with schizophrenia did not differ on this subscale from either the neurotypical group or the individuals with autism. A similar pattern of results was found for ADHD (Sizoo et al., 2009). With regard to OCD, results are mixed: whereas Cath et al. (2008) report no differences with ASD, Hoekstra et al. (2008) describe less impaired attention to detail in OCD compared to ASD. Furthermore, individuals with SAD report less attention to detail than an ASD group (Cath et al., 2008; Hoekstra et al., 2008). The above suggests that attention to detail is not limited to individuals with ASD, it can also be a feature of other psychiatric disorders.

### 4.1. Conclusions

The present study shows that the AQ is a useful screening instrument to differentiate between autism, schizophrenia and a neurotypical group. Especially the total AQ score and the subscales Social skill, Communication and Attention switching seem valuable when differentiating between the three groups.

### 4.2. Limitations and recommendations

An important limitation of the present study concerns the generalizability of the results. The individuals with schizophrenia were all of the paranoid subtype with no substance abuse and compliance to treatment. Furthermore the autism group consisted only of high functioning individuals with the autistic disorder. Therefore, our findings cannot be generalized to other subtypes within the schizophrenia and autism spectrum. Research in the differential diagnostic possibilities of the AQ in highfunctioning adults with other subtypes of autism and schizophrenia is warranted.

Furthermore it is important to mention that the participants in the present study were all high functioning. Since a considerable proportion of the total ASD population has a comorbid diagnosis of intellectual disability, our results can only be generalized to a subset of the total population. Replication of the present study in individuals with intellectual disability is not advisable, since the ability to complete a self-report questionnaire was a methodological requirement to participate in the study.

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