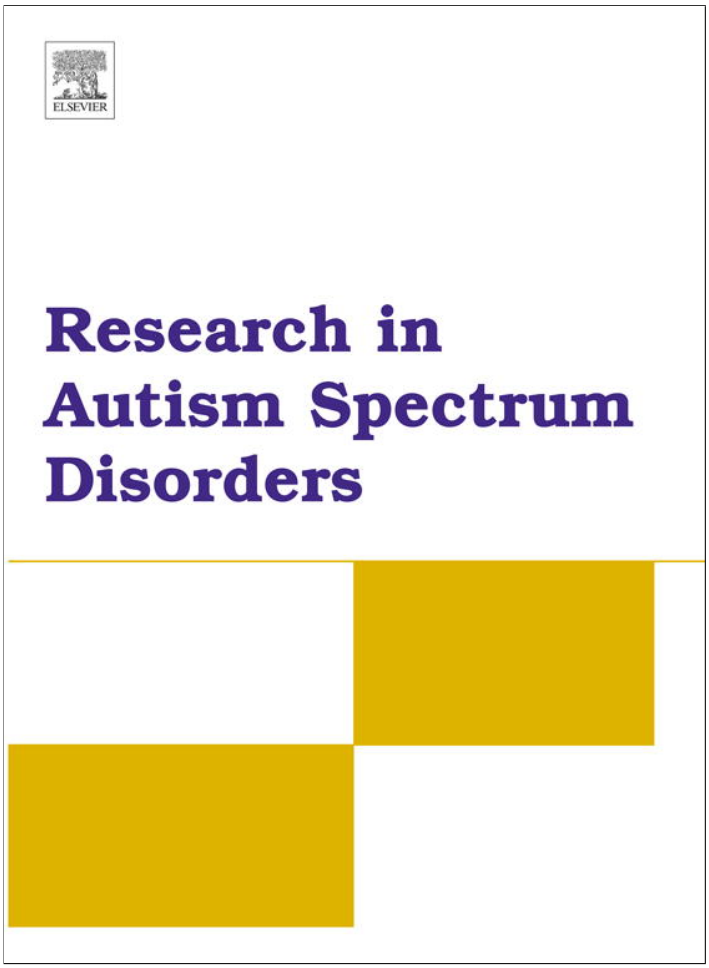

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Examining the relationship between Autism spectrum disorders and technical professions in high functioning adults

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ABSTRACT

A relationship has been hypothesized between Autism and technical professions. This has been attributed to superior folk physics in individuals with Autism. Folk physics can be described as the capability to understand physical causality. Since all the previous studies in this area were focused on family members of individuals with Autism, it was unclear if there is a direct relationship between Autism and technical professions. Therefore, we examined the degree to which the professions of high functioning adults with Autism ($N = 29$) encompass technical skills and compared the results to adults with Schizophrenia ($N = 17$) and a neurotypical control group ($N = 30$). Furthermore, we examined whether the degree of technical skills in the professions of the Autism group was related to their autistic traits. The results showed that the last and longest attained professions of the adults with Autism require more technical skills than those of the Schizophrenia and neurotypical group. Furthermore, the degree of technical skills in the professions of the adults with Autism is related to impairments in social skills, but not to strengths in detailed information processing.

1. Introduction

Autism is a neurobiological developmental disorder that first becomes apparent during childhood and which continues into adulthood. The core symptom domains of Autism include impairment in social interaction and communication and the presence of restricted, repetitive and stereotyped patterns of behavior, interests and activities (APA, 2000).

In Autism research throughout the years, emphasis has been put on the associated impairments. Recently, however, Autism has been described as having a 'different' mind rather than a 'deficient' mind (Happé, 1999). Individuals with autistic impairment are thought to have specific skills. They show enhanced detailed information processing, which means that they have a bias for detailed information (Happé & Frith, 2006). Research also provided evidence for enhanced perceptual functioning in Autism, which implies superior performance in both visual and auditory cognitive tasks, for example in recognizing visual patterns (Mottron, Dawson, Soulieres, Hubert, & Burack, 2006). These strengths have been hypothesized to be especially helpful in technical professions, for example in the areas of physics, engineering, and mathematics (Wheelwright & Baron-Cohen, 2001). It is therefore not surprising that a relationship has been hypothesized between the autistic phenotype and technical professions. This has been mainly attributed to superior folk physics and impaired folk psychology in individuals with Autism (Baron-Cohen et al., 1998). Folk psychology has been defined as the natural capacity to explain and predict the behavior and mental states of other people, folk physics can be described as the capability to understand physical objects in terms of their causal and mechanical properties (Baron-Cohen et al., 1998). Folk psychology is often used to understand 'how people work', folk physics is about how inanimate things, like machines, work.

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A strength in folk physics is thought to be related to strengths in technical areas (Wheelwright & Baron-Cohen, 2001). Results of a relevant study in this area showed higher numbers of children with Autism living in a technical region, when compared to a non-technical region (Roelofsma et al., 2011). Although the large number of participants in this study was advantageous, no formalized instruments were used in the diagnostic process. Also, response rate in the two control cities was relatively low (49.8 and 45.7%), which can give rise to a sampling bias. Furthermore, the study was correlational and other factors that might have been of influence were not investigated. Therefore, definite conclusions about the relationship between Autism and technical skills could not be drawn. To our knowledge, all other studies in which the relationship between Autism and technical occupations were examined, focused on family members of individuals with Autism, while the participants with Autism themselves were never assessed on their strengths (Baron-Cohen, Wheelwright, Stott, Bonton, & Goodyer, 1997, Baron-Cohen et al., 1998). Moreover, if individuals with Autism indeed have qualities in technical areas, as hypothesized, we do not know if they are able to use these qualities in their work environment. If they can incorporate their strengths into their daily working life, this could enhance the chance of finding a place in society.

Therefore, in this study we will investigate the nature of the professions of a high-functioning adult group with Autism and compare this to a control group of adults without psychiatric disorders or intellectual disability, a so-called neurotypical group. We aim to examine to which degree their professions encompass technical skills. For this end, we will use a dimensional approach as opposed to the categorical system that was used in previous studies that examined the relationship between Autism and technical skills (Baron-Cohen et al., 1997, Baron-Cohen et al., 1998; Windham, Fessel, & Grether, 2009). The reason for this was the awareness that most occupations require a certain degree of engineering skills. For instance, Information Technology (IT) occupations such as functional designer, business analyst and system analyst rely heavily on communicational and social skills, while they may also be considered 'engineering' professions. Therefore, a dimensional approach seems more suitable.

Furthermore, it may be important to examine whether a strength in technical skills is solely an Autism characteristic or a characteristic found in neurodevelopmental disorders in general. For this reason, we included a group of individuals with Schizophrenia in our study, alongside the neurotypical control group. We chose Schizophrenia, because of its overlap with Autism in social and communicative impairments (Konstantareas & Hewitt, 2001; Nylander, Lugnegard, & Hallerback, 2008).

Finally, if our findings point to a relationship between Autism and technical professions, it is relevant to examine the underlying mechanism. For example, impairment in social skills and/or communication might be an underlying mechanism, that decreases the chance of finding work in a social work environment and leads to a higher probability of working in a technical, less social environment. In that case, mechanisms underlying the relationship between Autism and technical professions are Autism-specific weaknesses, rather than strengths. Furthermore, more in line with the 'folk physics' theory of Baron-Cohen et al. (1998), choosing a technical profession may also be related to their strengths in detailed information processing. Therefore, we will relate the degree to which the professions encompass technical skills to the different autistic traits, as measured by the Autism-spectrum Quotient.

2. Method

2.1. Participants

All participants in the three groups were male, native Dutch inhabitants of the same city. The participants with Autism and Schizophrenia were randomly selected from a larger group of patients in Autism or Schizophrenia treatment programs. All participants received individual counseling from a mental health nurse or a psychologist. The Autism group encompassed only participants with the autistic disorder; participants with other Autism spectrum disorders were not included. We specifically chose for the autistic disorder because it is considered the most robust and valid diagnosis within the Autism spectrum (Volkmar & Klin, 2005). The neurotypical control subjects were recruited from the general population by advertisements in newspapers 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 were excluded, as were participants who were institutionalized. Only men who ranged in age from 18 to 65 were asked to participate. In total, 76 participants agreed to take part and signed informed consent forms prior to their inclusion in the present study. The group comprised 29 adults with Autism, 30 neurotypical adults and 17 adults with Schizophrenia. The relatively small size of the Schizophrenia group was due to problems in finding individuals who were capable and willing to participate in the study.

To be sure that all participants were able to understand the items of the questionnaires, participants were only included when the Verbal Comprehension Index (VCI) score of the Wechsler Adult Intelligence Scale III (WAIS III, Wechsler, 2000) was at least 80. This cutoff score was used by Wechsler (2005) as a boundary between retarded (lower than 80) and (below) average intelligence (higher than 80). It was not possible to use the WAIS IV, since at the time of this study, there was no Dutch translation available. In order to reduce the Flynn effect of the WAIS-III, an update of the Dutch norms was used (Wechsler, 2005).

2.2. Assessment of disorders

All adults with Autism and Schizophrenia were diagnosed by experienced psychologists or psychiatrists who were trained in assessing the Autistic Disorder Diagnostic Interview, revised version (ADI-R; Lord, Rutter, & Le Couteur, 1994) and the Structured Clinical Interview Schedule for the DSM-IV (SCID-CV; First, Spitzer, Gibbon, & Williams, 1996).

The individuals with Autism were previously diagnosed through evaluation of history and current symptomatology. To gather developmental information, parents or an older brother or sister were interviewed using the Dutch version of the ADI-R (De Jonge, De Bildt, Le Couteur, Lord, & Rutter, 2007). The ADI-R was administered by psychologists who were officially trained in the administration and scoring of this instrument. Research shows that the ADI-R yields excellent reliability and validity when used by trained examiners (Lord et al., 1994). To gather information of current symptomatology, a semi-structured interview was administered (Semi-structured Interview for Autism Spectrum Disorders; Spek, Scholte, & Van Berckelaer-Onnes, 2008). This interview has been developed to assesses the DSM-IV-TR criteria of the autistic disorder by asking the participant standard questions (APA, 2000). Only those participants who met the DSM-IV-TR criteria of the autistic disorder were included in the present study.

In order to examine symptoms that are considered characteristic for the autistic disorder, the Autism-spectrum Quotient was used (AQ; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001). The AQ is a 50 item self-administered questionnaire that assesses the degree to which an adult reports features of the core autistic phenotype. 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 generally able to describe their strengths and weaknesses adequately (Frith & Happé, 1999; Happé, 1991). The five subscales of the AQ assess the following features: Social skill, Attention switching, Attention to detail, Communication and Imagination. The internal consistency and test–retest reliability are satisfactory (Hoekstra, Bartels, Cath, & Boomsma, 2008). In the present study, a Dutch translation of the AQ was used (Ponnet, Roeyers, & Buysse, 2001) and all five subscale scores were included as variables.

The participants with Schizophrenia were diagnosed prior to the present study, by psychiatric assessment following standard protocols. To verify and confirm the diagnosis, the SCID-CV was used and results demonstrated that all participants met criteria for Schizophrenia, Paranoid type. The reliability of the SCID-I in specifically diagnosing Schizophrenia is high (Skre, Onstad, Torgersen, & Kringlen, 1991).

2.3. Assessment of level of technical skills required for the professions

All participants were asked about their most recent profession and the profession in which they had worked the longest. This was accomplished by means of a structured telephone interview (Calvert & Pope, 2005). After the professions of the participants and their relatives were noted, a list was made of all professions that were named. Two professionals who work in the employment sector were asked to score the degree of technical skills of each profession. These professionals each had more than ten years experience in recruiting and referring applicants to suitable jobs and were therefore experienced in determining job requirements. They did not know any of the participants of the present study, nor were they aware of the specific purpose of the study. The professionals were asked to score the degree of technical skills of each profession on a scale from zero to ten (zero meaning little technical knowledge and few technical skills required; ten meaning a lot of technical knowledge and many technical skills required). Examples of jobs that were considered highly technical were mechanic/technician, electrical engineer and software engineer. Jobs like male nurse, social worker and salesman at a department store were not held to be technical.

When the scores of the two raters differed, the average score was used. The definition of technical skills was based on the elaborate descriptions of Baron-Cohen (1997). The interrater reliability was satisfactory (Spearman's rho = 0.894).

2.4. Matching procedure

The three groups were matched according to age and level of education (see Table 1). In order to classify level of education, the *Verhage Scale* was used (Verhage, 1964). This scale contains the following seven categories: (1) Less than six years of primary education. (2) Finished six years of primary education. (3) Six years primary education and less than two years of low level secondary education. (4) Four years of low level secondary education. (5) Four years of average level secondary education. (6) Five years of high level secondary education. (7) University degree. The subject characteristics of the three groups are presented in Table 1. A Chi-square test showed no significant differences in level of education χ^2 (6) = 5.993, p = .424. *T*-tests showed that the three groups did not differ in mean age (F(2,73) = 1.155, p = .321).

Table 1
Matching variables.

	HFA (N = 29)	Schizophrenia (N = 17)	Control (N = 30)	Statistic	p Value
Mean age	44.0 (9.8)	41.9 (8.5)	39.7 (12.4)	F(2,73) = 1.155	.321
LEA[a]	0/0/0/2/8/19/0	0/0/2/3/3/9/0	0/0/1/3/9/17/0	χ^2 (6) = 5.993	.424

[a] LEA, level of educational attainment. The levels range from 0 to 7 and indicate the highest completed education. 0 equals low education (primary school not finished), 7 equals high education (academic degree).

3. Results

3.1. Professions of the participants

To examine possible differences in the degree of technical skills that are required in the last and the longest attained professions of the participants in the three groups, a multivariate analysis of variance (MANOVA) was performed. The diagnosis was used as the independent variable and the total mean score of the last and the longest attained profession as the dependent variables. The assumptions of univariate normality were met for each dependent variable, as was the assumption of equality of variances between the groups. The means and standard deviation of the last and longest attained professions of the three research groups are described in Table 2.

In order to examine the degree of technical skills needed for the last and the longest attained profession of the relatives of the participants, a MANOVA was performed. The diagnosis was used as the independent variable and the total mean score of the last and the longest attained profession were the dependent variables. The assumption of equality of variances between the groups was met, as were the assumptions of univariate normality for each dependent variable.

The analyses showed a significant main effect of diagnosis for the longest and last attained profession ($F(4,144) = 4.020$, $p = .004$) with a moderate effect size (partial eta squared = .100). When the results for the dependent variables were considered separately, both the longest ($p = .007$) and the last ($p = .003$) attained profession differed significantly between the three groups. The effect size was moderate for longest profession (partial eta squared = .128) and large for the last profession (partial eta squared = .150).

Post hoc Tukey comparisons showed that the longest attained profession of the Autism group contained significantly more technical skills than the Schizophrenia group ($p = .031$) and the control group ($p = .013$). The Schizophrenia group and the control group did not differ ($p = .994$). The last attained profession of the adults with Autism required significantly more technical skills compared to the adults with Schizophrenia ($p = .004$) and the control group ($p = .030$). The Schizophrenia group and the control group did not differ significantly in this respect ($p = .494$).

3.2. Differences in self-reported features of Autism

The mean scores and standard deviations of the AQ for the three groups are presented in Table 2. To test the hypotheses of differences in the AQ subscales between the two groups, a MANOVA was performed. The diagnosis was used as the independent variable and the AQ subscales as the dependent variables. The assumptions of univariate normality were met for each dependent variable, as was the assumption of equality of variances between the groups.

The results showed significantly higher scores in the Autism group as compared to the Schizophrenia group for the social skill subscale ($p > .001$), the Attention switching subscale ($p = .001$) and the Communication subscale ($p > .001$). Differences between the Autism and the Schizophrenia groups were not significant on the subscales Attention to detail ($p = .643$) and Imagination ($p = .180$). The adults with Autism scored significantly higher than the adults in the control group on the subscales: Social skill ($p < .001$), attention switching ($p < .001$), communication ($p < .001$) and imagination ($p < .001$). No significant differences were found on the subscale attention to detail ($p = .126$).

3.3. The association between the professions and features of Autism

To examine whether the last and longest professions of adults with Autism could in any way be related to characteristics of Autism, we examined the relationship between the professions and the AQ subscale scores. This was done by calculating Pearson product–moment correlation coefficients. Preliminary analyses were performed to ensure that assumptions of normality, linearity and homoscedasticity were not violated. Table 3 shows the correlation matrix for these results.

Small, but significant positive correlations were found between the last attained profession and the social skill subscale of the AQ ($r = .253$, $p = .027$), medium-sized correlations were found between the longest attained profession and the social skill subscale ($r = .303$, $p = .008$).

Table 2
Descriptives AQ and longest and last profession.

	HFA	Schizophrenia	Control group	*p*	Effect-size
Attention to detail (SD)	23.9 (5.6)	22.5 (4.2)	21.4 (4.4)	.150	.051
Social skill (SD)	30.2 (5.6)	23.1 (4.5)	18.9 (4.6)	.000	.515
Attention switching (SD)	29.1 (4.5)	24.1 (4.0)	19.9 (4.1)	.000	.492
Communication (SD)	27.0 (5.4)	20.6 (3.4)	17.6 (3.2)	.000	.504
Imagination (SD)	25.7 (4.4)	23.4 (4.0)	20.6 (4.1)	.000	.229
Mean LPP (SD)[a]	5.6 (2.9)	2.7 (2.7)	3.7 (2.7)	.003	.150
Mean LHPP (SD)[b]	5.4 (2.9)	3.2 (2.8)	3.3 (2.6)	.007	.128

[a] LPP, last profession participants.
[b] LHPP, longest held profession participants.

Table 3
Correlation coefficients total group ($N = 76$).

	Last profession	Longest profession
1. Last profession	–	
2. Longest profession	.886**	–
3. Attention to detail	−.012	−.069
4. Social skill	.253*	.303**
5. Attention switching	.066	.137
6. Communication	.164	.177
7. Imagination	.116	.103

* $p < .05$.
** $p < .01$.

4. Discussion

In the present study, we examined the nature of professions of a high-functioning adult group with Autism and compared the results against neurotypical adults and adults with Schizophrenia.

Our data showed that the last and longest attained professions of the adults with Autism encompass a higher degree of technical skills than those of the neurotypical adults and of the adults with Schizophrenia. This gives rise to the hypothesis that adults with Autism are more likely to find and keep a job in a technical area and chances of succeeding in a technical profession may be higher than in other professions, although this topic warrants further research. These results may be interpreted as supporting the 'superior folk physics' theory of Autism, which describes better technical and mechanical skills in people with Autism and presumes a relationship with technical occupations, in which possession of superior folk physics is an advantage (Baron-Cohen et al., 1997). Folk physics refers to skills that are involved in mechanics and understanding how things work. Superior folk physics in Autism has been attributed to their 'autistic brain'; which the authors considered an extreme form of the male brain (Baron-Cohen et al., 1998).

The results on the AQ clearly showed that the adults with Autism report more autistic features than the other two groups, especially with regard tot social and communicative impairment. Our finding that the adults with Autism reported more social impairment on the AQ, is also in line with the 'superior folk physics' theory of Baron-Cohen (1997), which describes that in Autism, superiority in folk physics is accompanied by deficits in folk psychology. They define folk psychology as theory of mind, mentalizing, or using mental states to predict action.

Interestingly, our results also demonstrated that the degree of technical skills involved in the professions is related to social skill, in such a way that more social impairment is related to a higher degree of technical skills in the profession. Apparently, the difficulty that adults with Autism experience in social interaction is related to the nature of their professions. It is possible, perhaps even likely, that their social impairment is an impeding factor in finding jobs that require social strengths, whereas social impairment is less impeding in occupations that require more, or mainly, technical skills. In contrast to what we expected, no relationship was found between degree of technical skills and attention to detail. This is not in line with the folk physics theory of Baron-Cohen (1997), which says that the relationship between Autism and technical occupations is based on strengths rather than weaknesses. This is why we expected a relationship with attention to detail, rather than with (impairment in) social skill. The fact that we did not find a relationship with attention to detail, may be partly due to the instrument we used to measure this concept. As Table 2 shows, we found no significant differences between the three groups in self-reported detailed information processing. This is in sharp contrast to the other four subscales of the AQ, in which large differences appeared between the three groups, with the adult Autism group showing the highest scores. Given the notion that detailed information processing is one of the key components of Autism spectrum disorders (Frith, 1989), this particular subscale of the AQ may not be valid, which may be due to impairment in insight in this aspect, which is common in Autism (Frith, 1989).

However, another explanation for why we did not find significant differences between the three groups, may be that enhanced detailed information processing is not limited to Autism. Results of previous studies showed that other disorder groups also show enhanced detailed information processing (Cath, Ran, Smit, Van Balkom, & Comijs, 2008; Wouters & Spek, 2011). To our knowledge, no existing empirical research addressed detailed information processing in neurotypical groups. Therefore, we do not know if our results in detailed information processing are valid or not. Overall, we cannot draw definite conclusions about the relationship between detailed information processing and technical occupations.

Based on our results, we believe we can conclude that professions of adults with Autism encompass more technical elements than adults with Schizophrenia and neurotypical adults, which may be related to their impairments in social skill. No evidence was found for a relationship between detailed information processing and degree of technical skills in the professions of our adult groups. Future research using different instruments is needed to further investigate the relationship between technical professions and detailed information processing, especially in adults with Autism spectrum disorders. Furthermore, since the results of our study suggest that the social impairment of adults with Autism is related to their professions, it is important to further examine how adults with Autism can be less hindered by their social impairment in a working environment.

4.1. Limitations

A limitation in this study is the use of self-reports in order to measure features of Autism. Deficiencies in semantic processing which characterize individuals with Autism may have influenced the answers to the questions. However, research in high functioning adults with ASD indicated that they are relatively able to describe their strengths and weaknesses adequately (Frith & Happé, 1999; Happé, 1991). Still, we cannot rule out that deficiencies in insight in the individuals with Autism (and Schizophrenia) may have influenced outcome with regard to the self-report questionnaire. Furthermore, the fact that the AQ was developed specifically for adults with ASD may have influenced the results that were found within the Schizophrenia and the neurotypical control groups.

Other limitations of this study are that the present study was undertaken in men with average to high verbal abilities. Therefore, the results cannot be generalized to Autism populations with below average verbal abilities or to women with Autism. Also, our sample size was relatively small, especially with regard to the Schizophrenia group, which limits the power of the present study and precludes any definite conclusions.

Furthermore, it was difficult to determine a good approach when it came to deciding level of technicality. We chose for two professionals working in the employment sector who were knowledgeable about job requirements. However, we acknowledge that the outcome of this measure can be variable across sites and raters.

Finally, although all adults with Autism in our study had regular jobs, we did not include information on whether they had received special education or support throughout their educational careers. This may have influenced our outcome and these variables should be included in future studies.

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