Cognitive profiles of adults with high functioning autism (HFA) and Asperger Syndrome

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1 Introduction

1.1 Aims and structure

Autism is a neurobiological developmental disorder that first becomes apparent during childhood. It is a life-long condition. In research, autism is studied generally at three levels: the neurobiological, the cognitive and the behavioral level (Frith, 2003; Happé & Frith, 1996). At the neurobiological level, the genetics of autism is complex. Extensive research has revealed the complexity of the nature of autism, but as yet has failed to unfold the exact nature of the neurobiological factors associated with autism (Rutter, 2005).

At the behavioral level, autism is characterized by impairments in social interaction and communication and by restricted and repetitive behavior. Throughout the years, the behavioral symptoms and diagnoses of autism spectrum disorders (ASD) have become more coherent and less controversial (Happé & Frith, 1996, Volkmar & Klin, 2005). At the cognitive level, different theories have been proposed to explain the behavioral symptoms of autism and provide markers of possible brain dysfunction. The three leading cognitive theories in autism describe: the 'theory of mind' (Baron-Cohen et al., 1985; Happé & Frith, 2006), 'central coherence' (Frith, 1989, 2003) and 'executive functioning' (Ozonoff et al., 2005; Rumsey, 1985). Previous studies that examined these three areas in individuals with ASD focussed predominantly on children. However, research has shown that features of ASD can change during development (Howlin, 2005). Since only a few studies have assessed cognitive features in high-functioning adults with ASD, with contradictory results, it is not clear whether the above-mentioned cognitive theories are still applicable when individuals with ASD reach adulthood. If impairment in these cognitive areas should lessen or even disappear during the patient's lifetime, one or more of the three theories may not be as fundamental to autism as previously thought. This could change our view of ASD fundamentally.

Therefore, in our research we examined theory of mind, central coherence and executive functioning in high-functioning adults with the autistic disorder and Asperger syndrome. By means of our studies, we aim to increase out knowledge about the characteristic features of autism and how they develop during the individual's lifetime. This can help us to understand the precise nature of ASD. Furthermore, it can result in better definitions of ASD in adults and therefore influence current frameworks for classification of autism spectrum disorders.

Before investigating the three cognitive theories in high-functioning individuals with ASD, we need to know the general intellectual capacity of individuals in the research groups.

The level of intelligence can play an important role in performance in theory of mind, central coherence and executive functioning (Frith, 1994; Luckasson et al., 2002; Van Lang et al., 2006). For example, impairment in theory of mind has frequently been reported as being characteristic of the individuals with intellectual disability (Yirmiya et al., 1998). Therefore, for our research studies we only included individuals with a minimal full scale WAIS-III intelligence score of 80 (Wechsler, 1997).
Furthermore, research has shown that general intellectual capacity is related to the ability of individuals with ASD to outgrow or compensate for at least some of their weaknesses during development (Howlin, 2005). Information about the intellectual capacities can help us to determine which level of performance we can expect of our research groups in theory of mind, central coherence and executive functioning. It can also provide valuable information about the general strengths and weaknesses of our research groups.
Therefore, the first aim of the study was to investigate the intelligence profiles of adults with the autistic disorder and adults with Asperger syndrome, as presented in chapter 1.

1.2 Cognitive theories of ASD

The aim of cognitive theories of ASD is to explain and understand the behavior of people with autism, in an attempt to find the underlying causes. Many different cognitive theories have been hypothesized, three of which have been the most influential: ‘weak theory of mind’, ‘weak central coherence’ and ‘executive functioning deficits’. Our second aim was to study the relevance of these theories for high-functioning adults with ASD. To this end, we examined the differences between adults with HFA and Asperger syndrome and a neurotypical control group in each of these areas. More information regarding the three cognitive theories of autism will be outlined in the following paragraphs.

Theory of mind can be described as the ability of a person to attribute mental states to oneself and others and to predict the behavior of others based on their mental states (Premack & Woodruff, 1978). It has also been described as ‘mind reading’ (Baron-Cohen, 2000). The theory of mind account tries to explain the triad of social, communicative and imaginative impairments in autism (Baron-Cohen, 2000). Specifically in the area of theory of mind, there is growing evidence that high-functioning adults with ASD develop skills in order to compensate for or camouflage weaknesses (Baron-Cohen, 2000; Ponnet et al., 2004). Chapter 3 describes our study of theory of mind in adults with the autistic disorder and Asperger syndrome. The results for the ASD groups will be compared to those found for a neurotypical group in order to determine whether theory of mind impairment is still present when individuals with ASD reach adulthood.

Whereas the 'theory of mind' account can be seen as a theory with a narrow perspective because it is used mainly to explain social-communicative characteristics in autism, the theories for 'weak central coherence' and 'executive functioning deficits' can be described as theories with a broad perspective because they use an array of mental operations to explain the cognitive deficits in autism (Volkmar et al., 2004). The weak central coherence theory describes strengths in detailed information processing, combined with a failure to integrate information into a meaningful whole, which are characteristic of autism (Frith, 1989, 2003). This theory was developed to explain the circumscribed interests, the preoccupations and the distinct information processing style in autism (Frith, 1989, 2003). Throughout the years, the central coherence account has been modified into the suggestion that local, fragmented information processing can be seen as a cognitive style in individuals with ASD, which can be overcome in tasks that demand global processing (Happé & Frith, 2006; Wang et al., 2007). However, considering the contradictory results found for high-functioning adults with ASD, it is unclear whether the cognitive theory of a detailed information processing style is still relevant in adults with ASD. Strengths in local information processing, as have been hypothesized, can be used to the advantage of individuals with ASD, because they can help them compensate for their weaknesses. Furthermore, they can create possibilities in the search for educational and occupational opportunities. In chapter 4, we will examine whether and to what extent adults with the autistic disorder and Asperger syndrome have a detailed information processing style.

Executive functioning covers a wide range of skills that are involved in goal-directed and future-oriented behaviors (Ozonoff et al., 2005). Executive skills are essential in order to function in a changing world. They include planning, fluency, inhibition of a prepotent response, working memory, and cognitive flexibility (Pennington & Ozonoff, 1996). The theory of impaired executive functioning in autism is associated mainly with repetitive behavior and inflexibility in behavior (Lopez et al., 2005; South et al., 2007). However, recent evidence suggests that repetitive behaviors in ASD seem to lessen during the individual's life span (Seltzer et al., 2009). This stresses the importance of investigating whether the hypothesis of executive dysfunction is still relevant when individuals with ASD reach adulthood. For this purpose, we will assess verbal fluency in two adult ASD groups, since these tasks are widely used to assess executive functioning (Henry & Crawford, 2004). In chapter 5, the results of this study are outlined.

Although it is questionable whether the autistic disorder and Asperger syndrome can be seen as different conditions, many researchers state that these two disorders differ at least in degree of impairment (Klin et al., 2005a; Ozonoff et al., 2000b). For example, it has been argued that theory of mind impairment is less severe in individuals

with Asperger syndrome compared to those with autism (Frith, 1991; Ozonoff et al., 1991b). Furthermore, differences in communication between the two disorders have been described (Klin et al., 2005a). Another marked contrast is verbosity in speech, which is distinct for those with theAsperger syndrome, whereas individuals with autism are often limited in speech (Klin et al., 2005a). On the basis of the above differences in symptom expression, we decided to differentiate between the two groups within our research population.

Finally, chapter 6 presents a summary of our findings. The results of the preceding chapters will be integrated and final conclusions will be drawn.

2 The use of WAIS-III in HFA and Asperger syndrome

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Abstract

The WAIS III was administered to 16 adults with the autistic disorder and 27 adults with Asperger syndrome. Differences between Verbal Intelligence (VIQ) and Performance Intelligence (PIQ) were not found. Processing Speed impairment was observed in the participants with the autistic disorder. At the subtest level, the Asperger syndrome group performed weak on Digit Span. Strengths were found on the subtests Comprehension and Block Design. In the autistic disorder group, performance on Digit-Symbol Coding and Symbol Search was relatively poor. Strengths were found on Information and Matrix Reasoning. The results suggest that the VIQ-PIQ difference cannot distinguish between the autistic disorder and Asperger syndrome. WAIS III Factor Scale and Subtest patterning provides a more valid indicator.

2.1 Introduction

Over the past few years, interest in HFA and Asperger syndrome in adults with normal intelligence has increased markedly. However, not much is known about the cognitive profiles of these groups. Only a few studies exist about adults who function relatively well in society and have been diagnosed late in life (Howlin, 2004; Vermeulen, 2002). The present study aims to assess the cognitive profiles of this relatively high-functioning subgroup by means of the Wechsler Intelligence Scale III (WAIS III, Wechsler, 1997).
In WAIS III, the intelligence pattern is described at three levels: The first level contains Performance Intelligence and Verbal Intelligence. The second level consists of the four factor scales: Verbal Comprehension, Perceptual Organization, Freedom from Distractibility and Processing Speed. The third level contains the subtests. The following paragraphs summarizes previous research results of the intelligence profiles adults with the autistic disorder and Asperger syndrome on these three levels.

The Performance IQ (PIQ) - Verbal IQ (VIQ) dichotomy has been previously used incorrectly to underpin the diagnosis of autistic disorder and Asperger syndrome. It is questionable whether the two constructs should even be applied in general, because research did not support the construct validity of the VIQ-PIQ dichotomy (Taub, 2001).
Studies examining WAIS-R in adults with HFA have yielded contradictory results (Minshew et al. 1992; Siegel et al., 1996; Vermeulen, 2002), which may reflect the validity problems of the VIQ-PIQ dichotomy (Arnau & Thompson, 2000; Taub, 2001).
The factor scale level is of great importance in assessing cognitive abilities, sinceactor analytic studies indicate that they give the best estimates of the four factors underlying intelligence (Arnau & Thompson, 2000; Ryan & Paolo, 2001).
No studies have investigated the WAIS-III profiles for adults with HFA and Asperger syndrome, as far as we know. Therefore we have no information about the factor scale profiles in these groups. This leads to the conclusion that the most important factors of the intelligence patterns for adults with HFA and Asperger syndrome are still unknown.
At subtest level, some studies on WAIS or WAIS-R reported low Comprehension versus high Block Design scores (Goldstein et al., 2001; Rumsey & Hamburger, 1988). A relatively high variability between the subtests scores in adults with HFA has also been reported (Siegel et al., 1996).
In summary, research shows that among adults with HFA and Asperger syndrome, results of VIQ-PIQ differences vary and may be influenced by the validity problems of the VIQ-PIQ dichotomy. The factor scale scores and the subtest patterns provide a better

representation of the intelligence pattern but these are still unknown in adults with HFA and Asperger syndrome.

2.1.1 Aims of the Present Study

The present study aims to acquire insight into the WAIS III profiles of normal intelligent adults with HFA and Asperger syndrome. Profiles in the total group and differences between the two diagnostic groups will be examined.

2.2 Methods

2.2.1 Procedure

All participants were recruited from the GGZ (Mental Health Center) Eindhoven and Oost-Brabant. The participants met the criteria for Asperger syndrome or HFA. Participants with relevant neurodevelopmental conditions and genetic conditions were excluded, as were institutionalized patients and patients with a Full Scale IQ below 80.

2.2.2 Subjects

The mean Full Scale IQ of the participants was 110.16, individual scores varied between 83 and 145 (see table 1).

Table 1

Characteristics of Participants

IQ and age	M	SD	Range
Full scale IQ	110.16	16.05	83 - 145
Mean age	41.93	10.67	20 - 60
Diagnosis	f	P	
Autistic disorder	16	37.2	
Asperger syndrome	27	62.8	
Gender			
Male	39	90.7	
Female	4	9.3	
Education			
Lower / middle education	18	41.9	
Higher education	25	58.1	
Employment status			
Employed or retired	30	69.8	
Studying	1	2.3	
Unemployed	12	27.9	
Current living circumstances			
Lives with partner	23	53.5	
Lives independently	12	27.8	
Sheltered living	2	4.7	
Lives with parents	6	14.0	

All individuals ranged in age from 18 to 60 years. The mean age was 41.93. Of all participants, 25 finished higher education and 30 individuals had work. 23 participants lived together with a partner. The relatively large number of participants who had a relationship, worked and were well educated emphasizes the relatively high level of functioning in this group.

2.2.3 Assessment of disorder

Hetero-anamnestic information was gathered using the Dutch version of the Autistic Disorder Diagnostic Interview, revised version (ADI-R, Lord et al., 1994), administered by psychologists who were officially trained in the administration and scoring of the

instrument. To gather anamnestic information, a semi-structured interview was used to assess presence of the DSM-IV criteria of HFA and Asperger syndrome (APA, 1994). Because of the controversial nature of the DSM-IV criteria (Ghaziuddin et al., 1992; Mayes et al., 2001), additional questions were used to differentiate between HFA and Asperger syndrome, based on the diagnostic criteria of Gillberg & Gillberg (1989) and ICD-10 (WHO, 1993).

2.2.4 Assessment of intelligence

The intelligence profile was assessed using the Dutch translation of the WAIS III (Wechsler, 1997). The WAIS-III has excellent psychometric properties (Sattler & Ryan, 1999) and has been validated for the Dutch population (Wechsler, 1997).

2.3 Results

Analyses were performed at the three WAIS-III levels: VIQ versus PIQ, the four factor scales and all subtests. Preliminary analysis included checks for normality, linearity, influential data points and assumptions of repeated measures. No serious deviations were found. T-tests showed that both diagnosis groups were comparable in education, work status and gender distribution.

2.3.1 Differences Between WAIS III VIQ and PIQ

Differences between VIQ and PIQ for the total group and for the two diagnostic groups were analyzed by means of paired *t*-tests. No statistically significant effects were found for any of the groups (see table 2).

Table 2

VIQ and PIQ Differences in the Total Group and in Diagnostic Groups

	VIQ		PIQ			
	M	SD	M	SD	mean diff.	n
Total group	110.30	13.83	108.42	18.21	1.88	43
Asperger	111.41	13.57	112.52	17.28	1.11	27
Autism	108.44	14.49	101.50	18.13	6.94	16

2.3.2 Differences Between Factor Scale Scores

Factor Scale profiles were studied within the total group and between the two diagnostic subgroups by means of repeated measures analysis of variance. Mauchly's test indicated that the assumption of sphericity was not met. Therefore the degrees of freedom were corrected using the Huynh-Feldt correction (ε=.89). Post-hoc comparisons using the Sidak adjustment for multiple comparisons showed that the main effect of the WAIS III Factor Scale was statistically significant (F(2.7,109.7)=7.0, p<0.001). An interaction effect of differences in Factor Scale mean by diagnostic group was also found (F(2.7, 109.7)=2.7, p=0.05). To find out which differences in WAIS III Factor Scale means added to the significant main effect, post hoc pairwise comparisons were done. This showed that the main effect in the total group can be attributed to Processing Speed being significantly lower than Verbal Comprehension (p < .01) and Perceptual Organization (p < .005).

Post hoc pairwise comparisons were done for the two diagnostic groups to analyse the 'within group' effect. In the Asperger group, no significant differences in Factor Scale mean scores were found. The HFA group however, showed a significant lower Processing Speed compared to Verbal Comprehension (p < .01), Perceptual Organization (p < .01) and Freedom from Distractibility (p < .05) (see table 3).

Table 3

Factor Scale Scores for the Total Group and the Diagnostic Groups

Factor Scale	M	SD	n
Verbal Comprehension			
Autistic disorder	107.5*	12.1	16
Asperger syndrome	110.8	11.9	27
Total	109.6*	12.0	43
Perceptual Organization			
Autistic disorder	105.0*	18.7	16
Asperger syndrome	111.8	13.0	27
Total	109.3*	15.5	43
Freedom from Distractibility			
Autistic disorder	105.1*	18.2	16
Asperger syndrome	107.2	15.4	27
Total	106.4	16.3	43
Processing Speed			
Autistic disorder	91.8*	17.4	16
Asperger syndrome	106.5	19.4	27
Total	101.0*	19.8	43

* $p < .05$.

2.3.3 Differences Between WAIS III Subtest Scores

The Subtest profiles were explored within the total group and between the two diagnostic subgroups by means of a repeated measures analysis of variance. The assumption of sphericity was not met. Therefore the degrees of freedom were corrected using the Huynh-Feldt correction (ε=.82). Post-hoc comparisons were performed using the Sidak adjustment for multiple comparisons. The results (see table 4) showed a significant main effect of the type of Subtest ($F(10.7,438.7)=4.8$, $p<0.001$).

Table 4

Mean Standardized Subtest Scores for the Total Group

Subtest Scores	M	SD	n
Vocabulary	11.63*	2.564	43
Similarities	11.42	2.490	43
Arithmetic	11.77*	3.046	43
Digit Span	10.72	3.268	43
Information	12.42*	2.779	43
Comprehension	12.53*	2.772	43
Letter-Number Sequencing	10.98	2.956	43
Picture Completion	10.88	3.253	43
Digit-Symbol Coding	9.81*	3.438	43
Block Design	12.02*	3.562	43
Matrix Reasoning	11.98*	2.454	43
Picture Arrangement	11.53	3.731	43
Symbol Search	10.37*	3.970	43
Object Assembly	11.16	3.086	43

* $p < .05$.

An interaction effect of Subtest by diagnosis was also found ($F(10.7, 438.7)=2.1$, $p<0.05$), indicating that the patterning of the WAIS III subtest mean scores for the two diagnostic groups differs. Table 5 and 6 show the mean Subtest scores and standard deviations for the HFA group and the Asperger syndrome group.

Table 5

Mean Standardized Subtest Scores for the Autistic Disorder Group

Subtest Scores	M	SD	n
Vocabulary	11.31	2.496	16
Similarities	10.94	1.769	16
Arithmetic	11.44	3.705	16
Digit Span	11.31	3.400	16
Information	12.13*	3.284	16
Comprehension	11.75	2.176	16
Letter-Number Sequencing	10.25	3.152	16
Picture Completion	10.81	4.070	16
Digit-Symbol Coding	8.38*	3.030	16
Block Design	10.56	3.444	16
Matrix Reasoning	11.44*	2.828	16
Picture Arrangement	10.19	3.674	16
Symbol Search	8.44*	3.483	16
Object Assembly	9.88	3.324	16

* $p < .05$.

Table 6

Mean Standardized Subtest Scores for the Asperger Syndrome Group

Subtest Scores	M	SD	n
Vocabulary	11.81	2.632	27
Similarities	11.70	2.826	27
Arithmetic	11.96	2.638	27
Digit Span	10.37*	3.200	27
Information	12.59	2.485	27
Comprehension	13.00*	3.013	27
Letter-Number Sequencing	11.41	2.805	27
Picture Completion	10.93	2.745	27
Digit-Symbol Coding	10.67	3.431	27
Block Design	12.89*	3.401	27
Matrix Reasoning	12.30	2.198	27
Picture Arrangement	12.33	3.595	27
Symbol Search	11.52	3.847	27
Object Assembly	11.93	2.716	27

* $p < .05$.

Post hoc pair wise comparisons showed that the main effect in the total group can be attributed to the fact that Digit-Symbol Coding was significantly lower than Vocabulary ($p < .05$), Arithmetic ($p < .05$), Information ($p < .005$), Comprehension ($p < .005$), Block Design ($p < .05$) and Matrix Reasoning ($p < .005$). Furthermore, Symbol Search was lower than Information ($p < .05$) and Comprehension ($p < .05$).

Post hoc pair-wise comparisons were also performed for the two diagnostic groups to analyze the 'within group' effect. The two groups showed significant differences in Subtest scores. In the Asperger syndrome group, Digit Span was lower than Comprehension ($p = .005$) and Block Design ($p < .05$).

In the HFA group performance was significantly higher in Information compared to Digit-symbol Coding ($p < .05$) and Symbol Search ($p < .05$). Furthermore, Digit-Symbol Coding was lower than Matrix Reasoning ($p < .05$).

2.4 Discussion

2.4.1 WAIS VIQ Versus PIQ

No significant differences were found between VIQ and PIQ in the total group nor in the two diagnostic subgroups. The results are in line with factor analytic studies which showed that the VIQ-PIQ dichotomy is not valid for general populations (Arnau & Thompson, 2000; Taub, 2001).

2.4.2 WAIS III Factor Scale Level

The Asperger syndrome group was characterized by a flat Factor Scale profile in the Asperger syndrome group, while the HFA group performed significant low in Processing Speed. A low Processing Speed indicates problems in speed of processing visual information (Wechsler, 1997). Adults with HFA apparently need more time than other people to process and integrate visual information and to act on this information.

The Processing Speed performance of the HFA group might be influenced by problems with top-down processing and ignoring irrelevant details, which are characteristic of people with HFA (Happé, 2005; Shah & Frith, 1993). In order to maintain an overview of what they are doing, they work slowly.

2.4.3 WAIS III Subtest Level

Analyses showed different Subtest patterns in the HFA and the Asperger syndrome groups.

The HFA group performed significantly poor in Digit-Symbol Coding and Symbol Search. These two subtests together form the Processing Speed Factor. The low scores for these subtests represent the problems in speed of processing visual information as described in the preceding paragraph.

The HFA group showed significantly high performance in Information and Matrix Reasoning. High scores for Information are in line with the fact that people with autism usually acquire much factual knowledge (Happé, 1999).

Matrix Reasoning taps nonverbal perceptual reasoning. Matrix Reasoning is the only Perceptual Organization subtest without a time limit and is possibly not influenced by low Processing Speed performance scores. The strengths of the HFA group in this subtest can probably be attributed to their visual-spatial strengths (Lincoln et al., 1995; Tsatsanis, 2005) and to the absence of a time limit for this subtest.

In the Asperger group, scores for Digit Span were relatively low. Digit Span taps working memory capabilities (Wechsler, 1997), which can been defined as 'the ability to hold in mind past states of the environment and past actions while currently performing an action' (Russell, 1997). People with autism and Asperger syndrome tend to store information in details instead of using strategies, which often leads to problems in retaining information (Happé, 2005; Minshew et al., 1992; Tsatsanis, 2005). Low Digit Span scores in the Asperger group may reflect problems in applying strategies to retain information.

The Asperger syndrome group performed significantly well on the subtest Comprehension. High scores on Comprehension in this group seem to contradict former research results (Klin et al., 2005b; Mayes & Calhoun, 2003; Siegel et al., 1996). However, people with Asperger syndrome often try to function in society by analyzing social situations at a cognitive level, which has been described as using an 'explicit theory of mind'(Frith & Happé, 1999). An extremely well developed explicit theory of mind may have caused the strengths of the Asperger syndrome group on Comprehension.

The Asperger Syndrome group also performed significantly well on Block Design. Qualities in Block Design have often been reported in studies of people with HFA and Asperger syndrome (Happé, 2005; Shah & Frith, 1993). This has been attributed to strengths in processing unconnected stimuli outside a meaningful context, which go together with the central coherence problems that are characteristic for people with autistic impairment (Shah & Frith, 1993).

2.4.4 Conclusions

The present study found participants with Asperger syndrome to differ significantly from individuals with HFA in WAIS III Factor Scale profiles and WAIS III Subtest patterning. In the individuals with HFA Processing Speed problems were found. Further, the HFA and Asperger syndrome group showed different subtest patterns. The present study supports the idea that HFA and Asperger syndrome can be differentiated empirically at the level of intellectual functioning. This lends support to the hypothesis that HFA and the Asperger syndrome are two separate disorders.

3 Theory of Mind in Adults with HFA and Asperger syndrome

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Abstract

Theory of mind was assessed in 32 adults with HFA, 29 adults with Asperger syndrome and 32 neurotypical adults. The HFA and Asperger syndrome groups were impaired in performance of the Strange stories test and the Faux-pas test and reported more theory of mind problems than the neurotypical adults. The three groups did not differ in performance of the Eyes test. Furthermore, correlations between the Eyes test and the three other theory of mind tests were low or absent. Therefore one can question the ability of the Eyes test to measure theory of mind. Of all theory of mind tests used, the self-report questionnaire (EQ) had the largest discriminating power in differentiating the two disorder groups from the neurotypical group.

3.1 Introduction

In autism research there are three leading cognitive theories which describe impairments in 'theory of mind' (Baron-Cohen et al., 1985), 'central coherence' (Frith, 1989, 2003) and 'executive functioning' (Ozonoff et al., 2005; Rumsey, 1985). This paper examines theory of mind and is part of an ongoing study to assess the three above-mentioned cognitive domains in adults with HFA and Asperger syndrome. Although theory of mind has been studied extensively in children with autism (Baron-Cohen et al., 1985; Baron-Cohen, 2000; Frith, 2003), studies that examined theory of mind functioning of adults with HFA and Asperger syndrome are limited. Furthermore, previous studies in adults with ASD used both neuropsychological tests and self-reports to assess deficits in theory of mind, although the relationship between these two measurement methods was never investigated. To fill this gap, in the present study theory of mind is assessed in adults with HFA and Asperger syndrome using both neuropsychological tests and self-reports.

3.1.1 Theory of Mind in Autism

The term 'theory of mind' was introduced in psychology by Premack and Woodruff (1978) to describe the ability of a person to attribute mental states to oneself and others and to predict the behavior of others based on their mental states. Research throughout the years has shown that children, and to some extent also adults, with ASD experience problems in theory of mind (Baron-Cohen, 2000; Bowler, 1992; Frith, 1989; Happé, 1994; Kaland et al., 2002; Leslie, 1987; Ozonoff et al., 1991b; Ponnet et al., 2004). In theory of mind functioning, a distinction is made between the different levels of theory of mind (Baron-Cohen, 2000). First order theory of mind involves inferring a person's own mental state (Baron-Cohen, 2000), while second-order theory of mind involves mental states about other peoples' mental states (Baron-Cohen, 2000). While most children with HFA and Asperger syndrome are impaired in first and/or second order theory of mind functioning, most adults with HFA and Asperger syndrome show no impairment (Baron-Cohen, 2000, Bowler, 1992; Happé, 1994; Ozonoff et al., 1991a). This does not imply, however, that they are able to function adequately in social situations, since in daily life social information is more subtle and difficult to interpret (Ozonoff et al., 1991b). Therefore, 'advanced theory of mind' has been proposed as a more difficult level in theory of mind functioning compared to the first and the second level. Advanced theory of mind involves interpreting complex social situations, based on subtle information.

The most commonly used instruments to assess advanced theory of mind in high functioning adults with ASD are the 'Reading the mind in the eyes' test (further denoted as the 'Eyes test', Baron-Cohen et al., 1997b), the Strange stories test (Happé, 1994) and

the Faux-pas recognition test (Stone et al., 1998). Yet, only few studies exist that formally investigated these instruments in adults with HFA and Asperger syndrome and the results of these studies are mixed. While most studies reported impairments in advanced theory of mind in adults with HFA and Asperger syndrome (Baron-Cohenet al., 1997a; Baron-Cohen et al., 1997b; Baron-Cohen et al., 2001; Happé, 1994; Kaland et al., 2002; Stone et al., 1998; Zalla et al., 2009), two studies could not replicate these findings (Ponnet et al., 2004; Roeyers et al., 2001). These contradictory results may be attributed to the small research groups, which comprised at most 17 individuals with ASD, and to variations in the tests that were used. In the present study, we aim to investigate theory of mind in adults with ASD more thoroughly, by examining all three above-mentioned theory of mind tests in 61 participants with ASD, 32 of whom were diagnosed with HFA and 29 with Asperger syndrome. The results of the three tests will be compared with the performance of a matched neurotypical group.

A recent development in autism research is the use of self-reports to examine theory of mind functioning. Results showed that adults with ASD report impairment in their theory of mind abilities (Baron-Cohen & Wheelwright, 2004). The use of self-reports in individuals with autistic impairment is controversial because of their hypothesized impaired introspective abilities (Frith & Happé, 1999, Hobson, 2005). However, as Frith and Happé (1999) describe, the 'explicit' theory of mind that characterizes adults with HFA and Asperger syndrome may enable them to recognize and describe their strengths and weaknesses adequately. Nevertheless, the results of self-reports to measure theory of mind have never been correlated with the results of neuropsychological tests to determine whether both point towards a similar phenomenon. The present study aims to fill this gap by using self-report questionnaires alongside neuropsychological tests to examine theory of mind and to investigate the relationships between these instruments.

In theory of mind research, it may be relevant to differentiate between HFA and Asperger syndrome. Although it is questionable whether HFA and Asperger syndrome can be differentiated, many researchers argue that these two disorders at least differ in degree of impairment (Klin et al., 2005a; Ozonoff et al., 2000a,b). In the present study, we differentiate between the two groups and match for verbal ability, since Frith (2004) suggested that differences in theory of mind performance between HFA and Asperger syndrome may reflect differences in verbal ability.

3.1.2 Hypotheses of the Present Study

We expect adults with HFA and the Asperger syndrome to be impaired, compared to neurotypical adults, in their performance of the three neuropsychological tests that measure theory of mind. We also expect them to report more theory of mind problems,

resulting in lower scores on the EQ. Furthermore, as the neuropsychological tests and the self-report questionnaires measure comparable phenomena, medium to high correlations are expected between the tests and the self-report questionnaires.

3.2 Methods

3.2.1 Procedure

The participants of the HFA and the Asperger groups were recruited from GGZ (mental health institution) Eindhoven and GGZ Oost-Brabant. The participants visited one of these mental health institutions for various reasons, for example problems at work and/or marital problems. The recruitment took place from July 2005 to June 2008.

Participants with genetic conditions or relevant neurological, psychiatric or medical conditions (e.g. ADHD, Tourette syndrome) were excluded. Institutionalized patients were not included in order to ensure a relatively homogenous disorder group with relatively high functioning individuals.

Furthermore, the participants were selected for having at least a normal intelligence and verbal ability (scoring 85 or more in full scale intelligence and in the verbal comprehension index) as measured by the WAIS-III (Wechsler, 1997). The neurotypical control participants were recruited from the general population by adds in local newspapers and by word of mouth. Typical controls were not included in the present study if they had a history of psychiatric illness or if autism ran in the family. In total, 93 of the 95 possible participants agreed to take part and signed informed consent forms prior to their inclusion in the present study. The individuals ranged in age from 18 to 60 years. The group comprised 32 individuals with HFA, 29 individuals with Asperger syndrome and 32 neurotypical adult controls. The mean Full Scale IQ of the participants with HFA and Asperger syndrome and the neurotypical group was 110.2, 114.5 and 115.9 respectively (see Table 1). The present study was approved by the Ethics Committees of the two participating centers.

Table 1
Matching Variables

	HFA	Asperger	Neurotypical	statistic	*p*
Gender (M:F)	32 (27:5)	29 (25:4)	32 (24:8)	χ^2= 1.509	.47
Mean age	42.1 (10.8)	43.67 (10.5)	38.68 (9.3)	F(2,90) = 1.92	.15
WAIS Scores					
Full Scale Int.	110.2 (13.8)	114.5 (16.7)	115.9 (10.0)	F(2,90) = 1.47	.24
Verbal Comp.	110.8 (10.4)	109.3 (12.6)	113.9 (11.7)	F(2,90) = 1.29	.28
Perceptual Org.	105.6 (15.2)	115.6 (15.3)	114.0 (9.5)	F(2,90) = 4.84	.01
Freemdom from Distr.	109.2 (16.0)	108.8 (15.4)	112.3 (11.6)	F(2,90) = .56	.57
Processing Speed	103.7 (19.4)	110.8 (17.4)	111.9 (14.6)	F(2,90) = 2.10	.13

3.2.2 Assessment of Disorder

The diagnosis of either HFA or Asperger syndrome was established through evaluation of historic and current symptomatology. To gather developmental information, parents were interviewed using the Dutch version of the Autism Diagnostic Interview, Revised version (ADI-R, Lord et al., 1994). When parental information was not available, an older brother or sister was interviewed. In these instances, further information about early childhood was gathered, for example from baby books and early clinical reports, until sufficient information was collected to fill in the diagnostic algorithm. The ADI-R was administered by psychologists who were officially trained in the administration and scoring of this instrument. Although the ADI-R has been validated only for children and adolescents, it is considered as the 'gold standard' for diagnosis, not only of children but also of adults (Lord & Corsello, 2005).

In the process of diagnosing ASD, the ADI-R is often used in combination with the Autism Diagnostic Observation Schedule (ADOS, Lord et al., 1999). Research shows, however, that the ADOS is under-inclusive in diagnosing mild, verbal adolescents and adults with autistic spectrum disorders (Lord et al., 2000). Therefore, in the present study, observations of the participant were systematically gathered during the diagnostic process and during the assessment of the neuropsychological tasks. These observations were subsequently arranged according to the DSM-IV-TR criteria of ASD (APA, 2000). Furthermore, a semi-structured interview was administered to all participants, whereby all

ASD criteria of the DSM-IV-TR were examined by asking the participant standard questions.

After the above diagnostic process, the DSM-IV-TR items of ASD were scored, based on the semi-structured interview and the observations of the participant. Only those participants who met the DSM-IV-TR criteria of the autistic disorder or Asperger syndrome were included in the present study. Because of the controversial nature of the DSM-IV criteria in differentiating between the two disorders (Ghaziuddin et al., 1992; Mayes et al., 2001), additional questions, based on the diagnostic criteria of Gillberg and Gillberg, were asked (1989) and ICD-10 (World Health Organization, 1993). When a significant delay in spoken or receptive language or development was present, a diagnosis of Asperger syndrome was excluded, following ICD-10 criteria. When there was no delay in development or language, the criteria of Gillberg and Gillberg (1989) were used to diagnose the participants with Asperger syndrome, since these criteria more closely resemble Asperger's own descriptions than the criteria of ICD-10 (Leekam et al., 2000).

3.2.3 Assessment of Theory of Mind

To assess theory of mind, three neuropsychological tasks and one questionnaire were used. The participants were tested alone in a room that was free from distractions. The four theory mind tests were presented on paper and, in case of the Strange stories and the Faux pas test, they were read out by the experimenter. The tests were translated using a backward-forward procedure, in which the test was translated from English to Dutch and, subsequently, from Dutch to English by a second translator. Differences between translations were discussed, leading to a final translation.

More information about the tests used in the present study is described in the following paragraph.

3.2.3.1 'Reading the mind in the eyes' test

The Eyes test was developed (Baron-Cohen et al., 1997b) and revised (Baron-Cohen et al., 2001) to measure subtle individual differences in social sensitivity of adults. We used the revised version of this Eyes test, which consists of 36 photographs of the region around the eyes of males and females (Baron-Cohen et al., 2001). Participants have to decide which of four words best describes what the person in each photograph is thinking or feeling. In the present study, a Dutch translation of the test was administered. Translations were made according to a forward-backward procedure. The number of errors made by the participants was used as a measure of theory of mind functioning in the present study.

3.2.3.2 Strange stories test

The Strange stories test was developed by Happé (1994) to measure advanced theory of mind. In the test, twenty-four vignettes present everyday situations in which people say things they do not mean literally. The stories were read aloud to the participants and the text of each vignette was placed in front of the participants, so they could also read the story themselves. Hereby the demands on working memory were reduced. The participants were asked questions about the intentions of the people in the vignettes. The eight stories that we chose were the most difficult for adults, as shown by studies of Happé (1994) and Jolliffe and Baron-Cohen (1999). These stories included misunderstanding, double bluff, irony, persuasion and white lies. Two scores were derived from the answers: First, the 'correct answer score', which is the sum of the scores for the answers about the intentions of the people in the stories (2 points for a fully correct answer, 1 point for a partially correct answer and 0 points for an incorrect justification; Happé et al., 1998). The second score was the number of stories for which the participant used a mental justification in their answers (in stead of a physical justification). All stories were scored by a second rater who was not involved in the testing process and who was unaware of the diagnostic status of the participants. The degree of concordance was 97 % for the 'correct answer score' and 95 % for the 'mental explanation score'. The test was officially translated into Dutch using a forward-backward procedure.

3.2.3.3 Faux-pas test

In the Faux-pas test, participants were asked whether anyone in the story said something awkward and questioned the underlying motive. The experimenter read out each story, while the stories were placed in front of the participants so they could read the stories as well. After each story, questions were asked about the detection of the faux-pas (did anyone say something awkward?), about the person identification (who said something awkward?), about the content (what was awkward?), about the explanation (why was it awkward?), about the false belief (Did they know/remember that..) and an empathy question was asked (How did … feel?). The adult version of the Faux-pas test was developed by Stone et al. (1998) and is based roughly on the children's version of the Faux-pas test (Baron-Cohen et al., 1999). A forward-backward procedure was followed for translation of the stories. The test comprises twenty stories, ten with and ten without a faux-pas. In the present study, four stories of both categories were randomly selected. The correct answer score was used as a variable in the present study. To score and interpret the answers, the instructions of Stone et al.(1998) were used. To validate the

scoring procedure, the answers were also scored by a second rater. The degree of concordance of the total score was 95 %.

3.2.3.4 Empathy quotient

The EQ is a self-report questionnaire, developed to examine empathizing tendencies in adults with normal intelligence (Baron-Cohen & Wheelwright, 2004). Empathizing involves two elements: The ability to attribute mental states to oneself and others and to show an emotional reaction that is appropriate to the other person's mental state. In this definition, empathizing corresponds to what is meant by the term theory of mind (Baron-Cohen & Wheelwright, 2004). The instrument comprises 60 questions, 20 of which are filler items and 40 items examine empathizing. The EQ proved to be a valid and reliable instrument (Lawrence et al., 2004). In the present study, a Dutch translation of the questionnaire was used. All participants filled in the EQ prior to receiving the results of their diagnostic process.

3.2.4 Assessment of intelligence

As part of the present study, the intelligence profile was 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). The norms have been improved to correct for the Flynn-effect that appeared to be present in the Dutch translation of WAIS-R. WAIS-III has excellent psychometric properties (Sattler & Ryan, 1999) and has been validated for the Dutch population (Wechsler, 2000).

3.2.5 Matching Procedure

The three groups were matched according to age, gender, verbal abilities and Full Scale Intelligence Quotient (FSIQ). To match for verbal abilities, the WAIS-III factor scale 'Verbal Comprehension Index' (VCI) was used. The subject characteristics of the three groups are presented in Table 1. The table shows that the three groups are well matched on nearly all characteristics. However, a significant difference was found with regard to the factor scale 'Perceptual organization' of the WAIS-III. The possible influence of this factor scale on theory of mind performance will be corrected for by using this subtest as a covariate (Field, 2009).

3.3 Results

3.3.1 Differences in the Neuropsychological Tasks Measuring Theory of Mind

The mean scores and standard deviations of the theory of mind tests used in the present study are presented in Table 2.

Table 2
Means and standard deviations for the tests

	M	SD	M	SD	n
	Eyes test: errors made		Faux-pas test: total score		
HFA	12.78	4.81	20.28	3.40	32
Asperger	11.86	3.88	18.97	3.95	29
Neurotypical group	11.00	3.59	22.22	2.70	32
	Strange stories: correct		Strange stories: mental		
HFA	14.13	1.96	7.88	.34	32
Asperger	13.62	2.29	7.79	.56	29
Neurotypical group	15.31	1.09	7.94	.25	32
	Total score EQ				
HFA	25.41	11.38			32
Asperger	24.66	9.94			29
Neurotypical group	51.56	11.53			32

To test the hypotheses of differences in the Eyes test, the Strange stories test and the Faux-pas test, three one-way between-group multivariate analyses of covariance (MANCOVA) were performed. In each analysis, the diagnosis was used as the independent variable and the three neuropsychological tests as the dependent variables, respectively. The factor scale 'Perceptual organization' was used as a covariate to rule out that possible differences can be attributed to the differences in Perceptual organization between the three groups. The assumptions of homogeneity were met, however, Levene's test indicated that the assumption of equality of variance was not met in the analysis of the correct answer score and the mental explanation score of the Strange stories test. Therefore a more conservative alpha of .025 was set for these two variables (Tabachnick & Fidell, 2001). After adjustment for Perceptual organization, a significant interaction effect was found with the correct answer score of the Strange

stories test (F (90) = 8.962, $p < .01$). With regard to the Eyes test and the Faux-pas test, no significant interaction effects of Perceptual organization were found.

For the Eyes test, no statistically significant main effect of diagnosis was found (F (2,90) = .959, $p = 0.39$). For the correct answer score of the Strange stories test, the results did reveal a statistically significant main effect of diagnosis (F (2,90) = 7.570, $p < .01$ partial eta squared = .09), which can be described as moderate (Cohen, 1988). Post-hoc Tukey comparisons showed that the HFA group ($p = .03$) and the Asperger syndrome group ($p < .01$) made significantly more errors compared to the neurotypical control group. No significant main effect was found for the mental explanation score in the Strange stories test (F (2,90) = 1.019, $p = .82$).

In performance of the Faux-pas test, a main effect of diagnosis appeared (F (2,90) = 6.984, $p < .01$ partial eta squared = .14), with a large effect size (Cohen, 1988). Post-hoc Tukey comparisons indicated that the adults with Asperger syndrome had a significantly ($p < .01$) lower total score compared to the neurotypical adults. A trend toward an effect was visible for the differences between the HFA group and the neurotypical group ($p = .06$).

No differences were found between the HFA and the Asperger syndrome group in the Eyes test, the Strange stories test or the Faux-pas test.

3.3.2 Differences in Self-reported Theory of Mind

The mean scores and standard deviations of the EQ for the HFA group, the Asperger syndrome group and the neurotypical group are presented in Table 2. To examine the hypothesis of differences in self-reported theory of mind, a one-way between-group multivariate analysis of variance was performed with the diagnosis as the independent variable or factor and the EQ as the dependent variable. Again, the factor scale 'Perceptual Organization' was used as covariate. The analyses showed that the assumptions of homogeneity and equality of variance were met. Wilks' Lambda was used to measure group differences. No interaction effect was found between Perceptual Organization and the EQ score (F (2,90) = .662, $p = .42$). For the EQ score, a statistically significant main effect of diagnosis was found (F (2,90) = 58.938, $p < .01$, partial eta squared = .57), with an effect size that can be interpreted as very large (Cohen, 1988). To investigate which differences between the three diagnostic groups added to the main effects, post-hoc Tukey comparisons were performed. Analyses showed that the neurotypical group yielded significantly higher EQ-scores in comparison to the HFA ($p < .01$) and the Asperger syndrome group ($p < .01$). The scores of the two disorder groups did not differ significantly. The findings support the hypothesis postulated in the present study of impaired theory of mind in the HFA and Asperger syndrome groups.

3.3.3 The Association Between the Neuropsychological Tasks and the Self-report questionnaire

To test the hypothesis that the total score for the self-report questionnaire is closely related to performance of the neuropsychological tasks measuring theory of mind, Pearson product-moment correlation coefficients were calculated for the total group. Preliminary analyses were performed to ensure that assumptions of normality, linearity and homoscedasticity were not violated. Only medium or high correlations that reached significance will be described. Table 3 shows the correlation matrix for these results.

Table 3 Correlation Coefficients

	1	2	3	4
		Total group		
1. Reading the Eyes test				
2. Faux-pas test	-.181			
3. Strange stories: correct score	-.226*	.359**		
4. Strange stories: mental answers	.024	.164	.387**	
5. Empathy Quotient	-.213*	.305**	.294**	.094

* $\underline{p} < .05$

** $\underline{p} < .01$

Medium-sized significant correlations were found between the correct answer score of the Strange stories test and the Faux-pas test ($r = .36$, $p < .001$), between the EQ and the Faux-pas test ($r = .31$, $p < .005$) and between the correct answer score of the Strange stories test and the EQ ($r = .29$, $p < .005$).

3.3.4 The Ability of the Tests to Predict Whether a Diagnosis is Present

Because we did not find any differences between the two disorder groups in the previous analyses, we decided to merge these two groups into one diagnostic group for further analysis.

In order to examine the ability of the tests to predict whether a certain person belonged to the diagnostic group or the neurotypical group, we performed a logistic regression analysis. The presence of a diagnosis was entered as the dependent variable and the

three tasks and the self-report questionnaire were entered as the independent variables. The Maximum Likelihood model was used to estimate the parameters. The Goodness of Fit of the analysis as measured by the Omnibus Tests of Model Coefficients and the Hosmer and Lemeshow test was sufficient. The results of the logistic regression analysis are presented in Table 4a. To determine the predictive power of the model the Classification results were calculated. Table 4b shows the results.

Table 4a

Logistic regression analysis

	B	SE	p-value	Wald	OR
Logistic regression analysis neuropsychological tests and self-report					
Faux-pas test : total score	.201	.117	.09	2.926	1.222
Strange stories test : correct	.332	.279	.23	5.133	1.394
Strange stories test: mental	.598	1.411	.67	.179	1.818
Reading the mind in the eyes	.024	.111	.83	.046	1.024
EQ	.169	.036	.00	22.160	1.184

Table 4b

Classification table

	Neurotypical group versus disorder group	
Observed	Disorder group	Neurotypical group
Disorder group	58 (95%)	3 (5%)[1]
Neurotypical group	4 (12%)[2]	28 (88%)

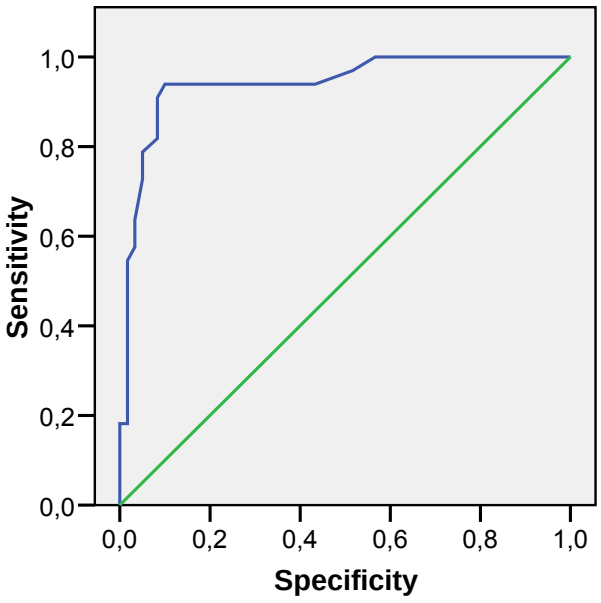
[1] false positives

[2] false negatives

Table 4b shows that the percentages of correct classifications are high: 95% are correctly placed in the disorder group and 88% are correctly placed in the neurotypical group, correspondingly implying low numbers of false positives (12%) and false negatives (5%). Table 4a illustrates that only the EQ measure is predictive for whether a participant belonged to the neurotypical group or the diagnostic group when the significance level is set at alpha = 0.01. Further analyses showed that the correct answer score of the Strange Stories Test (p=0.02) and the Faux-pas test (p=0.05) are predictive when the EQ measure is removed from the analysis and the significance level is set at alpha=0.05. Results of the Eyes test and the mental answer score of the Strange stories test were not significant. These findings suggest that the Strange stories test and the Faux-pas test are valuable instruments for examining theory of mind in adults when self-reports cannot be used.

Since the EQ was the most predictive for the presence of a diagnosis, we further examined the sensitivity of the EQ in making a correct group classification by calculating a Receiver Operating Characteristic analysis (ROC-analysis; Fawcett, 2006). The ROC curve is illustrated in figure 1.

Figure 1. Roc curve EQ



The analysis showed that the participants could be assigned correctly to either the neurotypical or the HFA/Asperger syndrome group in 94 % of the cases, based on their EQ scores. This suggests that the EQ is a highly sensitive marker of the presence of a diagnosis (HFA and Asperger syndrome).

3.4 Discussion

The present study aimed to assess theory of mind functioning in adults with HFA and Asperger syndrome and a neurotypical group. Differences were found for the Faux-pas test and the Strange stories test in the expected direction, indicating theory of mind impairment in the two disorder groups. These findings are in line with the results of the EQ, which showed more self-reported theory of mind problems in the HFA and Asperger syndrome groups compared to the neurotypical individuals. In contrast to our expectations, performance of the Eyes test did not differ between the three groups. Despite, since impairment was found for the disorder groups by three of the four theory of mind tests, the hypothesis of theory of mind impairment in adults with HFA and Asperger syndrome is confirmed.

As far as the relationships between the neuropsychological tests and self-reports are concerned, the analyses showed medium and significant correlations between the EQ, the Strange stories test and the Faux-pas test. This suggests that these three tests measure a similar underlying cognitive phenomenon, which is also in line with our expectations.

No differences were found between the HFA and the Asperger syndrome group for any of the tests that were used. These results replicate previous theory of mind research in children (Dahlgren & Trillingsgaard, 1996). Apparently, when corrected for verbal abilities, theory of mind ability is similar in adults with HFA and Asperger syndrome. This is at odds with the hypothesis that these two groups differ in degree of impairment (Klin et al., 2005a; Ozonoff et al., 2000b). Our findings do confirm other studies that question the validity of distinguishing Asperger syndrome and HFA as separate entities (Volkmar & Klin, 2005).

The results that were found for each of the four theory of mind tests will be specifically discussed in the following paragraphs.

The Eyes test is the only neuropsychological test in the present study which revealed no impairment for the HFA and the Asperger syndrome group. Whilst our results replicate the results of Roeyers et al. (2000), they are at odds with findings of the original Eyes test (Baron-Cohen et al., 1997b) and of the Revised Eyes test (Baron-Cohen et al., 2001). These contradictory results cannot be attributed to inaccuracy of the translation of the test, since was done carefully by following a forward-backward procedure.

When taking a closer look at our results, it is remarkable that the relationships between the Eyes test and the two other neuropsychological tests that measure theory of mind are weak or even absent. Furthermore, in contrast to the Strange stories test and the Faux-

pas test, the relationship with the self-reported theory of mind is weak. This underlines the hypothesis, put forward by Roeyers et al. (2001), that the Eyes test may not be a valid measure of advanced theory of mind. We need to stress here, however, that although the translation of the test was done carefully, cultural aspects may have played an important role. In each culture, there are implicit guidelines regarding the appropriateness of showing certain facial expressions in situations, which are called 'display rules' (Ekman & Friesen, 1996). Those implicit rules may be different for Dutch people compared to the English population that was investigated in the study of Baron-Cohen et al. (2001), leading to different scores on the Eyes test in a Dutch population. Interestingly, Roeyers et al. (2000) did not use the original version of the original Eyes test. Instead, they constructed a new Dutch version of the test, which makes the influence of display rules on performance unlikely. However, their results were similar to our results.

Another relevant factor in the performance on the Eyes test, may be the difficulty that was experienced by the neurotypical group. They frequently expressed the need for more information than only the eyes in order to correctly identify the emotions. This may be attributed to the drive for 'central coherence' that characterizes most neurotypical individuals (Frith, 1989). The tendency to integrate information in the context may be responsible for the relatively high mean error rate for the neurotypical group and the lack of differences between the three groups. Summarizing, it is questionable whether the Eyes test is a valid indicator of theory of mind in high-functioning adults with ASD, at least in a Dutch population. Performance of this task probably reflects other cognitive domains.

The strength of the Strange stories test as opposed to the Eyes test is that it closely resembles social situations as they occur in daily life. Our data showed that nonverbal reasoning skills influenced performance on this task. Apparently, the ability to analyze the (relevant variables in the) stories influenced the results. However, after correcting for nonverbal reasoning skills, the difference between the disorder groups and the neurotypical group still remained significant. Our results replicate the findings of previous studies of adolescents and adults with Asperger syndrome (Jolliffe & Baron-Cohen, 1999; Kaland et al., 2002) or HFA (Happé, 1994; Jolliffe & Baron-Cohen, 1999). Contradictory results were reported by Roeyers et al. (2001) who found no impairments in performance of the Strange stories test for a group of adolescents and adults with ASD. However, Roeyers et al. (2001) did not match their research groups with regard to verbal ability and age, while verbal abilities especially have been found of distinct influence on this verbal theory of mind test (Happé, 1994). The present study did show that a considerable proportion of the participants with HFA and Asperger syndrome performed faultlessly. For at least some of the individuals in the HFA and the Asperger syndrome groups, the Strange stories test may have been too easy. This is not surprising since the

test was originally developed for children, while our group consisted of relatively able adults. Although the most complicated stories were chosen for the present study, the level of difficulty is considerably lower than in real life social situations. This probably also explains why no differences were found between HFA and Asperger syndrome in the use of mental explanations in the Strange stories test, confirming previous findings of Happé (1994) and Roeyers et al. (2001) in adults with ASD.

Contrary to the Strange stories test, the Faux-pas test has been specifically developed for adults. The social scenarios in the vignettes closely resemble situations that occur on a regular basis in daily life (Baron-Cohen et al., 1999, Stone et al., 1998). Therefore, the ecological validity of this test is expected to be high, which means that performance on the Faux-pas test gives a valid indication of everyday cognitive ability (Chaytor et al., 2006). In the present study, the Asperger syndrome group was significantly impaired in performance of this test and impairment in the HFA group was near significant. These results confirm recent findings of Zalla et al. (2008) for adults with Asperger syndrome. Given the theory of mind impairment in individuals with ASD and considering the impairments found with the Strange stories test, we expected larger differences between the two disorder groups and the neurotypical group for this test. After taking a closer look at the results of the Faux-pas test, it became apparent that, especially compared to the Strange stories test, the neurotypical individuals made relatively many errors. Apparently, this specific test is also difficult for neurotypical adults.

In summary, we propose that the Faux-pas test and the Strange stories test are valuable instruments for clinical use because they closely resemble everyday social situations. In case of the Faux-pas task it is important to take into account the fact that neurotypical individuals usually do not perform faultlessly and that error rates need to be relatively high in order to provide a valid indication of theory of mind impairment. As for the Strange stories test, low error rates may be indicative for theory of mind impairment, whilst a faultless performance does not rule out subtle impairment in theory of mind.

The present study also examined self-reported theory of mind using self reported information by examining the EQ. Large differences were found between the neurotypical group and the two disorder groups, which agrees with previous results of Baron-Cohen and Wheelwright (2004). The correlations between the EQ, the Strange stories and the Faux-pas test confirm the hypothesis that the two disorder groups are able to recognize their theory of mind abilities adequately. This is in line with previous research, which demonstrated that high functioning adults with ASD have more self-knowledge and introspective abilities than was previously assumed (Blackshaw et al., 1999; Happé, 1991; Spek et al., in preparation). Somewhat similar results have also been found for

adults with schizophrenia, were EQ performance appeared modestly associated with social cognitive tasks (Bora et al., 2008).

The present study thus lends support to the validity of self-reports for examining theory of mind in adults with HFA or Asperger syndrome, not only in research but also in clinical practice. The large discriminating power of the EQ in differentiating between the two disorder groups and the neurotypical group indicates that the total score of the EQ may be considered an important marker for the presence of HFA and Asperger syndrome in adults.

3.4.1 Limitations

The present study was undertaken in adults with average to high verbal abilities. Therefore, the results deriving from this study cannot be generalized to ASD populations with below average verbal abilities.

Adequate understanding and interpretation of the questions used in the EQ relies on semantic capacities. Although the two disorder groups were carefully selected and all participants had at least average verbal abilities, deficiencies in semantic processing which characterize individuals with ASD may have influenced the answers to the questions.

The present study indicates that performance of the EQ may function as a marker for the presence of HFA and Asperger syndrome, when compared to a neurotypical group. However, to be a clinical marker it is of great importance that the EQ can also differentiate between ASD and other psychiatric diagnoses. Further research should shed more light on this.

4 Detailed information processing by adults with HFA and Asperger syndrome: The usefulness of neuropsychological tests and self-reports

Submitted.

Abstract

Detailed information processing in 42 adults with high functioning autism, 41 adults with Asperger syndrome and 41 neurotypical adults was examined. Contrary to our expectations, the disorder groups did not outperform the neurotypical group in the neuropsychological measures of detailed information processing. In line with our hypotheses, the self-reports did show higher levels of detailed information processing and a stronger tendency to use systemizing strategies in the two disorder groups. Absent and weak correlations were found between the self-reports and the two neuropsychological tasks in the three groups. The neuropsychological tests and the self-reports seem to measure different underlying constructs. The self-reports appeared to be the most predictive of the presence of a diagnosis.

4.1 Introduction

Detailed versus global information processing in children with autism has been a topic of extensive research since 1989 (Frith, 1989, 2003). However, the body of research that examined whether and to what extent adults with high functioning autism (HFA) or Asperger syndrome have a detailed information processing style is limited and the results of these studies are contradictory. Previous studies used both neuropsychological tests and self-reports to assess detailed information processing, although it has never been examined whether the two measure a similar underlying construct.

Therefore, in the present study detailed information processing by adults with HFA, Asperger syndrome and a neurotypical adult group will be investigated using neuropsychological tests and self-report questionnaires. Furthermore, the relationship between the neuropsychological tests and the self-reports will be assessed.

4.1.1 Detailed Information Processing in Autism

Frith (1989, 2003) was the first to examine detailed information processing in individuals with autism. In her 'weak central coherence theory', she described strengths in detailed information processing combined with a failure to integrate information into a meaningful whole as characteristic for autism (Frith, 1989, 2003). Throughout the years, the idea of a core deficit in central coherence has been replaced by the suggestion that local, fragmented information processing can be seen as a bias or cognitive style in individuals with autism spectrum disorders (ASD), which can be overcome in tasks that demand global processing (Happé & Frith, 2006; Wang et al., 2007). Currently, two prevailing frameworks in detailed information processing in ASD are the 'Enhanced Perceptual Functioning hypothesis' (EPF: Mottron et al., 2006), and the 'Empathizing-Systemizing account' (E-S: Baron-Cohen et al., 2002). The EPF hypothesis states that people with autism display a local bias without evidence of a global deficit (Mottron et al., 2007). According to the E-S approach (Baron-Cohen et al., 2002), individuals with autism are more likely to use systemizing strategies. Systemizing can be described as the tendency to analyze information and to construct systems that are lawful. Although the E-S approach is not a local versus global theory of cognition theory per say, it does consider excellent attention to detail as a core characteristic of autism.

4.1.2 Detailed Information Processing in Adults with ASD

Studies that examined detailed information processing specifically in adults are limited and results are contradictory. The Embedded figures test (EFT: Witkin et al., 1962) and the Block design subtest of the WAIS III (Wechsler, 1997) have been used the most

frequently to measure detailed information processing. However, to our knowledge only a few studies examined EFT performance in adults with HFA or Asperger syndrome. In one study, superior functioning was found for adult groups with HFA and Asperger syndrome (Jolliffe & Baron-Cohen, 1997), while another study of adults with HFA and Asperger syndrome reported no strengths for this task (Minshew et al., 2008). As for the Block Design task, superior performance by adult ASD groups was demonstrated in two studies (Rumsey & Hamburger, 1988; Pring et al., 1993). Yet, Kaland et al. (2007) reported no differences between adolescents with Asperger syndrome or HFA and a neurotypical group. Overall, the studies that examined detailed information processing in adults are limited and the results are contradictory. Therefore, it remains undetermined whether and to what extent adults with ASD still experience strengths in detailed information processing. It is important to be aware of the specific impairments and coping mechanisms of adults with ASD, in order to recommend appropriate treatment and guidance. Furthermore, knowledge about their qualities and impairments enables the search for occupations in which they can use their qualities and be restricted only minimally by their impairments. The present study aims to fill this gap by examining detailed information processing in a relatively large group of adults with HFA and Asperger syndrome, using both the EFT and the Block Design task. Their performance will be compared with an IQ-matched control group of neurotypical individuals.

A recent development in autism research is the use of self-reports to examine cognitive and behavioral features. In order to assess self-perceived detailed information processing and systemizing tendencies in adults with ASD, the Autism Spectrum Quotient (AQ: Baron-Cohen et al., 2001) and the Systemizing Quotient (SQ: Baron-Cohen et al., 2003) have been developed. Research demonstrated that adults with ASD obtained higher scores for both questionnaires compared to neurotypical adults (Baron-Cohen et al., 2003, Goldenfield et al., 2005; Baron-Cohen et al., 2001; Hoekstra et al., 2008). Although the use of self-reports in individuals with autism is controversial, adults with average verbal ability and a relatively high level of functioning seem able to describe their strengths and weaknesses adequately (Frith & Happé, 1999; Happé, 1991; Spek et al., 2010). However, it has never been formally investigated whether self-report questionnaires and the neuropsychological tasks that aim to measure detailed information processing actually measure similar underlying constructs. Therefore, the present study will examine the relationship between self-reports and the neuropsychological tests that we use to measure detailed information processing.

When examining detailed information processing, it may be relevant to differentiate between HFA and Asperger syndrome. Although it is questionable whether HFA and Asperger syndrome can be differentiated, many researchers argue that these

two disorders differ in at least degree of impairment, and especially in language skills (Klin et al., 2005a; Ozonoff et al., 2000b; Spek et al., 2008). For this reason, we chose to study the two groups separately.

Another factor that may be relevant to the use of the EFT and the Block design task is speed of information processing. Both tasks make use of a time limit and bonus points can be earned when less time is spent on resolving the items. The impairment in speed of information processing that has been found for children (Calhoun & Mayes, 2005) and adults with HFA (Spek et al., 2008) may influence their performance of the EFT and the Block design task negatively. Therefore, processing speed will be included as a variable in the present study.

4.1.3 Hypotheses of the Present Study

In line with the 'enhanced detailed information processing' theories in autism, we expect that the adult HFA and Asperger syndrome groups will perform better on the EFT and the Block design task and will receive higher scores on the AQ and the SQ, compared to the neurotypical group. We expect medium to high correlations between the neuropsychological instruments (Block design task and EFT) and the self-reports (AQ and SQ) in the research groups, since all these instruments aim to measure similar phenomena.

We also expect the speed of processing information to influence performance on the EFT and the Block Design task, specifically in the HFA group.

4.2 Methods

4.2.1 Procedure

The participants of the HFA and the Asperger groups were recruited from GGZ (Dutch Mental Health Agency) Eindhoven and GGZ Oost-Brabant. They visited one of these mental health agencies for various reasons, for example problems at work and/or marital problems. Recruitment took place from July 2005 to June 2008.

Participants with genetic conditions or relevant neurodevelopmental conditions (e.g. ADHD, Tourette syndrome) were excluded, as were institutionalized participants and participants with a below average intelligence and verbal ability (scoring 85 or less in full scale intelligence and the verbal comprehension index, as measured by the WAIS-III). The neurotypical control subjects were recruited from the general population by adds in local 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. In

total, 124 of the 126 possible participants agreed to take part and signed informed consent forms prior to their inclusion in the present study. The total group comprised 42 individuals with HFA, 41 individuals with Asperger syndrome and 41 neurotypical adult controls. (see Table 1). The present study was approved by the Ethics Committees of the two participating centers.

4.2.2 Assessment of Disorder

Of all participants in the present study, approximately one-third was diagnosed with an autism spectrum disorder in childhood, about one-third had previously received care for an unknown or with an unclear diagnosis and the remaining participants had not been diagnosed until adulthood. In the three groups, a similar standardized diagnostic process was executed, as further described in this paragraph.

The diagnosis of either HFA or Asperger syndrome was established through evaluation of historic and current symptomatology. To gather developmental information, parents were interviewed using the Dutch version of the Autism Diagnostic Interview, Revised version (ADI-R, Lord et al., 1994). When parental information was not available, an older brother or sister was interviewed. In these instances, further information about early childhood was gathered, for example from baby books and early clinical reports. 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). Although the ADI-R has been validated only for children and adolescents, it is considered the 'gold standard' for diagnosis, not only for children but also for adults (Lord & Corsello, 2005).

In the process of diagnosing ASD, the ADI-R is often used in combination with the Autism Diagnostic Observation Schedule (ADOS, Lord et al., 1999). Research shows, however, that the ADOS is under-inclusive in diagnosing mild, verbal adolescents and adults with autistic spectrum disorders (Lord et al., 2000). Therefore, in the present study, a semi-structured interview was administered to all subjects, whereby all ASD criteria of the DSM-IV-TR were assessed by asking the participant standard questions. Furthermore, observations of the participants were gathered systematically during the diagnostic process and in the course of the assessment of the neuropsychological tasks. These observations were subsequently arranged according to the DSM-IV-TR criteria for ASD (APA, 2000). After the diagnostic process described above, the DSM-IV-TR items of ASD were scored, based on the semi-structured interview and the observations of the participant. Only those participants who met the DSM-IV-TR criteria for the autistic disorder or Asperger syndrome were included in the present study. Because of the controversial nature of the DSM-IV criteria in differentiating between the two disorders

(Ghaziuddin et al., 1992; Mayes et al., 2001), additional questions, based on the diagnostic criteria of Gillberg & Gillberg (1989) and ICD-10 (WHO, 1993), were asked. When a significant delay in spoken or receptive language or development was present, a diagnosis of Asperger syndrome was excluded, in accordance with the ICD-10 criteria. When there was no delay in development or language, the criteria of Gillberg and Gillberg (1989) were used to diagnose the participants with Asperger syndrome, since these criteria more closely resemble Asperger's own descriptions than the criteria of ICD-10 (Leekam et al., 2000).

4.2.3 Assessment of Detailed Information Processing

To assess detailed information processing, two neuropsychological tasks and two questionnaires were used; they will be described in the following paragraph.

4.2.3.1 Embedded figures test

In the Embedded Figures Test (Witkin et al., 1962), 12 simple figures have to be traced. These simple figures are embedded in larger, more elaborate designs. In the process of assessing the EFT, the official manual by Witkin et al. (1962) was followed. The average mean time spent to detect each simple figure was used as a dependent variable in the present study. The time the participant needed to trace the figure with the stylus (after having found the figure) was not included in this score, so the total time-score did not reflect any motor demands.

4.2.3.2 Block design test

The Block Design task is a subtest of the WAIS III (Wechsler, 1997). In this test, patterns have to be arranged with blocks that have differently coloured sides. The score obtained reflects whether, and how fast, the participant has completed the patterns within a given time limit. In autism research, strengths in performance on the Block Design task have been attributed to strengths in mentally breaking down a whole into its constituent parts (analysis) and then reconstructing the whole from these parts (synthesis). The WAIS-III has been validated for the Dutch population (Wechsler, 1997).

4.2.3.3 Autism spectrum quotient

The AQ is a 50-item self-administered questionnaire that assesses the degree to which an adult recognizes features of the core autistic phenotype (Baron-Cohen et al., 2001). The internal consistency and test-retest reliability are satisfactory (Hoekstra et al., 2008). The AQ subscale 'attention to detail', that was used in the present study, comprises 10 items. Results of a factor-analysis indicated that this subscale can be seen as a separate,

valid factor (Hoekstra et al., 2008). In the present study, a Dutch translation of the AQ was used (Ponnet et al., 2001).

4.2.3.4 Systemizing quotient

The Systemizing Quotient (SQ) is a self-report questionnaire, developed to assess systemizing tendencies in adults with normal intelligence (Baron-Cohen et al., 2003). Systemizing can be described as the tendency to analyze information and construct systems that are lawful in order to predict novel situations. The SQ comprises 60 questions: 40 items assess systemizing and 20 are filler items. In the present study, a Dutch translation of the questionnaire was used.

4.2.4 Assessment of Processing Speed

To assess the speed of information processing, the factor scale 'Processing Speed' of the WAIS III was used (Wechsler, 1997). WAIS-III has excellent psychometric properties (Sattler & Ryan, 1999) and has been validated for the Dutch population (Wechsler, 1997). The Processing speed factor scale consists of two paper-and-pencil subtests and refers to the speed with which cognitive processes are carried out.

4.2.5 Matching Procedure

The three groups were matched according to age, gender, handedness, full Scale intelligence and verbal abilities. To match for verbal abilities, the WAIS-III factor scale 'Verbal Comprehension Index' (VCI) was used. The subject characteristics for the three groups are presented in Table 1. A Chi-Square test illustrated that the three groups did not differ in gender distribution or handedness. T-tests showed that the three groups were comparable in VCI, FSIQ and mean age (see Table 1).

Table 1
Matching Variables

	HFA	Asperger	Neurotypical	statistic	*p*
Gender (M:F)	42 (35:7)	41 (37:4)	41 (30:11)	$\chi^2 = 4.145$	.13
Handedness (R:L)	42 (39:3)	41(34:7)	41 (36:5)	$\chi^2 = 1.925$	.38
Mean age	37.2 (10.8)	41.3 (11.5)	39.3 (9.7)	t(121) = 1.498	.23
FSIQ *	108.1 (14.3)	112.9 (14.8)	114.2 (11.5)	t(121) = 2.311	.10
VCI **	109.8 (10.8)	110.7 (10.7)	112.0 (11.6)	t(121) = .453	.64

* FSIQ = Full Scale Intelligence, measured by the WAIS-III

** VCI = verbal comprehension index, measured by the WAIS-III

4.3 Results

4.3.1 Differences in EFT Response-time and Block Design Performance

The mean scores and standard deviations of detailed information-processing as measured by the EFT and the Block Design task for the HFA group, the Asperger syndrome group and the neurotypical group are presented in Table 2.

Table 2

Means and standard deviations for the neuropsychological tests and the questionnaires

	M	SD	M	SD	n
	AQ subscale		*SQ*		
HFA	25.52	6.06	36.00	11.52	42
Asperger	25.44	5.79	34.24	11.25	41
Neurotypical group	21.07	4.79	25.32	9.56	41
	Block Design		*EFT*		
HFA	12.12	3.63	38.71	21.33	42
Asperger	12.56	3.67	35.65	22.17	41
Neurotypical group	12.93	2.25	25.99	14.08	41
	Processing speed				
HFA	100.19	19.11			42
Asperger	109.44	17.10			41
Neurotypical group	112.24	15.62			41

To test the hypothesis of differences in performance on the EFT and the Block Design task between the three groups, two one-way between-group analyses of variance (ANOVA) were performed, using the diagnosis as the independent variable and the two neuropsychological tests as the dependent variables, respectively. The assumption of homogeneity was met, however, Levene's test indicated that the assumption of equality of variance was violated in the analysis. Therefore a more conservative alpha of .025 was set (Tabachnick & Fidell, 2001).

For mean response time in the EFT, the results displayed a statistically significant main effect of diagnosis (F (2,121) = 4.76, p = 0.01, partial eta squared = .07) with a moderate effect size (Cohen, 1988). For the Block Design task, no statistically significant main effect of diagnosis was found (F (2,121) = .642, p = .53). Post-hoc Tukey comparisons revealed that the neurotypical group was significantly faster in the EFT than the HFA group (p = 0.01). The Asperger syndrome group did not differ in response time from either the neurotypical group or the HFA group.

4.3.2 AQ Detailed Information Processing and Systemizing Tendencies

To test the hypothesis of differences in self-perceived detailed information processing and the tendency to systemize, two one-way between-group analyses of variance (ANOVA) were performed with the diagnosis as the independent variable or factor and the AQ and the SQ scores as the dependent variables, respectively. The assumptions of homogeneity and equality of variance were met. Wilks' Lambda was used to measure group differences. For the AQ subscale, the results displayed a statistically significant main effect of diagnosis (F (2,121) = 8.578, p < .01, partial eta squared = .12). The effect size can be interpreted as moderate (Cohen, 1988). For the SQ, a large and statistically significant main effect of diagnosis was found (F (2,121) = 11.57, p < .01, partial eta squared = .16). Post-hoc Tukey comparisons revealed that the neurotypical group scored significantly lower on the AQ subscale then the individuals with HFA (p < .01) and the Asperger syndrome group (p < .01). Furthermore, the neurotypical group obtained lower scores on the SQ compared to the HFA (p < .01) and the Asperger syndrome group (p < .01). There were no significant differences between the two disorder groups in the AQ and the SQ. The findings thus support the hypothesis that adults with HFA and Asperger syndrome report higher levels of local information processing and systemizing tendencies compared to the neurotypical adult group.

4.3.3 The Relationship Between the SQ, the AQ Subscale, the EFT the Block Design Task

To investigate whether the self-assessments on the two self-report questionnaires and the performance on the two neuropsychological tasks are related, Pearson product-moment correlation coefficients were calculated. Table 3 presents the results.

Table 3
Correlation Coefficients

	1	2	3	4
1. AQ subscale	-			
2. SQ total score	.58**	-		
3. Block Design task	.10	.19*	-	
4. EFT	-.01	-.07	-.63**	-

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

Strong and significant correlations were found between the SQ and the AQ subscale (r = .58, p < .01) and between the EFT and the Block Design task (r = -.63, p < .01). The correlation between the SQ and the Block Design task was significant but small (r = .19, p = .03). Other correlations were not significant.

The finding of a strong association between the two neuropsychological tasks and between the two self-report assessments on the one hand and the lack of association between the neuropsychological tasks and self-report detailed information processing on the other, raises the question whether the two instruments assess a similar underlying construct.

This issue of construct validity was further explored by performing a factor analysis with the two neuropsychological tasks and the two self-report questionnaires as the variables. If all four measures point towards the same underlying construct, this points to the emergence of one factor (Gregory, 2007).

Analysis yielded a KMO value above 0.5, and Barlett's Test of Sphericity was significant at <0.01, suggesting satisfactory conditions for factor analysis to proceed (Field, 2005). In the analysis (method: Principal Components) two components emerged with eigenvalues exceeding 1, explaining 48 per cent and 36 per cent of the variance, respectively. The Oblimin rotated structure matrix of the two principal components is presented in table 4.

Table 4

Principal Component Analysis: Factor Loadings (Rotated component matrix) [a]

Variable	Factor 1 [b]	Factor 2
Embedded figures test	-.907	
Block design task	.894	
SQ total score		.892
AQ subscale		.883

[a] Rotation method: Oblimin with Kaiser Normalization

[b] $R_{\text{factor 1 - factor 2}} = 0.11$

As table 4 shows, the EFT and the Block design task loaded predominantly on component 1, while the AQ and the SQ assessments loaded predominantly on component 2, with both components being only loosely associated ($b_{\text{between factors}}=0.11$). The findings of the analysis indicate that the neuropsychological tasks and the self-reports do not point towards a similar underlying construct, but refer to two different constructs.

4.3.4 Exploration of the Predictive Validity of the SQ, the AQ Subscale, the EFT and the Block Design Task

To examine the ability of the neuropsychological test and self-report questionnaires to predict whether a person belonged to the neurotypical or to one of the diagnostic groups, a discriminant analysis was performed. The Asperger group and the HFA group were merged and a two-group discriminant analysis was performed with the neurotypical group and the merged Asperger syndrome/HFA group as the dependent variable. This analysis yielded a statistically significant function ($\chi^2(4) = 32.18$, $p < .01$.). Overall the discriminant function successfully predicted outcome for 77 % of the cases, with accurate predictions being made for 77% of the HFA/Asperger group and 78% of the neurotypical group. The correlations between the predictor variables and the discriminant function showed that the SQ score (r = .72) and the AQ score (r = .63) are highly relevant in order to determine whether an individual belonged to either the HFA/Asperger group or the neurotypical group, while the EFT (r = .36) and the Block design task (r = -.18) are less relevant in this respect.

4.3.5 The Influence of Processing Speed on Embedded Figures Test Performance

A one-way between-groups analysis of covariance was conducted to investigate whether the differences in Embedded Figures Test performance between the three groups can be attributed to processing speed differences. After adjusting for the processing speed scores, there was no significant difference between the neurotypical and the HFA group in the Embedded Figures Test (F (2,120) = 2.84, p = .06). This suggests that processing speed, as was expected, is an underlying factor of EFT performance in adults with HFA.

4.4 Discussion

The present study aimed to investigate detailed information processing in adults with HFA and Asperger syndrome and the usefulness of neuropsychological instruments and self-report questionnaires in this respect.

We expected to find superior performance on the EFT and the Block Design task; however, the data of the present study did not support this hypothesis. The three groups did not differ in performance in the Block design task and the neurotypical group even outperformed the two disorder groups on the EFT. Although the impairment in the EFT can be attributed to the relatively low processing speed in the HFA group, this does not explain why the expected strengths in the two neuropsychological tests were not found in the disorder groups. Although the results of the present study are in contrast to most previous studies of children and adults with ASD that used the EFT and the Block design task, one study of adults (Minshew et al., 2008) and one study of adolescents (Kaland et al., 2007) with ASD reported similar results.

As opposed to the results of the neuropsychological tests, the findings of the self-report questionnaires were in line with what we expected to find. The two disorder groups obtained higher scores for both the SQ and the AQ compared to the neurotypical group. Apparently, individuals with HFA and Asperger syndrome perceive themselves as being more detail-oriented and report the use of more systemizing strategies compared to the neurotypical group. These results replicate previous findings for adults with HFA and Asperger syndrome and are in line with the EPF hypothesis and the E-S approach (Baron-Cohen et al., 2001; Baron-Cohen et al., 2003; Hoekstra et al., 2008; Mottron et al., 2006; Wakabayashi et al., 2007).

The contrast between the results of the self-reports and the findings of the neuropsychological tasks is striking. Moreover, the analyses pointed to different underlying constructs. The finding of minimal or even absent associations between neuropsychological tasks and self-reports that aim to measure the same construct is not new. Previous studies reported similar results in other cognitive areas (Veenman, 2005).

Our results leave only two possible explanations: either the neuropsychological tasks or the self reports are valid indicators of detailed information processing. If, according to the first possibility, the results of the neuropsychological tasks are a valid representation of detailed information processing, then adults with ASD would not differ from neurotypical adults in this respect. This would indicate that they have 'overgrown' their local information processing bias. It would also suggest that the relatively high level of self-reported detailed information processing that was found for the disorder groups is not valid. We can think of two possible explanations for this: first, the disorder groups may have adjusted their answers to what, in their opinion, corresponded to their diagnosis. However, this explanation seems unlikely because most of the participants were unaware of their diagnosis until after the neuropsychological testing process took place. Second, it could be argued that a lack of insight influenced the results of the self-report questionnaires for the individuals with ASD. However, this would imply that healthy adults are also unable to determine their level of detailed information processing, since in this group correlations between the neuropsychological tasks and the self-reports were also low or absent. Although it is theoretically possible, it does not seem likely that neurotypical adults with average intellectual capacities have so little insight into their cognitive functions.

According to the second possibility, the self-reports are a valid indicator of detailed information processing, which implies that the EFT and the Block design task measure different cognitive features. In favor of this hypothesis is the fact that the performance on two self-report questionnaires appeared to be highly indicative of whether a person belonged to one of the disorder groups or to the neurotypical group, while the neuropsychological tests were less specific in this respect.

Furthermore, it is important to note that the EFT and the Block design task were not developed to measure detailed information processing. Research indicated that performance in the two tasks can be affected by multiple cognitive features (Happé & Frith, 2006; Lezak et al., 2004; Witkin et al., 1962; Witkin et al., 1971). For example, right and left hemisphere problems can influence performance on the Block design task (Lezak et al., 2004). From this perspective, it is possible that the performance by our research groups in the EFT and the Block design subtest was influenced by other cognitive features than detailed information processing. Following this line of thought, the present data add to a recent discussion about the clinical relevance of cognitive tasks in general, which has been referred to as ecological validity (Chaytor et al., 2006). It appears that a large amount of variation in everyday cognitive and behavioral skills cannot be accounted for in neuropsychological tests. In addition, factors such as compensation strategies and environmental characteristics influence test performance and have a negative impact on

ecological validity (Chaytor et al., 2006). Although it seems most plausible that the self-reports provide the most valid representation of detailed information processing, our proof is only indirect. Therefore we need to be careful with conclusions in this respect. It is clear, however, that adults with HFA and Asperger syndrome report to be more detail-prone and more inclined to use systemizing strategies. It is important to take this into account when searching for an optimal educational and work environment where these individuals can use their strengths and abilities.

Although more research on this subject is needed, the results of the present study raise questions about the ability of the EFT and the Block design task to measure detailed information processing in adults. If our results are replicated in future studies in adults, self-reports might be considered first choice for examining detailed information processing in adults, at least until valid neuropsychological instruments are developed specifically to measure this feature.

When looking more closely at the results of the self-reports, the present study showed that the correlation between the SQ and the AQ subscale is medium to strong in all three groups. The two questionnaires share a considerable proportion of the variance. Detailed information processing is apparently related to the use of systemizing strategies. This is in line with the E-S approach, which states that for systemizing, detailed processing is inevitable because a high systemizing mechanism needs to record each data-point (Baron-Cohen, 2006). People with autism appear to use these lawful systems to keep an overview of all the details they are perceiving. This hypothesis supports recent ideas that individuals with autism are able to process information globally when necessary or when instructed to do so (Plaisted et al., 1999). It is interesting that the SQ and AQ subscale are also closely related in the neurotypical group. Systemizing strategies may also be used by healthy individuals as a way of organizing details and predicting change. This indicates that detailed information processing can be seen as a cognitive style and not as a defect, which is not only present in ASD but also in the general population. The idea of detailed information processing as a style rather than a deficit lends itself to a continuum approach, which is in line with recent perspectives on autism (Rapin, 2005). In this view, individuals with ASD can be placed at the extreme end of the continuum, whereas people with impaired detailed information processing are placed at the opposite end of the same continuum.

In this study, we differentiated the individuals with HFA group from those with Asperger syndrome group, since research has shown that the degree of impairment in various areas is different in the two groups (Klin et al., 2005a). Contrary to our expectations, no differences in the neuropsychological test results or in the self-report measures were found between the HFA and the Asperger syndrome group. It may be

possible that, because of the relatively high level of functioning, differences in impairment between individuals with HFA and Asperger syndrome diminish during their lifetime. The results of the present study confirm the studies that stress the questionable validity of identifying autism and Asperger syndrome as separate disorders (Volkmar & Klin, 2005).

4.4.1 Limitations

In the present study, all participants had at least average verbal ability. Because these participants represent a select subgroup of the total population of adults with autism, the results of the present study cannot be generalized to individuals with ASD who are not as verbally capable.

Furthermore, the relatively late diagnosis of a proportion of the participants characterizes our research group. A relatively late diagnosis has been hypothesized to be related to milder symptoms (Vermeulen, 2002). However, all the individuals in the disorder groups matched criteria for HFA or Asperger syndrome and individuals with relatively mild symptoms were not included in the present study because they were, in most cases, diagnosed with PDD-NOS. The present study used two self-report questionnaires to assess detailed information processing and systemizing tendencies. An adequate understanding and interpretation of the questions used in the questionnaires relies on semantic capacities. Although the two disorder groups were carefully selected and all participants had at least average verbal abilities, deficiencies in semantic processing which characterize individuals with ASD may have influenced the performance in the two questionnaires.

5 Verbal fluency in adults with HFA and Asperger syndrome

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Abstract

The semantic and phonemic fluency performance of adults with high functioning autism (HFA), Asperger syndrome and a neurotypical control group were compared. All participants were matched for age and verbal ability. Results showed that the participants with HFA were significantly impaired in their performance of both semantic fluency tasks and the phonemic fluency task using the letter M. The Asperger group was only impaired in their performance of the semantic fluency tasks 'professions'. The social components of the 'professions' task may have influenced the performance of the two disorder groups for this subtest negatively. The fluency deficits could not be attributed to a lack of the use of strategies or to difficulties in switching between strategies. The impairment in two of the three verbal fluency subtests in the HFA group can be attributed to the relatively low processing speed found in this group.

5.1 Introduction

Executive functioning covers a wide range of skills that are involved in dealing with novel situations. The executive functioning hypothesis offers possible explanations for the various impairments often associated with autism (Ozonoff et al., 2005; Rumsey, 1985). Tasks of verbal fluency are commonly used instruments to assess executive functioning (Henry & Crawford, 2004). Research on fluency functioning in autistic subjects has focussed largely on children and adolescents (Boucher, 1988; Geurts et al., 2004; Minshew et al., 1992; Turner, 1999, Williams et al., 2002). Recently, however, clinical practice has been confronted with a growing group of adults that get diagnosed with high functioning autism (HFA) or Asperger syndrome (Gillberg, 1998). Their ability to compensate and camouflage the autistic characteristics throughout their lives led to diagnosis at a relatively old age (Vermeulen, 2002). It is still not clear whether adults with autism spectrum disorders (ASD) and a high level of functioning have overgrown or compensated for the fluency impairments often found in children with ASD. To be able to recommend appropriate treatment, it is necessary to know which impairments and coping mechanisms people with ASD have. It is also important to distinguish between HFA and Asperger syndrome, given the previously found differences in executive functioning between these two groups (for an overview: Klin et al., 2005a). The present article aims to increase the understanding of the impairments in adults with HFA and Asperger syndrome.

5.1.1 Verbal Fluency and Underlying Mechanisms

Verbal fluency can be described as the ability to generate novel verbal responses (Turner, 1999). Two types of verbal fluency can be distinguished: semantic and phonemic fluency.

In phonemic fluency tasks, words have to be generated starting with a certain letter (Benton, 1968; Luteijn & Barelds, 2004). In semantic fluency tasks, words have to be generated based on a semantic category, for example ‘animals’ (Benton, 1968).

In order to examine cognitive mechanisms underlying verbal fluency performance, Troyer and others (1997) devised a two-component model. Using the protocols of generated words, they extracted two scores that reflect clustering and switching, respectively. Clustering can be described as the ability to generate words in a certain semantic or phonemic subcategory. Producing words in clusters or subcategories is generally seen as a more efficient way of generating words than a disorganized search. The switching score reflects the ability to switch to a new cluster in order to avoid slowing down (Troyer et al., 1997). Switching abilities and using semantic relationships in order to generate ideas

have been found deficient in individuals with autism (Hill, 2004; Tager-Flusberg et al., 2005; Ozonoff et al., 2005). Alongside switching and clustering abilities, the ability to initiate and activate responses was distinguished as a relevant factor in verbal fluency performance (Reverberi et al., 2006). Individuals who suffer an initiation and activation deficits are slower in processing information and retrieving items in the fluency tasks. Meta-analytic studies in Schizophrenia (Henry & Crawford, 2005b), Huntington's disease (Henry et al., 2005) and depression (Henry & Crawford, 2005a) showed, that fluency deficits did not exceed the deficits in speed of processing information in these groups. This suggests that fluency deficits did not qualify as differential deficits relative to processing speed deficits. The speed of processing information has been found impaired in individuals with HFA (Calhoun & Mayes, 2005; Spek et al., 2008).
An analysis of word protocols may reveal whether difficulties in switching, clustering or processing speed are at the base of the verbal fluency performance problems in these groups.

Summarizing the above, research provided evidence that verbal fluency functioning of children and adolescents with HFA is impaired. However, there is still little known about the verbal fluency functioning in individuals with HFA and Asperger syndrome. Differences between HFA and Asperger syndrome in verbal fluency functioning might be expected based on previous research differentiating between the two disorders. Furthermore, not much is known about the underlying mechanisms of verbal fluency performance for individuals with HFA and Asperger syndrome.

5.1.2 Aims of the Present Study

The present study will examine whether late diagnosed adults with HFA and Asperger syndrome show impaired functioning in verbal fluency tasks compared to a matched control group of neurotypical individuals. Based on former research among children, we expect that the performance of adults with HFA and Asperger syndrome will be weaker compared to a neurotypical control group. The Asperger syndrome group is expected to show less impairment than the HFA group, since previous studies revealed differences between the two groups in various cognitive areas. To examine the cognitive processes underlying verbal fluency performance, the verbatim reports of the fluency performance will be analyzed to assess switching and clustering abilities. Also the relationship between verbal fluency and processing speed will be examined.

5.2 Methods

5.2.1 Procedure

All participants were recruited from GGZ (Mental Health Center) Eindhoven and GGZ Oost-Brabant. The participants visited one of these Mental Health Centers for various reasons. In many cases marital problems or problems at work were the main reason to ask for help. Participants with relevant neurodevelopmental conditions (e.g. ADHD, Tourette syndrome) and genetic conditions were excluded, as were institutionalized patients and patients with a Full Scale IQ below 80. All participants who met the inclusion criteria were asked to participate in the present study. In total, 92 of the 93 possible participants agreed to take part and signed informed consent forms prior to their inclusion in the present study.

In the present study, 31 participants with HFA, 31 participants with Asperger syndrome and 30 neurotypical participants took part. All individuals ranged in age from 18 to 60 years. The mean age of the control group was 39, the mean age of the HFA group was 38, and that of the Asperger syndrome group was 40 (see table 1). Three quarters of the respondents had a relatively high level of education. The level of achieved education in the three groups is also presented in table 1. The present study was approved by the Ethics Committees of both centers. The neurotypical control subjects were recruited from the general population. Healthy controls were not included in the present study if they had a history of psychiatric illness or if autism ran in the family.

Table 1

Matching Variables

	Autism	Asperger	Control	statistic	*p*
Gender (M:F)	31 (28:3)	31 (29:2)	30 (28:2)	$\chi^2 = 0.286$	.87
Education (L/M:H)*	31 (9:22)	31 (10:21)	30 (6:24)	$\chi^2 = 1.239$	.54
Mean age	38.58 (11.75)	40.75 (10.95)	39.89 (11.45)	t(91) = 0.285	.75
VCI **	111.81 (9.65)	114.84 (9.51)	116.77 (11.33)	t(91) = 1.845	.16

* Educational level L/M:H = Lower/Middle versus Higher

** VCI = verbal comprehension index as measured by the WAIS-III

5.2.2 Assessment of disorder

The diagnosis of either HFA or Asperger syndrome was established 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 Autistic Disorder Diagnostic Interview, revised version (ADI-R, Lord et al., 1994). The ADI-R was administered by psychologists who were officially trained in the administration and scoring of this instrument. The ADI-R has excellent reliability and validity when used by trained examiners (Lord et al., 1994).

To gather information of current symptomatology, a semi-structured interview was administrated. This interview assessed the DSM-IV-TR criteria of the autistic disorder and Asperger syndrome by asking the participant standard questions (APA, 2000). Because of the controversial nature of the DSM-IV criteria in differentiating between the two disorders (Ghaziuddin et al., 1992; Mayes et al., 2001), additional questions were used, based on the diagnostic criteria of Gillberg & Gillberg (1989) and ICD-10 (WHO, 1993).

5.2.3 Assessment of intelligence

The intelligence profile was assessed using the Dutch version of the WAIS-III (Wechsler, 2000). Compared to WAIS-II, significant modifications and structural changes have been made. The WAIS-III has a new factor structure that gives the best representation of the factors underlying intelligence (Arnau & Thompson, 2000; Ryan & Paolo, 2001). WAIS-III has excellent psychometric properties (Sattler & Ryan, 1999) and has been validated for the Dutch population (Wechsler, 2000).

5.2.4 Assessment of semantic and phonemic fluency

The semantic fluency tasks used in the present study were subtasks of the Groninger Intelligentie Test (GIT, Luteijn & Barelds, 2004). Participants were asked to name as many animals, and in the second task professions, as possible within one minute. The phonemic fluency task used in the present study was originally designed by Benton (1968), using the letters *F, A,* and *S*. It was adapted for use in Dutch and Flemish populations by Verté and others (2006) using the letters *K* and *M*. The participants were asked to name as many words as possible starting with the letter *K,* and in the second task with the letter *M*, within one minute. Subjects were instructed not to use people's names or repetitions of the same word with different endings (e.g. *power*, *power*boat, *power*plant, etc.). When a certain word was repeated within a task, this response was eliminated from the total score.

5.2.5 Analysis of mechanisms underlying semantic and phonemic fluency

To explore the underlying mechanisms of verbal fluency, the number of switches and clusters was quantified using the two-component model of Troyer et al. (1997) and modifications of this model by Reverberi et al. (2006). In semantic fluency, clusters were defined as groups of successively generated words that belong to the same semantic subcategory. The determination of subcategories of animals was based on the results of the study of Troyer et al. (1997). The subcategories for professions were derived from the actual patterns of words generated by a neurotypical group of participants. Two independent raters derived subcategories out of the word protocols. Only the subcategories named by both raters were used in the present study.

Clusters in phonemic fluency were defined as groups of successively generated words that start with the same two letters, words that differed only by a vowel sound, or words that rhymed or were homonyms. The following scores were extracted from the word protocols, using the guidelines of Troyer et al. (1997) and Reverberi et al. (2006):

1. The relative number of repeated words. This variable represents the percentage of the total number of produced words that were repetitions of a word that was already named.
2. The mean cluster size. This represents the total number of words named in the clusters, divided by the number of clusters generated. The size of each cluster was counted starting with the second word of the cluster. For example: two words had a cluster size of 1 (see Troyer et al., 1997).
3. The relative number of switches. This variable consists of the number of switches divided by the total number of words generated including repetitions, minus 1 (see Reverberi et al., 2006).

5.2.6 Matching Procedure

Fluency performance is highly correlated with verbal abilities in the general population (Crawford et al., 1992; Crawford et al., 1993; Miller, 1984). To prevent that fluency performance differences in the present study can be attributed to differences in verbal ability, the three groups were matched for performance on the WAIS-III factor scale 'Verbal Comprehension Index' (VCI). Those participants with a VCI-score of 95 or above were selected for the present study to ensure normal to high level of functioning. Further, the three groups were matched according to age, gender distribution and educational level because these factors have also been proven to influence verbal fluency performance (Henry & Crawford, 2004; Van der Elst et al., 2006). A Chi-Square test illustrated that the three groups did not differ in gender distribution ($\chi^2(2) = .286$, $p = .87$) or level of education ($\chi^2(2) = 1.239$, $p = .54$) and a one-way analysis of variance (ANOVA)

showed that the three groups were comparable in VCI (F(2,89) = 1.845, *p* = .16) and age (F(2,89) = .285, *p* = .75). The characteristics of the subjects in the three groups are presented in table 1.

Qualitative data collection in a clinical setting had practical constraints, since it is time-consuming. Therefore, only three groups of 14 participants were included into the qualitative analyses of the word protocols to determine the clustering and switching abilities according to the two-component model of Troyer et al. (1997) and modifications by Reverberi et al. (2006). These qualitative analyses can be regarded as a pilot experiment to assess whether qualitative features might be present in larger groups. In each of the three groups, 14 participants were randomly selected for this analysis of switching abilities. T-tests and χ2-analysis showed that the three subgroups were comparable in VCI, mean age, and gender distribution. All generated words were scored by the first author and by an independent rater. Interrater reliabilities, calculated by using Pearson correlation coefficients, were high for cluster size (r=.99, *n*=42, *p*=.00) and for number of switches (r=.99, *n*=42, *p*=.00).

5.3 Results

5.3.1 Differences in Verbal Fluency Between the Three Groups

Verbal fluency scores for the HFA group, the Asperger syndrome group and the control group were studied by means of a one-way between-group multivariate analysis of variance (MANOVA). The results showed that the main effect of diagnosis was statistically significant (*F* (8,172) = 2.34, *p* = .02, partial eta squared = .10). The effect-size can be interpreted as moderate according to the criteria of Cohen (1988). When the results for the dependent variables were considered separately, two of four verbal fluency scores were statistical significant: professions (*F* (2,89) = 8.58, *p* < .01, partial eta squared = .16) and the letter M (*F* (2,89) = 3.47, *p* = .03, partial eta squared = .07). The effect sizes reflect a large effect for professions and a moderate effect for the letter M, according to Cohen (1988). A trend towards an effect was found for animals (*F* (2,89) = 2.93, *p* = .06, partial eta squared = .06), with an effect size that can be interpreted as moderate (Cohen, 1988). Analysis of the letter K yielded no significant results (*F* (2,89) = 1.82, *p* = .16, partial eta squared = .04). To investigate which differences between the three diagnostic groups added to the main effects, post-hoc Tuckey comparisons were performed. The means and standard deviations of the various groups are presented in table 2.

Table 2

Semantic and Phonemic Fluency Differences in the Diagnostic Groups

	M	SD	M	SD	n
Semantic Fluency					
	Animals		Professions		
HFA	24.71	6.26	17.55	5.10	31
Asperger	26.52	7.23	20.16	5.22	31
Control group	28.70	5.71	23.57	6.64	30
Phonemic fluency					
	K		M		
HFA	14.97	4.17	13.00	4.22	31
Asperger	15.55	4.11	14.81	4.59	31
Control group	16.90	3.86	15.93	4.36	30

Analysis showed that the control group named more words in all verbal fluency tasks compared to the individuals with HFA and Asperger syndrome. The differences between the HFA and the control group in both semantic fluency tasks (animals: $p = .04$, professions $p < .01$) and the phonemic fluency task using the letter M ($p = .02$) were significant. The difference between the control group and the Asperger syndrome group was significant only for the semantic fluency task using professions ($p = .05$). Differences between HFA and Asperger syndrome were not significant for any of the fluency tasks. No interaction-effects were found between the two phonemic fluency tasks and the research group being either HFA or neurotypical ($p = .30$, partial eta squared = .02). Further, analysis showed no interaction effects between the two semantic fluency tasks and HFA versus the neurotypical group ($p = .15$, partial eta squared = .04).

Figure 1 and 2 illustrate the means and differences of the three research groups in the verbal fluency tasks.

Figure 1. Semantic fluency in the three research groups

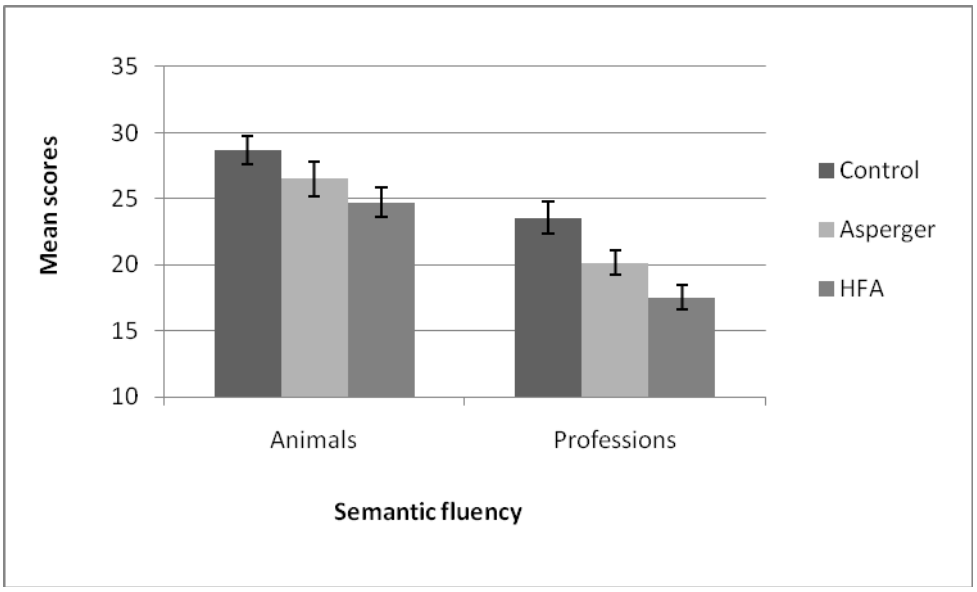
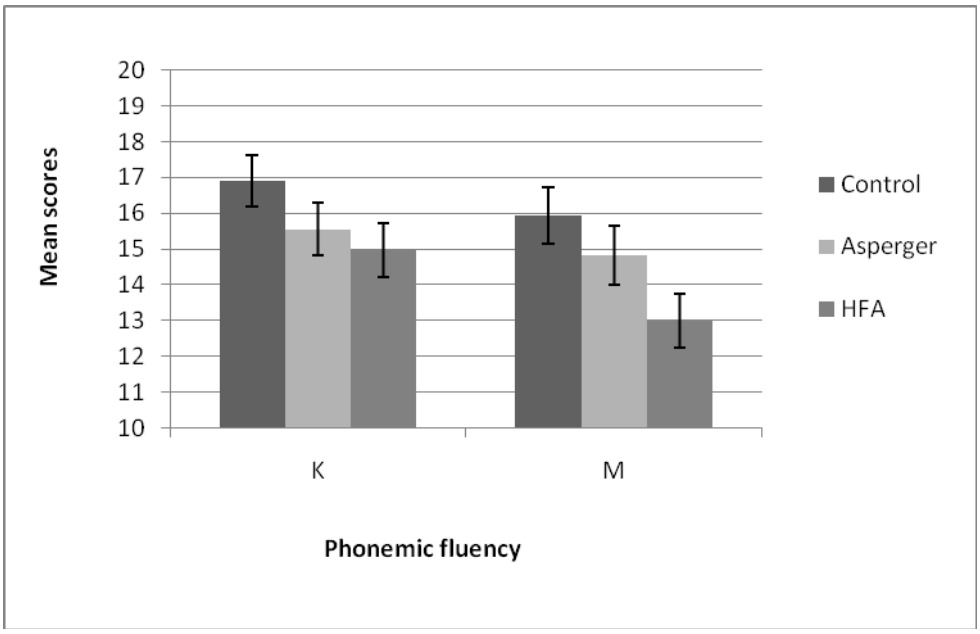


Figure 2. Semantic fluency in the three research groups



5.3.2 Processing Speed in the Three Groups

The differences in processing speed between the three groups were analyzed by means of a one way between-groups analysis of variance. The assumptions of homogeneity were met.

The mean score of the neurotypical group (M = 112.2, SD = 14.0) was higher than the mean scores of the Asperger syndrome group (M = 108.9, SD = 17.2) and the HFA group (M = 99.8, SD = 21.3). A significant main effect of diagnosis on processing speed was

found (F (2,89) = 4.01, p = .02). Post-hoc Tuckey comparisons showed that processing speed (p = .02) was significantly lower among the HFA subjects compared to the neurotypical subjects. The effect size can be described as moderate according to criteria of Cohen (1988) (partial eta squared = .08). No differences appeared between the HFA and the Asperger syndrome group or between the Asperger syndrome and the neurotypical group.

5.3.3 The Relationship Between Verbal Fluency Performance and Processing Speed

A one-way between-groups analysis of covariance was conducted to investigate whether the differences in verbal fluency between the three groups can be attributed to processing speed differences. After adjusting for the processing speed scores, there were no significant differences between the neurotypical and the HFA group on the semantic fluency task using animals (F (2,88) = 1.14, p = .32, partial eta squared = .03) or on the phonemic fluency task using the letter M (F (2,88) = 1.32, p = .27, partial eta squared = .03). The semantic fluency differences on the task using professions remained significant after adjusting for processing speed scores (F (2,88) = 6.23, p < .01, partial eta squared = .12).

5.3.4 The Use of Clustering and Switching in the Three Diagnostic Groups

In the three diagnostic groups word protocols were analyzed to determine the relative number of repeated words, the mean cluster size and the relative number of switches. Table 3 presents the results for semantic fluency, table 4 for phonemic fluency.

Table 3
Qualitative Analysis Semantic Fluency

Variable	Controls	Asperger	HFA	*p*
Relative number repeated words	0.00 (.00)	0.01 (.02)	0.00 (.01)	.53
Mean cluster size	2.60 (1.70)	2.29 (1.02)	2.22 (1.60)	.77
Relative number of switches	0.94 (.30)	0.97 (.21)	1.02 (.28)	.70

Table 4
Qualitative Analysis Phonemic Fluency

Variable	Controls	Asperger	HFA	*p*
Relative number repeated words	0.01 (.02)	0.01 (.01)	0.02 (.03)	.30
Mean cluster size	0.97 (1.05)	0.84 (.50)	0.94 (.57)	.89
Relative number of switches	1.44 (.35)	1.42 (.23)	1.42 (.23)	.99

To trace possible differences between the three diagnostic groups, between group analyses of variance were done with semantic fluency, respectively, phonemic fluency as the dependent variables. The assumptions of homogeneity and equality of variance were met. Therefore Wilks' Lambda was used to measure group differences. No differences between the three groups were found in the relative number of repeated words, mean cluster size or relative number of switches. No main effect of diagnosis was also found when the findings for the semantic and phonemic fluency were combined ($F(24,56)=.096$, $p = .53$). These findings suggest that no differences in switching and clustering abilities exist between the three diagnostic groups.

5.4 Discussion

5.4.1 Differences in Verbal Fluency Between the Three Groups

The present study compared verbal fluency performance in adults with HFA, Asperger syndrome and a matched neurotypical control group. The participants with HFA were impaired in their performance of semantic and phonemic fluency, in comparison to the neurotypical group. No significant differences appeared between the HFA and the Asperger syndrome group. The Asperger syndrome group exhibited impaired functioning in the semantic fluency task 'professions' compared to the neurotypical control group.

The verbal fluency impairment found in the HFA group of this study replicates for adults what Geurts and colleagues (2004) and Turner (1999) found for children with HFA. The participants with HFA had an average verbal comprehension index (VCI) of 112, which is defined by the WAIS-III scoring manual as above average ability (Wechsler, 2000). Since all groups were matched for VCI and age, differences in verbal fluency can not be attributed to verbal abilities or age. Our findings thus suggest a broadly based deficit in verbal fluency in individuals with HFA at all levels of functioning and age.

The results show no significant differences in number of generated words between the Asperger syndrome group and the HFA group in all verbal fluency tasks. The Asperger syndrome group differed significantly from the neurotypical group only in the semantic fluency tasks using professions. A careful look at the professions task reveals that this is the only verbal fluency task used in this study encompassing social elements. This may have negatively influenced the performance of the two disorder groups. The relatively unimpaired verbal fluency in the Asperger syndrome group may indicate that the executive impairment found in children with Asperger syndrome (Nyden et al., 1999; Ozonoff et al., 1991b) diminishes during lifetime. This hypothesis may have significant implications for the clinical practice. A decrease of executive impairment, possibly enhanced by treatment programs, can positively influence opportunities in work and education, which may improve outcome of individuals with Asperger syndrome.

5.4.2 The Relationship Between Verbal Fluency Performance and Processing Speed

The present findings indicate that processing speed is an important underling factor of verbal fluency performance in adults with HFA and Asperger syndrome, since the impairments on two of the three verbal fluency tasks can be attributed to processing speed differences between the three diagnostic groups. Similar results were found for individuals with Huntington's disease, schizophrenia and depression, in which the fluency deficits did not qualify as differential deficits relative to psychomotor speed (Henry & Crawford, 2005a, Henry & Crawford, 2005b, Henry et al., 2005). In the present study, only the impairment on the verbal fluency task using professions could not be attributed to differences in processing speed. As previously mentioned, the social constraints of this task may have influenced performance in the HFA and the Asperger syndrome group negatively.

5.4.3 Cluster-size and Switching

Both switching problems and a lack of use of strategy can be hypothesized for individuals with HFA and Asperger syndrome. Switching problems are expected to lead to long clusters and relatively few switches between clusters (Reverberi et al., 2006). A limited use of strategy is expected to lead to a small mean cluster size and to large numbers of switches (Reverberi et al., 2006). In this study, however, no differences in clustering and switching were found. When the relatively minor generation of words is taken into account, no differences appeared between the three diagnostic groups. Reverberi et al. (2006) state that a small number of words produced combined with normal clustering and switching can point to an isolated initiation and activation deficit and thus a relatively slow

word retrieval. This is in line with the relationship between speed of information processing and fluency performance that was found in the HFA group.

5.4.4 Conclusions

The present study identified deficits in individuals with HFA in two semantic fluency tasks and in the phonemic fluency task using the letter M. The Asperger syndrome group was only impaired in semantic fluency when professions were used, which may be due to the social constraints of this specific subtask. No impairments were found for the switching or clustering abilities of both disorder groups. The impairments on the semantic fluency tasks using animals and the phonemic fluency task using the letter M can be attributed to the relatively low processing speed of the HFA group. Apparently, adults with HFA and Asperger syndrome show normal use of strategies and have normal switching abilities compared to a neurotypical group. The virtually intact verbal fluency in the adult Asperger syndrome group of this study gives rise to the hypothesis that the deficits in executive functioning found in children with Asperger Syndrome reduce as children grow older and largely disappear during adulthood.

5.4.5 Limitations

In this study no statistical significant differences in clustering and switching abilities were found between the individuals in the three groups studied. However, this can be due to the limited power of our analysis, as this part of the study was based on relatively few individuals (Cohen, 1988). To settle this issue, further studies are needed with larger groups of neurotypical individuals and individuals with HFA and Asperger syndrome elaborating the role of these abilities in verbal fluency functioning more thoroughly. There is also a need for future research with larger samples to further investigate the underlying mechanisms of verbal fluency, particularly with regard to the role of processing speed in individuals with HFA and Asperger syndrome. Furthermore, longitudinal research is needed to test the hypothesis arisen in this study that impairment in executive functioning diminishes in adulthood in individuals with Asperger syndrome.

6 General Discussion and Conclusions

6.1 Introduction

This research project focussed on the relevance of the three leading cognitive theories characterizing ASD in adults with the autistic disorder or Asperger syndrome. To this end, we investigated their general intelligence, their intelligence profiles and their characteristics with respect to theory of mind, central coherence and executive functioning.

6.2 Main findings

6.2.1 Intelligence profiles

Our first aim was to assess the general cognitive ability of adults with the autistic disorder and Asperger syndrome and with an average to above-average intelligence. The WAIS-III was used to examine the intelligence profiles of these individuals. The results showed no differences in VIQ and PIQ between the two disorder groups. This discovery, combined with the recent finding that the VIQ-PIQ difference is not empirically valid (Arnou & Thompson, 2000; Ryan & Paolo, 2001) confirms the fact that these two scales cannot and should not be used in order to distinguish the autistic disorder from Asperger syndrome.

At the factor scale level of the WAIS-III, adults with the autistic disorder showed impairment in their processing speed, in contrast to the Asperger syndrome group and the neurotypical individuals. The slowness in processing and acting upon information also influenced their performance in some of the tasks that aimed to assess the three cognitive theories of autism. For example, the verbal fluency impairment and the weakness in the Embedded Figures Test in adults with the autistic disorder could be attributed mainly to the impairments in processing speed. Subsequently, in several of the WAIS-III subtests, a time limit is used and bonus points can be earned when less time is spent on resolving the items. It is likely that the impaired processing speed in the autistic disorder group influenced performance on these subtests negatively. Overall, it is important to acknowledge that the processing speed impairment in adults with the autistic disorder can influence performance in a broad array of cognitive tests. We hypothesized that the impaired processing speed may be due to a bottom-up information processing style, which is characteristic for ASD (Frith, 1989; Happé, 2005). In this style of processing information, the basic elements of a concept are first specified in great detail before linking them together to form larger subsystems. This is more time-consuming than top-down information processing, in which irrelevant details are ignored and the

focus is placed on relevant information (Frith, 1989, 2003, 2008; Happé, 2005; Shah & Frith, 1993).

6.2.2 Theory of Mind

The strengths of the disorder groups in the Comprehension subtest of the WAIS-III show that adults with ASD acquired relatively much knowledge about the rules and customs of society for how one should act in certain situations (For instance, one of the Comprehension subtest items is: what do you do if you find an envelope in the street that is sealed and addressed and has a new stamp?). Frith and Happé (1999) described this knowledge as an 'explicit' theory of mind. Apparently, adults with ASD train themselves to analyze social situations cognitively, which can lead to an above average knowledge of the rules in society in general. However, it remains difficult for individuals with ASD to react adequately in everyday social situations, as Frith et al. (1994) observed in a group of autistic children. Our third paper showed that this also applies to high-functioning adults with ASD. They exhibit a weakness in interpreting and acting upon subtle social situations as they occur on a daily basis, which has been described as advanced theory of mind (Happé, 1994). The emphasizing-systemizing account (Baron-Cohen, 2009) may be relevant in this respect. Systemizing strategies, in which underlying rules are identified in order to distinguish laws, may be helpful in distinguishing rules of society. However, these strategies may be less advantageous in social situations, since they are usually not (completely) lawful (Baron-Cohen, 2006). In real life social situations, empathizing strategies appear most effective. The tendency of individuals with ASD to use systemizing strategies has been hypothesized to influence performance in social situations negatively (Baron-Cohen, 2006, 2009).

In our study, impairment in advanced theory of mind was not only found for two of the three neuropsychological instruments that were used, it was also expressed in the self-reports. This suggests that the 'theory of mind' theory of autism is still relevant when individuals with ASD reach adulthood. Furthermore, the relationship between the self-reports and the neuropsychological instruments illustrated that high-functioning adults with ASD groups are, to a great extent, aware of their theory of mind impairment. Whereas previous research stressed the lack of insight in individuals with ASD (Frith & Happé, 1999, Hobson, 2005), a subgroup of the high-functioning adults with ASD is apparently conscious of their strengths and impairments.

6.2.3 Detailed information processing

We also examined detailed information processing in the two disorder groups and the neurotypical group. The self-reports strongly indicated a detailed information processing

style which characteristic for the ASD groups. However, no impairments were found for the neuropsychological instruments in this respect. To our surprise, the relationship between the neuropsychological instruments and the self-reports was only minimal or even nonexistent, not only for the disorder groups but also for the neurotypical group. Since it is not likely that neurotypical adults are entirely incapable of determining their information processing style, most evidence points to the validity of the self-reports in measuring detailed information processing. This would suggest that adults with ASD are more detail-prone. Our third paper also showed that our adult ASD groups are more inclined to use systemizing strategies compared to the neurotypical adults. Systemizing has been described as the drive to analyze variables in a system in order to identify underlying rules, which can be used to understand and predict the system. Therefore, the use of systemizing strategies may help individuals with ASD to maintain the overall picture in a world in which they tend to process more details than others do. Systemizing may be very helpful for individuals who use a bottom-up information processing style, because it presents a structured mode of interpreting the details in the environment. Our results thus suggest that the theory of a detailed information processing style in autism is still applicable in high-functioning adult ASD groups and that they develop strategies in order to handle this fragmented information processing style.

6.2.4 Executive functioning

In chapter five, executive functioning has been assessed by means of verbal fluency tasks. Impairment was found, mainly for individuals with the autistic disorder. However, based on the hypothesis of executive dysfunction in autism, we expected that problems with switching and using strategies would underlie the fluency impairment. To our surprise, this was not what we found. The verbal fluency impairment in the autistic disorder group could be attributed predominantly to the impaired processing speed that characterizes this specific group. Therefore, our results in verbal fluency do not point to impairment in executive functioning in high-functioning adults with ASD. This is in line with the lack of impairment in the WAIS-III factor scale ‘Freedom from distractibility’ for the two ASD groups. Performance in this factor scale has been thought to reflect working memory skills. Based on the hypothesis of executive deficits in ASD, impairment would be expected in the 'Freedom from distractibility' scale (Pennington & Ozonoff, 1996). Our findings demonstrate that impairment in executive functioning is less severe or at least more subtle in adults with ASD than we expected. This gives rise to the hypothesis that the theory of executive impairment is less central to autism than previously thought.

6.2.5 Autistic disorder versus Asperger syndrome

The results of our studies demonstrated differences between the autistic disorder and Asperger syndrome in processing speed, while similarities appeared in the three cognitive areas that characterize ASD. More research is needed to examine whether the slowness in processing information in the autistic disorder group is related to the three cognitive theories that describe ASD. In general, our results are in line with the recent observation that the autistic disorder and Asperger syndrome have too many features in common to justify a distinction between the two disorders (Volkmar & Klin, 2005).

6.3 Clinical implications

The results of the present studies can provide useful information about the strengths and weaknesses of adults with ASD in the following areas:

Our data showed that adults with the autistic disorder are impaired in their speed of processing information. This can strongly influence performance of daily-life tasks: Whereas it may often seem as if adults with the autistic disorder do not understand the information they receive from their environment, this may actually be due to their slowness in processing information. Adults with the autistic disorder will be able to use their qualities more adequately when they are given more time and when emphasis is put on perfection instead of working speed.

The results of our studies illustrated that self-reports can be a great help, not only in research but also in clinical practice. Self-reports can be valuable for examining strengths and needs, especially since the validity of neuropsychological instruments for assessing daily life skills is questionable (Chaytor et al., 2006). Moreover, self-reports are generally more specific in what they aim to measure, compared to neuropsychological instruments. Apparently, adults with ASD and a relatively high level of functioning and average to above average intelligence can have relatively good insight. For these individuals, their introspective ability can have a positive impact on opportunities in work and education. When people with ASD are able to recognize and express their strengths and needs, it will be easier for employers and teachers to match these needs and find employment and education programs that suit their cognitive abilities. This can enhance the employment prospects and the job satisfaction for individuals with ASD.

Another clinically relevant finding is that individuals with ASD report strengths in the area of detailed information processing and the tendency to use systemizing strategies. These strengths and preferences can lead educational and vocational opportunities. For instance in job placement it is important to be aware of the environmental and instructional conditions under which individuals with ASD can function

optimally. Considering the results of these studies, high-functioning adults with ASD may function best in a vocational or educational area in which there is little time pressure and social constraints are limited. Emphasis is put on perfection in a setting in which a systematic and detail-focussed approach is beneficial. In this respect, it is not surprising that previous studies list administrative, computer and technical professions as suitable for high-functioning adults with ASD (Howlin et al., 2005).

6.4 Limitations and implications for future research

The present research project was undertaken with adults with average to high verbal abilities. Therefore, our results cannot be generalized to ASD populations with below average verbal abilities. This emphasizes the importance of examining similar cognitive features in adults with ASD and a below average intellectual ability.

Secondly, although the research groups were carefully selected and all participants had at least average verbal ability, deficiencies in semantic processing which are characteristic for individuals with ASD may have influenced performance, mainly in the self-reports. Furthermore, the lack of insight that has been associated with ASD (Frith & Happé, 1999, Hobson, 2005) also warrants caution with the clinical use of self-reports. Therefore, the self-reports should, when possible, be used together with anamnestic and hetero-anamnestic information when investigating the strengths and impairments that characterize ASD.

Third, although our results did not point to impairment in executive functioning in the two disorder groups, we only examined verbal fluency and working memory. There is evidence that high-functioning adults with ASD show impairment in the Wisconsin Card Sorting Task (Rumsey & Hamburger, 1988) and the 'shift' task of the CANTAB (Ozonoff et al., 2004), which has been attributed to impairments in cognitive flexibility. It is possible that impairment in executive functioning is present in adults with ASD, but only subtle and restricted to certain areas. Further research is necessary to examine more thoroughly whether the theory of executive dysfunction is still relevant for high-functioning adults with ASD.

Finally, a proportion of our ASD individuals was diagnosed in adulthood. A late diagnosis has been hypothesized to be related to milder symptoms (Vermeulen, 2002). Although all individuals matched the diagnostic criteria for the autistic disorder or Asperger syndrome, the characteristics of our group may be somewhat different compared to an adult group in which all individuals were diagnosed at a young age. Therefore, we need to be careful about generalizing our results to all adults with ASD. Further research on adult groups,

specifically those in which all individuals have been diagnosed early in life, may shed more light on this.

Nederlandstalige samenvatting

Autisme is een ontwikkelingsstoornis, waarvan de symptomen zich in de kindertijd voor het eerst manifesteren en gedurende het gehele leven in verschillende vormen aanwezig blijven. Autismespectrumstoornissen (ASS) kunnen worden beschreven op neurobiologisch, cognitief en gedragsniveau (Frith, 2003; Happé & Frith, 1996). Op neurobiologisch niveau hebben tweelingstudies en familiestudies aangetoond dat autisme voor 90 % erfelijk bepaald is (Rutter, 2005). Het is echter nog niet bekend welke genen of welke combinatie(s) van genen precies aan autisme ten grondslag liggen. Het stellen van een diagnose binnen het autismespectrum vindt tot nu toe daarom plaats aan de hand van gedragssymptomen. Het DSM-IV classificatiesysteem hanteert in dit verband als gedragscriteria: kwalitatieve beperkingen in de sociale interacties en in de communicatieve vaardigheden en de aanwezigheid van stereotiepe patronen van gedrag, belangstellingen en activiteiten (APA, 2000).

Bij autisme zijn er, naast gedragssymptomen, ook specifieke cognitieve kenmerken. Aan de hand van deze kenmerken wordt getracht om enerzijds het gedrag van mensen met autisme te verklaren en anderzijds aanwijzingen te vinden voor mogelijke disfuncties in het brein. De drie meest toonaangevende cognitieve theorieën op het gebied van autisme beschrijven beperkingen in de theory of mind (Baron-Cohen, 2000), de centrale coherentie (Frith, 1989, 2003) en in de executieve functies (Ozonoff et al., 2005). Deze cognitieve theorieën zijn met name ontleend aan studies bij kinderen en adolescenten met ASS. Onderzoek laat echter zien dat bepaalde symptomen van ASS verminderen of veranderen gedurende de levensloop (Howlin, 2005; Seltzer et al., 2009). Naar analogie hiermee zouden bij mensen met ASS ook de cognitieve kenmerken tijdens de levensloop kunnen veranderen. Er is echter slechts een beperkt aantal studies voor handen, waarin de cognitieve kenmerken van volwassenen met ASS zijn onderzocht. Daarnaast zijn de gepubliceerde uitkomsten met elkaar in tegenspraak.

Dit roept de vraag op in hoeverre de drie cognitieve theorieën relevant zijn voor volwassenen met ASS. Het is mogelijk dat op bepaalde cognitieve gebieden sprake is van een vertraging in de ontwikkeling in plaats van een defect of onvermogen. In zo'n geval zou er niet langer gesproken kunnen worden van *pervasieve* kenmerken, hetgeen een fundamentele wijziging zou inhouden van de opvattingen over ASS.

Het onderhavige proefschrift beoogt aan deze discussie een bijdrage te leveren door de relevantie van de drie cognitieve theorieën voor volwassenen met hoog functionerend autisme (HFA) en met de stoornis van Asperger nader te onderzoeken. In dit verband is

eerst het algemeen cognitief functioneren van deze groepen personen in beeld gebracht, waarna vervolgens de specifieke kenmerken op het gebied van de theory of mind, de centrale coherentie en de executive functies zijn beschreven en geanalyseerd. De volwassenen met HFA en de stoornis van Asperger werden daartoe vergeleken met een gematchte neurotypische controlegroep.

In hoofdstuk 2 van dit proefschrift wordt een studie behandeld waarin de intelligentie-profielen van volwassenen met HFA zijn vergeleken met die van volwassenen met de stoornis van Asperger. De onderzoeksresultaten laten zien dat er geen significante verschillen zijn in performaal IQ (PIQ) en verbaal IQ (VIQ) tussen beide onderzoeksgroepen. In tegenstelling tot eerdere onderzoeken blijkt er geen sprake te zijn van een kenmerkend VIQ-PIQ profiel bij de autistische stoornis (HFA), noch bij de stoornis van Asperger. Dit sluit aan bij ander onderzoek waarin eveneens naar voren kwam dat VIQ en PIQ als constructen onvoldoende valide en betrouwbaar zijn om uitspraken op te baseren (Arnau & Thompson, 2000; Taub, 2001; Watkins e.a., 2004). Op het niveau van de factor schalen van de gebruikte IQ-test komt naar voren dat de volwassenen met HFA, in tegenstelling tot de participanten met de stoornis van Asperger, significant laag scoren op de schaal ‘verwerkingssnelheid’. Dit betekent dat volwassenen met HFA relatief veel tijd nodig hebben voor het proces van verwerken en reageren op informatie. Dit kan samen hangen met de zogenaamde ‘bottom-up’ denk- en werkstrategie, die kenmerkend is voor autisme. Opvallend is dat er in beide onderzoeksgroepen geen beperkingen worden geconstateerd in de verbale en perceptuele capaciteiten, noch in het werkgeheugen. Op subtestniveau worden diverse verhoogde en verlaagde scores geconstateerd. De relatief hoge score bij de subtest ‘Informatie’ geeft aan dat de feitenkennis sterk ontwikkeld is bij volwassenen met HFA. Ook wordt geconstateerd dat de participanten met de stoornis van Asperger relatief hoog scoren op de subtest ‘begrijpen’. Dit is een bijzondere bevinding, aangezien bij kinderen met ASS tegengestelde resultaten zijn gerapporteerd (Klin et al., 2005b; Mayes & Calhoun, 2003; Siegel et al., 1996). De hoge score binnen het huidig onderzoek lijkt toe te schrijven aan een sterk ontwikkelde ‘expliciete’ theory of mind (Frith & Happé, 1999). Dit wordt omschreven als een vorm van sociaal inzicht, die is gebaseerd op het beredeneren van sociale situaties in plaats van het inschatten op basis van gevoel. Deze expliciete theory of mind lijkt gedurende de levensloop steeds meer tot ontwikkeling te komen.

Hoofdstuk 3 behandelt een studie waarin de theory of mind is onderzocht bij volwassenen met HFA en volwassenen met de stoornis van Asperger. Om te bepalen of er sprake is van beperkingen op dit gebied zijn beide groepen vergeleken met een gematchte neurotypische controlegroep. Eerder onderzoek heeft laten zien dat

volwassenen met ASS door hun expliciete theory of mind relatief goed presteren op theory of mind gerelateerde taken (Baron-Cohen, 2000, Bowler, 1992; Happé, 1994; Ozonoff et al., 1991a). Echter, dagelijkse sociale situaties zijn doorgaans vele malen complexer dan middels neuropsychologische taken nagebootst kan worden. Dit roept de vraag op of met neuropsychologische taken een adequate inschatting gemaakt kan worden van de theory of mind. Dit wordt geïllustreerd aan de hand van de bevindingen in deze studie. Zo werd bij de lees-de-ogen test geconstateerd dat volwassenen met ASS en de neurotypische controlegroep gelijk presteerden op deze taak. Verder bleken de correlaties van deze taak met alle andere theory of mind gerelateerde taken laag te zijn. Deze uitslagen duiden erop dat de lees-de-ogen-test onvoldoende valide is om de theory of mind in beeld te brengen. De faux-pas test en de strange-stories test lijken betere perspectieven te bieden om de theory of mind te onderzoeken bij relatief intelligente volwassenen met ASS. Bij deze taken worden sociale situaties weergegeven die ook in de dagelijkse praktijk voor kunnen komen. Aldus wordt de complexiteit van het dagelijks leven nagebootst. De onderhavige studie wijst uit dat volwassenen met HFA en de stoornis van Asperger bij deze taken zwakker presteren dan de neurotypische controlegroep. Wanneer gebruik gemaakt wordt van zelfrapportage van sociale problemen komt er echter een aanzienlijk groter verschil naar voren tussen de volwassenen met een autismespectrumstoornis en de neurotypische controlegroep. Dit doet vermoeden dat ook de subtielere neuropsychologische theory of mind gerelateerde taken niet in staat zijn om de theory of mind problemen in hun volle omvang weer te geven. Dit sluit aan bij recent onderzoek waarin de ecologische validiteit van neuropsychologische taken in het algemeen in twijfel wordt getrokken (Chaytor et al., 2006).

In hoofdstuk 4 is onderzocht in hoeverre volwassenen met HFA en de stoornis van Asperger gericht zijn op details en of zij detail-informatie beter en sneller verwerken dan een neurotypische controlegroep. Hierbij is gebruik gemaakt van neuropsychologische testinstrumenten en van zelfrapportages. Uit de resultaten van de neuropsychologische testinstrumenten blijkt, in tegenstelling tot de verwachting, niet dat volwassenen met ASS meer op details gericht zijn dan de neurotypische controlegroep. De zelfrapportage wijst daarentegen wel op een grotere gerichtheid op details en op een sterkere neiging tot systematiseren van informatie bij de volwassenen met ASS. De correlatie tussen de prestaties bij de neuropsychologische taken en de uitkomsten van de zelfrapportage blijkt zeer gering en in sommige gevallen zelfs verwaarloosbaar. Dit lijkt erop te duiden dat beide soorten instrumenten een verschillend onderliggend construct meten. In dit hoofdstuk wordt de hypothese opgesteld dat zelfrapportage instrumenten

een adequatere inschatting geven van detailgerichtheid dan neuropsychologische instrumenten. Dit wordt gebaseerd op de volgende twee argumenten:

1. De gebruikte neuropsychologische testen zijn niet ontwikkeld om detailgerichtheid te meten, maar zijn bedoeld om andere neuropsychologische aspecten in kaart te brengen, zoals non-verbaal redeneren en visueel-motorische coördinatie (Happé & Frith, 2006; Lezak et al., 2004; Wechsler, 1997; Witkin et al., 1962; Witkin et al., 1971), dit in tegenstelling tot de zelfrapportage vragenlijsten.
2. Nadere analyses laten zien dat ook bij de neurotypische groep de twee soorten instrumenten nauwelijks aan elkaar gecorreleerd zijn. Het is echter niet waarschijnlijk dat zich normaal ontwikkelende personen niet in staat zouden zijn om aan te kunnen geven in welke mate zij gedetailleerd denken en handelen.

In dit hoofdstuk wordt als meest aannemelijke hypothese gesteld dat volwassenen met HFA en de stoornis van Asperger meer gericht zijn op details en meer geneigd zijn om bij verwerking van informatie onderliggende systemen te gebruiken. Deze neiging om informatie te systematiseren lijkt voort te komen vanuit de behoefte om de detailinformatie te ordenen en structureren om zo toch tot een overzicht te komen. Op deze wijze kunnen zij ‘systemen voorspellen’, waardoor zij het overzicht op de details die zij waarnemen niet, of in mindere mate verliezen.

Hoofdstuk 5 behandelt een onderzoek naar verbale fluency bij volwassenen met HFA en de stoornis van Asperger. In vergelijking met een neurotypische controlegroep presteren volwassenen met HFA significant zwakker op drie van de vier gebruikte verbale fluency taken. De volwassenen met de stoornis van Asperger vallen uit bij slechts één van de vier taken; die waarbij binnen een minuut zoveel mogelijk beroepen bedacht en genoemd moeten worden. Dit is echter de enige van de vier fluency taken waarbij sociale aspecten een rol spelen. Namelijk bij het bedenken van beroepen zullen de meeste mensen refereren aan beroepen vanuit de eigen werkplek of van mensen in hun sociale netwerk. Wanneer dit netwerk klein is en/of wanneer men zelf geen baan heeft, zoals bij veel mensen met ASS het geval is, dan is het moeilijker om beroepen te bedenken. Het is aannemelijk dat dit de prestaties van de volwassenen met ASS op deze taken negatief heeft beïnvloed.

De relatief zwakke prestaties van de volwassenen met HFA op de andere twee fluency taken blijkt herleid te kunnen worden tot de relatief trage verwerkingssnelheid, hetgeen kenmerkend is voor deze groep. Om te bepalen of problemen in de executieve functies mede ten grondslag liggen aan de gevonden beperkingen in de verbale fluency van de volwassenen met HFA werd een kwalitatieve analyse verricht. Hierbij is het aantal gebruikte strategieën en het aantal wisselingen van strategie onderzocht. Op deze gebieden blijken er geen verschillen te bestaan tussen de volwassenen met ASS en de

neurotypische controlegroep. Dit betekent dat de relatief zwakke prestaties op de fluency taken niet toegeschreven kunnen worden aan beperkingen in de executieve functies, maar aan de relatief trage verwerkingssnelheid van de volwassenen met HFA en aan de beperkingen in het sociale gedrag zoals kenmerkend voor ASS.

In hoofdstuk 6 worden de bevindingen van de voorgaande hoofdstukken besproken en bediscussieerd. In de verschillende studies is onderzocht of de drie theorieën die de cognitie van mensen met ASS beschrijven ook relevant zijn bij volwassenen met ASS.

De studies laten zien dat er duidelijk sprake is van beperkingen op het gebied van de theory of mind. Met name de zelfrapportage wijst uit dat er op dit gebied forse beperkingen zijn. Ook zijn er sterke aanwijzingen dat volwassenen met HFA of de stoornis van Asperger in vergelijking met een neurotypische controlegroep meer gericht zijn op details en meer geneigd zijn om bij de verwerking van informatie gebruik te maken van achterliggende systemen . Er zijn echter geen aanwijzingen gevonden voor beperkingen in de executieve functies; de gevonden beperkingen in de verbale fluency blijken voornamelijk toegeschreven te kunnen worden aan de trage informatieverwerking. Ook bij de WAIS-III factorschaal ‘werkgeheugen’, welke ook geschaard kan worden onder de executieve functies (Pennington & Ozonoff, 1996), zijn geen afwijkingen geconstateerd. Het is mogelijk dat de beperkingen in de executieve functies zich alleen voordoen op deelgebieden, zoals de cognitieve flexibiliteit. Op basis van de huidige studies kan echter gesteld worden dat de voor autisme kenmerkende beperkingen in de executieve functies in de volwassenheid minder relevant lijken te zijn dan bij kinderen met ASS. Dit leidt tot de overweging dat de theorie van de stoornis in de executieve functies wellicht minder centraal is bij ASS dan eerder is aangenomen.

De resultaten van de verschillende studies zijn ook relevant voor de klinische praktijk.

De trage informatieverwerking bij de volwassenen met HFA zal voor veel van hen van invloed zijn op het dagelijks functioneren en is daarnaast relevant voor het functioneren in opleidings- en werksituaties. Het trage werktempo kan er bijvoorbeeld toe leiden dat mensen met HFA onderschat worden in hun cognitieve vermogens. Bij achterblijvende prestaties is het daarom belangrijk om te onderzoeken of dit (mede) veroorzaakt wordt door een traag tempo. In dergelijke gevallen is het aan te bevelen om de persoon meer tijd te geven, waardoor deze meer gebruik kan maken van zijn of haar kwaliteiten.

Het is ook van belang om te onderkennen dat de trage informatieverwerking kan leiden tot relatief zwakke prestaties bij neuropsychologische taken die andere functies in kaart

beogen te brengen. Hierdoor bestaat het risico dat verkeerde conclusies worden getrokken.

Verder zijn ook de resultaten met betrekking tot de zelf-rapportage vragenlijsten relevant voor de klinische praktijk. Gedurende lange tijd is gedacht dat mensen met ASS nauwelijks beschikten over zelfinzicht. Echter, bij volwassenen met een (boven)gemiddelde intelligentie blijkt het inzicht in de symptomen van de stoornis relatief goed ontwikkeld. Het kunnen herkennen van de eigen kwaliteiten en valkuilen kan de kans op slagen in een opleiding en/of werksituatie vergroten. Dit kan een positieve bijdrage leveren aan de zelfstandigheid van volwassenen met ASS. Vanuit het onderhavige onderzoek wordt dan ook aanbevolen om zelfrapportage instrumenten te gebruiken bij het diagnostisch onderzoek bij volwassenen met ASS. Niet alleen om de symptomen van ASS in kaart te brengen, maar ook om het zelfinzicht te onderzoeken.

Verder komt in onderhavig onderzoek naar voren dat volwassenen met ASS in sterke mate gericht zijn op detailinformatie en dat zij de neiging hebben om informatie te systematiseren. Dit zijn kwaliteiten die van toegevoegde waarde kunnen zijn bij bepaalde opleidingen en functies. De kwaliteiten van mensen met ASS lijken met name tot uiting te komen bij werkzaamheden waarbij zorgvuldigheid van belang is en waarbij op een gestructureerde, systematische manier gewerkt moet worden. Hierbij is het wel van belang dat de taak duidelijk omschreven is en er rekening gehouden wordt met het werktempo van de persoon in kwestie.

Het onderhavige onderzoek kent ook beperkingen. Alle volwassenen met ASS die zijn onderzocht hebben gemiddelde tot hoge intellectuele en verbale capaciteiten. De resultaten van de studies kunnen dus niet gegeneraliseerd worden naar een populatie met een beneden gemiddelde intelligentie. Verder kunnen we niet uitsluiten dat een gebrekkig zelfinzicht de resultaten van de zelfrapportage vragenlijsten heeft beïnvloed, ondanks de matching van de onderzoeksgroepen op verbaal begrip.
Ook moet vermeld worden dat wat de executieve functies betreft alleen gekeken is naar verbale fluency en het werkgeheugen. Om meer algemene uitspraken te doen over het executief functioneren bij volwassenen met ASS is het van belang om ook andere aspecten van executieve functies te onderzoeken zoals bijvoorbeeld de cognitieve flexibiliteit.

References

American Psychiatric Association. (1994). *Diagnostische Criteria van de DSM-IV.* Lisse: Swets & Zeitlinger.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders (4th ed.), text revision.* Washington, DC: American Psychiatric Association.

Arnou, R.C., & Thompson, B. (2000). Second Order Confirmatory Factor Analysis of the WAIS-III Assessment, 7 (3), 237-246.

Baron-Cohen, S. (2000). Theory of mind and autism: a fifteen year review. In S. Baron-Cohen, H. Tager-Flusberg, & D.J. Cohen (Ed.) *Understanding other minds. Perspectives from developmental cognitive neuroscience* (pp. 3-21). Oxford: University Press.

Baron-Cohen, S. (2006). The hyper-systemizing, assortative mating theory of autism. *Progress in Neuro-Pharmacology and Biological Psychiatry,* 30, 865-872.

Baron-Cohen, S. (2009). Autism: the empathizing-systemizing (E-S) theory. *Annals of the New York Academy of Sciences,* 1156, 68-80.

Baron-Cohen, S., Jolliffe, T., Mortimore, C., & Robertson, M. (1997a). Another advanced test of theory of mind: evidence from very high functioning adults with autism or Asperger Syndrome. *Journal of Child Psychology and Psychiatry,* 38, 813-822.

Baron-Cohen, S., Leslie, A.M., & Frith, U. (1985). Does the autistic child have a theory of mind? *Cognition*, 21, 37-46.

Baron-Cohen, S., O'Riordan, M., Jones, R., Stone, V.E., & Plaisted, K. (1999). A new test of social sensitivity. Detection of faux-pas in normal children and children with Asperger syndrome. *Journal of Autism and Developmental Disorders,* 29, 407-418.

Baron-Cohen, S., Richler, J., Bisarya, D., Gurunathan, N., & Wheelwright, S. (2003). The systemizing quotient: an investigation of adults with Asperger syndrome or high-functioning autism, and normal sex differences. *Philosophical Transactions of the Royal Society, Series B, Special issue on "Autism: Mind and Brain",* 358, 361-174.

Baron-Cohen, S., & Wheelwright, S. (2004). The empathy quotient: An investigation of adults with Asperger syndrome or high functioning autism, and normal sex differences. *Journal of Autism and Developmental Disorders,* 34 (2), 163-175.

Baron-Cohen, S., Wheelwright, S., Griffin, R., Lawson, J., & Hill, J. (2002). The exact

mind: Empathizing and systemizing in autism spectrum conditions. In U. Goswami (Ed), *Handbook of cognitive development.* pp. 491-508. Malden, M.A., USA: Blackwell Publishers.

Baron-Cohen, S., Wheelwright, S., & Jolliffe, T. (1997b). Is there a "language of the eyes"? Evidence from normal adults and adults with autism or Asperger syndrome. *Visual Cognition*, 4, 311-331.

Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y., & Plumb, I. (2001a). The 'Reading the mind in the eyes' test Revised Version: A study with normal adults, and adults with Asperger syndrome or High-Functioning autism. *Journal of Child Psychology and Psychiatry,* 42, 241-252.

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubley, E. (2001b). The Autism-spectrum quotient (AQ): Evidence from Asperger syndrome / high functioning Autism, males and females, scientists and mathematicians. *Journal of Autism and Developmental Disorders,* 31, 5-17.

Benton, A. L. (1968). Differential behavioral effects in frontal lobe disease. Neuropsychologia, 6, 53-60.

Blackshaw, A.J., Kinderman, P., Hare, D.J., & Hatton, C. (2001). Theory of mind, causal attribution and paranoia in Asperger syndrome. *Autism,* 5 (2), 147-163.

Bora, E., Gökçen, S., & Veznedaroglu, B. (2008). Empathic abilities in people with schizophrenia. *Psychiatry Research,* 160, 23-29.

Boucher, J. (1988). Word fluency in high-functioning autistic children. *Journal of Autism and Developmental Disorders*, 18, 637-645.

Bowler, D.M. (1992). Theory of mind in Asperger Syndrome. *Journal of Child Psychology and Psychiatry,* 33, 877-895.

Calhoun, S.L., & Mayes, S.D. (2005). Processing Speed in Children with Clinical Disorders. *Psychology in the Schools*, 42 (4), 333-343.

Chaytor, N., Schimitter-Edgecombe, M., & Burr, R. (2006). Improving the ecological validity of executive functioning assessment. *Archives of Clinical Neuropsychology,* 21, 217-227.

Cohen, J. (1988). *Statistical power analysis for the behavioural sciences.* Hillsdale, NJ: Erlbaum.

Crawford, J.R., Moore, J.W., & Cameron, I.M. (1992). Verbal fluency: A NART-based equation for the estimation of premorbid performance. *British Journal of Clinical Psychology*, 31, 327-329.

Crawford, J.R., Obonsawin, M.C., & Bremner, M. (1993). Frontal lobe impairment in schizophrenia: Relationship to intellectual functioning. *Psychological Medicine*, 23, 787-790.

Dahlgren, O., & Trillingsgaard, A. (1996). Theory of mind in non-retarded children with autism and Asperger's syndrome. A research note. *Journal of Child Psychology and Psychiatry,* 37 (6) 759-763.

Ekman, P., & Friesen, W.V. (1969). The repertoire of nonverbal behavior: categories, origins, usage and coding. *Semiotica*, 1, 49-98.

Fawcett, T. (2006). An introduction to ROC analysis. *Pattern Recognition Letters,* 27, 861-874.

Field, A. (2005). *Discovering Statistics Using SPSS*. London: Sage.

Frith, U. (1989). Explaining the Enigma. Oxford: Blackwell Publishing.

Frith, U. (1991). Asperger and his syndrome. In U. Frith (Eds.) *Autism and Asperger Syndrome.* Cambridge: University Press, 1-36.

Frith, U. (1994). Wechsler IQ profile and theory of mind: A research note. *Journal of Child Psychology and Psychiatry,* 35, 1461-1471.

Frith, U. (2003). Autism. Explaining the Enigma. Oxford: Blackwell Publishing.

Frith, U. (2004). Emanuel Miller lecture: confusions and controversies about Asperger syndrome. *Journal of Child Psychology and Psychiatry,* 45 (4), 672.

Frith, U. (2008). *Autism: A Very Short Introduction to Autism.* Oxford: Oxford University Press.

Frith, U., & Happé, F. (1999). Theory of mind and self-consciousness: What is it like to be autistic? *Mind and Language*, 14 (1), 1-22.

Frith, U., Happé, F., & Siddons, F. (1994). Autism and theory of mind in everyday life. *Social* Development, 3, 108-124.

Geurts, H.M., Verté, S., Oosterlaan, J., Roeyers, H., & Sergeant, J.A. (2004). How specific are executive functioning deficits in attention hyperactivity disorder and autism? *Journal of Child Psychology and Psychiatry*, 45, 836-854.

Ghaziuddin, M., Tsai, L.Y., & Ghaziuddin, N. (1992). A comparison of the diagnostic criteria for Asperger syndrome. *Journal of Autism and Developmental Syndromes*, 22, 634-639.

Gillberg, C. (1998). Asperger syndrome and high-functioning autism. *British Journal of Psychiatry*, 172, 200-209.

Gillberg, I.C., & Gillberg, C. (1989). Asperger syndrome – some epidemiological considerations: a research note. *Journal of Child Psychology and Psychiatry*, 30, 631-638.

Goldenfield, N., Baron-Cohen, S., & Wheelwright, S. (2005). Empathizing and systemizing in males, females and autism. *Clinical Neuropsychiatry*, 2 (6), 338-345.

Goldstein, G., Beers, S.R., Siegel, D.J., & Minshew, N.J. (2001). A Comparison of WAIS-

R Profiles in Adults With High-Functioning Autism or Differing Subtypes of Learning Disability. *Applied Neuropsychology,* 8 (3), 148-154.

Gregory, R. J. (2007). *Psychological testing. History, principles and applications.* London: Pearson Education, Inc.

Happé, F. (1991). The autobiographical writings of three Asperger syndrome adults: Problems of interpretation and implications for theory. In: U. Frith (Ed.), *Autism and Asperger syndrome.* New York: Cambridge University Press.

Happé, F. (1994). An advanced test of theory of mind: understanding of story character thoughts and feelings by able autistic, mentally handicapped, and normal children and adults. *Journal of Autism and Developmental Disorders,* 24, 129-154.

Happé, F.G.E. (1999). Autism: cognitive deficit or cognitive style? *Trends in Cognitive Sciences*, 6 (3), 216-222.

Happé, F.G.E. (2005). The weak central coherence account of autism. In: F.R. Volkmar, P. Rhea, A. Klin & D. Cohen (Eds.). *Handbook of Autism and Pervasive Developmental Disorders* 772-798. New Jersey: John Wiley & Sons.

Happé, F., & Frith, U. (1996). The Neuropsychology of Autism. *Brain,* 119, 1377-1400.

Happé, F., & Frith, U. (2006). The weak central coherence account: Detail-focused cognitive style in autism spectrum disorders. *Journal of Autism and Developmental Disorders,* 36 (1), 5-25.

Happé, F., Winner, E., & Brownell, H. (1998). The getting of wisdom: Theory of mind in old age. *Developmental Psychology,* 34, 358-362.

Henry, J.D., & Crawford, J.R. (2004). A meta-analytic review of verbal fluency performance following focal cortical lesions. *Neuropsychology*, 18, 284-295.

Henry, J.D., & Crawford, J.R. (2005a). A meta-analytic review of verbal fluency deficits in depression. *Journal of Clinical and Experimental Neuropsychology*, 27, 1-24.

Henry, J.D., & Crawford, J.R. (2005b). A meta-analytic review of verbal fluency deficits in schizophrenia relative to other neurocognitive deficits. *Cognitive Neuropsychiatry*, 10, 1-33.

Henry, J.D., Crawford, J.R., & Philips, L.H. (2005). A meta-analytic review of verbal fluency deficits in Huntington's disease. *Neuropsychology,* 19(2), 243-252.

Hill, E. L. (2004). Evaluating the theory of executive dysfunction in autism. *Developmental Review*, 24, 189-233.

Hobson, P. (2005). Autism and emotion. In F.R. Volkmar, P. Rhea, A. Klin & D. Cohen (Ed.), *Handbook of Autism and Pervasive Developmental Disorders* (pp. 406-422). New Jersey: John Wiley & Sons.

Hoekstra, R.A., Bartels, M., Cath, D.C., & Boomsma, D.I. (2008). Factor structure,

reliability and criterion validity of the Autism-spectrum Quotient (AQ): a study in Dutch population and patient groups. *Journal of Autism and Developmental Disorders,* 38 (8), 1555-1566.

Howlin, P. (2005). Outcomes in autism spectrum disorders. In F.R. Volkmar, R. Paul, A. Klin & D. Cohen (Eds.) *Handbook of Autism and Pervasive Developmental Disorders* (pp. 201-220). New Jersey: John Wiley & Sons.

Howlin, P., Alcock, J., & Burking, C. (2005). An 8 year follow-up of a specialist supported employment service for high-ability adults with autism or Asperger syndrome. *Autism*, 9, 533-549.

Howlin, P., Goode, S., Hutton, J., & Rutter, M. (2004). Adult outcome for children with autism. *Journal of Child Psychology and Psychiatry*, 45 (2), 212-229.

Jolliffe, T., & Baron-Cohen, S. (1997). Are people with autism and Asperger syndrome faster than normal on the Embedded Figures Test? *Journal of Child Psychology and Psychiatry,* 38, 527-534.

Jolliffe, T., & Baron-Cohen, S. (1999). The Strange Stories Test: A replication with high-functioning adults with autism or Asperger syndrome. *Journal of Autism and Developmental Disorders,* 29, 395-406.

Kaland, N., Moller-Nielsen, A., Callesen, K., Mortensen, E.L., Gottlieb, D., & Smith, L. (2002). A new 'advanced' test of theory of mind: evidence from children and adolescents with Asperger syndrome. *Journal of Child Psychology and Psychiatry,* 43 (4), 517-528.

Kaland, N., Mortensen, E.L., & Smith, L. (2007). Disembedding performance in children and adolescents with Asperger syndrome or high-functioning autism. *Autism*, 11(1), 81-92.

Klin, A., McPartland, J., & Volkmar, F.R. (2005a). Asperger syndrome. In F.R. Volkmar, P. Rhea, A. Klin & D. Cohen (Ed.), *Handbook of Autism and Pervasive Developmental Disorders* (pp. 88-125). New Jersey: John Wiley & Sons.

Klin, A., Saulnier, C., Tsatsanis, K., & Volkmar, F. (2005b). Clinical Evaluation in Autism Spectrum Disorders: Psychological Assessment within a Transdisciplinary Framework. In: F.R. Volkmar, P. Rhea, A. Klin & D. Cohen (Eds.). *Handbook of Autism and Pervasive Developmental Disorders* 772-798. New Jersey: John Wiley & Sons.

Lawrence, E.J., Shaw, P., Baker, D., Baron-Cohen, S., & David, A.S. (2004). Measuring empathy: reliability and validity of the Empathy Quotient. *Psychological Medicine*, 34, 911-924.

Leekam, S., Libby, S., Wing, L., Gould, J., & Gillberg, C. (2000). Comparison of ICD-10 and Gillberg's criteria for Asperger syndrome. *Autism*, 4, 11-28.

Leslie, A.M. (1987). Pretence and representation: The origins of "Theory of mind". *Psychological Review,* 94, 412-426.

Lezak, M.D., Howieson, D.B., & Loring, D.W. (2004). *Neuropsychological assessment, fourth edition.* Oxford: University Press.

Lincoln, A.J., Allen, M.H., & Kilman, A. (1995). The assessment and interpretation of intellectual abilities in people with autism. In: E. Schopler & G.B. Mesibov (Eds.). *Learning and Cognition in Autism* 89-117. New York: Plenum Press.

Lopez, B.R., Lincoln, A.J., Ozonoff, S., & Lai, Z. (2005). Examining the relationship between executive functions and restricted, repetitive symptoms of the autistic disorder. *Journal of Autism and Developmental Disorders,* 35, 445-460.

Lord, C., & Corsello, C. (2005). Diagnostic instruments in autistic spectrum disorders. In F.R. Volkmar, P. Rhea, A. Klin & D. Cohen (Ed.), *Handbook of Autism and Pervasive Developmental Disorders* (pp. 730-771). New Jersey: John Wiley & Sons.

Lord, C., Risi, S., Lambrecht, L., Cook, E.H., Leventhal, B.L., DiLavore, P.C., et al. (2000). The Autism Diagnostic Observation Schedule-Generic: A standard measure of social and communication deficits associated with the spectrum of autism. *Journal of Autism and Developmental Disorders,* 30 (3) 205-223.

Lord, C., Rutter, M.L., DiLavore, P.C., & Risi, S. (1999). *Autism Diagnostic Observation Schedule.* Los Angeles: Western Psychological Services.

Lord, C., Rutter, M., & Le Couteur, A. (1994). Autism diagnostic interview-Revised: A revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorders*, 24, 659-685.

Luckasson, R., Borthwick-Duffy, S., Buntinx, W.H.E., Coulter, D.L., Craig, E.M., Reeve, A., Schalock, R.L., Snell, M.E., Spitalnik, D.M., Spreat, S., & Tasse, M.J. (2002). Mental retardation: Definition, classification, and systems of supports. Washington DC: American Association on Mental Retardation.

Luteijn, F., & Barelds, D. (2004). *GIT-2 Handleiding*. Amsterdam: Harcourt Test Publishers.

Mayes, S.D., & Calhoun, S.L. (2003). Analysis of WISC-III, Stanford-Binet:IV, and Academic Achievement Test Scores in Children with Autism. *Journal of Autism & Developmental Disorders*, 33 (3), 329-241.

Mayes, S.D., Calhoun, S.L., & Crites, D.L. (2001). Does DSM-IV Asperger's disorder exist? *Behavioral Science*, 29 (3), 263-271.

Miller, E. (1984). Verbal fluency as a function of a measure of verbal intelligence and in

relation to different types of cerebral pathology. *British Journal of Clinical Psychology*, 23, 53-57.

Minshew, N.J., Goldstein, G., Muenz, L.R., & Patyon, J.B. (1992). Neuropsychological functioning in non-mentally retarded autistic individuals. *Journal of Clinical and Experimental Neuropsychology*, 14, 749-761.

Minshew, N.J., Williams, D.L, & Gastgeb, H. (2008, Mai). *Inferior performance on Embedded figures tasks by high functioning children and adults with autism consistent with reduced local connectivity & slower search strategy.* Poster session presented at the International Meeting for Autism Research, London.

Mottron, L., Dawson, M., Bertone, A., & Wang, L. (2007). Cognitive versatility in autism cannot be reduced to a deficit. *Cognitive neuropsychology,* 24 (5) 578-580.

Mottron, L., Dawson, M., Soulieres, I., Hubert, B., & Burack, J. (2006). Enhanced perceptual functioning in autism: An update, and eight principles of autistic perception. *Journal of Autism and Developmental Disorders,* 36, 27-43.

Mottron, L., Peretz, I., & Menard, E. (2000). Local and global processing of music in high-functioning persons with autism: Beyond central coherence? *Journal of Child Psychology & Psychiatry,* 41, 1057-1065.

Nyden, A., Gillberg, C., Hjelmquist, E., & Heiman, M. (1999). Executive function/attention deficits in boys with Asperger syndrome, attention disorder and reading/writing disorder. *Autism*, 3, 213-228.

Ozonoff, S., Cook, I., Coon, H., Dawson, G., Joseph, R.M., Klin, A., McMahon, W.M., Minshew, N., Munson, J.A., Pennington, B.F., Rogers, S.J., Spence, M.A., Tager-Flusberg, H., Volkmar, F.R., & Wrathall, D. (2004). Performance on Cambridge neuropsychological test automated battery subtests sensitive to frontal lobe function in people with autistic disorder: evidence from the collaborative programs of excellence in autism network. *Journal of Autism and Developmental Disorders*, 34, 139-150.

Ozonoff, S., Pennington, B.F., & Rogers, S. (1991a). Executive function deficits in high-functioning autistic individuals: relationship to theory of mind. *Journal of Child Psychology and Psychiatry,* 32 (7), 1081-1105.

Ozonoff, S., Rogers, S.J., & Pennington, B.F. (1991b). Asperger's Syndrome: Evidence of an empirical distinction from high functioning autism. *Journal of Child Psychology and Psychiatry,* 32, 1107-1122.

Ozonoff, S., South, M., & Miller, J.N. (2000a). The external validity of Asperger disorder: Lack of evidence from the domain of neuropsychology. *Journal of Abnormal Psychology,* 109, 227-238.

Ozonoff, S., South, M., & Miller, J.N. (2000b). DSM-IV-defined Asperger syndrome:

cognitive, behavioral and early history differentiation from high-functioning autism. *Autism*, 44 (1), 29-46.

Ozonoff, S., South, M., & Provencal, S. (2005). Executive Functions. In F.R. Volkmar, R. Paul, A. Klin & D. Cohen (Eds.) *Handbook of Autism and Pervasive Developmental Disorders* (pp. 606-627). New Jersey: John Wiley & Sons.

Pennington, B.F., & Ozonoff, S., (1996). Executive functions and developmental psychopathology. *Journal of Child Psychology and Psychiatry*, 37, 51-87.

Plaisted, K., Swettenham, J., & Rees, L. (1999). Children with autism show local precedence in a divided attention task and global precedence in a selective attention task. *Journal of Child Psychology and Psychiatry,* 40, 733-742.

Pring, L, Hermelin, B., & Heavey, L. (1995). Savants, segments, art and autism. *Journal of Child Psychology and Psychiatry*, 36, 1065-1076.

Ponnet, K., Roeyers, H., & Buysse, A. (2001). Het Autismespectrum Quotient [The Autism-spectrum quotient]. (Baron-Cohen, Wheelwright, Skinner, Martin & Clubley, 2001), unpublished translation, Ghent University, Ghent.

Ponnet, K.S., Roeyers, H., Buysse, A., De Clercq, A., & Van der Heyden, E. (2004). Advanced Mind-Reading in Adults with Asperger Syndrome. *Autism,* 8, 249-266.

Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind? *Behavioral and Brain Sciences,* 1, 515-526.

Rapin, I. (2005). Autism: Where we have been, where we are going? In F.R. Volkmar, P. Rhea, A. Klin & D. Cohen (Ed.), *Handbook of Autism and Pervasive Developmental Disorders* (pp. 1304-1317). New Jersey: John Wiley & Sons.

Reverberi, C., Laiacona, M., & Capitani, E. (2006). Qualitative features of semantic fluency performance in mesial and lateral frontal patients. *Neuropsychologia*, 44, 469-478.

Roeyers, H., Buysse, A., Ponnet, K., & Pichal, B. (2001). Advancing advanced mind-reading tests: empathic accuracy in adults with a pervasive developmental disorder. *Journal of Child Psychology and Psychiatry* 42, 271-278.

Rumsey, J. (1985). Conceptual problem solving in highly-verbal, nonretarded autistic men. *Journal of Autism and Developmental Disorders,* 15, 23-36.

Rumsey, J.M., & Hamburger, S.D. (1988). Neuropsychological findings in high-functioning men with infantile autism, residual state. *Journal of Clinical and Experimental Neuropsychology*, 10 (2), 201-221.

Russell, J. (1997). *Autism as an Executive Disorder.* Oxford: Oxford University Press.

Rutter, M. (2005). Genetic influences and autism. In F.R. Volkmar, R. Paul, A. Klin & D. Cohen (Eds.). Handbook of Autism and Pervasive Developmental Disorders (pp. 425-452). New Jersey: John Wiley & Sons.

Ryan, J.J., & Paolo, A.M. (2001). Exploratory factor analysis of the WAIS-III in a mixed patient sample. Archives of Clinical Neuropsychology, 16(2), 151-156.

Sattler, J.M., & Ryan, J.J. (1999). *Assessment of children, revised: WAIS-III supplement.* LeMesa, CA: Jerome Sattler Publishing.

Seltzer, M.M., Lam, K.S.L., & Bodfish, J.W. (2009). Age-related differences in restricted repetitive behaviors in autism spectrum disorders. *Journal of Autism and Developmental Disorders,* 39, 57-66.

Shah, A., & Frith, U. (1993). Why do autistic individuals show superior performance on the Block Design task? *Journal of Child Psychology and Psychiatry*, 34, 1351-1364.

Siegel, D.J., Minshey, N.J., & Goldstein, G. (1996). Wechsler IQ Profiles in Diagnosis of High-Functioning Autism. *Journal of Autism and Developmental Disorders*, 26, 389-406.

South, M., Ozonoff, S., & McMahon, W.M. (2007). The relationship between executive functioning, central coherence, and repetitive behaviours in the high-functioning autism spectrum. *Autism,* 11, 437-451.

Spek, A.A., Scholte, E.M., & Van Berckelaer-Onnes, I.A. (2008). *The use of WAIS-III in adults with HFA and Asperger syndrome.* Journal of Autism and Developmental Disorders, 38 (4), 782-787.

Spek, A.A., Scholte, E.M., & van Berckelaer-Onnes, I.A. (2010). Theory of mind in adults with HFA and Asperger syndrome. *Journal of Autism and Developmental Disorders, 280-289.*

Stone, V.E., Baron-Cohen, S., & Knight, R.T. (1998). Frontal lobe contributions to theory of mind. *Journal of Cognitive Neuroscience,* 10, 640-656.

Tabachnick, B.G., & Fidell, L. S. (2001). *Using Multivariate Statistics, Fourth Edition.* Boston: Allyn and Bacon.

Tager-Flusberg, H., Paul, R., & Lord, C. (2005). Language and communication in autism. In F.R. Volkmar, P. Rhea, A. Klin & D. Cohen (Eds.), *Handbook of Autism and Pervasive Developmental Disorders* (pp. 335-364). New Jersey: John Wiley & Sons.

Taub, G.E. (2001). A Confirmatory Analysis of the Wechsler Adult Intelligence Scale-Third Edition: Is the Verbal/Performal Discrepancy Justified? *Practical Assessment, Research & Evaluation*, 7 (22).

Troyer, A.K., Moscovitch, M., & Winocur, G. (1997). Clustering and switching as two components of verbal fluency: Evidence from younger and older healthy adults. *Neuropsychology*, 11, 138-146.

Tsatsanis, K.D. (2005). Neuropsychological Characteristics in Autism and Related

Conditions. In: F.R. Volkmar, P. Rhea, A. Klin & D. Cohen (Eds.). *Handbook of Autism and Pervasive Developmental Disorders* 772-798. New Jersey: John Wiley & Sons.

Turner, M.A. (1999). Generating novel ideas: Fluency performance in high functioning and learning disabled individuals with autism. *Journal of Child Psychology and Psychiatry*, 40, 189-201.

Van der Elst, W., Van Boxtel, M.P.J., Van Breukelen, G.J.P., & Jolles J. (2006). Normative data for the animal, profession and letter M naming verbal fluency tests for Dutch speaking participant and the effects of age, education, and sex. *Journal of the International Neuropsychological Society*, 12, 80-89.

Van Lang, N.D.J., Bouma, A., Sytema, S., Kraijer, D.W., & Minderaa, R.B. (2006). A comparison of central coherence skills between adolescents with an intellectual disability with and without comorbid autism spectrum disorder. *Research in Developmental Disabilities,* 27, 217-226.

Veenman, M.V.J. (2005). The assessment of metacognitive skills: What can be learned from multi-method designs? In C. Artelt & B. Moschner (Ed.), *Lernstrategien und Metakognition; Implikationen für Forschung und Praxis* (pp. 77-99). Münster: Waxmann.

Vermeulen, P. (2002). *Beter vroeg dan laat en beter laat dan nooit (Better early than late but better late than never).* Berchem: Uitgeverij EPO.

Verté, S., Geurts, H.M., Roeyers, H., Oosterlaan, J., & Sergeant, J.A. (2006). Executive functioning in children with autism spectrum disorder: Can we differentiate within the spectrum? *Journal of Autism and Developmental Disorders*, 36, 351-372.

Volkmar, F.R., Lord, C., Bailey, A., Schultz, R., & Klin, A. (2004). Autism and pervasive developmental disorders. *Journal of Child Psychology and Psychiatry* 45, 135-170.

Volkmar, F.R., & Klin, A. (2005). Issues in the classificaton of autism and related conditions. In F.R. Volkmar, R. Paul, A. Klin & D. Cohen (Ed.) *Handbook of Autism and Pervasive Developmental Disorders* (pp. 606-627). New Jersey: John Wiley & Sons.

Wang, L., Mottron, L., Peng, D., Berthiaume, C., & Dawson, M. (2007). Local bias and local-to-global interference without global deficit: A robust finding in autism under various conditions of attention, exposure time, and visual angle. *Cognitive Neuropsychology,* 24, 550-574.

Wakabayashi, A., Baron-Cohen, S., Uchiyama, T., Yoshida, Y., Kuroda, M., &

Wheelwright, S. (2007). Empathizing and systemizing in adults with and without autism spectrum conditions: cross-cultural stability. *Journal of Autism and Developmental Disorders*, 37 (10), 1823-1832.

Wechsler, D. (1997). *Manual for the Wechsler adult intelligence scale-Third edition (WAIS-III).* San Antonio, TX: Psychological Corporation.

Witkin, H.A., Dyck, R.B., Faterson, H.F., Goodenough, D.G., & Karp, S.A. (1962). *Personality through perception.* New York: Harper & Row.

Witkin, H.A., Oltman, P.K., Raskin, E., & Karp, S. (1971). *Manual for the Embedded Figures Test.* Palo Alto, C.A: Consulting Psychologists Press.

Williams, D.L., Moss, S.A., Bradshaw, J.L., & Rinehart, N.J. (2002). Random number generation in autism. *Journal of Autism and Developmental Disorders*, 32, 43-47.

World Health Organization. (1993). *The ICD-10 classification of mental and behavioral disorders. Diagnostic criteria for research*. Geneva: WHO.

Yirmiya, N., Shaked, E.O., & Solomonica-Levi, D. (1998). Meta-analyses comparing theory of mind abilities of individuals with autism, individuals with mental retardation, and normal developing individuals. *Psychological Bulletin,* 124, 283-307.

Zalla, T., Sav, A., Stopin, A., Ahade, S., & Leboyer, M. (2008). Faux-pas detection and intentional action in Asperger syndrome. A replication on a French sample. *Journal of Autism and Developmental Disorders,* 93, 373-382.

Curriculum Vitae

Annelies Spek was born on June 12, 1975 in Lexmond. She graduated her VWO (preparatory scientific education) in 1993 at 'De Bruijne Luceum' in Utrecht. She attended Leiden University in 1996 and received a master degree in clinical and health psychology in 2000. In 2002 she received postdoctoral degree in mental health psychology (GZ-psychologie). In 2003 she attended a four-year postdoctoral study in clinical psychology and graduated in 2007 as clinical psychologist (Klinisch Psycholoog). Hereafter she became clinical psychologist / research coordinator at the Adult Autism Centre at GGZ Eindhoven. She has been involved in different research projects concerning the cognitive abilities of adults with autism spectrum disorders (ASD). Furthermore, she investigates the effects of treatment such as mindfulness and psychoeducation. She also assessed the differences and overlap between autism and schizophrenia. Annelies gives lectures and courses about (diagnosing) ASD in adults.
The research for this theses was conducted at the Adult Autism Centre at GGZ Eindhoven.

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