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

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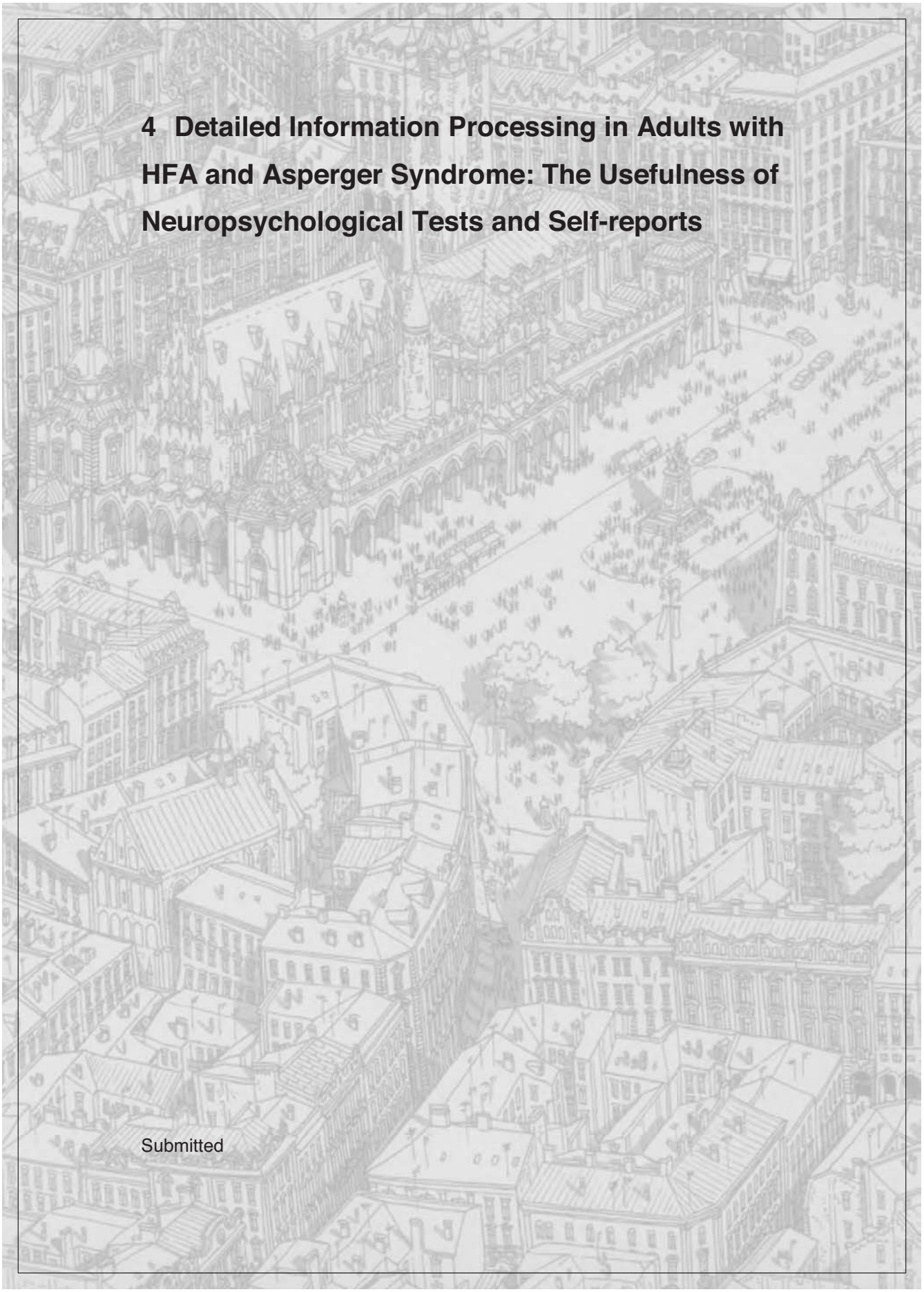

4 Detailed Information Processing in Adults with HFA and Asperger Syndrome: The Usefulness of Neuropsychological Tests and Self-reports

Submitted

Chapter 4

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 Neuropsychological Tasks and Questionnaires

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 Tasks and Questionnaires

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

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.