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Comparing cognitive functioning in schizophrenia and autism using WAIS-III

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ABSTRACT

The main goal of this study was to investigate differences and similarities in general cognitive functioning between adults with schizophrenia and autism, because this has not been systematically investigated. We used a cross-sectional design to compare adults with schizophrenia ($n = 27$), with autism ($n = 114$) and a healthy control group ($n = 30$). Schizophrenia diagnoses were based on the Structured Clinical Interview for the DSM-IV Axis I (SCID-I) and behavioral symptoms were assessed with the Positive and Negative Syndrome Scale (PANSS). Autism was diagnosed with a DSM-IV questionnaire for autism spectrum disorders and the Autistic Diagnostic Interview, revised version. The Wechsler Adult Intelligence Scale, third version (WAIS-III) was used to assess cognitive functions. All participants were between 18 and 65 years of age and had a minimum full scale intelligence of 80. Results showed that patients with schizophrenia scored significantly lower on processing speed than patients with autism and the healthy control group. Differences on other index scales were not found. In participants with schizophrenia a correlation was found between processing speed impairment and negative symptoms. Diagnosis could be predicted correctly with WAIS-III profile in 70.4% of the cases with schizophrenia compared to 56.7% of the healthy control group and 22.8% of the autism group.

1. Introduction

Since the seventies, schizophrenia and autism have been classified as two separate clinical disorders (Kolvin, 1971; Rutter, 1972; Volkmar & Cohen, 1991). However, throughout the years research also pointed to overlap in behavioral features, for example in thought disorders (Dykens, Volkmar, & Glick, 1991), social communication deficits (Tordjman, 2008), negative symptoms, disorganization and attention to detail (Konstantareas & Hewitt, 2001; Spek & Wouters, 2010). Because of this overlap, it can sometimes be difficult to differentiate schizophrenia and autism in clinical practice, specially when no clear positive symptoms are apparent and developmental information is not available. Recent studies also showed

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evidence for genetic similarity between schizophrenia and autism (Burbach & van der Zwaag, 2009; Rapoport, Chavez, Greenstein, Addington, & Gogtay, 2009; Tabares-Seisdedos & Rubenstein, 2009). Based on behavioral and genetic overlap between schizophrenia and autism, cognitive overlap might also be expected, although research in this area is limited. The current study therefore aimed to assess possible differences and similarities between schizophrenia and autism in general cognitive functioning measured with the Wechsler Adult Intelligence Scale, third version (WAIS-III).

Intelligence profiles have often been used to investigate general cognitive functioning (Joyce, Hutton, Mutsatsa, & Barnes, 2005; Torrent et al., 2007), because intelligence encompasses a range of cognitive functions and abilities. Dickinson and Harvey (2009) provided a rationale for using an intelligence profile for investigating general cognitive functioning in schizophrenia. They questioned the validity of traditional domain-specific neuropsychological tests to assess cognitive functioning, because neurocognitive impairments are found in different brain areas and cognitive ability domains.

Only two studies directly compared general cognitive functioning in schizophrenia and autism. Both studies used the WAIS, but no index scales were available at that time; instead, subtests were used as variables. Using the WAIS-II, no group differences were found on subtest level (Bölte, Rudolf, & Poustka, 2002). Another study using the WAIS-R, reported similarities on the subtests information and block design, which were both elevated in the autism group and one subgroup of schizophrenia, namely the high-functioning group with normal to close to normal scores. In addition, it was found that both groups showed impairment on comprehension and digit-symbol coding. The schizophrenic sample was divided into four subgroups of cognitive functioning using Ward's method of cluster analysis (Goldstein, Minshew, Allen, & Seaton, 2002). A limitation of this study was that the autism group was significantly younger than the schizophrenia group. To the best of our knowledge, WAIS-III profiles of adults with schizophrenia and autism have not yet been compared. Therefore we do not know whether both groups differ on index scale level, which is the best reflection of general cognitive abilities (Arnau & Thompson, 2000).

Cognitive functioning in individuals with schizophrenia seems to be related to behavioral features, which can be divided into positive, negative and disorganized symptoms. Negative symptoms have been associated with deficits in verbal and visual memory, visual/motor processing and impaired executive functioning (Dibben, Rice, Laws, & McKenna, 2009; Gracia Dominguez, Viechtbauer, Simons, Krabbedam, & van Os, 2009; Krabbendam & Jolles, 2002). Positive symptoms have been found to co-occur with impaired auditory attention and verbal memory (Krabbendam & Jolles, 2002). However, most evidence points to independence of positive symptoms and cognitive deficits (Gracia Dominguez et al., 2009). Disorganized symptoms have been associated with impaired cognitive functions, impaired selective attention and inhibition, low verbal IQ and impaired concept attainment and auditory attention (Dibben et al., 2009; Gracia Dominguez et al., 2009; Krabbendam & Jolles, 2002). Because of the relationship between cognitive and behavioral features in schizophrenia and the fact that previous studies found overlap in negative symptoms between schizophrenia and autism (Spek & Wouters, 2010), we decided to include behavioral features in the present study.

The objective of this study was to compare general cognitive functioning in adults with schizophrenia and autism by examining their intelligence profiles. We expected to find similar impairment in processing speed in both diagnostic groups as compared to the healthy control group. Furthermore, we expected lower scores on working memory for patients with schizophrenia compared to the autistic and healthy control group. We also hypothesized that negative symptoms were inversely related to processing speed and that disorganized symptoms would be inversely related to working memory.

2. Methods

2.1. Participants

A cross-sectional design was used to compare a schizophrenia group ($n = 27$) with an autism group ($n = 114$) and a healthy control group ($n = 30$). See Table 1 for group characteristics. The subjects with schizophrenia and autism were diagnosed according to DSM-IV-TR criteria. To ensure there was no overlap between the two patient groups, a psychiatrist or clinical psychologist was consulted for their clinical opinion on the presence of psychiatric disorders. Inclusion criterion was a full scale intelligence score of at least 80. This score was not used as a variable in this study. Exclusion criteria for all groups were drug abuse, admission to a hospital, non-stabilized psychotic episode and changes in medication within the last three

Table 1
Characteristics of participants.

	Schizophrenia	Autistic disorder	Control group	Total
Age (M/SD)	41.48 (9.26)	37.35 (10.60)	37.28 (11.03)	37.99 (10.53)
TIQ				
(M)	101.85	105.25	107.13	105.04
(SD)	(12.32)	(12.45)	(4.98) (11.53)	
Sex (male/female)	21/6	92/22	21/9	134/37
Number of participants	27	114	30	171

Note. No sign. differences between groups were found regarding age ($p = 0.17$) and TIQ ($p = 0.21$) tested with ANOVA, p's > 0.05 and no differences on sex ratio tested with independent T-test ($p = 0.40$).

months or sedative medication. Since several reviews have concluded that the adverse effects of antipsychotic medication on cognitive functioning of people with schizophrenia are minor (Dickinson & Harvey, 2009; Medalia, Gold, & Merriam, 1988; Spohn & Strauss, 1989; Tam & Liu, 2004), patients taking antipsychotic medication were not excluded from this study. The three groups were matched on age, gender and full scale intelligence.

2.2. Assessment

2.2.1. Diagnosing schizophrenia

The diagnosis schizophrenia was established using a semi-structured interview for Axis I disorders, the Structured Clinical Interview for the DSM-IV Axis I (SCID-I/P; First, Spitzer, Gibbon, & Williams, 1996; Groenestijn, Akkerhuis, Kupka, Schneider, & Nolen, 1999). This interview is based on the DSM-IV (APA, 2000). The interrater reliability of the SCID-I in diagnosing specifically schizophrenia appears high, Kappa = 0.94 (Skre, Onstad, Torgersen, & Kringlen, 1991).

2.2.2. Behavioral symptoms of schizophrenia

In order to measure symptoms within schizophrenia, the Positive and Negative Syndrome Scale (PANSS), a semi-structured interview, was administered. Reliability, validity and stability with chronic patients proved to be good. Internal reliability varied between $\alpha = 0.73$ and 0.83 for each scale (Kay, Opler, & Fiszbein, 1987; de Ruiter & Hildebrand, 2000). A professionally trained clinical psychologist obtained the data for this study.

2.2.3. Diagnosing autism

For the assessment of high functioning autism and Asperger's disorder, the patient's development history and current symptomatology were evaluated. To gather information on development history, parents or an older sibling were interviewed using the Dutch version of the Autistic Diagnostic Interview, revised version (ADI-R; Lord, Rutter, & Le Couteur, 1994). The ADI-R was administered by psychologists who were specially trained in administration and scoring. The ADI-R is a reliable and valid instrument if administered by trained examiners. Internal consistency ranged from $\alpha = 0.69$ to 0.95. To gather information on current symptomatology a DSM-IV questionnaire, a semi-structured interview for autism spectrum disorders, was undertaken. This interview was also used in earlier research (Spek, Scholte, & Berckelaer-Onnes, 2008; Spek & Wouters, 2010) and assesses the DSM-IV-TR criteria of high functioning autism and Asperger's disorder by asking the participant standard questions (APA, 2000).

2.2.4. Intelligence measure

General cognitive functioning was assessed using the Dutch version of the WAIS-III (Wechsler, 2000). Compared to WAIS-II, significant modifications and structural changes have been made in WAIS-III. The WAIS-III has a new factor structure, which is similar to WAIS-IV (Wechsler, 2012). Psychometric studies indicated that four factors or index scales can be derived: verbal comprehension, perceptual organization, working memory and processing speed (Ryan & Paolo, 2001). The WAIS is already in its fourth edition, but at the start of this study, this was not yet translated into Dutch. In order to reduce the Flynn effect of the WAIS-III, an update of the Dutch norms was used. This sample dates back to 2004 (Wechsler, 2005).

2.3. Procedure

Patients were recruited from a mental health institution in Eindhoven (GGzE), the Netherlands, with approval from the internal scientific committee. All participants gave their informed consent. Data from the group of patients with schizophrenia was collected during two sessions. In the first session, diagnosis and symptoms of schizophrenia were examined using the SCID-I and PANSS. In the second session, the WAIS-III was conducted. Five participants were excluded as they failed to meet the criterion of a full scale IQ above 80. Both the autism and healthy control groups had already been recruited for previous research.

2.4. Statistics

Statistic analyses were conducted using SPSS 19. Preliminary analyses were done including checks for normality, homogeneity, linearity and influential data points. Independent *t*-tests and ANOVA's were used to show that all groups were comparable with respect to gender, age and full scale intelligence. Scores on variance within index scales of WAIS-III of the healthy control group differed from the patient groups. Levene's test results for all index scores were significant. This discrepancy was dealt with by conducting a conservative post hoc comparison, namely Bonferroni adjustment for multiple comparisons. Multivariate analysis of variance (MANOVA) followed up by discriminant analysis was used to test differences between the groups. A bootstrap method (1000 samples) was used in the MANOVAs because of the unequal group numbers. Discriminant analysis was done to test the probability of group membership based on the dependent variables. Finally, correlation analyses were performed to investigate the relationship between behavioral symptoms of schizophrenia measured with PANSS and index scores of WAIS-III. We followed Cohen's guidelines to determine effect size of differences between the groups.

Table 2
Mean standardized scores index scales.

	Schizophrenia (1)	Autistic disorder (2)	Control group (3)	*p*-Value	Effect size		
	N=27	N=114	N=30		Cohen's *d* (1)–(2)	Cohen's *d* (2)–(3)	Cohen's *d* (1)–(3)
Verbal comprehension	107.48 (11.90)	105.97 (11.44)	106.77 (7.21)	0.791	0.13	−0.08	0.07
Perceptual organization	101.59 (14.03)	105.49 (13.66)	108.27 (8.21)	0.152	−0.28	−0.25	−0.58
Working memory	101.26 (11.91)	103.25 (15.18)	105.20 (10.13)	0.568	−0.15	−0.15	−0.36
Processing speed	91.81 (13.88)	101.28 (18.09)	107.87 (12.71)	0.002*	−0.59	−0.59	−1.21

* Sign. differences on mean between groups $p < 0.05$.

3. Results

3.1. Index scales of WAIS-III

Table 2 shows the means scores and standard deviations of all groups. A main group effect was found in processing speed ($F(2,168) = 6.66$, $p < 0.05$). Bonferroni-corrected post hoc comparison showed that the schizophrenia group scored lower than the autism ($p = 0.03$) and the healthy control group ($p < 0.01$).

Discriminant analysis revealed two discriminant functions. The first explained 97.7% of the variance, canonical $R^2 = 0.30$, whereas the second explained only 2.3% of the variance, canonical $R^2 = 0.05$. Inspection of the Wilks' lambda values showed that only the first function significantly differentiated between groups (Wilks' lambda = 0.91; χ^2 [df 8] = 15.62; $p = 0.05$), whereas the second did not (Wilks' lambda = 0.99; χ^2 [df 3] = 0.38; $p = 0.95$). The structure matrix further indicated that both processing speed and perceptual organization both contributed to this first function and therefore distinguished the groups. See for details, Table 3.

The discriminant function plot showed that the first function discriminated the group of patients with schizophrenia from the control group (Fig. 1). This can be deduced from the fact that the centroid of the schizophrenia group on the function 1 axes is negative, while that of the control group is positive. Based on both functions a prediction could be made about to which group a participant belonged. The schizophrenia group was predicted correctly in 70.4% of the cases compared to 56.7% of the healthy control group and 22.8% of the autism group. Overall, the hit rate when classifying the patients with schizophrenia and the patients with autism by the discriminant function using index scores was 36.3%.

3.2. Subtests of WAIS-III

Differences in subtest scores were examined in all groups using MANOVA followed by discriminant analysis. Table 4 shows the means scores and standard deviations for all groups. The table showed a significant main group effect on picture completion ($F(2,168) = 3.71$, $p = 0.03$), digit-symbol coding ($F(2,168) = 6.61$, $p < 0.01$), picture arrangement ($F(2,168) = 3.85$, $p = 0.02$) and symbol search ($F(2,168) = 5.13$, $p = 0.01$). Post hoc analysis with Bonferroni correction revealed that the schizophrenia group scored lower than the autism group on picture completion ($p = 0.01$) and on picture arrangement ($p = 0.02$); the schizophrenia group scored lower than the autism ($p = 0.01$) and the control group ($p < 0.01$) on digit symbol coding; the schizophrenia group scored lower than the control group ($p = 0.01$) on symbol search.

The discriminant analysis of the subtests revealed two discriminant functions. The first explained 75.3% of the variance, canonical $R^2 = 0.41$, whereas the second explained 24.7% of the variance, canonical $R^2 = 0.25$. Inspection of the Wilks' lambda values showed that only the first function significantly differentiated between groups (Wilks' lambda = 0.78; χ^2 [df 28] = 41.08; $p = 0.05$), whereas the second did not (Wilks' lambda = 0.94; χ^2 [df 13] = 10.65; $p = 0.64$). The structure matrix further indicated that nine of the subtests contributed to this first function and therefore distinguished the groups the most. See for details, Table 5.

Table 3
Structure matrix index scales.

	Function	
	1	2
Processing speed	0.91[a]	0.40
Perceptual organization	0.49[a]	0.24
Verbal comprehension	−0.09	0.95[a]
Working memory	0.26	0.36[a]

Note. Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions are shown.
[a] Largest absolute correlation between each variable and any discriminant function.

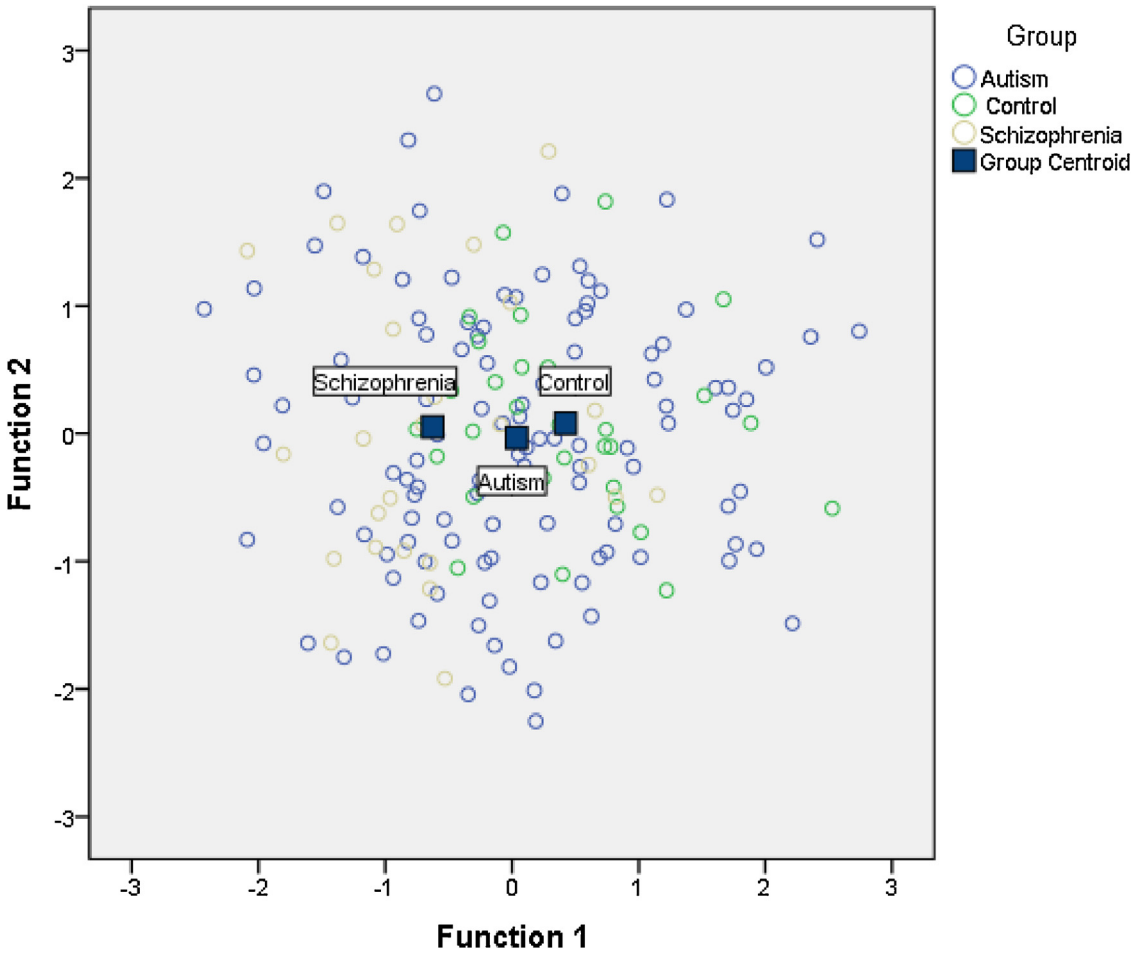

Fig. 1. Canonical discriminant functions subtests scores.

Table 4
Mean standardized scores subtests.

	Schizophrenia (1) $N = 27$	Autistic disorder (2) $N = 114$	Control group (3) $N = 30$	p-Value	Effect size		
					Cohen's d (1)–(2)	Cohen's d (2)–(3)	Cohen's d (1)–(3)
Vocabulary (VC)	10.81 (2.39)	10.94 (2.41)	11.17 (2.04)	0.842	−0.054	−0.10	−0.16
Similarity (VC)	11.56 (2.59)	10.65 (2.37)	10.83 (1.88)	0.194	0.37	−0.08	0.32
Information (VC)	11.85 (2.13)	11.82 (2.85)	11.83 (1.72)	0.999	0.01	−0.00	0.01
Picture completion (PO)	8.93 (2.34)	10.38 (2.66)	10.47 (2.47)	0.027*	−0.58	−0.04	−0.64
Block design (PO)	11.33 (3.41)	11.58 (3.17)	12.13 (2.10)	0.578	−0.08	−0.20	−0.28
Matrix reasoning (PO)	10.89 (2.74)	11.12 (2.56)	11.93 (1.72)	0.208	−0.09	−0.37	−0.45
Arithmetic (WM)	10.85 (2.49)	11.06 (2.85)	11.90 (1.67)	0.237	−0.08	−0.36	−0.50
Digit span (WM)	10.74 (2.74)	10.11 (3.16)	10.40 (2.34)	0.583	0.21	−0.10	0.13
Letter-number sequencing (WM)	9.33 (2.57)	10.58 (3.18)	10.57 (2.33)	0.137	−0.43	0.00	−0.51
Digit-symbol coding (PS)	7.59 (2.81)	9.77 (3.46)	10.57 (2.79)	0.002*	−0.69	−0.25	−1.06
Symbol search (PS)	9.30 (2.80)	10.68 (3.75)	12.17 (2.18)	0.007*	−0.42	−0.49	−1.14
Comprehension (–)	10.89 (3.13)	11.39 (2.61)	11.67 (2.04)	0.520	−0.06	−0.12	−0.30
Picture arrangement (–)	9.33 (3.28)	10.98 (2.71)	10.90 (2.71)	0.023*	−0.55	0.03	−0.52
Object assembly (–)	10.44 (2.79)	10.81 (2.79)	11.03 (2.75)	0.723	−0.13	−0.08	−0.21

Note. VC, verbal comprehension, PO, perceptual organization, WM, working memory, PS, processing speed.
* Sign. differences on mean between all groups $p < 0.05$.

Table 5
Structure matrix subtests scores.

	Function	
	1	2
Digit-symbol coding	0.59[a]	0.32
Picture arrangement	0.47[a]	−0.07
Picture completion	0.46[a]	0.03
Letter-number sequencing	0.34[a]	−0.02
Similarity	−0.30[a]	0.13
Comprehension	0.18[a]	0.14
Digit span	−0.15[a]	0.15
Object assembly	0.12[a]	0.11
Information	−0.01[a]	0.01
Symbol search	0.41	0.61[a]
Matrix reasoning	0.14	0.47[a]
Arithmetic	0.13	0.45[a]
Block design	0.10	0.26[a]
Vocabulary	0.06	0.14[a]

Note. Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions are shown.
[a] Largest absolute correlation between each variable and any discriminant function.

The discriminant function plot showed that the first function discriminated the schizophrenia group from the autism and control groups (Fig. 2). This can be deduced from the fact that the centroid of the schizophrenia group on the function 1 axes is negative, while those of the other two groups are positive.

Based on both functions a prediction could be made about to which group a participant belonged. The schizophrenia group was predicted correctly in 77.8% of the cases compared to 60% of the control group and 46.5% of the autism group.

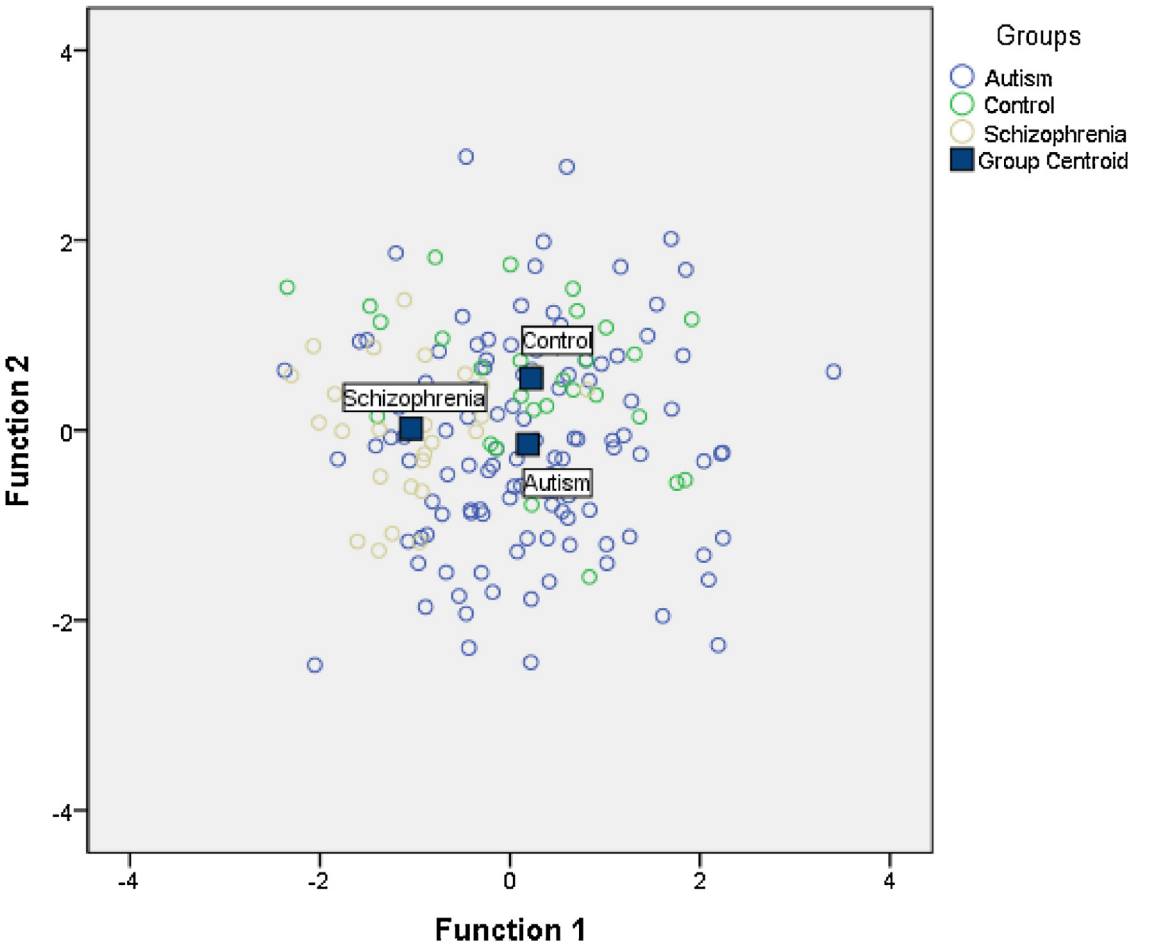

Fig. 2. Canonical discriminant functions subtests scores.

Table 6
Correlation matrix (Pearson-R), $N = 32$.

	Positive symptoms	Negative symptoms	Disorganized symptoms
Verbal comprehension	−0.30	−0.29	−0.25
Perceptual organization	−0.18	−0.14	−0.15
Working memory	−0.23	−0.14	−0.24
Processing speed	−0.33	−0.45**	−0.27
Vocabulary	−0.46**	−0.38*	−0.36*
Similarity	−0.19	−0.16	−0.14
Arithmetic	−0.24	−0.06	−0.26
Digit span	−0.17	−0.06	−0.07
Information	−0.16	−0.25	−0.39*
Comprehension	−0.23	−0.39*	−0.18
Letter-number sequencing	−0.12	−0.22	−0.23
Picture completion	−0.20	−0.09	−0.14
Digit-symbol coding	−0.29	−0.37*	−0.23
Block design	−0.05	0.02	−0.02
Matrix reasoning	−0.22	−0.32	−0.25
Picture arrangement	−0.09	−0.05	−0.06
Symbol search	−0.31	−0.45*	−0.26
Object assembly	−0.13	0.10	−0.001

* Sign. correlation $p < 0.05$.
** Sign. correlation $p < 0.01$.

Overall, the hit rate when classifying the patients with schizophrenia and patients with autism by the discriminant function using subtests scores is 53.8%.

3.3. WAIS-III and symptoms of schizophrenia

Bivariate Pearson's correlation coefficients were used to investigate the relationship between scores on WAIS-III and symptoms of schizophrenia (Table 6). Processing speed and negative symptoms of schizophrenia were inversely related ($r = -0.45$, $p = 0.01$). Other significant relations were not found for index scales. For subtests, vocabulary was inversely related with all behavioral symptoms; positive symptoms ($r = -0.46$, $p = 0.01$), negative symptoms ($r = -0.38$, $p = 0.03$) and disorganized symptoms ($r = -0.36$, $p = 0.04$). Further significant negative correlations were found for negative symptoms on the following subtests; comprehension ($r = -0.39$, $p = 0.03$), digit-symbol coding ($r = -0.37$, $p = 0.04$) and symbol search ($r = -0.45$, $p = 0.01$).

4. Discussion

There is mounting interest in investigating differences and similarities between schizophrenia and autism, since it helps to answer core questions about the unique aspects of both disorders. Recently, similarities were found in genetic and behavioral features. Research into general cognitive functioning of people with schizophrenia and autism is still limited. The current study used the WAIS-III to examine cognitive differences and similarities between both disorders. Significant differences were found in processing speed between the groups. Patients with schizophrenia scored lower than patients with autism and a healthy control group.

In contrast to our hypothesis, we found no difference between the schizophrenia group and the two other groups with regard to working memory. This is in contradiction with results from several other studies that showed that patients with schizophrenia have deficits in working memory (Barch, 2003; Horan et al., 2008; Krabbendam, 2001; Lee & Park, 2005; Peuskens et al., 2002; Pukrop et al., 2003; Zilles, Gruber, Falkai, & Gruber, 2010). In these studies, other measures of working memory were used, which may account for the differences with our study. Research showed that the performance of working memory tests in patients with schizophrenia is better if they have a limited number of items to remember over a short time period and if no other processing tasks were added (Barch, 2003; Cohen, Barch, Carter, & Servan-Schreiber, 1999), which is the case in the current study. As far as we know, no study to date has used the WAIS-III index scale to measure working memory in patients with schizophrenia. McGurk et al. (2004) found that letter-number sequencing, a subtest of WAIS-III, is a good indicator of the functioning of working memory in patients with schizophrenia. We did not find impairment on this subtest. Thus, based on our findings we hypothesize that there is no difference in working memory between schizophrenia and autism. Instead, differences can be found in processing speed.

Patients with schizophrenia were impaired on the digit symbol coding and symbol search subtest. This reflects the impairment in processing speed, which appears present in schizophrenia. Results are in line with previous research (Wilk, Gold, McMahon, & Humber, 2005). For patients with autism we did not find significant differences with either the control group or the schizophrenia group. Previous research found impairment in processing speed in high-functioning autism and not in the Asperger's syndrome, which cognitive profile seems to more closely resemble our control group (Holdnack, Goldstein, & Drozdick, 2011; Kanai et al., 2012; Spek, Scholte, & Berckelaer-Onnes, 2009) Furthermore, the adults with

schizophrenia were relatively impaired on the picture completion subtest and the picture arrangement subtest. Allen and Barchard (2009) investigated the factor structure of WAIS-III and proposed a new index scale, which they call social cognition. This scale consisted of picture completion, picture arrangement and object assembly. Impairments found within schizophrenia in the present study may thus be partly explained by social cognition. However, conclusions on significant differences between scores on subtests must be drawn with caution, due to insufficient power. Future research might shed more light on this issue.

The results of the current study also showed that based on the WAIS-III, schizophrenia patients were easier to identify as belonging to that group than patients with autism. This is in line with earlier research which found differences in processing speed between a high functioning autism group and Asperger's disorder group (Holdnack et al., 2011; Kanai et al., 2012; Spek et al., 2008). The difficulty in predicting which group the patients with autism belong to stems from the autism group scoring more on average due to different diagnostic classifications as a result of being part of a spectrum which may cause more cognitive variability. Happé and Charlton (2012) have hypothesized that patients with autism continue to develop skills throughout their life, which helps them to compensate for their impairments. Possibly, this does not apply to individuals with schizophrenia who tend to develop the disorder later in life.

As expected, negative symptoms were inversely related to processing speed. Other correlations between behavioral symptoms and index scales were not found. In conclusion, limitations on processing speed were found in both schizophrenia and high-functioning autism (Spek et al., 2008), next to similarities in negative symptoms (Wouters & Spek, 2011). This lends credence for an underlying common limitation in both classifications. Other research also suggests high comorbidity in schizophrenia and autism, especially in the paranoid type. Hallerbäck, Lugnegård, & Gillberg (2012) found a 60% rate of autism spectrum disorder in schizophrenia. King and Lord (2011) review the question whether schizophrenia is on the autism spectrum.

Limitations of this study were as follows. This study was conducted with small-sized patient groups. Larger numbers of participants, especially in the schizophrenia and healthy control groups, would be required in order to draw definite conclusions. In the schizophrenia group, only paranoid and undifferentiated type patients were included. All participants used antipsychotic medication which may have caused underestimation of the cognitive impairment in the schizophrenia group. Future research should take this into account. The autism group consisted of patients that had been diagnosed later in life. In general, we only included participants with minimal below average intelligence. Therefore, results of this study may not be applicable to people with autism who were diagnosed earlier in life or people with a lower level of functioning. It would be of interest to further study the effects of autistic symptoms on cognitive function and to examine the relationship between autistic symptom categories and other features, like social cognition or negative symptoms.

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