



Contribution of specific cognitive dysfunction to people with schizotypal personality

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ABSTRACT

The current study aimed to determine whether there is a specific neurocognitive deficit in individuals with schizotypal personality features. One hundred and fifty-nine healthy participants and 62 schizotypal individuals completed a comprehensive battery of cognitive tests. The cognitive functions captured by the battery could be reduced to 6 factors. Significant difference was found between participants with schizotypal features and healthy controls in allocation, verbal memory and marginally in working memory. Schizotypal traits tended to correlate with some of the cognitive factors, especially allocation, verbal memory and working memory.

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1. Introduction

Recent findings on the prediction of the development of schizophrenia and related disorders have led researchers to focus on individuals who manifest subclinical features of psychosis. These signs may be demonstrated in different stages of the illness and are also key features of schizotypal personality disorder. There is also a genetic link demonstrated between schizophrenia and schizotypal personality features (Lenzenweger, 1999; Siever et al., 1993). Moreover, a recent meta analysis has demonstrated that fronto-temporal brain structural abnormalities are evident in non-psychotic individuals demonstrating schizotypal personality features (Chan et al., *in press*). These individuals were found to have lower anterior cingulate and right insula volumes than healthy controls.

Consistent findings have shown that cognitive impairment, including working memory and verbal memory deficits, is exhibited in schizophrenia (Conklin et al., 2000, 2005; Fuller et al., 2005; Glahn et al., 2005; Lee and Park, 2005; Lencz et al., 2003; Wittorf et al., 2004). Others (Fuller et al., 2005; Goldberg et al., 2003; Lee and Park, 2005; Lencz et al., 2003) also indicated that different sub-processes of working memory were impaired in schizophrenia irrespective of the modality of the task, and negative symptoms were correlated with working memory deficits (Cameron et al., 2002). Studies found that patients with schizotypal personality disorder were impaired in cognitive functions, e.g., working

memory (McClure et al., 2007; Mitropoulou et al., 2005), context processing (McClure et al., 2008), and arithmetic ability (Trotman et al., 2006). Psychometrically identified schizotypal individuals also showed cognitive impairments, e.g., sustained attention (Gooding et al., 2006), working memory (Kerns and Becker, 2008; Matheson and Langdon, 2008), verbal IQ (Noguchi et al., 2008), and executive function (Gooding et al., 1999), both in student population (Gooding et al., 2006; Kerns and Becker, 2008; Matheson and Langdon, 2008) and adult population (Chen et al., 1997; Noguchi et al., 2008).

Nuechterlein et al. (Nuechterlein et al., 2004) identified seven most common cognitive factors from 13 empirical factor analysis studies, i.e., speed of processing, attention/vigilance, working memory, verbal learning and memory, visual learning and memory, reasoning and problem solving, and verbal comprehension. However, most of the previous studies of schizotypal individuals were primarily based on a small set of cognitive tests; few studies explore the cognitive functions of schizotypal participants with a comprehensive cognitive test battery and identify the specific cognitive impairments.

The main purpose of this investigation was twofold. First, it aimed to determine whether there are specific neurocognitive deficits in individuals with schizotypal personality features. Second, we attempted to explore the relationship between these schizotypal personality symptoms and neurocognitive functions.

2. Methods

2.1. Participants

A large-scale psychological investigation was conducted in the university and the community in which 781 participants completed a full version of the Schizotypal

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Table 1

Factor structure of cognitive measures.

	1, allocation	2, executive function	3, semantic inhibition	4, visual memory & attention	5, working memory	6, verbal memory
SET profile score	0.892					
SET raw score	0.876					
SET total no of rule break	−0.778					
WCST perseverative error		−0.877				
WCST categories		0.833				
SART correct		0.659				
Hayling B total error (A + B)			−0.942			
Hayling B correct			0.942			
Visual reproduction delayed				0.857		
Visual reproduction immediate				0.855		
VF correct				0.553		
SART commission error				0.397		
LN longest					0.899	
LN total correct					0.854	
2-back accuracy					0.475	
Logical memory immediate						0.941
Logical memory delayed						0.923

SET = Six Elements Test; WCST = Wisconsin Card Sorting Test; Hayling = Hayling Sentence Completion Test; VF = verbal fluency; SART = Sustained Attention to Response Task; LN = Letter-Number span test.

Questionnaire (SPQ, (Raine, 1991); Chinese version, (Chen et al., 1997)). The SPQ was designed to measure schizotypal personality according to the nine features of the DSM-III-R schizotypal personality disorder (SPD). It is a 74-item questionnaire rating on a “yes/no” scale. It captures specifically the nine traits of SPD, namely idea of reference, excessive social anxiety, odd belief or magical thinking, unusual perceptual experiences, odd or eccentric behaviour, no close friends, odd speech, constricted affect, and suspiciousness/paranoid ideation; and all items can be reduced to three factors: cognitive-perceptual, interpersonal, and disorganized. Impressive psychometric properties of the original and Chinese version have been described elsewhere (e.g., Chen et al., 1997; Raine, 1991, 2006; Raine et al., 1994).

Table 2

Demographics and raw score of cognitive test.

	Schizotypal (N = 62)		Control (N = 63)		F/χ^2	p
	Mean	SD	Mean	SD		
Gender ratio (male : female)	39:23		25:38		6.74	0.012
Age	20.65	3.33	26.19	8.28	24.02	<0.001
Education	13.79	1.26	14.22	2.39	1.59	0.210
IQ	102.47	18.58	106.48	14.08	1.85	0.176
<i>SPQ</i>						
SPQ cognitive-perceptual factor	18.23	4.36	9.13	4.30	129.18	<0.001
SPQ interpersonal factor	17.64	5.21	7.34	5.08	117.12	<0.001
SPQ disorganisation factor	10.70	2.86	4.07	2.42	184.17	<0.001
SPQ total score	42.61	7.29	19.11	8.02	273.25	<0.001
<i>Cognitive measures</i>						
Logical memory immediate	13.40	4.08	14.32	4.06		
Logical memory delayed	11.71	4.52	12.37	4.62		
Visual reproduction immediate	23.11	1.52	22.29	2.07		
Visual reproduction delayed	22.71	1.30	22.22	2.17		
LN total correct	13.79	3.22	14.48	3.28		
LN longest	5.45	1.08	5.67	1.09		
VF correct	20.03	5.50	20.21	4.77		
WCST perseverative error	2.34	3.23	1.97	3.09		
WCST categories	5.13	1.45	5.30	1.27		
SART correct	0.98	0.03	0.98	0.02		
SART commission error	0.36	0.20	0.37	0.25		
2-back accuracy	0.43	0.23	0.42	0.18		
Hayling B correct	11.15	4.04	11.68	3.60		
Hayling B total error (A + B)	3.85	4.04	3.32	3.60		
SET raw score	4.89	1.27	5.41	0.94		
SET total no of rule break	1.35	4.53	0.46	1.26		
SET profile score	3.26	0.77	3.56	0.67		

SPQ = Schizotypal Personality Questionnaire; LN = Letter-Number span test; VF = verbal fluency; WCST = Wisconsin Card Sorting Test; SART = Sustained Attention to Response Task; Hayling = Hayling Sentence Completion Test; SET = Six Elements Test. Gender ratio used Chi-square test.

According to the SPQ manual, the people with scores in the highest 10% were defined as having schizotypal personality traits (high SPQ or schizotypal); 75 people with an SPQ score over 36 were classified as high SPQ in the present study, and 62 completed all the tests; 159 of those participants with a SPQ score below the cut-off were randomly selected as healthy group. All the participants (both high SPQ and healthy group) had been screened by a trained research assistant to ascertain the absence of a history of psychiatric and neurological diseases. None had a history of psychosis in their first-degree relatives.

2.2. Measures

The IQ of participants was estimated by a short form (information, arithmetic, similarity, and digit span) of Chinese version of Wechsler Adult Intelligence Scale-Revised (WAIS-R) (Gong, 1992). The participants also completed a battery of cognitive function tests; including logical memory (LM) and visual reproduction (VR) from the Wechsler memory scale (Wechsler, 1987), Chinese version (Gong et al., 1989), immediate recall and 30 min delayed recall were recorded in both tests; N-back (Callicott et al., 1998), 2-back accuracy was recorded; Letter Number Span test (LN, Gold et al., 1997), the total correct items and longest passed were recorded; Sustained Attention Response to Task (SART, Robertson et al., 1997), the correct response rate and commission error rate were recorded; Six Elements Test (SET, Burgess et al., 1996), the raw score, total rule break, and profile score were recorded; Wisconsin Card Sorting Test (WCST, Nelson, 1976), the perseverative error and categories were recorded; Hayling Sentence Completion Test (HSCT, Burgess and Shallice, 1996), Chinese adapted version, (Chan et al., 2004), the total correct and total error (A + B) in part B were recorded; verbal fluency for animal names in 1 minute (VF, Spreen and Strauss, 1998), the correct items were recorded. Detailed descriptions of these tests can be found elsewhere (Chan et al., 2006a,b).

2.3. Procedure

This study received ethical approval as part of an extensive project examining the prevalence of schizotypy in a healthy population in China. Participants gave informed written consent before tests began. The cognitive tests were administered in random order.

2.4. Data analysis

First, a principal component factor analysis was conducted to all the variables from the neurocognitive tests for the healthy group, with the varimax rotation method and an eigenvalue larger than 1, factor loadings larger than 0.3 were acceptable. Second, we performed a MANCOVA, with group as independent variable, factors extracted from factor analysis as dependent variables, controlled for age and gender. Third, correlations between SPQ scores and cognitive factor scores in schizotypal participants and matched controls were analyzed.

3. Results

3.1. Factor analysis of cognitive tests

There were 58 males and 101 females in the healthy group. Mean age and education of the healthy group were 25.04 (SD = 7.74), and 15.12 (SD = 2.10) respectively.

Table 3
Comparison of factor scores (control for age and gender).

	Schizotypal (N = 62)		Control (N = 63)		F	p
	Mean	SD	Mean	SD		
Factor1: allocation	−0.57	3.00	0.56	2.02	8.83	0.004
Factor2: executive function	−0.14	2.55	0.14	2.11	0.57	0.451
Factor3: semantic inhibition	0.04	0.91	−0.04	0.54	0.96	0.331
Factor4: visual memory & attention	0.37	1.93	−0.36	2.59	3.13	0.080
Factor5: working memory	−0.17	2.51	0.17	2.21	3.40	0.068
Factor6: verbal memory	−0.19	1.92	0.18	1.96	4.18	0.043

The bolded indicate $p < 0.05$.

A total of 17 variables from the cognitive tests were included in the factor analysis, and six factors were extracted. The factors were named: (1) allocation. SET profile score, SET raw score and SET total rule break were included in this factor; (2) executive function. WCST perseverative error, WCST category, and SART correct responses were included in this factor; (3) semantic inhibition. Hayling sentence part B total correct and total error were included in this factor; (4) visual memory & attention. Visual reproduction immediate recall, visual reproduction delayed recall, verbal fluency correct, SART commission error were included in this factor; (5) working memory. LN total correct, LN longest passed, and 2-back accuracy were included in this factor; (6) verbal memory. Logical memory immediate recall and logical memory delayed recall were included in this factor. For this model, $KMO = 0.667$, $p < 0.001$, total variance explained was 75.42% (see Table 1).

3.2. Comparison of cognitive function between groups

Sixty-three controls were selected from the healthy group. The demographics and raw score of cognitive test of healthy control group and schizotypal group see Table 2. Significant differences were found in gender ratio ($p = 0.012$) and age ($p < 0.001$) between groups, so gender and age was controlled in the following analysis.

Cognitive measures were Z-transformed (save as standardized score in SPSS 13.0) and added to generate factor scores in schizotypals and controls. MANCOVA was conducted to examine the difference in factors between groups controlling for age and gender. Schizotypals performed worse than controls in allocation and verbal memory, and marginally worse in working memory (see Table 3).

3.3. Correlation analysis

There were significant correlations between IQ and cognitive factors, the correlation between IQ and cognitive factor was allocation ($r = 0.23$, $p = 0.009$), executive function ($r = 0.30$, $p = 0.001$), semantic inhibition ($r = -0.19$, $p = 0.03$), visual memory & attention ($r = 0.28$, $p = 0.002$), working memory ($r = 0.628$, $p < 0.001$), verbal memory ($r = 0.238$, $p = 0.007$), so IQ was controlled in the following correlation analysis in addition to age and gender. See Table 4 for

correlations between three factors of SPQ, SPQ total score and cognitive factors. After Bonferroni correction ($0.05/24 = 0.002$), there was no significant correlations, the relation between verbal memory and disorganization factor near significant ($p = 0.009$). See Table 5 for correlation between SPQ subscales and cognitive factors. After Bonferroni correction ($0.05/54 = 0.0009$), there were no significant correlations; the relation between verbal memory and suspiciousness approached significance ($p = 0.001$).

4. Discussion

The main findings of the present study can be summarized as follows: (1) Cognitive functions captured in our cognitive test battery can be reduced to six factors: allocation, executive function, semantic inhibition, visual memory and attention, working memory, and verbal memory; (2) Psychometrically identified schizotypal participants were impaired in allocation and verbal memory, and marginally impaired in working memory; (3) Schizotypal traits show some trend to be correlated with cognitive factors.

Our findings on the factor structure of neurocognitive deficits in schizotypal individuals were consistent with that of schizophrenia (Nuechterlein et al., 2004). In particular, specific deficits of allocation, verbal memory, and working memory were demonstrated in our present sample, suggesting that these functions may be core deficits of schizophrenia spectrum disorders, including schizophrenia (Conklin et al., 2000, 2005; Fuller et al., 2005; Glahn et al., 2005; Lee and Park, 2005; Lencz et al., 2003) and schizotypy (Gooding and Tallent, 2003; Kerns and Becker, 2008; Matheson and Langdon, 2008; Noguchi et al., 2008; Park et al., 1995b; Park and McTigue, 1997; Tallent and Gooding, 1999). It is interesting that our sample of psychometric schizotypal individuals with normal or above normal IQ showed intact performance on other neuropsychological tests, but specific allocation, verbal memory, and working memory deficits (Kerns and Becker, 2008; Matheson and Langdon, 2008; Noguchi et al., 2008; Park et al., 1995a; Park and McTigue, 1997; Tallent and Gooding, 1999). The measures in allocation factor are all from the Six Elements Test; previous studies showed that Six Elements Test had good psychological property and was sensitive to traumatic brain injury (Burgess et al., 1996, 2007; Burgess, 2000; Shallice and Burgess, 1991), suggesting it was a test of frontal lobe. The present study may indicate individuals with schizotypal characteristics may have mild frontal lobe impairments. All these data suggest that allocation, verbal memory and working memory deficit may be candidate endophenotypic markers of schizophrenia.

In schizophrenic patients, severity of negative symptoms correlated with impaired ability to hold letter and number sequences on-line and manipulate them simultaneously, compromised visuo-spatial working memory under distraction-free conditions, while disorganization symptoms correlated with impaired visuo-spatial working memory and inhibition (Cameron et al., 2002). A meta-analysis by Nieuwenstein et al. (Nieuwenstein et al., 2001) suggested that significant relationships were found between negative symptoms and poor performance on the WCST and the continuous performance

Table 4
Correlations between SPQ factor scores and cognitive factor scores (partial out age, gender, and IQ).

	1, allocation	2, executive function	3, semantic inhibition	4, visual memory & attention	5, working memory	6, verbal memory
SPQ cognitive-perceptual factor	r −0.20	−0.02	0.15	0.19	−0.10	−0.18
	p 0.031	0.810	0.104	0.041	0.292	0.053
SPQ interpersonal factor	r −0.10	−0.08	0.09	0.19	−0.20	−0.20
	p 0.278	0.408	0.368	0.044	0.036	0.037
SPQ disorganization factor	r −0.21	0.06	0.12	0.23	−0.06	−0.24
	p 0.028	0.535	0.217	0.016	0.555	0.009
SPQ total score	r −0.19	−0.03	0.12	0.24	−0.13	−0.22
	p 0.042	0.769	0.197	0.011	0.166	0.020

The p -values of bolded correlations were < 0.05 .

After Bonferroni correction ($0.05/24 = 0.002$), there were no significant correlations; only the relation between verbal memory and the disorganization factor approached significance.

Table 5

Correlations between SPQ subscales and cognitive factor scores (partial out age, gender, and IQ).

		1, allocation	2, executive function	3, semantic inhibition	4, visual memory & attention	5, working memory	6, verbal memory
Ideas of reference	<i>r</i>	−0.14	0.13	0.09	0.11	−0.06	−0.10
	<i>p</i>	0.126	0.163	0.352	0.233	0.549	0.312
Excessive social anxiety	<i>r</i>	−0.09	−0.06	0.00	0.08	−0.12	−0.05
	<i>p</i>	0.356	0.558	0.972	0.410	0.189	0.624
Odd beliefs or magical thinking	<i>r</i>	−0.21	−0.10	0.03	0.11	0.09	−0.08
	<i>p</i>	0.023	0.286	0.765	0.230	0.333	0.374
Unusual perceptual experiences	<i>r</i>	−0.12	−0.06	0.13	0.20	−0.07	−0.07
	<i>p</i>	0.188	0.514	0.158	0.033	0.432	0.474
Odd or eccentric behavior	<i>r</i>	−0.13	0.07	0.09	0.23	0.01	−0.19
	<i>p</i>	0.158	0.491	0.325	0.015	0.879	0.045
No close friends	<i>r</i>	−0.06	−0.08	0.02	0.16	−0.15	−0.09
	<i>p</i>	0.553	0.427	0.859	0.086	0.115	0.364
Odd speech	<i>r</i>	−0.24	0.04	0.12	0.18	−0.12	−0.26
	<i>p</i>	0.009	0.660	0.207	0.049	0.216	0.006
Constricted affect	<i>r</i>	−0.03	−0.08	0.07	0.22	−0.11	−0.20
	<i>p</i>	0.743	0.420	0.463	0.019	0.241	0.029
Suspiciousness	<i>r</i>	−0.14	−0.04	0.20	0.15	−0.24	−0.30
	<i>p</i>	0.125	0.691	0.034	0.122	0.012	0.001

The *p*-values of bolded correlations were <0.05.

After Bonferroni correction (0.05/54 = 0.0009), there were no significant correlations. Only the relation between verbal memory and suspiciousness approached significance.

test in schizophrenia, while disorganization showed a significant positive correlation with perseverations on the WCST. In general, negative symptoms in schizophrenia were correlated with working memory and executive function impairments, while disorganization symptoms were correlated with working memory, inhibition and switching deficits.

In psychometric schizotypy, negative symptoms were associated with poor performance on the WCST (Suhr and Spitznagel, 2001), verbal IQ (Noguchi et al., 2008) and working memory (Matheson and Langdon, 2008); the “no close friends” subscale of the SPQ was correlated with working memory deficits (Park and McTigue, 1997). Results of the present study were consistent with these findings that there was a trend that negative symptoms (interpersonal) were negatively correlated with working memory and verbal memory, whereas disorganization symptoms were negatively correlated with allocation and verbal memory.

There are several limitations of the present study: First, the schizotypal group and control group were not well matched in age and gender. However, it should be noted that participants of the current study were all young adults with similar age and this discrepancy would not affect the cognitive performance in this young adult sample too much. Second, the sample size of the schizotypal group is relatively small, future study should recruit more individuals with schizotypal characteristics. Moreover, only psychometric schizotypal subjects were included in this study; future studies should recruit clinically diagnosed patients with schizotypal personality disorders.

Notwithstanding these limitations, the current study is one of the very few studies specifically examining the cognitive functions of individuals with schizotypal personality features with a comprehensive battery of cognitive measures. Therefore, the current study adds further knowledge to the field of schizotypal personality disorders. In particular, it identifies specific cognitive impairments of psychometric schizotypal individuals, i.e., allocation, verbal memory and working memory; negative symptoms and disorganized symptoms showed a trend to correlate with cognitive functions.

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