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Schizotypal traits and cognitive function in healthy adults

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Abstract

Growing evidence has shown that psychometrically identified schizotypes among student populations have subtle cognitive impairments in several domains such as attention, working memory and executive function, but the possible association between psychometric schizotypy in adult populations and cognitive function has not been well documented. Here we examined the association between schizotypal traits as assessed by the Schizotypal Personality Questionnaire (SPQ) and cognitive function including memory, attention, executive function, and general intelligence in 124 healthy adults. Cognitive functioning was assessed with the Wechsler Memory Scale-Revised (WMS-R), the Wechsler Adult Intelligence Scale-Revised (WAIS-R), and the Wisconsin Card Sorting Test (WCST). SPQ scores showed a significant inverse correlation with verbal IQ and the information, comprehension and similarities subtests. No correlation was found between SPQ scores and memory, attention, performance IQ, or executive functioning. These results indicate that schizotypal traits in healthy adults are associated with verbal IQ decrements, suggesting that schizotypal traits themselves, even at a non-clinical level, may play unfavorable roles in cognitive functioning, which is in line with the viewpoint that schizotypy is on a continuum with normality, with its extreme form being clinically expressed as schizophrenia.

Keywords: Schizotypal personality; Cognitive function; Healthy adults

1. Introduction

Schizotypal personality and schizophrenia have been suggested to share common genetic (Siever and Davis, 2004; Lin et al., 2005), neuroimaging (Dickey et al., 2002), neurophysiological (Siever and Davis, 2004; Kiang and Kutas, 2005), and neurocognitive (Spaulding et al., 1989; Siever and Davis, 2004) abnormalities.

Generalized neurocognitive deficits, with profound deficits in certain areas such as verbal memory and learning (Saykin et al., 1991; Heinrichs and Zakzanis, 1998), are established as part of the core pathophysiology of schizophrenia and considered to have a major impact on patients' daily lives (Green, 1996). Patients with schizotypal personality disorder (SPD) also demonstrate cognitive impairments in several domains including verbal memory and learning (Voglmaier et al., 1997; Siever et al., 2002; Mitropoulou et al., 2005), working memory (Roitman et al., 2000; Siever et al., 2002; Mitropoulou et al., 2005) and executive functioning as assessed with the Wisonsin Card Sorting Test (Trestman et al., 1995; Voglmaier et al., 1997; Diforio et al., 2000). In addition,

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unaffected biological relatives of patients with schizophrenia have been shown to display cognitive impairments in areas such as verbal memory (Faraone et al., 1995; Toomey et al., 1998), attention (Keefe et al., 1997; Schubert and McNeil, 2005) and executive function (Faraone et al., 1995; Toomey et al., 1998); however, in studies of the association between schizotypy and neurocognition among first degree relatives of persons with schizophrenia, results are somewhat mixed such that some investigators have reported inverse relationships between schizotypy and neurocognitive functioning (e.g., Conklin et al., 2002), while others have found no or only weak association (e.g., Laurent et al., 2000).

Besides the studies of patients with SPD and of biological relatives of schizophrenia, those of psychometric schizotypes have drawn more and more attention from schizophrenia/schizotypy researchers as a promising endophenotypic approach to schizophrenia. Examining schizotypal traits in the non-clinical population is important to elucidate the predisposition to schizophrenia as these traits are not confounded by treatment or psychosocial consequences of psychiatric diagnoses (Mednick and McNeil, 1968), and as such, a large number of studies have investigated the relationship between schizotypy and neurocognitive functioning using non-clinical student populations (e.g., Lenzenweger and Korfine, 1994; Park and McTigue, 1997; Lenzenweger and Gold, 2000; Dinn et al., 2002; Spitznagel and Suhr, 2004; Gooding et al., 2006; Jahshan and Sergi, 2007). Most of these psychometric schizotypy studies targeting students have found inverse relationships between schizotypal traits and neurocognitive functions including sustained attention (Lenzenweger, 2001; Gooding et al., 2006), spatial working memory (Park and McTigue, 1997) and executive functioning assessed with the Wisconsin Card Sorting Test (Lenzenweger and Korfine, 1994; Daneluzzo et al., 1998; Gooding et al., 1999). In contrast, relatively few studies (Chen et al., 1997, 1998) have used other populations, such as community-based adults, to examine the relationship between schizotypy and neurocognition. From the standpoint of a "fully dimensional" approach (i.e., the individual differences approach) to schizotypy as proposed by Claridge and Beech (1995), it is considered to be important to examine such relationship among various populations. Based on the assumption that the degree to which individuals in the general population exhibit schizotypal traits varies on a continuum (Kendler et al., 1991), it can be predicted that the findings of inverse associations between schizotypy and cognitive function obtained by the studies using student populations would be extended, if not of the same magnitude, to the studies using adult populations.

With regard to general intellectual function, while patients with schizophrenia have been shown to have compromised intellectual ability compared with healthy people (Heinrichs and Zakzanis, 1998; Dickinson et al., 2004), there have been few explicit schizotypy studies on this issue. On the other hand, several lines of evidence have demonstrated the positive association between schizotypy and verbal creativity, or abnormal typicality of verbal response (Miller and Chapman, 1983; Folley and Park, 2005; Kiang and Kutas, 2006), indicating that schizotypy may be related to altered verbal abilities. This may in turn suggest that schizotypy might be associated with some impairments in standardized neuropsychological tests which assess verbal intelligence, such as the Wechsler Adult Intelligence Scale.

The present study aimed to examine the possible association between schizotypal traits as assessed with the Schizotypal Personality Questionnaire (SPQ, Raine, 1991) and a wide range of cognitive functions including memory, attention, executive function, and general intelligence in healthy adults from the general population.

2. Methods

2.1. Subjects

One hundred and twenty-four healthy volunteers were recruited from hospital staff and their associates through flyers and by word of mouth, and also from the community through local newspaper advertisements and our website announcement. A portion of the subjects was from our previous sample (Hori et al., 2006). Participants were interviewed for enrollment using the Japanese version of the Mini-International Neuropsychiatric Interview (MINI, Sheehan et al., 1998; Otsubo et al., 2005) by a research psychiatrist (H.H.), and only those who demonstrated no history of psychiatric illness or contact with psychiatric services were enrolled in this study. Participants were excluded if they had a prior medical history of central nervous system disease or severe head injury. Those who had one or more first-degree relatives with a psychiatric disease were also excluded. All subjects were biologically unrelated Japanese who resided in the Western part of Metropolitan Tokyo. Written informed consent was obtained from all subjects and the study was approved by the ethics committee of the National Center of Neurology and Psychiatry (NCNP), Japan. The Japanese version of the SPQ translated by Fujiwara (1993) was used in the present study. The questionnaire was distributed to participants at our laboratory. Each participant was allowed to take as much time as needed to complete the questionnaire, which was then returned to us by mail or by hand.

2.2. Schizotypy measure

The SPQ (Raine, 1991) is a 74-item validated self-report questionnaire with a "yes/no" response format, which incorporates DSM-III-R (American Psychiatric Association, 1987) criteria for a diagnosis of schizotypal personality disorder. All items endorsed "yes" are scored 1. The questionnaire consists of nine subscales, which have been found to load onto three factors: cognitive-perceptual (comprising the ideas of reference, odd beliefs/magical thinking, unusual perceptual experiences and suspiciousness/paranoid ideation subscales), interpersonal (social anxiety, no close friends, constricted affect and suspiciousness), and disorganized (eccentric/odd behavior and odd speech) factors (Raine et al., 1994).

2.3. Cognitive test measures

A wide range of neurocognitive tests were administered to all subjects in a random order that took at least 3 h to complete. The battery included the Wechsler Memory Scale-Revised (WMS-R, Wechsler, 1987; Sugishita, 2001), the Wechsler Adult Intelligence Scale-Revised (WAIS-R, Wechsler, 1981; Shinagawa et al., 1990), and the Wisconsin Card Sorting Test (WCST, Heaton, 1981; Kashima et al., 1987).

2.3.1. Wechsler Memory Scale-Revised

A full version of the WMS-R (Wechsler, 1987) was administered. The average score and standard deviation (S.D.) for the WMS-R in the general population are 100 and 15, respectively. This test mainly measures memory functions, namely verbal memory, visual memory and delayed recall. In addition, it includes the attention/concentration index, which consists of digit span forward/backward and visual span forward/backward subtests, thus being able to tap not only attention and concentration but verbal and spatial working memory.

2.3.2. Wechsler Adult Intelligence Scale-Revised

A full version of the WAIS-R (Wechsler, 1981) was administered, which yielded scores of verbal IQ, performance IQ and full-scale IQ.

2.3.3. Wisconsin Card Sorting Test

The WCST (Heaton, 1981) mainly assesses executive function including cognitive flexibility in response to feedback. We used a modified and computerized version of the test (Kashima et al., 1987; Kobayashi, 1999). In this test, subjects are required to correctly sort the cards on a computer screen either by color, shape, or number. The total number of the cards used herein is 48, which is fewer than the standard number of 128. Outcome measures were numbers of categories achieved, total errors, and perseverative errors.

2.4. Statistical analyses

Averages are reported as means±S.D. Means were compared using the *t*-test. The relationships between SPQ scores and cognitive test results were examined by Pearson's r and further by partial correlation analysis controlling for confounding variables. Statistical significance was set at two-tailed $P<0.05$ unless otherwise specified. Conservative $P<0.01$ was adopted as statistical significance and $P<0.05$ as trend-level significance where multiple correlational analyses were performed simultaneously. Analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 11.0 (SPSS Japan, Tokyo).

3. Results

3.1. Sample characteristics, SPQ scores, and cognitive test results

Of the 124 subjects, 24 were male and 100 were female. Mean age of the subjects was 46.3±14.8. Mean years of education was 14.4±2.3. SPQ scores of participants including nine subscales, three factors and total score are presented in Table 1. Males and females did not significantly differ in total SPQ score ($t=1.5$, $df=27$, $P=0.13$). Age showed a significant negatively correlation with total SPQ score ($r=-0.22$, $P=0.015$), whereas years of education did not show a significant correlation with the total SPQ score ($r=0.05$, $P=0.49$). Age was thus

Table 1
SPQ scores of the study sample

Characteristic	Total subjects ($n=124$)	
	Mean	S.D.
Ideas of reference	0.66	0.98
Social anxiety	2.67	2.13
Odd beliefs/Magical thinking	1.29	1.59
Unusual perceptual experiences	0.66	0.97
Eccentric/odd behavior and appearance	0.52	1.21
No close friends	0.8	1.3
Odd speech	2.48	2.17
Constricted affect	1.21	1.51
Suspiciousness/Paranoid ideation	0.82	1.34
Cognitive–perceptual factor	3.44	3.22
Interpersonal factor	5.5	4.79
Disorganized factor	2.99	2.89
Total SPQ	11.09	8.09

Table 2
Cognitive test results of the study sample

Variable	Total subjects (n=124)	
	Mean	S.D.
WMS-R		
Verbal memory	112.6	13.4
Visual memory	110.5	9.6
Delayed recall	112.6	12.6
Attention/concentration	107.0	13.4
WAIS-R		
Full scale IQ	112.6	10.8
Verbal IQ	110.7	12.0
Information	11.4	2.6
Digit span	11.5	2.8
Vocabulary	11.7	2.6
Arithmetic	11.2	2.9
Comprehension	11.9	2.4
Similarities	12.2	2.1
Performance IQ	112.4	10.8
Picture completion	10.5	2.2
Picture arrangement	11.7	2.5
Block design	12.5	2.6
Object assembly	11.4	2.8
Digit symbol	13.4	2.6
WCST		
Categories achieved	3.4	2.0
Total errors	18.9	8.0
Perseverative errors	7.1	7.4

controlled for in the partial correlation analyses. Table 2 shows the cognitive test results of the subjects.

3.2. Correlation between SPQ scores and cognitive test results

We examined correlations between SPQ scores and cognitive test results in the total group of subjects, controlling for age. Verbal IQ and its subscales information, comprehension, and similarities were significantly negatively correlated with one or more subscales of SPQ (Table 3), while 3 memory indices, attention/concentration, performance IQ (and its 5 subscales), and executive functioning were not significantly correlated with any subscales or total score of SPQ (data not shown). Of the cognitive indices examined, similarities showed the strongest negative correlation with SPQ measures. On the other hand, in terms of SPQ subscales, "odd beliefs/magical thinking" and "odd speech" subscales showed significant negative correlations with 2 of the 7 verbal IQ indices.

4. Discussion

Our results showed that schizotypal traits among healthy adults were correlated with poorer performance on verbal IQ and its information, comprehension, and similarities subscales, but not with verbal and visual memories, delayed recall, attention/concentration, performance IQ, or executive functioning.

Regarding the relationships between SPQ subscales and cognitive functions, a specific pattern of associations was found: "odd beliefs/magical thinking" and "odd speech" subscales were negatively correlated with verbal IQ subtests. These relationships might be plausible, taking into account that these two SPQ subscales contain several questions where "yes" answer would be closely related to poorer verbal intelligence. For example, "odd beliefs/magical thinking" subscale has questions such as "do you believe in telepathy?" and "have you had experiences with astrology, seeing the futures, UFOs, ESP, or a sixth sense?". It is likely that persons who demonstrate high

Table 3
Partial correlations between SPQ scores and WAIS-R verbal IQ test results, controlling for age

	Verbal IQ	Information	Digit span	Vocabulary	Arithmetic	Comprehension	Similarities
Ideas of reference	0.039	−0.030	0.002	0.114	0.034	0.045	0.021
Social anxiety	−0.211†	−0.211†	−0.027	−0.202†	−0.104	−0.160	−0.191†
Odd beliefs/Magical thinking	−0.238*	−0.254*	−0.057	−0.178†	−0.199†	−0.176	−0.136
Unusual perceptual experiences	−0.089	−0.173	−0.006	−0.011	−0.045	0.003	−0.146
Eccentric/odd behavior and appearance	0.106	0.161	0.007	0.123	0.112	0.059	−0.045
No close friends	0.018	0.054	0.081	0.003	0.110	−0.049	−0.153
Odd speech	−0.185†	−0.158	−0.070	−0.087	−0.042	−0.235*	−0.247*
Constricted affect	−0.091	−0.024	−0.062	−0.069	0.061	−0.094	−0.238*
Suspiciousness/Paranoid ideation	0.040	0.072	0.088	0.010	0.189†	−0.099	−0.203†
Cognitive–perceptual factor	−0.119	−0.160	0.007	−0.055	−0.024	−0.116	−0.193†
Interpersonal factor	−0.106	−0.067	0.015	−0.108	0.056	−0.142	−0.258*
Disorganized factor	−0.098	−0.055	−0.051	−0.016	0.014	−0.155	−0.206†
Total SPQ	−0.153	−0.138	−0.019	−0.095	−0.003	−0.172	−0.271*

Each figure represents partial correlation coefficient (r).
† $P<0.05$ (2-tailed).
* $P<0.01$ (2-tailed).

scores in these questions have an unusual cognitive function, leading to impairments in the standardized verbal assessment measure, the WAIS-R verbal IQ test. Similarly, the "odd speech" subscale has questions such as "I sometimes forget what I am trying to say", "I often ramble on too much when speaking", or "I sometimes use words in unusual ways", all of which could mean certain abnormalities in verbal abilities. Further, these routes as well as other potential routes by which poorer cognitive performance in schizotypes could be accounted for might be particularly relevant to the inhibition of "correct" responding on the similarities subtest.

The current results may be intriguing, taking account of an association between schizotypy and altered verbal abilities (Miller and Chapman, 1983; Folley and Park, 2005; Kiang and Kutas, 2006). It may be that schizotypy is related to unique verbal ability and therefore associated with somewhat poor performance on a standardized verbal intelligence test. Moreover, because the "odd speech" subscale is reported to be positively associated with creative thinking (Folley and Park, 2005) and was also related to poorer performance on the WAIS-R verbal IQ subtests in the present study, this subscale might be particularly involved in the altered verbal ability of schizotypes. Schizophrenia patients also display lowered verbal intellectual functioning (Heinrichs and Zakzanis, 1998; Dickinson et al., 2004; Hori et al., 2006). While Pickup (2006) has recently reported that verbal IQ is independent of theory of mind among non-clinical schizotypes, the relationship of schizotypy with IQ has been an under-studied topic thus far, and the current findings are, to our knowledge, the first to show that schizotypy is associated with a subtle decrement in verbal ability based on a full version of the standardized WAIS.

In the present study schizotypy did not influence the performance of attention/concentration as assessed with the WMS-R digit span and visual span subtests. Using community-based adult samples, however, Chen et al. (1997, 1998) have shown that schizotypy is related to poorer attention as measured by the Continuous Performance Test. This inconsistency between studies may result from differential constructs within attentional function assessed in the previous and present studies (i.e., sustained attention vs. selective attention).

We included the WMS-R in the cognitive battery to assess subjects' memory function, partly because a paucity of material has precluded definitive conclusions regarding an association of non-clinical schizotypy with this cognitive domain, particularly with visual memory and delayed recall. The present results showed no correlation between schizotypal traits and the WMS-R verbal memory test, in line with the previous studies that have found no verbal memory impairments among psychometric schizotypes (Lenzenweger and Gold, 2000; Spitznagel and Suhr, 2004; Jahshan and Sergi, 2007). On the other hand, whether patients with SPD display verbal memory deficits is somewhat controversial: some studies have shown that verbal memory decrements are seen in these patients (Voglmaier et al., 1997; Bergman et al., 1998; Mitropoulou et al., 2005), but others have found no impairment (Mitropoulou et al., 2002; Trotman et al., 2006). With respect to visual memory and delayed recall as assessed with the WMS, patients with SPD are reported to be compromised compared with healthy controls (Mitropoulou et al., 2002, 2005); however, in the present study, schizotypal traits among non-clinical adults did not affect performance on these memory domains. These discrepancies between the prior and present studies may be attributed to the differential extent of schizotypal traits (i.e., patients with SPD vs. schizotypy at a non-clinical level).

In the present study, no association was seen between schizotypal traits and WCST performance, whereas earlier studies have shown that schizotypic non-clinical students performed more poorly on the WCST than controls (e.g., Lenzenweger and Korfine, 1994; Daneluzzo et al., 1998; Gooding et al., 1999). This inconsistency might be due in part to the difference in sample characteristics, particularly age, between the previous studies and ours. It should also be noted that a recent study which screened thousands of undergraduates and identified high- and low-schizotypes found no difference on WCST performance between these two groups (Jahshan and Sergi, 2007), being in line with the present results.

There are several limitations to the current study. First, we enrolled healthy volunteers after asking their medical histories and administering the MINI to them, but we did not use any diagnostic tools for personality disorders such as the Structured Clinical Interview for DSM-IV Axis II Personality Disorders (First et al., 1997), which might have led to the inclusion of SPD subjects as healthy participants. However, there were only three participants whose total SPQ scores were above 30 in the present study, suggesting a very low possibility of including SPD subjects. Second, since we relied mostly on newspaper advertisements and website announcements to recruit participants, it is possible that certain sampling biases existed. This might be related to the higher cognitive functioning in our sample compared with the normative data of the WMS-R and the WAIS-R. The third limitation relates to the sampling strategy. Several recent studies, in contrast to the current study, have chosen schizotypy subjects from thousands of

undergraduates and thus the threshold for high schizotypes is ideal (e.g., Gooding et al., 2006; Jahshan and Sergi, 2007). Nevertheless, our "fully dimensional" sampling would have its own merits, as described earlier. Fourth, as we administered SPQ alone to the consecutively recruited healthy volunteers and therefore their SPQ scores were relatively low as a group, the possibility cannot be ruled out that a certain degree of cognitive decrements attributed to schizotypy herein could actually be accounted for by other traits such as temperament characteristics (Daneluzzo et al., 2005) and autistic traits (Hurst et al., 2007), both of which are reported to be associated with schizotypal traits. Finally, since the subjects were predominantly female, it is possible that the present findings are applicable only to females.

In summary, the present findings indicate that schizotypal traits in healthy adults are associated with mild verbal IQ decrements, suggesting that schizotypal traits even at a non-clinical level, rather than diagnosis of SPD or schizophrenia, may play unfavorable roles in cognitive function, which is in line with the viewpoint that schizotypy is a continuum from normality to its extreme expressed as schizophrenia.

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Personality in schizophrenia assessed with the Temperament and Character Inventory (TCI)

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Abstract

The Temperament and Character Inventory (TCI) is a well-established self-report questionnaire measuring four temperament and three character dimensions. However, surprisingly few studies have used it to examine the personality of patients with schizophrenia, and none in Japan. Moreover, possible gender differences in personality among patients with schizophrenia have not been well documented. We administered the TCI to 86 Japanese patients with schizophrenia and 115 age- and gender-matched healthy controls to characterize personality traits in patients with schizophrenia and to examine their relationships with clinical variables, particularly gender and symptoms. Compared with controls, patients demonstrated significantly lower novelty seeking, reward dependence, self-directedness and cooperativeness, and higher harm avoidance and self-transcendence. Male patients showed even more pronounced personality alteration than female patients when both of them were compared with healthy people. Personality dimensions were moderately correlated with symptom dimensions assessed by the Positive and Negative Syndrome Scale (PANSS). These results, together with prior findings in several other countries, suggest that schizophrenia patients have a unique personality profile which appears to be present across cultures and that the greater alteration of personality in schizophrenia males might be related to their poorer social and community functioning.

Keywords: Schizophrenia; Personality; Temperament; Character; Gender difference

1. Introduction

Personality in schizophrenia has been of interest ever since the pioneering work of Bleuler (1950) and Kraepelin (1919). Personality is considered to be an important aspect of schizophrenia primarily because it may influence symptom expression (Lysaker et al., 1999; Guillem et al., 2002) and social functioning (Lysaker et al., 1998; Eklund et al., 2004).

The Temperament and Character Inventory (TCI, Cloninger et al., 1993) is a well-established self-report

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questionnaire measuring four temperament and three character dimensions, developed on the basis of a psychobiological model of personality. The TCI has recently been widely used in personality studies in various psychiatric disorders including mood disorders (Hansenne et al., 1999; Cloninger et al., 2006) and personality disorders (Svrakic et al., 1993, 2002). However, to our knowledge, only three studies (Guillem et al., 2002; Boeker et al., 2006; Calvo de Padilla et al., 2006) have examined the personality of schizophrenia patients in comparison with healthy controls, using the TCI. The findings from these studies on unique personality profiles of schizophrenia are, to some extent, consistent with each other; but the limited sample sizes of the studies have made it difficult to draw definitive conclusions. It is also possible that cultural differences in personality exist between these studies, in view of the fact that personality traits among the general population as measured by the TCI vary across cultures (Pélissolo and Lépine, 2000; Brändström et al., 2001). Such cross-cultural comparison of personality in schizophrenia is an under-studied topic.

The knowledge to date on the personality characteristics of schizophrenia patients has been based mostly on instruments other than the TCI (Malmberg et al., 1998; Lysaker et al., 1999; Gurrera et al., 2000; Van Os and Jones, 2001; Pillmann et al., 2003). A number of studies have been done to investigate personality in patients with schizophrenia by using the well-known NEO Five-Factor Inventory (NEO-FFI, Costa and McCrae, 1992), and the results are fairly consistent in showing higher neuroticism and lower extraversion and conscientiousness in schizophrenia patients than in healthy controls (Gurrera et al., 2000; Pillmann et al., 2003; Camisa et al., 2005). Given the close relationship of the TCI dimensions to the "Big Five" personality dimensions of the NEO-FFI (De Fruyt et al., 2000; MacDonald and Holland, 2002; Ramanaiah et al., 2002), it would be intriguing to examine whether the personality of schizophrenia patients as assessed by the TCI shows a compatible pattern with that assessed by the NEO-FFI.

Concerning the association between personality and symptom dimensions in schizophrenia, previous studies that employed the TCI (Guillem et al., 2002) as well as the NEO-FFI (Lysaker et al., 1999) found certain relationships between these two dimensions; for example, Guillem et al. (2002) reported that psychotic symptoms in schizophrenia patients were associated with specific personality dimensions of the TCI. Boeker et al. (2006), by contrast, did not find any relationships between personality and symptoms, although the sample size of this study was relatively small. Due to the paucity of material, the association between personality and symptoms in schizophrenia remains to be further clarified.

Gender difference in essential facets of a particular disorder can yield important clues to its pathogenesis. In schizophrenia, gender differences have been shown in premorbid functioning, age at onset, symptomatology, and neuropsychological functioning. In general, male patients are reported to show indications of severer illness than female counterparts (Castle et al., 1993; Leung and Chue, 2000). However, possible gender differences in personality among patients with schizophrenia have not been well documented.

In this context, the present study aimed (1) to characterize personality traits in Japanese patients with schizophrenia using the TCI and compare the results with findings from the prior TCI as well as the NEO-FFI studies, and (2) to examine whether personality is related to clinical variables, particularly gender and symptoms, in schizophrenia. The study hypotheses were as follows: (i) Japanese patients with schizophrenia would show a unique personality profile, which is similar to that found in previous TCI studies of other countries as well as NEO studies; (ii) when compared with the personality profile of healthy people, the alteration of personality in male patients would be even greater than that in female patients, as is usually the case with gender differences in schizophrenia; and (iii) the more severe the symptoms, the more prominent the personality alteration would be.

2. Methods

2.1. Subjects

Subjects were 86 patients with chronic schizophrenia who were under treatment at the National Center of Neurology and Psychiatry, Musashi Hospital, Tokyo, Japan. All met the DSM-IV criteria (American Psychiatric Association, 1994) for schizophrenia. Consensus diagnoses were made based on clinical interviews, observations and case notes by clinicians who were all senior psychiatrists. One hundred and fifteen age- and gender-matched healthy volunteers were recruited from hospital staff and their associates through flyers and by word of mouth, and also from the community through local newspaper advertisements, our website announcement, and notices posted on bulletin boards at a college. Healthy participants were interviewed for enrollment using the Japanese version of the Mini-International Neuropsychiatric Interview (MINI, Sheehan et al., 1998; Otsubo et al., 2005) by a research psychiatrist

Table 1
Demographic and clinical characteristics of patients with schizophrenia and healthy controls stratified by gender

Characteristic	Schizophrenia patients (n=86)		Analyses (male vs. female patients)		Healthy controls (n=115)		Analyses (male vs. female controls)	
	Male (n=53)	Female (n=33)	Statistics	P	Male (n=71)	Female (n=44)	Statistics	P
Age, years: mean (S.D.)	41.5 (11.8)	41.9 (10.6)	$F(1,84)=0.025$	0.87	41.2 (14.0)	41.6 (4.1)	$F(1,113)=0.046$	0.83
Education, years: mean (S.D.)	13.6 (2.6)	13.1 (1.7)	$F(1,84)=1.19$	0.28	17.3 (3.0)	14.4 (1.9)	$F(1,113)=31.9$	<0.001
Family history of psychiatric disease: yes/no	20/33	9/24	$\chi^2(1)=0.996$	0.32				
Age at illness onset, years: mean (S.D.)	23.6 (6.6)	25.1 (8.8)	$F(1,84)=0.83$	0.36				
Duration of illness, years: mean (S.D.)	17.9 (11.4)	16.8 (10.1)	$F(1,84)=0.22$	0.64				
CPZeq of total antipsychotics, mg/day: mean (S.D.)	974.5 (927.5)	837.6 (690.8)	$F(1,84)=0.53$	0.47				
Number of hospitalizations, n: mean (S.D.)	2.3 (2.1)	2.2 (2.7)	$F(1,84)=0.061$	0.81				
Outpatients/Inpatients, n	35/18	22/11	$\chi^2(1)=0.0036$	0.95				
PANSS scores (n=53): mean (S.D.)	(n=31)	(n=22)						
Positive subscale	13.3 (5.6)	15.8 (7.7)	$F(1,51)=1.79$	0.19				
Negative subscale	20.5 (6.9)	18.9 (7.0)	$F(1,51)=0.63$	0.43				
General subscale	29.0 (8.8)	30.1 (8.1)	$F(1,51)=0.20$	0.66				
Total score	62.8 (16.8)	64.8 (18.9)	$F(1,51)=0.16$	0.69				

CPZeq: Chlorpromazine equivalents.
PANSS: Positive and Negative Syndrome Scale (Kay et al., 1987).

(H.H.), and only those who demonstrated no history of psychiatric illness or contact with psychiatric services were enrolled as healthy controls. Participants were excluded from both the patient and control groups if they had a prior medical history of central nervous system disease or severe head injury, or if they met DSM-IV criteria for mental retardation, substance dependence, or substance abuse within the past 6 months. All subjects were biologically unrelated Japanese who resided in the Western part of Metropolitan Tokyo. Written informed consent was obtained from all subjects prior to their inclusion in the study, and the study was approved by the ethics committee of the National Center of Neurology and Psychiatry (NCNP), Japan.

2.2. Personality assessment

Personality was assessed in all subjects with the Temperament and Character Inventory (TCI, Cloninger et al., 1993). TCI is a 240-item (including 14 items which are not analyzed) self-report questionnaire; each item requires a true/false answer. The term *temperament* refers to automatic emotional reactions to subjective experiences that may be genetically transmitted and therefore stable over time. Four dimensions of temperament are distinguished by the TCI: novelty seeking (NS), harm avoidance (HA), reward dependence (RD), and persistence (PS). NS, HA, and RD have been assumed to relate to dopaminergic, serotonergic, and noradrenergic neurotransmission, respectively (Cloninger, 1987). This model, therefore, may be particularly relevant in schizophrenia since such neurotransmitters are involved in symptom expression and are the main targets of antipsychotic medication (Markianos et al., 2001). The term *character* refers to concepts pertaining to the individual, focusing on personal differences in intentions, decisions and values. Three dimensions of character are distinguished: self-directedness (SD), cooperativeness (CO), and self-transcendence (ST). The reliability and validity of the original American version of the TCI in general community dwellers and in psychiatric patients have been established (Cloninger et al., 1993; Svrakic et al., 1993). Moreover, the TCI has been translated into and validated in more than seven languages including Japanese (Kijima et al., 1996, 2000), and used in many genetic (Benjamin et al., 1996; Ebstein et al., 1996) and clinical studies (Eklund et al., 2004; Cloninger et al., 2006). The Japanese version of the TCI, translated by Kijima et al. (1996), was used in the present study. The questionnaire was distributed to both patients and controls at the hospital and at our laboratory, respectively. Each subject was allowed to take as much time as needed to complete the questionnaire, then returned it to us by mail or by hand.

2.3. Clinical assessment and antipsychotic medication

Schizophrenic symptoms were assessed by an experienced research psychiatrist (H.K.) in 53 (male, 31; female, 22) of 86 patients using the Positive and

Table 2
Comparisons of TCI scores between patients with schizophrenia and control subjects

Variable		No. of items	Schizophrenia patients ($n=86$)	Healthy controls ($n=115$)	ANOVA[a]		ANCOVA[b]	
			Mean (S.D.)	Mean (S.D.)	F	P	F	P
Novelty seeking	NS	40	17.4 (4.6)	20.6 (4.1)	26.69	<0.001	27.79	<0.001
Harm avoidance	HA	35	22.7 (6.0)	16.9 (5.6)	48.4	<0.001	40.87	<0.001
Reward dependence	RD	24	13.6 (3.5)	15.2 (3.7)	9.86	0.002	13.55	<0.001
Persistence	PS	8	4.1 (1.9)	4.6 (1.7)	3.81	0.052	0.36	0.55
Self-directedness	SD	44	23.6 (6.6)	30.1 (5.8)	55.07	<0.001	32.64	<0.001
Cooperativeness	CO	42	26.7 (5.4)	28.5 (5.4)	5.38	0.02	5.18	0.02
Self-transcendence	ST	33	13.8 (7.5)	10.9 (5.1)	10.79	0.001	5.24	0.02

[a] Degrees of freedom = 1, 199.
[b] Education (in years) was controlled for. Degrees of freedom = 1, 199.

Negative Syndrome Scale (PANSS, Kay et al., 1987); this yields a total score in addition to scores on positive, negative, and general psychopathology subscales. All patients with schizophrenia were receiving antipsychotic agents and were clinically stable at the time of the personality evaluation. Daily doses of antipsychotics, including depot antipsychotics, were converted to chlorpromazine equivalents (CPZeq) using published guidelines (American Psychiatric Association, 1997; Inagaki et al., 1999).

2.4. Statistical analyses

Demographic characteristics and TCI scores were compared between groups. Means and categorical variables were compared using analysis of variance (ANOVA) and the χ^2 test, respectively. Pearson's r was used to examine correlations. One-way ANOVA with Bonferroni correction, allowing for multiple comparisons, was performed to examine differences between three groups. Analysis of covariance (ANCOVA) was used to compare TCI scores between groups, controlling for confounding variables. Statistical significance was set at two-tailed $P<0.05$. Analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 11.0 (SPSS Japan, Tokyo).

3. Results

3.1. Sample characteristics

Table 1 shows the characteristics of patients with schizophrenia and healthy controls (both are stratified by gender), respectively. Patients with schizophrenia and healthy controls did not differ in age ($F(1,199)=0.033$, $P=0.86$) or gender ($\chi^2(1)=0.00026$, $P=0.99$), but patients demonstrated significantly fewer years of education as compared with controls ($F(1,199)=51.1$, $P<0.001$). Schizophrenic males and females did not significantly differ in any of the characteristics examined. Control males and females did not differ in age, but control males had received significantly more years of education than females. Education was significantly correlated with RD ($r=-0.22$, $P=0.02$) and PS ($r=0.35$, $P<0.001$) in healthy controls; thus, in ANCOVA it was used as a covariate where appropriate.

3.2. TCI scores of patients vs. controls

TCI scores of patients with schizophrenia and control subjects are presented in Table 2. All personality dimensions except PS, namely six dimensions, were

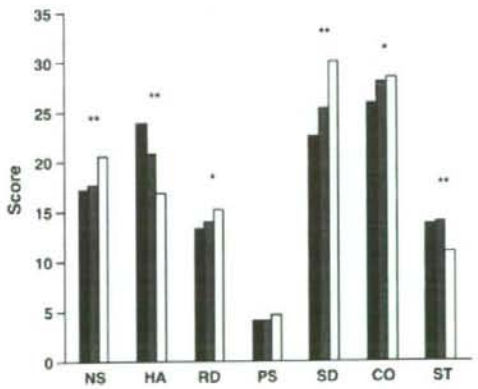

Fig. 1. Mean scores on 7 dimensions of TCI. ■, schizophrenia males; ▨, schizophrenia females; □, total controls (male and female combined). *Only schizophrenia males significantly differed from controls; **Both schizophrenia males and females significantly differed from controls.

Table 3
Correlations between TCI and PANSS scores

	NS	HA	RD	PS	SD	CO	ST
Positive subscale	0.02	−0.14	−0.10	0.23	−0.17	−0.04	0.34*
Negative subscale	0.04	0.11	−0.34*	−0.27*	−0.25	−0.28*	−0.25
General subscale	0.26	0.004	−0.37**	0.03	−0.32*	−0.29*	0.16
Total score	0.15	−0.01	−0.35**	−0.01	−0.32*	−0.27	0.11

Each figure represents Pearson's *r*.
* <0.05, **$P<0.01$.

significantly different between patients and controls using ANOVA; patients showed significantly higher scores on HA and ST and lower scores on NS, RD, SD and CO than controls. These differences between patients and controls in the six dimensions all remained significant after ANCOVA was performed with years of education as a covariate.

3.3. Gender differences in TCI scores

3.3.1. TCI scores of male patients vs. female patients

When TCI scores were compared between male and female patients using ANOVA, male patients showed significantly higher HA ($F(1,84)=5.23$, $P=0.025$) than female patients. In addition, male patients demonstrated lower SD ($F(1,84)=3.78$, $P=0.055$) and CO ($F(1,84)=3.46$, $P=0.066$) than female patients with statistical trend.

3.3.2. TCI scores of male patients vs. female patients vs. controls (male and female combined)

Fig. 1 shows comparisons of three groups (male patients/female patients/total controls) using one-way ANOVA with Bonferroni correction. Regarding RD and CO, male patients, but not female patients, significantly differed from controls. Concerning NS, HA, SD and ST, both male and female patients significantly differed from controls. In this analysis, male and female patients did not significantly differ in any of the seven personality dimensions.

3.4. Correlations between TCI scores and clinical variables (including symptoms) of patients

Duration of illness showed a significantly negative correlation with NS ($r=-0.23$, $P=0.04$). CPZeq medication dosage showed a significantly positive correlation with PS ($r=0.23$, $P=0.04$) and ST ($r=0.22$, $P=0.04$). Correlations between scores on the TCI and the PANSS are presented in Table 3. Family history of psychiatric disease, age at onset, and number of hospitalizations were not correlated with any of the TCI dimensions.

3.5. Comparisons of TCI scores in patients and controls between prior studies and ours

Table 4 shows a comparison of our TCI results and those of the two previous studies (Guillem et al., 2002; Boeker et al., 2006) which examined the personality of patients with schizophrenia using the TCI with a cross-sectional case–control design. All directions of differences between patients and controls in TCI dimensions, except for RD, were consistent in these three studies. Lower SD in patients with schizophrenia was the most consistent finding. Lower NS and CO and higher HA and ST in patients were quite consistent findings. Lower PS in patients was also a consistent finding, but not of great statistical significance. In addition, Calvo de Padilla et al. (2006) reported with an indigenous sample of Argentina that patients with schizophrenia showed significantly lower

Table 4
Comparisons of TCI results in schizophrenia patients and healthy controls between prior studies and ours

	Country (City)	No. of sample		Matching status	TCI results (patients vs. controls)*						
		Patients	Controls		NS	HA	RD	PS	SD	CO	ST
The present study	Japan (Tokyo)	86	115	Age/gender	−3.2**	5.8**	−1.6**	−0.5	−6.5**	−1.8*	2.9**
Guillem et al. (2002)	Canada (Montreal)	52	25	Age	−4.4**	8.1**	−0.9	−1.4*	−8.1**	−3.6**	2.4
Boeker et al. (2006)	Germany (Magdeburg)	22	22	Age/gender	−0.4	2.9	0.4	−0.4	−5.9**	−2.8*	4.1*

Each figure in these 7 columns was calculated as follows: ⟨mean of patients⟩ − ⟨mean of controls⟩
* Differences in sub-dimensions of TCI between patients and controls of each study.
* Patients showed a significant difference from controls ($P<0.05$).
** Patients showed a significant difference from controls ($P<0.01$).

RD, SD and CO compared with community controls (their data are not included in Table 4 because mean TCI scores were not presented in their report).

4. Discussion

In this study we report personality, as assessed with the TCI, in patients with schizophrenia compared to healthy subjects. Patients with schizophrenia demonstrated marked alteration of personality. Male patients seemingly showed greater alteration than female patients.

4.1. Personality traits in patients with schizophrenia

Our results indicate that patients with schizophrenia have pervasively altered personalities. Furthermore, the findings of the present and prior two studies (Guillem et al., 2002; Boeker et al., 2006), as shown in Table 4, are fairly consistent with each other. Guillem et al. (2002) reported that patients with schizophrenia showed significantly higher HA, and lower NS, PS, SD and CO compared to healthy controls, all of which were congruent with the present study, although the lower PS in our patients just failed to reach statistical significance. In contrast, RD and ST showed significant differences between the two diagnostic groups only in the present study. These could mainly be attributed to the larger sample size in the present study since the patterns of differences in mean scores on RD and ST between patients and controls were similar in these two studies. Moreover, Boeker et al. (2006) found that patients with schizophrenia showed significantly lower SD and CO and higher ST than healthy subjects, all of which corroborated our results. In addition, Calvo de Padilla et al. (2006) reported that patients with schizophrenia showed significantly lower RD, SD and CO compared to controls, all of which were also in line with our results. In general, our findings confirmed and extended the prior ones in that patients with schizophrenia have unique personality profile, in which lower SD is the most prominent abnormality. These findings may be of clinical importance, taking account of the studies that reported TCI scores, especially SD, were related to level of functioning and psychological health (Eklund et al., 2004) and to subjective quality of life (Hansson et al., 2001) in patients with schizophrenia.

On the other hand, cross-cultural differences in personality assessed with the TCI may exist (Pélissolo and Lépine, 2000; Brändström et al., 2001). Indeed, mean scores for both patients and controls on each dimension of TCI were substantially different between our subjects and the prior ones. Further, these differences of TCI scores between studies within the same diagnostic groups were of comparable size to the differences between patients and controls within each study.

The most plausible explanation may be that although personality itself may vary across cultures, it may be a worldwide phenomenon that patients with schizophrenia collectively have markedly different personality profiles from healthy people in their own cultural group, especially regarding NS, HA, SD, CO and ST.

Moreover, the fact that the NEO-FFI findings higher neuroticism and lower extraversion and conscientiousness are well established in schizophrenia (Gurrera et al., 2000; Pillmann et al., 2003; Camisa et al., 2005), coupled with the substantial overlap between NEO-FFI and TCI dimensions (e.g., positive correlation between neuroticism and HA, negative correlation between neuroticism and SD, and positive correlation between conscientiousness and PS) (De Fruyt et al., 2000; MacDonald and Holland, 2002; Ramanaiah et al., 2002), would theoretically predict the following TCI results in schizophrenia patients: high HA, low PS, low SD. Indeed, these predictions are largely in accord with our actual results as well as with previous TCI findings. Regarding NS, positive correlation with extraversion and negative correlation with conscientiousness have simultaneously been reported (De Fruyt et al., 2000; MacDonald and Holland, 2002; Ramanaiah et al., 2002); however, since both extraversion and conscientiousness are low in schizophrenia, it is impossible to examine the compatibility of this TCI dimension with the NEO findings. In short, the personality profile of schizophrenia patients as assessed by the TCI showed a compatible pattern with that assessed by NEO-FFI. All in all, hypothesis (i) has largely been supported.

4.2. Gender differences in personality among schizophrenia patients

Hypothesis (ii) was partly supported in that male patients showed even greater personality alteration than female patients (when both groups are compared to controls) for the two dimensions, RD and CO (Fig. 1). These results are in harmony with a precedent study that reported schizophrenic males showed greater abnormality in premorbid personality than schizophrenic females (Foerster et al., 1991). Gender differences have already been reported concerning other important variables in schizophrenia such as age at illness onset, premorbid functioning, symptomatological characteristics, and neuropsychological function (Castle et al., 1993;

Leung and Chue, 2000). Generally, male patients with schizophrenia tend to be more severely ill than their female counterparts as shown by earlier age of onset, poorer premorbid functioning, severer cognitive deficits, and higher risk of having a deficit state (Castle et al., 1993; Leung and Chue, 2000). Some of these gender differences might reflect the gender difference in personality in the present study, in which male patients apparently showed more unique personality profiles than female patients.

4.3. Relationships between personality and symptom dimensions

In the present study, since TCI dimensions were somewhat correlated with schizophrenic symptoms and dosage of antipsychotics, personality might be affected by illness severity. For instance, ST was positively correlated with positive symptoms and dosage of antipsychotics, suggesting that this personality dimension could be substantially related to the severity of positive symptoms. This positive correlation between ST and psychotic symptoms has also been found in the precedent study (Guillem et al., 2002) which used the three-dimensional model of Andreasen et al. (1995) and the five-dimension model of Toomey et al. (1997) for assessment of symptoms. In addition, Guillem et al. (2002) have reported that psychotic symptoms are positively correlated with NS and negatively with SD, both of which were not replicated in the present study. Instead, in the present study negative symptoms were negatively correlated with RD, PS and CO. These correlations in the present study appear to be plausible, given that the negative subscale of PANSS is composed of items which assess, for example, "blunted affect", "passive social withdrawal", and "poor rapport". These relationships observed between personality and symptom dimensions were in support of our hypothesis (iii). The inconsistencies between studies might be due in part to the differential instruments of symptom assessment used, and require further investigations.

4.4. Strengths and limitations of the study

A major advantage in this study was that we examined personality by using the TCI, which has a number of merits in personality research that have already been mentioned in the present report. Sample size of the present study was the largest of the four personality studies of schizophrenia where the TCI was used (Guillem et al., 2002; Boeker et al., 2006; Calvo de Padilla et al., 2006). Moreover, our patients and controls were matched for age and gender, and male and female patients were similar to each other regarding all clinical variables examined, both of which made further comparisons by gender relatively free from confounders. On the other hand, education was significantly different between patients and controls or control males and females, but the lowered education in schizophrenia could be closely related to the illness itself. It should also be noted that in Japan it is common for men to achieve higher educational status than women. Thus our subjects, both patients and controls, are likely to be representative of the general Japanese population in terms of education.

There are several limitations to this study. First, its cross-sectional nature does not permit any definite conclusions as to whether personality traits we found to be altered in schizophrenia are premorbid ones or the results of changes after illness onset. Second, personality assessment was based on self-report, thus not objective. However, our results that showed moderate correlations between TCI and PANSS scores might suggest that the results of subjective personality assessment with the questionnaire were corroborated by those of objective symptom assessment. Third, since our sampling was not community-based random sampling, it is possible that certain sampling biases existed; people who had high "novelty seeking", for example, were likely to become interested in this study. Finally, our patients with schizophrenia were chronic, which precluded extrapolation of the results to recent-onset patients.

4.5. Conclusions

The present findings indicate that patients with chronic schizophrenia have pervasively altered personality profile as measured by TCI which is in line with previous studies, and male patients may undergo even more pronounced personality alteration than female patients when both of them are compared to healthy people.

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Impairment of motor dexterity in schizophrenia assessed by a novel finger movement test

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Abstract

Schizophrenia is characterized by a series of serious mental disturbances, including social, cognitive, and emotional dysfunctions. Although motor dysfunctions as well as the cognitive impairments in schizophrenia have been noted since the era of Kraepelin, little attention has been paid to motor dysfunctions until recently. Here, we examined the characteristics of motor dysfunctions and their relationship to other cognitive functions in schizophrenia. Subjects were 27 patients who met the DSM-IV criteria for schizophrenia and 49 healthy volunteers. A series of motor tests, i.e., pegboard, mirror drawing, normal drawing, and finger movement tests, were administered, and cognitive functions were assessed with the Wechsler Adult Intelligence Scale Revised, the Wechsler Memory Scale Revised and the Wisconsin Card Sorting Test. The finger movement test is a novel motor test that we developed to assess motor dexterity independent of motor speed. A stepwise discriminant analysis revealed that the finger movement and delayed recall tests were able to distinguish patients and controls most effectively. The scores of these two tests showed no correlation. Educational level was correlated with the delayed recall score, but not with the finger movement score. A significant difference was observed in the finger movement test score between inpatients and outpatients. There was no significant correlation between dosage of antipsychotic drugs and finger movement score in the patient group. The present results suggest that impairment in motor dexterity is a major characteristic of schizophrenia, which might be independent of cognitive functions.

Keywords: Schizophrenia; Motor function; Cognitive function; Education level

1. Introduction

Patients with schizophrenia have a wide spectrum of disturbances, including social, cognitive, and emotional dysfunctions. Of these, the most serious dysfunction may be cognitive impairment (Goldberg and Seidman, 1991),

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with the associated memory deficits (Saykin et al., 1991, 1994; Heinrichs and Zakzanis, 1998). Whereas motor dysfunctions, as well as cognitive impairments, have been noted since the time of Kraepelin (Kraepelin, 1919), research interest in motor activity diminished after the introduction of antipsychotic drugs, when symptoms of motor dysfunction were mainly interpreted as side effects. Nevertheless, motor function in schizophrenia has been revisited by recent investigators (e.g. Rogowska et al., 2004; Jahn et al., 2006).

The most remarkable motor dysfunction in schizophrenia may be the deficit in fine motor skills (Rosofsky et al., 1982; Manschreck, 1986). Three tests have most commonly been used to evaluate motor function in schizophrenia: the reaction time test to evaluate the speed of initial timing, the finger tapping test to examine the speed of continued oscillatory movement, and the pegboard test to determine motor dexterity (King, 1958; Heinrichs and Zakzanis, 1998). However, scores on the pegboard test are thought to be affected by motor speed as well as dexterity (Rosofsky et al., 1982). Therefore, the development of a motor test that can evaluate dexterity irrespective of motor speed would be beneficial. The examination of movement dexterity has recently received an increasing amount of attention because dexterity has been shown to be associated with functional outcomes (Lehoux et al., 2003). Furthermore, some studies have found that deficits in dexterity were greater in familial than in sporadic forms of schizophrenia (Sautter et al., 1997; Gschwandtner et al., 2005).

In this study, we attempted to elucidate motor dysfunction using some traditional tests and a newly developed test (finger movement test) in chronic schizophrenia. We also attempted to elucidate which among several motor and cognitive tests most effectively discriminated patients from controls.

2. Methods

The research protocol was approved by the ethics committee of the National Center of Neurology and Psychiatry (NCNP), Tokyo, Japan. Written informed consent was obtained from all subjects.

2.1. Subjects

The participants in the present study were 27 patients who met the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV) criteria for schizophrenia and 49 healthy volunteers (Table 1). The patients were under treatment at the Department of Psychiatry, Musashi Hospital, NCNP. A consensus diagnosis of schizophrenia was made by at least two psychiatrists based on clinical interviews, observations, and case notes. Patients had been clinically stable and maintained on a stable dose of antipsychotic medication for at least 3 months prior to the neuropsychological testing sessions. Among 27 patients, there were 15 inpatients under long-term care. Healthy volunteers from hospital staff and their associates who had no history of psychiatric treatment were recruited. The subjects had no history of central nervous system disease, severe head injury, alcohol/drug dependence, or mental retardation. They were biologically unrelated Japanese who resided in the same geographical area, the Western part of the Tokyo metropolitan area.

2.2. Procedures

We selected the following four motor function tests: pegboard, mirror drawing, normal drawing, and finger movement tests. The pegboard test has been widely used to evaluate motor dexterity (e.g. King, 1958; Heinrichs and Zakzanis, 1998). The mirror drawing test measures visuo-motor coordination and procedural learning, which have been shown to be impaired in patients with schizophrenia (Scherer et al., 2003). To assess whether deficits in the mirror drawing test depend on the mirroring procedure, a normal (non-mirror) drawing test using the same figure was also administered. In order to evaluate motor dexterity, excluding the effect of motor speed, we developed the "finger movement test". In addition to the motor domain, memory, intelligence, and executive functions were also examined, since such functions have been found to be impaired in schizophrenic patients (e.g. Bilder et al., 2000). The handedness of each subject was evaluated using the Edinburgh inventory (Oldfield, 1971). With the exception of the finger movement test, each motor test was performed with the dominant hand.

The grooved pegboard test (Matthews and Klove, 1964) was used with minor modifications, i.e., the subjects were asked to pinch aluminum rivet pins (3 mm in diameter, 1.5 cm in length) one by one and insert them into small holes arrayed in a 5×5 grid as fast as possible. The time (seconds) for completion was measured as the score. In the mirror drawing test (Milner et al., 1968), the subjects were asked to use a pencil to trace a shape, which was a modified hexagon with double lines (Fig. 1) while looking at it through a mirror apparatus (TAKEI Corporation, Tokyo, Japan). The width between the lines was 3 mm. At the beginning of a trial, the examiner put the tip of the pencil at the starting position and asked the subject to trace the shape as fast as