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Clinical and neurocognitive course in early-onset psychosis: a longitudinal study of adolescents with schizophrenia-spectrum disorders*

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Abstract

Aim—Adolescents with psychotic disorders show deficits in IQ, attention, learning and memory, executive functioning, and processing speed that are related to important clinical variables including negative symptoms, adaptive functioning and academics. Previous studies have reported relatively consistent deficits with varying relationships to illness status and symptoms. The goals of this study were to examine these relationships in a larger sample at baseline, and also to examine the longitudinal course of these deficits in a smaller subset of adolescents.

Method—Thirty-six subjects, aged 10 to 17 years, were included at baseline. All had Diagnostic and Statistical Manual-Fourth Edition diagnoses of schizophrenia, schizoaffective disorder, schizophreniform disorder and psychosis – not otherwise specified, as determined by Kiddie-Schedule for Affective Disorders and Schizophrenia for School-Age Children structured interviews. Patients were administered a neuropsychological battery, and Positive and Negative Syndrome Scale ratings were completed at baseline and again at 1 year (n = 14). Most participants were inpatients at baseline, and 13 of 14were on atypical antipsychotic medication during both sessions.

Results—At baseline, the patients demonstrated impairments in working memory, processing speed, executive function and verbal learning. No significant cognitive change was detected at 1-year follow-up. In contrast, clinical symptoms were variable across 1 year, with an improvement in positive symptoms at 1 year. No relationships between clinical and cognitive symptoms were observed, with the exception of baseline IQ predicting negative symptoms at 1 year.

Conclusions—Young patients with schizophrenia-spectrum disorders displayed neurocognitive impairments at baseline. Despite measurable fluctuations in clinical symptoms over the year, no significant changes were measured in cognition. Lower IQ at baseline was predictive of more negative symptoms at 1 year.

Keywords

adolescent; longitudinal; neuropsychology; psychosis; schizophrenia

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Introduction

Interest is growing in the early identification, characterization and treatment of psychotic disorders, accompanied by a new sense that the trajectory of psychotic illness is not necessarily one of progressive decline.[1] Historically, adolescent psychosis has been understudied, especially considering that symptoms commonly present during adolescence.[2] Nearly one-third of patients who eventually receive diagnoses of schizophrenia experience an initial psychotic break by age 19.[3] It is well known that the early stages of psychosis are accompanied by a significant cognitive impairment, but questions remain about the course of that impairment and relationships with key clinical variables.[4–8] The current study examines clinical status and neurocognitive functioning in a sample of adolescents with early-onset schizophrenia-spectrum disorders, and also reports on a subset that was followed longitudinally.

Early-onset schizophrenia is typically conceptualized as falling on a continuum with the adult-onset form of the illness,[9,10] and can be reliably diagnosed using the same criteria.[11] Some investigators have proposed that adolescent-onset schizophrenia may represent a more severe form of the illness, as supported by retrospective studies showing less favourable clinical outcome[12–14] and more severe cognitive impairment in adult patients who had onset during adolescence.[15–17] However, one study directly comparing adult patients who had adolescent-onset with a sample of adult-onset patients[18] found that adolescent patients showed greater deficits than adult-onset patients in motor function only. Despite mixed findings regarding relative severity and trajectory, these studies all suggest that early-onset schizophrenia is associated with many of the same cognitive deficits as adult-onset patients, including slow processing speed, working memory problems, inattention and other executive functioning deficits.

Adolescent patients have been shown to be impaired on most cognitive measures compared with controls, with the largest effect sizes for working memory and attention.[5] Ueland *et al.* found impairment in adolescent patients compared with controls in pre-attentional processing, visual long-term memory, auditory short-term memory and working memory.[19] In another study,[20] both adolescent-onset and childhood-onset patients showed neurocognitive deficits of up to 2.0 SD, with the most severe deficits in executive functioning. In that study, neurocognitive performance correlated more with negative symptoms than with positive symptoms. Fagerlund *et al.* reported that patients with early-onset schizophrenia were significantly impaired on tasks of executive functioning, attention, verbal memory and intelligence.[21]

One advantage of studying early-onset psychosis is that patients have not yet had years of exposure to neuroleptic medications, which could potentially confound outcome measures. Brickman *et al.* found that drug-naive, first-break adolescents had significant impairments compared with controls, especially in executive functioning, attention and memory, suggesting that at least some of the cognitive deficits in schizophrenia precede exposure to neuroleptics.[4] In a sample of adolescent-onset patients, Kravariti *et al.* found no significant correlations between cognition and illness duration, severity of symptoms or medication dose, but did find that longer neuroleptic exposure was associated with lower performance in

attention, psychomotor speed and working memory.[22] Taken together, these studies make clear the importance of evaluating cognition in the early stages of the illness.

One frequently cited potential complication in studies of early-onset psychotic conditions is the diagnostic heterogeneity of patient groups during the emergent phase of the illness. In contrast to a fluctuating, heterogeneous clinical picture, neurocognitive impairment seems to be a predictable and, perhaps, a stable characteristic of young patients with psychosis. Kumra *et al.* found that patients with childhood-onset schizophrenia and atypical psychosis (psychotic disorder – not otherwise specified) scored 1–2 SDs below average on cognitive tests; however, there were no differences in the level or pattern of deficits between the groups.[6] Similarly, McClellan *et al.* found no differences in the neurocognitive profiles from three diagnostic groups: schizophrenia, bipolar and psychosis not otherwise specified.[8] Thus, neurocognitive impairment is a common characteristic of early psychosis and may ultimately serve as an important marker or anchor point in the face of a changing clinical presentation.

Very few longitudinal studies directly address the course of cognitive impairment over time in this population. In one large first-episode study of both adolescents and adults, Rund *et al.* found a relative stability in neurocognitive functioning, such that most deficits were present at onset and remained constant over 2 years.[23] There was no association between the duration of untreated psychosis (DUP) and the course of cognitive functioning. A study of treatment-refractory patients with childhood-onset showed impaired intelligence at onset, but no further decline during the early years of the illness.[24] A third longitudinal study evaluating intelligence, memory, attention, executive functioning and motor skill in early-onset schizophrenia found that, although patients' clinical symptoms improved over the 13-month period, there was a general stability in neurocognitive status.[25]

We hypothesized that adolescents with schizophrenia-spectrum conditions would display significant deficits in working memory, processing speed, executive functioning and verbal learning. The goals of the current study were to characterize the cognitive deficits and clinical symptoms in adolescents with psychotic disorders, to track the stability of deficits over a 1-year course of illness in a subset of patients, and to examine the relationships between cognition and clinical status at both time points.

Methods

Subjects

Patients were recruited from an adolescent psychiatric inpatient unit and a university-based outpatient clinic through contact with treating psychiatrists. Patients receiving a diagnosis of schizophrenia, schizoaffective disorder, schizophreniform disorder or psychosis not otherwise specified were included (see Table 1). Specific information on DUP was not collected. Additional inclusion criteria were ages 10–17, ability to participate in neurocognitive testing, and availability of a caregiver to participate in diagnostic and symptom interviews. Exclusion criteria were comorbid neurological disorder, medical condition known to affect brain function, affective psychotic disorder or an IQ less than 70. An IQ estimate was obtained with the Wechsler Abbreviated Scales of Intelligence

(WASI).[26] Thirty-six patients (mean age = 14.58, SD = 1.90) were included at baseline. Patients were not asked to commit to the follow-up study at the time of enrolment. All were invited to return, and 14 patients returned for the follow-up evaluation at 1 year. The remainder either did not respond to invitations or declined to return for follow-up.

Procedures

Consent—The informed consent process included a discussion of the study with the patient and a parent, a consent form signed by the parent, and an assent form signed by the adolescent. All procedures were reviewed and approved by a university institutional review board. Subjects were compensated with a $25 gift card for the baseline visit and another $25 gift card for the follow-up visit.

Diagnosis and symptom rating—Psychiatric diagnoses were made in accordance with the Diagnostic and Statistical Manual-Fourth Edition, and were based on a structured diagnostic interview with the adolescent and parent using the Kiddie-Schedule for Affective Disorders and Schizophrenia for School-Age Children, Present and Life-time[27] (JRW, JBJ and TW). Diagnoses were reached through a consensus of at least two clinicians (JRW, TW and JBJ). Clinical symptoms were evaluated with the Positive and Negative Syndrome Scale (PANSS)[28] (JRW and EEB).

Neurocognitive assessment battery—The subjects completed the following neuropsychological measures: the WASI[26] (intelligence domain), the working memory (also called ‘freedom from distractibility’) (working memory domain) and processing speed subtests from the Wechsler Intelligence Scale for Children (3rd or 4th edn) (WISC-III or WISC-IV)[29,30] (arithmetic, digit span, coding and symbol search) or the Wechsler Adult Intelligence Scale (WAIS)[31] (arithmetic, digit span, letter–number sequencing, digit symbol and symbol search) (processing speed domain), Controlled OralWord Association Test,[32] Wisconsin Card Sorting Test,[33] Tower of London[34] and the Stroop Test[35] (all part of the executive functioning domain), and the California Verbal Learning Test (CVLT-II or CVLT-C)[36,37] (verbal learning domain). At baseline, subtests from the WISC-III or WISC-IV (which became available during the course of the data collection) were administered to the subjects up to and including the age of 16. Consistent with standardized testing procedures, 17-year-olds were administered subtests from the WAIS-III at baseline. The subjects who returned for follow-up were administered the same measures as at baseline. Baseline test choice was consistent with the tests' standardized age ranges so that scores could be provided to the treating clinicians. In addition to cognitive testing, the Behavior Rating Inventory of Executive Functioning (BRIEF)[38] was administered to the patients' primary caregivers to assess the behavioural expressions of executive function deficits (also part of the executive functioning domain). The BRIEF and the WASI were not repeated at follow-up. The battery was constructed of commonly used and readily available clinical neuropsychological instruments specifically to enhance the clinical relevance of the findings. The study was conducted within the context of active clinical practice, and the neurocognitive findings were provided to the treating psychiatrists and psychologists.

The battery was administered after a clinical neuropsychologist (JRW) determined that the patient was stabile enough to participate. Testing was postponed if a patient was experiencing hallucinations, high anxiety or persecutory ideation, or if the patient was currently in a severe amotivational state. For inpatients at baseline, the mean stabilization period was 9.2 days from the time of admission, with a range from 3 to 23 days. Information about DUP was not collected. At follow-up, all patients were seen on an outpatient basis.

Data analysis—Two separate manovas were conducted to ensure that there were no neurocognitive or clinical differences between patients who returned for follow-up and those who did not. Because no control group was included, descriptive statistics were presented comparing patients' neurocognitive scores with normative standards. Correlational analyses were used to examine potentially confounding relationships between antipsychotic dose and cognitive performance. Paired samples *t*-tests were used to examine the change over time (baseline vs. follow-up) for neurocognitive measures and for PANSS ratings. The stability of individual clinical ratings and neurocognitive performance over time was examined with Pearson correlations. In order to examine the relationship between cognitive performance and clinical symptoms, Pearson correlations were computed.

Results

In order to assess for differential dropout, baseline symptom ratings and neurocognitive data were compared for completers and non-completers. A manova examining the eight neurocognitive measures at baseline (not including BRIEF scores) did not reveal a significant difference between the groups (Wilks' lambda = 0.726, $F(8, 23) = 1.08$, $P = 0.409$). A manova examining the baseline PANSS positive, negative and total scores for completers versus non-completers was non-significant (Wilks' lambda = 0.903, $F(3, 31) = 1.11$, $P = 0.358$).

In order to examine for possible confounding effects of antipsychotic medication on cognitive test performance, doses were converted to chlorpromazine equivalents[39] and were tested using Pearson correlations with each of the cognitive variables of interest. No significant correlations were found at either baseline or follow-up (Table 2).

Baseline neurocognitive data are contained in Table 3. The mean *z*-scores, based on standardized norms, are included as clinical reference points. The patients performed consistently below average, in the range of −0.54 to −1.64 SDs below the mean on all neuropsychological tests. Behavioural ratings (BRIEF) indicated that the patients also displayed real-world executive function deficits compared with controls, in the range of 1.73–2.09 SDs from the mean. Table 3 contains the PANSS ratings from the entire sample at baseline ($n = 36$), illustrating the significant levels of symptoms in the patients.

Table 4 displays the results of two sets of paired samples *t*-tests, for neurocognitive performance and for clinical measures, which assessed the change over time for subjects who returned for follow-up at 1 year ($n = 14$). These analyses were performed using standardized neurocognitive scores and PANSS raw scores. For the clinical measures, only the PANSS positive scores showed a significant decrease from baseline to 1 year ($P =$

0.036). In order to statistically control for multiple comparisons for the neurocognitive measures, a Bonferroni correction was applied by dividing the alpha level of 0.05 by the number of tests, which resulted in a threshold significance level of 0.007. Using this conservative threshold level, none of the results reached significance, although there were trend-level changes from baseline to follow-up, including a decline in working memory ($P = 0.022$) and an improvement in WCST errors ($P = 0.016$).

Individual change/stability in symptom presentation and cognition over 1 year was examined with Pearson correlations (Table 5). The PANSS scores were not correlated from baseline to follow-up, suggesting that the patients' symptoms were variable over time. In contrast, all of the cognitive measures showed significant correlations from baseline to follow-up, indicating individual stability in cognitive functioning over the time period examined.

Because the literature suggests that the course of cognitive deficits and the course of clinical symptoms may differ, we chose to examine the relationship between global cognitive status and clinical symptoms. Correlations were computed between full-scale IQ and PANSS positive and negative symptoms at baseline. These correlations showed no significant relationship between IQ and negative symptoms ($r = -0.212$, $P = 0.228$) or positive symptoms ($r = -0.047$, $P = 0.791$) at baseline. The predictive power of IQ at baseline to clinical symptoms at 1-year follow-up was also examined. Baseline IQ was correlated with negative ($r = -0.706$, $P = 0.007$), but not with positive ($r = -0.498$, $P = 0.083$) symptoms at follow-up. Lower IQ at baseline was associated with greater negative symptoms at follow-up.

Finally, an exploratory set of correlations was performed in order to examine the relationship between the change in cognitive performance over 1 year and the change in clinical symptoms over 1 year. Change scores were computed for each of the neurocognitive measures and for PANSS scores by subtracting the baseline values from the follow-up values. These data are presented in Table 6. Only Stroop Color Word score change was associated with change in clinical symptoms. Improvement in Stroop performance (an increase in score) was associated with improvement in positive, negative and total symptoms (a decrease in PANSS score).

Discussion

The current data are consistent with previous studies showing a range of cognitive deficits in young patients with schizophrenia-spectrum conditions.[5,20,21,23] Patients in the sample scored approximately 1–2 SDs below the mean across the range of neurocognitive measures at baseline. One notable exception was that of overall intelligence (as assessed by an abbreviated measure), which fell about one-half SD below the average at baseline. Wisconsin Card Sorting Test performance was also within the average range at baseline.

A significant change in cognitive performance was not observed over the 1-year time frame of the study for most domains examined, although there was a trend towards reduced working memory capacity over 1 year and a trend towards improvement in Wisconsin Card Sorting Test performance. Across most measures, strong positive correlations were observed

between the cognitive performance at baseline and follow-up. Because this study did not include a control group, we do not know whether control subjects would have shown an improved performance at follow-up (because of practice effects), potentially casting a different interpretation on the apparent stability of performance in patients. This is a significant limitation of the current study. Because the Wisconsin Card Sorting Test involves a significant amount of learning over 128 trials, repeated administration is likely confounded by practice effects, even at the 1-year readministration interval used here. Although not directly comparable, a recent 4-year longitudinal study of early-onset schizophrenia is relevant for context.[40] That study demonstrated a relative overall stability in cognitive functioning including a slight improvement in intellectual functioning and a slight decrement in verbal memory. No changes in memory, no changes in executive functioning (Tower of London) and a slight improvement in working memory (trail-making test) were observed. Practice effects for non-verbal measures, such as the Wechsler subtests, can be substantial in the short term (11.5–13 standard score points for the WISC-III readministered at 3 weeks, for example)[41] but are typically small (less than 5 standard score points) when the interval between administration is 1 year in control subjects.[42]

Overall, the profile of cognitive deficits that emerged from the current sample of young patients is similar to the pattern of deficits commonly seen in adult patients with schizophrenia, supporting the notion that studies of early-onset psychosis have the potential to inform our understanding of schizophrenia across the lifespan.[6,8,10] Furthermore, studies such as these, which focus on early-onset psychosis, provide a unique window to observe the condition before years of illness and exposure to neuroleptic medication may have confounded the neurocognitive variables of interest.[4,22] Although the majority of the patients included in the study was being prescribed antipsychotic medication at baseline and throughout the follow-up period, the overall exposure to antipsychotics was very low compared with typical studies of adults with schizophrenia because the patients were enrolled near the time of their first psychotic episode. As this was a naturalistic study of the longitudinal course of early-onset psychosis, no attempt was made to control for or to explain the relationship of clinical symptoms or cognitive results with the type or dose of anti-psychotic medication.

In contrast to cognitive functioning, the longitudinal data examining the clinical course of the disease (including positive, negative and total symptoms) showed considerable intersubject variability over 1 year. As expected, positive symptoms improved over the 1-year study. Negative symptoms also improved slightly but not significantly. At the individual level, a patient's clinical symptoms at baseline were not predictive of symptoms at 1-year follow-up. In contrast, the baseline cognitive performance was highly correlated with the cognitive performance at 1 year. Also, a lower intellectual functioning at baseline was correlated with more negative symptoms at follow-up, suggesting that neurocognitive variables may be of some prognostic utility in this population.

Previous studies have suggested that cognitive status is relatively stable over the first year of psychotic illness.[22,23] The findings of relatively stable cognitive status in early schizophrenia will need to be resolved in light of recent longitudinal neuroimaging studies, some of which suggest that abnormalities are present early in the course of the disease,[43] and others which

indicate progressive changes in brain ventricular volume and grey matter density during the early phases of illness in adolescents and young adults.[44–49] Longitudinal studies that combine neurocognitive and neuroimaging measures will be particularly useful.

Another potential limitation to the current study was the lack of control over specific medications, doses and precise length of exposure to medications. However, it is worth noting that a recent study of first-break, neuroleptic-naive adolescents with psychosis found significant cognitive deficits, suggesting that these deficits are indeed core symptoms of psychotic disorders and not simply the effects of exposure to psychotropic medication.[4] Similarly, White *et al.* reported cognitive deficits in both neuroleptically naive adolescents and adults, again suggesting that the deficits are inherent to the disease.[18] In the current study, there was no correlation between medication dose and cognitive performance. One possibility that the current data cannot address is that medication could have attenuated some aspects of cognitive decline that might have been seen were medications not being taken.

Finally, the inclusion of patients with a range of schizophrenia-spectrum diagnoses is a potential concern. Although the heterogeneity of the sample may contribute to a greater variance in symptom presentation and cognitive performance, the mixed diagnostic group may actually increase the generalizability of the study's findings. In clinical practice, the diagnosis of adolescent patients is more difficult and often takes substantially longer to confirm than in adult patients, because of the slow emergence of symptoms and the common initial presentation of only a few key symptoms.[4] Therefore, studying the wider phenomena of psychoses, as they present in various forms early on in the course of the illness, may be an appropriate approach. In fact, as the early identification and treatment movement is taking hold, some investigators are suggesting that early intervention efforts be launched across the full spectrum of psychotic disorders, including the prodrome,[50] and that focusing on a single diagnostic group, such as schizophrenia, may be a less effective approach given the broad nature of psychotic illnesses and the high levels of comorbidity in this population.[51]

In conclusion, the current data confirm the presence of significant neurocognitive deficits in adolescents with psychotic disorders, but do not provide evidence for significant change in cognition over a 1-year period. In contrast, clinical symptoms routinely fluctuate over the same time period. Despite the presence of significant baseline cognitive deficits, the lack of evidence of deterioration during this time period is informative and, potentially, clinically relevant.

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Table 1

Subject characteristics

Variable, *n* (%)	Baseline (*n* = 36)	1-year follow-up (*n* = 14)
Age at baseline (mean (SD))	14.58 (1.90)	16.29 (1.35)
Gender		
Male	23 (64%)	8 (57%)
Female	13 (36%)	6 (43%)
Diagnosis		
Schizophrenia	14 (39%)	5 (36%)
Psychosis not otherwise specified	9 (25%)	4 (29%)
Schizoaffective disorder	7 (19%)	3 (21%)
Schizophreniform disorder	6 (17%)	2 (14%)

Table 2

Correlations between chlorpromazine equivalent and neurocognitive variables at baseline and 1-year follow-up

Measure	Baseline (*n* = 14)		Follow-up (*n* = 14)	
	r	*P*	*r*	*P*
Neurocognitive measure				
Full-scale IQ estimate	−0.270	0.372		
Wechsler working memory or freedom from distractibility index	−0.259	0.371	−0.045	0.880
Wechsler processing speed index	−0.219	0.452	−0.187	0.522
Wisconsin Card Sorting Test % errors	−0.178	0.560	−0.042	0.887
Controlled Oral Word Association Test total score	−0.164	0.575	−0.064	0.829
Tower of London total score	−0.262	0.365	0.004	0.990
Stroop Color Word score	−0.148	0.614	0.204	0.484
California Verbal Learning Test total score	0.214	0.463	−0.180	0.537

Table 3

Neurocognitive performance and Positive and Negative Syndrome Scale (PANSS) ratings for the entire sample at baseline

Domain	Baseline (*n* = 36) Mean (SD)	*Z*-score
Intelligence *		
Full-scale IQ	91.91 (12.79)	−0.539
Working memory *		
Wechsler working memory or freedom from distractibility index	84.14 (12.65)	−1.057
Processing speed *		
Wechsler processing speed index	85.26 (15.01)	−0.983
Executive functioning		
Wisconsin Card Sorting Test (% errors)	89.79 (19.30)	−0.680
Tower of London	–	−1.639
Controlled Oral Word Association Test total score	–	−0.863
Stroop Color Word score	38.81 (7.87)	−1.119
Parent-report ratings of executive functioning (Behavior Rating Inventory of Executive Functioning)		
Behavioural regulation index	69.31 (16.99)	1.931
Metacognition index	67.31 (13.76)	1.731
General executive composite	70.91 (19.97)	2.091
Verbal learning		
California Verbal Learning Test total score	40.11 (11.64)	−0.989
Clinical symptoms – PANSS		
Positive symptoms	23.50 (7.81)	NA
Negative symptoms	24.36 (8.04)	NA
Total score	91.75 (22.73)	NA

Z-scores were computed from published standardized normative data.

* Full-scale IQ was from the Wechsler Abbreviated Scales of Intelligence (WASI), the Wechsler Intelligence Scale for Children (WISC-III or WISC-IV) or the Wechsler Adult Intelligence Scale (WAIS-III). Working memory/freedom from distractibility and processing speed were from the WISC-III, WISC-IV or WAIS-III.

Table 4

Paired samples *t*-tests examining change in neurocognitive performance and change in Positive and Negative Syndrome Scale (PANSS) ratings between baseline and 1-year for those patients who returned for follow-up

Measure	Baseline (*n* = 14)	1-year (*n* = 14)	*t*-Value	Significance (two-tailed)
Neurocognitive measure				
Wechsler working memory or freedom from distractibility index	87.43 (11.04)	82.14 (14.42)	2.61	0.022
Wechsler processing speed index	83.50 (14.91)	86.00 (15.70)	−1.10	0.290
Wisconsin Card Sorting Test % errors	82.62 (17.47)	92.71 (24.58)	−2.80	0.016
Tower of London	−2.01 (2.32)	−1.65 (2.25)	−0.880	0.395
Controlled Oral Word Association Test total score	−0.700 (0.884)	−0.952 (1.21)	1.11	0.288
Stroop Color Word score	37.14 (7.48)	39.00 (8.03)	−1.31	0.213
California Verbal Learning Test total score	38.86 (11.83)	39.36 (14.21)	−0.152	0.882
Clinical symptoms				
PANSS positive symptoms	21.50 (5.26)	15.57 (7.63)	2.34	0.036
PANSS negative symptoms	21.71 (7.59)	19.07 (8.17)	1.08	0.299
PANSS total score	83.21 (17.02)	68.29 (27.93)	1.58	0.139

Table 5

Clinical symptoms and cognitive performance: correlations between baseline and 1-year follow-up

Measure	*r*	*P*
Neurocognitive measure		
Wechsler working memory or freedom from distractibility index	0.855	<0.001
Wechsler processing speed index	0.848	<0.001
Wisconsin Card Sorting Test % errors	0.911	<0.001
Controlled Oral Word Association Test total score	0.708	0.005
Tower of London total score	0.768	0.001
Stroop Color Word score	0.773	0.001
Clinical symptoms		
PANSS positive symptoms	−0.050	0.866
PANSS negative symptoms	0.328	0.252
PANSS total score	−0.196	0.502

PANSS, Positive and Negative Syndrome Scale.

Table 6

Correlations between change in cognitive test performance and change in Positive and Negative Syndrome Scale (PANSS) ratings at 1-year follow-up

Measure	PANSS positive change		PANSS negative change		PANSS total change	
	r	*P*	*r*	*P*	*r*	*P*
Wechsler working memory or freedom from distractibility index	0.06	0.829	0.32	0.265	0.21	0.475
Wechsler processing speed index	0.01	0.973	−0.01	0.953	−0.41	0.889
Wisconsin Card Sorting Test % errors	−0.38	0.195	−0.20	0.508	−0.34	0.230
Tower of London	−0.21	0.281	−0.08	0.783	−0.35	0.221
Controlled Oral Word Association Test total score	0.26	0.378	0.30	0.298	0.27	0.351
Stroop Color Word score	−0.67	0.009 *	−0.63	0.016 *	−0.66	0.010 *
California Verbal Learning Test total score	0.16	0.579	0.01	0.968	0.16	0.595

* $P < 0.05$.