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Differentiating adolescents at clinical high risk for psychosis from psychotic and non-psychotic patients with the Rorschach

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ABSTRACT

This study was designed to assess cognitive functioning in a clinical sample of adolescents with heterogeneous psychiatric diagnoses, with a specific focus on patients at clinical high risk (CHR) for psychosis. The sample comprised 22 patients identified at CHR for psychosis, 67 psychotic and 187 non-psychotic, non-CHR patients. Neuropsychological assessment was conducted as part of the clinical examination and treatment, including Wechsler Intelligence Scale for Children (WISC)-III and/or Wechsler Adult Intelligence Scale (WAIS)-III measures of verbal comprehension, perceptual organisation, working memory and processing speed, Wisconsin Card Sorting Test (WCST) measures of executive function, and the Rorschach Comprehensive System measures of perceptual and thinking accuracy. Patients at CHR for psychosis did not significantly differ from other patient groups in terms of intellectual or executive functions. The Rorschach Perceptual Thinking Index (PTI) distinguished patients at CHR for psychosis from those diagnosed as having non-psychotic disorders, but not from those diagnosed as psychotic. Our results suggest perceptual and thought disturbance as an important indicator of vulnerability to psychosis.

1. Introduction

In recent years, an extensive research effort has been made towards developing tools to identify young persons at psychosis risk. Studies of cognitive performance in people thought to be at ultra-high risk of developing psychosis have demonstrated cognitive impairments in multiple cognitive domains, such as attention, working memory, processing speed, verbal learning and memory and executive function (Brewer et al., 2005; Hambrecht et al., 2002; Hawkins et al., 2004; Keefe et al., 2006; Niendam et al., 2007; Pukrop et al., 2006, 2007; Simon et al., 2007; Smith et al., 2006; Wood et al., 2003). The level of impairment usually takes an intermediate position between healthy controls and patients with first-episode schizophrenia (Brewer et al., 2003; Hambrecht et al., 2002; Hawkins et al., 2004). Moreover, global intellectual functioning appears to be intact (Brewer et al., 2006).

In clinical practice, the potential to distinguish patients at clinical high risk for psychosis (CHR) from those who are not is of significant interest in terms of early intervention. Some previous studies indicate that vulnerability may only be revealed by a high-demand task, not by a routine and less-demanding task (Brewer et al., 2006). Nevertheless, most studies have assessed the level of the patient's disturbance with the interview-based scales and tests where the cues are clear. In contrast, using the Rorschach task in the context of neuropsychological assessment allows us to understand perceptual and cognitive functioning beyond that which can be obtained by a less demanding task (Cadenhead et al., 1996; Perry and Braff, 1994; Perry et al., 1999; Zillmer and Perry, 1996). The Rorschach consists of 10 stimulus cards. In the Response Phase, subjects are shown the cards one at a time and asked to say what they see in them. In a subsequent Inquiry Phase subjects are asked to indicate where in the cards they saw each of the percepts they reported, and what made those percepts look the way they did. Thus, subjects must visually synthesise the information and effectively organise the stimuli presented to them. They need to use their available cognitive, perceptual and affective resources in producing a response, all of which are functions that are integrated by the prefrontal cortex (Minassian et al., 2005).

The Rorschach test has been used historically as a way to identify psychological processes associated with thought and perceptual disturbance, and to aid in the differential diagnosis of schizophrenia. This supports the notion of applying it to the detection of psychosis risk in a clinical population. Early efforts at using the Rorschach to assess thought disturbance were reported by Singer and Wynne (1966) and Solovay et al. (1986). Later, the use of the Rorschach Comprehensive System (RCS; Exner, 1993, 2003) in the study of disordered cognition became well established (Perry et al., 1992, 1995, 1999; Shenton et al., 1989). The Ego Impairment Index (Perry et al., 1992) and the Perceptual Thinking Index (PTI; Exner, 2000) have become the preferred indices for assessing perceptual inaccuracy and cognitive slippage typical of psychotic processes, and have demonstrated their use in discriminating between psychotic and non-psychotic individuals (Dao and Prevatt, 2006; Dao et al., 2008; Kumar and Khess, 2005; Ritsher, 2004). Schizophrenia patients reliably demonstrate visual scanning abnormalities and

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elevation in the number of perceptually inaccurate and thought-disturbed responses (Minassian et al., 2005; Perry et al., 1992). Schizotypal patients also exhibit perceptual distortion and thought disorder, but to a lesser extent than schizophrenia patients (Exner, 1993). Perry et al. (2003) compared non-patients, first-degree family members of schizophrenia patients, undergraduates who scored high on the Perceptual Aberration/Magical Ideation Scale, schizotypal personality disorder patients, and outpatient and hospitalised schizophrenia patients ($n=314$). The authors found a significant linear increase in perceptual and thought disturbance as the level of pathology increased.

To date, the vast majority of Rorschach studies have focussed on adults with schizophrenia spectrum disorders, whereas only few studies of adolescents have been undertaken (Archer and Gordon, 1988; Skelton et al., 1995; Smith et al., 2001; Stokes et al., 2003). Moreover, in spite of the substantial literature on CHR studies using numerous cognitive tests, only one Rorschach study of patients at CHR for psychosis has been published. Kimhy et al. (2007) assessed visual form perception in patients at CHR for psychosis, recent onset schizophrenia patients and chronic schizophrenia patients. They found that individuals at CHR for psychosis display substantial deficits in visual form perception as assessed by the Rorschach. The deficits were comparable in severity to those observed in patients with schizophrenia.

The present study aimed to examine cognitive functioning in a clinical sample of adolescents with heterogeneous psychiatric diagnoses, with a specific focus on CHR for psychosis. A naturalistic design was selected to give information generalisable to clinical practice. We asked whether patients at CHR for psychosis can be distinguished from psychotic and non-psychotic, non-CHR patients using neuropsychological tests. Neuropsychological assessment was conducted as part of the clinical examination and treatment, and included Wechsler Intelligence Scale for Children (WISC)-III and/or Wechsler Adult Intelligence Scale (WAIS)-III measures of verbal comprehension, perceptual organisation, working memory and processing speed, WCST measures of executive function and the RCS measures of perceptual and thinking accuracy. Based on previous studies (Brewer et al., 2006; Perry et al., 2003), we hypothesised that patients at CHR for psychosis would show more deficits in the domains of verbal comprehension, perceptual organisation, working memory, executive function and perceptual and thinking accuracy than non-high-risk patients, but not as much as psychotic patients.

2. Methods

This study is a part of the Detection of Early Psychosis Project in the city of Turku and neighboring communities. The research plan was approved by the Ethical Committee of Turku University and Turku University Hospital.

2.1. Subjects

A total of 67 psychotic patients, 22 CHR patients, and 187 non-psychotic, non-CHR patients, aged 13 to 21 years (mean age = 15.6, S.D. = 1.6) participated in the present study. The patient sample was recruited from an inpatient ward for young psychiatric patients at the Unit of Adolescent Psychiatry of Turku University Hospital in Finland. All participants gave written informed consent for participation. An initial diagnostic assessment was made by the psychiatrist according to International Classification of Diseases (ICD)-10. The final grouping of study subjects was made on the basis of their main Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV) Axis I diagnosis. These diagnoses were based on patient case record evaluation by one of four experienced psychiatrists (M.H., J.K, T.S. and R.K.R.S) blind with regard to the neuropsychological assessment.

Patients at CHR for psychosis had to meet the criteria for one of three definitions of the prodromal state, as assessed by the Structured Interview for Prodromal Symptoms and the Scale of Prodromal Symptoms (SIPS/SOPS; Miller et al., 2002). The SIPS is a semi-structured clinical interview that identifies clinical high-risk status on the basis of the presence of attenuated psychotic symptoms, brief intermittent psychotic symptoms, and/or genetic risk with recent functional deterioration. Twenty-two (8%) patients were included in the CHR group, primarily due to the presence of attenuated positive symptoms. Prodromal state was considered the main diagnosis in this group. All interviews were administered by trained interviewers. Interrater reliability was established by extensive training given by two of the authors. However, formal assessment of interrater reliability was not conducted.

Table 1 shows the demographic information about the study groups. The groups differed in terms of age, male/female ratio and medication. Patients at CHR for psychosis did not significantly differ from the other groups in terms of age. *Post hoc* analysis revealed that non-psychotic, non-high-risk patients were younger than psychotic patients (mean difference −0.61, $P=0.027$). There were fewer males in the CHR group than in the other groups. At the time of the neuropsychological assessment, 42.4% of subjects had been taking medication: 17.4% were on atypical antipsychotic medications, 19.9% were on antidepressants and 5.1% were on psychostimulants or other medications.

2.2. Neuropsychological assessment

Neuropsychological data were collected as part of the clinical examination and treatment. Patients were administered the WISC-III (Wechsler, 1999) or the WAIS-R (Wechsler, 1992) when aged over 16, to obtain information on general intelligence and neuropsychological domains, such as verbal comprehension, perceptual organisation, working memory and processing speed. The Wisconsin Card Sorting Test (WCST; Heaton et al., 1993) was used to assess components of executive function. The WCST requires subjects to sort cards according to criteria that must be inferred from correct or incorrect responses. The Rorschach as a cognitive-perceptual problem solving task was administered and scored according to the standard procedure of the Comprehensive System (Exner, 2001) by the first author who has been trained in using the method. She was blind to the group status of the participants. All patients produced 14 or more responses. Thus, the protocols are considered to be of sufficient length to be regarded as interpretatively useful (Exner, 1993). The mean *R* (number of responses) for the psychotic group was 24.69 (S.D. = 9.36), for the CHR group 20.09 (S.D. = 4.53), and for the non-psychotic group 20.86 (S.D. = 6.57). The mean Lambda (a ratio that compares the frequency of pure form responses to all other answers in the record) for the psychotic group was 1.77 (S.D. = 2.78), for the CHR group 0.97 (S.D. = 0.59) and for the non-psychotic group 1.00 (S.D. = 0.54). The CHR group did not significantly differ from psychotic or non-psychotic patients in terms of the mean *R* or the mean Lambda.

In this study, we used the Perceptual Thinking Index (PTI) for assessing perceptual and thought disturbance. The PTI includes variables that are arranged according to a combination of different values on five empirical criteria, as follows:

1. XA%<0.70 and WDA%<0.75 (XA% = the proportion of responses in which there is an appropriate use of form features; WDA% = the proportion of responses in which there is an appropriate use of form features given to whole (W) and common detail (D) areas).
2. X-%>0.29 (X-% = the sum of distorted form level responses divided by total responses, *R*).
3. Lvl2>2 and FAB2>0 (Lvl2 = severe cognitive disruption; FAB2 = implausible relationship between two objects).
4. *R*<17 and WSum6>12 or *R*>16 and WSum6>17 (WSum6 = the weighted sum of the 6 Cognitive Special Scores indicating cognitive disruption).
5. M->1 or X-%>0.40 (M- = human movement responses with poor form quality).

PTI is a continuous scale (0–5) on which higher values are less preferable than lower values. Results from international non-patient samples suggest that the PTI scores are very low in each of these normative groups (Meyer et al., 2007). Reliability and validity estimates of the RCS are described extensively elsewhere (Dao and Prevatt,

Table 1
Demographic characteristics and clinical diagnoses across comparison groups [mean (S.D.) or *N* (%)].

	Psychotic group ($n=67$)	CHR group ($n=22$)	Non-psychotic group ($n=187$)	F or χ^2	P
Age (years)	16.1 (1.4)	15.7 (1.8)	15.5 (1.7)	3.50	0.032
Gender					
Male	28 (41.8)	2 (9.1)	69 (36.9)	7.96	0.019
Female	39 (58.2)	20 (90.9)	118 (63.1)		
Medication					
Yes	43 (64.2)	7 (31.8)	67 (35.8)	17.33	<0.001
No	24 (35.8)	15 (68.2)	120 (64.2)		
DSM-IV Axis I diagnosis					
Schizophrenia	13 (19.4)				
Schizophreniform disorder	5 (7.5)				
Schizoaffective disorder	4 (5.9)				
Delusional disorder	2 (3.0)				
Brief psychotic disorder	5 (7.5)				
Psychotic disorder NOS	12 (17.9)				
Mood disorder with psychotic features	26 (38.8)				
Mood disorder without psychotic features		11 (50.0)	87 (46.5)		
Anxiety disorder		6 (27.3)	30 (16.1)		
Disorders usually first diagnosed in infancy, childhood, or adolescence		2 (9.1)	53 (28.3)		
Other psychiatric disorders		3 (13.6)	17 (9.1)		

CHR = clinical high risk of psychosis.

Table 2
Mean scores on the neuropsychological test measures.

Domain and test variables	Psychotic group ($n=67$)	CHR group ($n=22$)	Non-psychotic group ($n=187$)	Analysis		*Post hoc* comparisons[a]
	Mean (S.D.)	Mean (S.D.)	Mean (S.D.)	*F*	*P*	
Verbal comprehension						
Information	10.4 (2.5)	9.4 (3.2)	9.8 (2.7)	1.19	ns	
Vocabulary	9.5 (2.5)	9.9 (2.1)	9.7 (2.2)	0.35	ns	
Comprehension	8.9 (2.8)	10.2 (2.4)	9.8 (2.5)	2.81	ns	
Similarities	10.2 (3.5)	11.5 (2.6)	10.4 (2.9)	0.85	ns	
Perceptual organisation						
Picture Completion	9.4 (2.7)	10.3 (3.4)	10.5 (2.8)	2.96	0.054	PS<NP
Picture Arrangement	9.8 (3.4)	10.2 (3.7)	10.1 (2.9)	0.36	ns	
Block Design	9.9 (3.9)	9.4 (2.7)	9.5 (3.0)	0.39	ns	
Working memory						
Digit Span	8.9 (2.6)	9.3 (2.1)	9.5 (2.5)	0.82	ns	
Processing speed						
Digit Symbol	9.4 (3.3)	10.5 (1.9)	9.4 (3.3)	0.18	ns	
WISC-III/WAIS-R						
Full-scale IQ	100.1 (14.3)	102.8 (13.0)	100.7 (11.6)	0.14	ns	
Verbal IQ	101.3 (12.9)	103.6 (12.6)	101.6 (11.9)	0.21	ns	
Performance IQ	98.9 (17.9)	101.7 (15.5)	100.1 (14.5)	0.13	ns	
Executive function (WCST)						
% errors	32.7 (14.3)	28.0 (13.0)	30.4 (13.1)	0.55	ns	
% perseverative responses	18.7 (11.0)	15.9 (8.3)	17.5 (12.6)	0.18	ns	
Perception (RCS)						
XA%	0.65 (0.13)	0.71 (0.07)	0.78 (0.10)	33.03	<0.001	PS/CHR < NP
WDA%	0.70 (0.14)	0.74 (0.08)	0.81 (0.09)	24.04	<0.001	PS/CHR < NP
X-%	0.32 (0.12)	0.28 (0.07)	0.19 (0.09)	39.93	<0.001	PS/CHR > NP
M-	1.30 (1.6)	0.55 (0.8)	0.67 (0.9)	7.33	<0.01	PS > CHR/NP
Thinking (RCS)						
Lvl2	1.04 (1.4)	1.23 (0.9)	0.37 (0.7)	17.97	<0.001	PS/CHR > NP
FAB2	0.34 (0.6)	0.50 (0.5)	0.17 (0.5)	5.20	0.006	PS/CHR > NP
WSum6	14.3 (11.7)	15.6 (5.2)	6.51 (7.0)	26.51	<0.001	PS/CHR > NP
Perceptual Thinking Index (PTI; RCS)	1.94 (1.5)	1.50 (1.3)	0.54 (1.0)	34.70	<0.001	PS/CHR > NP

[a] For variables with significant differences according to the initial test: *post hoc* Bonferroni tests; PS = psychotic group, CHR = clinical high risk of psychosis, and NP = non-psychotic group.

2006; Dao et al., 2008; Meyer et al., 2002; Smith et al., 2001; Viglione, 1999; Viglione and Taylor, 2003). For the purpose of interrater agreement, 20 Rorschach protocols were chosen at random and rescored independently by a trained psychologist who was blind to the original Rorschach scores and diagnoses. Using Meyer's (1999) formulas intraclass correlation coefficients (ICC) interrater reliability analyses were conducted for the total PTI score, which was 0.84, and for the PTI variables. Interrater reliability ranged from 0.78 for WSum6 to 0.90 for X-%. An examination of ICC revealed an excellent interrater reliability (Cicchetti, 1994).

2.3. Data analysis

All statistical analyses were performed using SPSS 14.0 statistical software. The statistical significance level for testing the hypothesis was set at $P<0.05$. Comparative analyses were performed with the help of one-way analysis of variance (ANOVA) for continuous variables and with chi-square tests for categorical variables. Univariate one-way ANOVAs were performed on each test score. Tests were followed by *post hoc* comparisons of means between specific patient groups using Bonferroni's correction. Follow-up analyses were performed to assess the effect of age, gender and medication on the cognitive performance of the patient groups. The relationships between demographic and cognitive performance were examined with *t*-tests and Pearson's product moment correlations.

3. Results

3.1. Relationship between demographic and test variables

Age correlated significantly with full-scale intelligence quotient (IQ) ($r=0.18$, $P=0.002$), performance IQ ($r=0.20$, $P<0.001$), comprehension ($r=-0.17$, $P<0.001$), digit symbol ($r=0.22$, $P<0.001$), picture arrangement ($r=0.14$, $P=0.024$), block design ($r=0.16$, $P=0.008$) and WSum6 ($r=0.15$, $P=0.011$). As a whole, girls performed better on the digit symbol test than boys ($P<0.001$).

Patients on medication performed more poorly on the digit symbol test ($P=0.044$) and had higher X-% ($P=0.013$) than those who did not. As age, gender and medication had significant effects on some test scores, all data were controlled for age, gender and medication.

3.2. Test performance

The results of the neuropsychological assessment are summarised in Table 2. Performance on the PTI differed significantly across groups (Fig. 1). *Post hoc* analyses revealed that psychotic patients and patients at CHR for psychosis differed significantly from non-psychotic, non-CHR patients in terms of the PTI (mean difference 1.389, $P<0.001$ and 0.945, $P=0.001$. respectively), indicating that the CHR group had perceptual and thinking difficulties similar to those of the psychotic group. The CHR group performed as poorly as the psychotic group on all PTI subcomponents except the human movement responses with

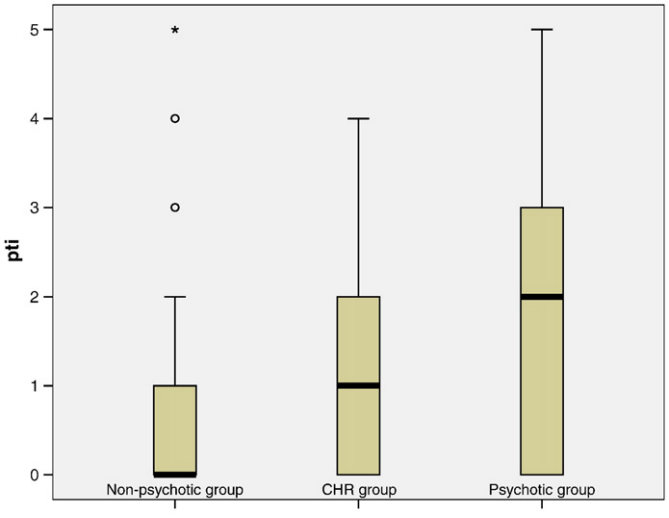

Fig. 1. Mean PTI scores across comparison groups.

poor form quality (M-). A significant negative correlation was found between the Digit Span backwards, a measure of working memory, and the PTI ($r = -0.14$, $P = 0.023$). The poorer the working memory, the more perceptual and thinking difficulties there were. When the Digit Span was used as a covariate, differences between the groups remained ($F = 13.91$, $P < 0.001$). Information ($r = 0.15$, $P = 0.013$) and vocabulary ($r = 0.13$, $P = 0.026$) correlated significantly with the WSum6, indicating that language skills are associated with thinking disorders. Even when information and vocabulary were controlled, the differences between the groups remained ($F = 11.17$, $P < 0.001$).

Psychotic patients scored lower than non-psychotic patients on the picture completion subtest which, at its basic level, tests visual organisation and reasoning abilities (mean difference −1.019, $P = 0.047$). Patients at CHR for psychosis did not statistically significantly differ from other patient groups in terms of intellectual or executive functions.

4. Discussion

This study compared cognitive functioning in adolescents at CHR for psychosis with psychotic and non-psychotic, non-CHR patients. The most obvious finding of this article was that adolescents at CHR for psychosis displayed poor visual form perception and thinking disorder as assessed by the Rorschach PTI. The deficits were comparable in severity to those observed in adolescents with psychotic diagnoses. Like other patient groups, patients at CHR for psychosis displayed mild-to-moderate executive impairment as assessed by the WCST, but intellectual functioning as assessed by the Wechsler scales seemed to be intact. Our data are consistent with those of Brewer et al. (2006), who reported that general cognitive ability as assessed by established batteries appears to remain intact in high-risk cohorts. Impaired executive functioning has frequently been reported not only in adolescents with schizophrenia (Ueland et al., 2004), but also in patients at risk of psychosis (Simon et al., 2007). In comparison to published norms (Heaton et al., 1993), we found mild-to-moderate deficits on this task in all patient groups. The results are in agreement with previous studies demonstrating cognitive impairment in a variety of psychiatric disorders (Weiser et al., 2004). Thus, executive impairment may be less useful as a predictor of psychotic illness.

Adolescents at CHR for psychosis showed an elevated PTI, indicating a cognitive dysfunction, that is, perceptual and thinking difficulties in these patients. The PTI increased in a graduated fashion from non-CHR patients to psychotic patients. The CHR group performed as poorly as the psychotic group. This finding supports a previous result by Kimhy et al. (2007) that the deficits in visual form perception in patients at high risk of psychosis are comparable in severity to those observed in patients with schizophrenia. Similarly, in their study, high-risk status was established by the SIPS/SOPS. Earlier, Perry et al. (2003) applied the Rorschach Ego Impairment Index as a measure of perceptual and thought disturbance across the schizophrenia spectrum, and found high scores in all the schizophrenia spectrum groups when compared with normal controls. Our data are also in line with Dao et al. (2008) who examined the clinical utility of the Rorschach PTI, and found that the PTI was able to distinguish patients diagnosed with a primary psychotic disorder from those diagnosed with a primary mood disorder. An interesting finding was a relationship between working memory and the PTI. Impairment of working memory has been regarded as a basic feature in schizophrenia.

The ability of individuals to perceive events accurately is measured on the Rorschach PTI by three form quality variables expressed in percentages: Form Appropriate (XA%), Form Appropriate-Common Areas (WDA%) and Distorted Form (X-%). Our data indicate that patients at CHR for psychosis differ significantly from non-psychotic patients whose performance is comparable to new normative data for Italian adolescent non-patients (Lis et al., 2007). The mean values of XA% (0.71), WDA% (0.74) and X-% (0.28) in patients at CHR for psychosis approach criterion values on PTI, indicating that there may be a pervasive tendency towards some sort of mediational dysfunction, that is, patients at CHR for psychosis give numerous perceptually inaccurate responses that do not resemble the shapes of the figures. Our score of X-% (0.28) is slightly lower but in line with Kimhy et al. (2007) who reported the X-% mean score of 0.36 in the high-risk group. They did not present data on XA% or WDA%. Ordinarily, when the XA% is less than 0.70, and the WDA% is less than 0.75, this reflects a significant perceptual impairment. In addition, the X-% of 0.30 or more denotes a severe perceptual impairment and identifies a psychotic degree of disturbance (Exner, 2003). More detailed analysis would reveal whether features of an affective psychosis or a schizophreniform disturbance are raised.

Logical and coherent thinking are reflected on the Rorschach by the WSum6. This is a weighted summary score comprising three different categories of unusual thinking: deviant verbalisation, inappropriate combinations or unrealistic relationships between objects and the use of strained, illogical reasoning to justify a response. The mean WSum6 score among non-patient adolescents ranges from 7.54 (13 years old) to 4.57 (16 years old) (Exner, 2003). The WSum6 of 12 or less in adolescents usually signifies good capacities to think logically and coherently (Weiner, 2003). In our study, there is no reason to question the clarity of conceptual thinking in non-psychotic, non-CHR patients. Instead, the WSum6 mean score of 15 in patients at CHR for psychosis in our sample signals the likelihood that episodes of faulty conceptualisation cloud their thinking and promote more instances of flawed judgement than are common for their age. Our score is slightly higher but in line with Perry et al. (2003) who reported a WSum6 mean score of 10.17 in schizotypal patients, and Kimhy et al. (2007) who reported a WSum6 mean score of 9.65 in individuals at clinical high risk.

The CHR group performed as poorly as the psychotic group on all PTI subcomponents except the M-, i.e., human movement responses with poor form quality. The frequency with which human movement responses occur in a record may restrict the interpretation. However, a study by Smith et al. (2001) reported that M- may be a sensitive indicator of thought disorder in children and adolescents. On the other hand, human movement minus responses have been found to occur more frequently in the schizophrenia and major depression groups than in other diagnostic categories (Archer and Gordon, 1988).

There are some limitations to consider, the first of which is that our study reports cross-sectional clinical data, and thus we do not know how many patients assessed to be at CHR for psychosis will go on to develop manifest psychosis. According to follow-up studies of prodromal patients fulfilling the SIPS/SOPS criteria, the conversion rate to schizophrenic psychosis was 46–54% at 12 months (Miller et al., 2002). In addition, previous meta-analyses have shown high temporal stability of the Rorschach variables (Grønnerød, 2003, 2006). For example, major Rorschach indices of psychological disturbance, perceptual inaccuracy (X-%) and disordered thinking (WSum6) have had retest correlations of 0.85 or higher in either 1-year or 3-year retesting of non-patient adults. Exner et al. (1985) found that between the ages 14 and 16, adolescents display the same level of retest stability as adults. Among severely disturbed adolescent groups, retest correlations of variables associated with perceptual inaccuracy and cognitive slippage have ranged from 0.72 to 0.87, suggesting that the major operations affected by schizophrenia do not readily change (Exner et al., 1985). The stability of thought disorders has also been shown among adoptees in the Finnish adoptive family study of schizophrenia, where the mean evaluation interval was 11 years (Metsänen et al., 2005). Thus, there is reason to suppose that adolescents assessed to be at CHR for psychosis have already had markers of perceptual inaccuracy and cognitive slippage for years, and they may be at real risk of psychosis, though not necessarily of schizophrenia. In the study of Klosterkötter et al. (2001), self-experienced cognitive thought and perception deficits identified 70% of patients who developed schizophrenia within 5.4 years.

Second, the sample size of the CHR group was small and included more girls than boys. In general, treatment seeking is more frequent among females than males in Finland (Aalto-Setälä et al., 2002). Further, previous studies show that females are more likely than males to experience an anxiety disorder or depression (Lewinsohn et al., 1998; Nolen-Hoeksema and Girgus, 1994). The female-to-male ratio is approximately 2:1. In our study, most of the adolescents at CHR for psychosis were given clinical diagnoses of anxiety disorder or mood disorder without psychotic features. Thus, among patients with anxiety symptoms or mood disorder, there may be many who are at risk of psychosis. Fig. 1 revealed three outliers in the non-psychotic group; they all were males with clear perceptual and thinking difficulties. However, the SIPS instrument was not able to pick them out from the non-CHR group.

Finally, in our study, almost 50% of the patients were on antipsychotic or antidepressant medications. Medication may affect the cognitive domains of attention, memory and executive function (Bilder et al., 2002). Patients, who received medication, performed more poorly than those who did not on the digit symbol test measuring processing speed, and had a higher X-%, indicating poor visual form perception. As medication could be a confounding variable we controlled all data for medication. However, although it could be supposed that when the patient is receiving antipsychotic medication, perceptual inaccuracy would disappear, it did not, indicating stability of perceptual inaccuracy.

In summary, our results suggest that perceptual and thinking disturbance appears to be a promising indicator of vulnerability to psychosis. The Rorschach PTI distinguished patients at CHR for psychosis from those diagnosed with non-psychotic disorders, but not from those diagnosed as psychotic. We were not able to distinguish adolescents at CHR for psychosis from the other patients when assessing cognitive functioning by the Wechsler scales and the WCST. However, the multi-method approach is important in clinical practice. The findings of this article also have implications for future research. Follow-up study is needed to investigate how many adolescents now at CHR for psychosis later become psychotic. We need also to determine the pattern of neurocognitive deficits most predictive of conversion to psychotic disorder.

References

Aalto-Setälä, T., Marttunen, M., Tuulio-Henriksson, A., Poikolainen, K., Lönnqvist, J., 2002. Psychiatric treatment seeking and psychosocial impairment among young adults with depression. Journal of Affective Disorders 70, 35–47.

Archer, R.P., Gordon, R.A., 1988. MMPI and Rorschach indices of schizophrenic and depressive diagnoses among adolescent inpatients. Journal of Personality Assessment 52 (2), 276–287.

Bilder, R.M., Goldman, R.S., Volavka, J., Czobor, P., Hoptman, M., Sheitman, B., Lindenmayer, J.P., Citrome, L., McEvoy, J., Kunz, M., Chakos, M., Cooper, T.B., Horowitz, T.L., Lieberman, J.A., 2002. Neurocognitive effects of clozapine, olanzapine, risperidone and haloperidol in patients with chronic schizophrenia or schizoaffective disorder. American Journal of Psychiatry 159 (6), 1018–1028.

Brewer, W.J., Wood, S.J., McGorry, P.D., Francey, S.M., Phillips, L.J., Young, A.R., Anderson, V., Copolov, D.L., Singh, B., Velakoulis, D., Pantelis, C., 2003. Impairment of olfactory identification ability in individuals at ultra-high risk for psychosis who later develop schizophrenia. American Journal of Psychiatry 160, 1790–1794.

Brewer, W.J., Francey, S.M., Wood, S.J., Jackson, H.J., Pantelis, C., Phillips, L.J., Young, A.R., Anderson, V.A., McGorry, P.D., 2005. Memory impairment identified in people at ultra-high risk for psychosis who later develop first-episode psychosis. American Journal of Psychiatry 162, 71–78.

Brewer, W.J., Wood, S.J., Phillips, L.J., Francey, S.M., Pantelis, C., Yung, A.R., Cornblatt, B., McGorry, P.D., 2006. Generalized and specific cognitive performance in clinical high-risk cohorts: a review highlighting potential vulnerability markers for psychosis. Schizophrenia Bulletin 32, 538–555.

Cadenhead, K.S., Perry, W., Braff, D.L., 1996. The relationship of information-processing deficits and clinical symptoms in schizotypal personality disorder. Biological Psychiatry 40, 853–858.

Cicchetti, D.V., 1994. Guidelines, criteria, and rules of thumb for evaluating normed and standardized instruments in psychology. Psychological Assessment 6, 284–290.

Dao, T.K., Prevatt, F., 2006. A psychometric evaluation of the Rorschach Comprehensive System's Perceptual Thinking Index. Journal of Personality Assessment 86 (2), 180–189.

Dao, T.K., Prevatt, F., Horne, H.L., 2008. Differentiating psychotic patients from nonpsychotic patients with the MMPI-2 and Rorschach. Journal of Personality Assessment 90 (1), 93–101.

Exner, J.E., 1993. The Rorschach: a Comprehensive System: Vol. 1. Basic Foundations, 3rd ed. Wiley, New York.

Exner, J.E., 2000. A Primer for Rorschach Interpretation. Rorschach Workshops, NC, Asheville.

Exner, J.E., 2001. A Rorschach Workbook for the Comprehensive System, 5th ed. Rorschach Workshops, Asheville, NC.

Exner, J.E., 2003. The Rorschach: a Comprehensive System: Vol. 1. Basic Foundations, 4th ed. Wiley, New York.

Exner, J.E., Thomas, E.A., Mason, B.J., 1985. Children's Rorschachs: description and predictions. Journal of Personality Assessment 49 (1), 13–20.

Grønnerød, C., 2003. Temporal stability in the Rorschach method: a meta-analytic review. Journal of Personality Assessment 80 (3), 272–293.

Grønnerød, C., 2006. Reanalysis of the Gronnerod (2003) Rorschach temporal stability meta-analysis data set. Journal of Personality Assessment 86 (2), 222–225.

Hambrecht, M., Lammertink, M., Klosterkötter, J., Matuschek, E., Pukrop, R., 2002. Subjective and objective neuropsychological abnormalities in a psychosis prodrome clinic. British Journal of Psychiatry 181 (suppl. 43), 30–37.

Hawkins, K.A., Addington, J., Keefe, R.S., Christensen, B., Perkins, D.O., Zipursky, R., Woods, S.W., Miller, T.J., Marquez, E., Breier, A., McGlashan, T.H., 2004. Neuropsychological status of subjects at high risk for a first episode of psychosis. Schizophrenia Research 67, 115–122.

Heaton, R.K., Chelune, G.J., Talley, J.L., Kay, G.G., Curtiss, G.C., 1993. Wisconsin Card Sorting Test Manual. Psychological Assessment Resources, Inc.. (Revised and expanded).

Keefe, R.S., Perkins, D.O., Gu, H., Zipursky, R.B., Christensen, B.K., Lieberman, J.A., 2006. A longitudinal study of neurocognitive function in individuals at-risk for psychosis. Schizophrenia Research 88, 26–35.

Kimhy, D., Corcoran, C., Harkavy-Friedman, J.M., Rizler, B., Javitt, D.C., Malaspina, D., 2007. Visual form perception: a comparison of individuals at high risk for psychosis, recent onset schizophrenia and chronic schizophrenia. Schizophrenia Research 97, 25–34.

Klosterkötter, J., Hellmich, M., Steinmeyer, E., Schultze-Lutter, F., 2001. Diagnosing schizophrenia in the initial prodromal phase. Archives of General Psychiatry 58 (2), 158–164.

Kumar, R., Khess, C.R.J., 2005. Diagnostic efficiency of Schizophrenia Index and Perceptual-Thinking Index in schizophrenia and mania. Journal of Projective Psychology and Mental Health 12, 115–122.

Lewinsohn, P.M., Gotlip, I.H., Lewinsohn, M., Seeley, J.R., Allen, N.B., 1998. Gender differences in anxiety disorders and anxiety symptoms in adolescents. Journal of Abnormal Psychology 107, 109–117.

Lis, A., Salcuni, S., Parolin, L., 2007. Rorschach comprehensive system data for a sample of 116 preadolescent and 117 adolescent nonpatients from Italy. Journal of Personality Assessment 89 (S1), 91–96.

Metsänen, M., Wahlberg, K.E., Saarento, O., Hakko, H., Tarvainen, T., Koistinen, P., Tienari, P., 2005. Stability of Thought Disorder Index among high-risk and low-risk adoptees in the Finnish adoptive family study of schizophrenia. European Psychiatry 20, 35–40.

Meyer, G.J., 1999. Simple procedures to estimate chance agreement and kappa for interrater reliability of response segments using the Rorschach Comprehensive System. Journal of Personality Assessment 72, 230–255.

Meyer, G.J., Hilsenroth, M.J., Baxter, D., Exner Jr., J.E., Fowler, J.C., Piers, C.C., Resnick, J., 2002. An examination of interrater reliability for scoring the Rorschach Comprehensive System in eight data sets. Journal of Personality Assessment 78, 219–274.

Meyer, G.J., Erdberg, P., Shaffer, T.W., 2007. Toward international normative reference data for the comprehensive system. Journal of Personality Assessment 89 (S1), 201–216.

Miller, T.J., McGlashan, T.H., Rosen, J.L., Somjee, L., Marcovich, P.J., Stein, K., Woods, S.W., 2002. Prospective diagnosis of the initial prodrome for schizophrenia based on the structured interview of for prodromal syndromes: preliminary evidence of interrater reliability and predictive validity. American Journal of Psychiatry 159 (5), 863–865.

Minassian, A., Granholm, E., Verney, S., Perry, W., 2005. Visual scanning deficits in schizophrenia and their relationship to executive functioning impairment. Schizophrenia Research 74, 69–79.

Niendam, T.A., Bearden, C.E., Zinberg, J., Johnson, J.K., O'Brien, M., Cannon, T., 2007. The course of neurocognition and social functioning in individuals at ultra high risk for psychosis. Schizophrenia Bulletin 33 (3), 772–781.

Nolen-Hoeksema, S., Girgus, J.S., 1994. The emergence of gender differences in depression during adolescence. Psychological Bulletin 115 (3), 424–443.

Perry, W., Braff, D.L., 1994. Information processing deficits and thought disorder in schizophrenia. American Journal of Psychiatry 151, 363–367.

Perry, W., Viglione, D.J., Braff, D., 1992. The Ego Impairment Index and schizophrenia: a validation study. Journal of Personality Assessment 59 (1), 165–175.

Perry, W., McDougall, A., Viglione, D.J., 1995. A five year follow-up on the temporal stability of the Ego Impairment Index. Journal of Personality Assessment 64 (1), 112–118.

Perry, W., Geyer, M., Braff, D.L., 1999. Sensorimotor gating and thought disturbance measured in close temporal proximity in schizophrenia patients. Archives of General Psychiatry 56, 277–281.

Perry, W., Minassian, A., Cadenhead, K., Sprock, J., Braff, D., 2003. The use of the Ego Impairment Index across the schizophrenia spectrum. Journal of Personality Assessment 80 (1), 50–57.

Pukrop, R., Schultze-Lutter, F., Ruhrmann, S., Brockhaus-Dumke, A., Tendolkar, I., Bechdolf, A., Matuschek, E., Klosterkötter, J., 2006. Neurocognitive functioning in subjects at risk for a first-episode of psychosis compared with first- and multiple-episode schizophrenia. Journal of Clinical and Experimental Neuropsychology 28, 1388–1407.

Pukrop, R., Ruhrmann, S., Schultze-Lutter, F., Bechdolf, A., Brockhaus-Dumke, A., Klosterkötter, J., 2007. Neurocognitive indicators for a conversion to psychosis:

comparison of patients in a potentially initial prodromal state who did or did not convert to a psychosis. Schizophrenia Research 92, 116–125.
Ritsher, J.B., 2004. Association of Rorschach and MMPI psychosis indicators and schizophrenia spectrum diagnoses in a Russian clinical sample. Journal of Personality Assessment 83 (1), 46–63.
Shenton, M.E., Solovay, M.R., Holzman, P.S., Coleman, M., Gale, H.J., 1989. Thought disorder in the relatives of psychotic patients. Archives of General Psychiatry 46, 897–901.
Simon, A.E., Cattapan-Ludewig, K., Zmilacher, S., Arbach, D., Gruber, K., Dvorsky, D.N., Roth, B., Isler, E., Zimmer, A., Umbricht, D., 2007. Cognitive functioning in the schizophrenia prodrome. Schizophrenia Bulletin 33 (3), 761–771.
Singer, M.T., Wynne, L.C., 1966. Principles for scoring communication defects and deviances in parents of schizophrenics: Rorschach and TAT scoring manuals. Psychiatry 29, 260–288.
Skelton, M.D., Boik, R.J., Madero, J.N., 1995. Thought disorder on the WAIS-R relative to the Rorschach: assessing identity-disordered adolescents. Journal of Personality Assessment 77 (3), 447–463.
Smith, S.R., Baity, M.R., Knowles, E.S., Hilsenroth, M.J., 2001. Assessment of disordered thinking in children and adolescents: the Rorschach Perceptual-Thinking Index. Journal of Personality Assessment 77, 447–463.
Smith, C.W., Park, S., Cornblatt, B., 2006. Spatial working memory deficits in adolescents at clinical high risk for schizophrenia. Schizophrenia Research 81, 211–215.
Solovay, M.R., Shenton, M.E., Gasperretti, C., Coleman, M., Kestenbaum, E., Carpenter, J.T., Holzman, P.S., 1986. Scoring manual for Thought Disorder Index (revised version). Schizophrenia Bulletin 12, 483–496.
Stokes, J.M., Pogge, D.L., Powell-Lunder, J., Ward, A.W., Bilginer, L., DeLuca, V.A., 2003. The Rorschach Ego Impairment Index: prediction of treatment outcome in a child psychiatric population. Journal of Personality Assessment 81 (1), 11–19.
Ueland, T., Øie, M., Landro, N.I., Rund, B.R., 2004. Cognitive functioning in adolescents with schizophrenia spectrum disorders. Psychiatry Research 126, 229–239.
Viglione, D.J., 1999. A review of recent research addressing the utility of the Rorschach. Psychological Assessment 11, 251–265.
Viglione, D.J., Taylor, N., 2003. Empirical support for interrater reliability of Rorschach comprehensive system coding. Journal of Clinical Psychology 59, 111–121.
Wechsler, D., 1992. Wechsler Adult Intelligence Scale-Revised Manual, Cleveland, Ohio: the Psychological Corporation. Finnish translation. Psykologien Kustannus Oy, Helsinki.
Wechsler, D., 1999 Wechsler Intelligence Scale for Children (WISC-III). The Psychological Corporation, Sidcup, UK. Finnish translation, Psykologien Kustannus Oy, Helsinki.
Weiner, I.B., 2003. Principles of Rorschach Interpretation, 2nd ed. LEA, Mahwah, New Jersey.
Weiser, M., Reichenberg, A., Rabinowitz, J., Knobler, H.Y., Lubin, G., Yazvitzky, R., Nahon, D., Gur, R.C., Davidson, M., 2004. Cognitive performance of male adolescents is lower than controls across psychiatric disorders: a population-based study. Acta Psychiatrica Scandinavica 110, 471–475.
Wood, S.J., Pantelis, C., Proffitt, T., Phillips, L.J., Stuart, G.W., Buchanan, J.A., Mahony, K., Brewer, W., Smith, D.J., McGorry, D.J., 2003. Spatial working memory ability is a marker of risk-for-psychosis. Psychological Medicine 33, 1239–1247.
Zillmer, E.A., Perry, W., 1996. Cognitive-neuropsychological abilities and related psychological disturbance: a factor model of neuropsychological, Rorschach, and MMPI indices. Assessment 3, 209–224.