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General intellectual functioning as a buffer against theory-of-mind deficits in individuals at ultra-high risk for psychosis

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ABSTRACT

The influence of neurocognition, including general intelligence, on theory of mind (ToM) among patients with schizophrenia spectrum disorder is controversial. The purpose of the present study was to identify the influences of the non-ToM cognition and general intelligence on ToM performance in individuals at ultra-high risk (UHR) for psychosis. Fifty-five UHR subjects and 58 healthy controls (HCs) completed neurocognitive, verbal, and nonverbal ToM tasks. UHR individuals showed poorer performance in the two verbal ToM tasks, the false-belief task and the strange-story tasks. Moreover, the UHR subjects displayed poorer recall on the interference list of the verbal learning test. Linear regression analysis revealed that neurocognitive functioning, including executive functioning, working memory, and general intelligence, accounted for significant amounts of the variance in the results for UHR individuals: 20.4% in the false-belief task, 44.0% in the strange-story task, and 49.0% in the nonverbal cartoon task. Neurocognition, including general intelligence, was not a significant contributor to performance on ToM tasks in HCs. ToM deficits were not noted in UHR individuals with above-average IQ scores (≥110) compared with UHR subjects with IQ scores less than 110, who displayed significant differences on all ToM tasks compared with HCs. The present results suggest that ToM deficits in UHR individuals are complex and may be influenced by non-ToM cognition. Our findings are discussed in relation to the role of neurocognitive abilities in ToM-related impairments in UHR individuals.

1. Introduction

Theory of mind (ToM) is the mentalizing capacity to infer the mental state of others, including their thoughts, desires, and intentions, after establishing a reasonable conception of one's own mind (Frith, 1992; Abu-Akel, 2003). ToM dysfunction has been studied in patients with psychiatric and autism spectrum disorders. Deficits in ToM may underlie some of the issues associated with difficulties in daily functioning and predict the prognosis in certain patient groups (Baron-Cohen, 1989; Frith and Corcoran, 1996; Bora et al., 2009a; Gooding and Pflum, 2011). The nature of ToM impairments as well as the factors that likely affect ToM have been the focus of previous studies (Langdon et al., 2005).

Several recent studies in patients with schizophrenia (SZ) have examined whether non-ToM cognition and/or general intelligence affects ToM impairment. Previous research has suggested that cognition, including IQ, is not associated with impairment in ToM (Harrington et al., 2005; Inoue et al., 2006; Sprong et al., 2007; Mo et al., 2008). However, other studies (Pickup, 2008; Bora et al., 2009b) have suggested the possible correlations among IQ, executive functioning, memory, and ToM performance in patients with SZ. Moreover, deficits in ToM are neither consistent states nor independent traits in SZ samples (Brüne, 2003). For example, one research group reported that they did not find the ToM deficit in SZ after correcting for IQ (Pentaraki et al., 2008). Furthermore, working-memory deficits may explain ToM impairment in symptom-free patients (Bora et al., 2008). A meta-analysis also noted that the significant effect of IQ on ToM is present only in the individuals who have experienced remission from schizophrenia (Bora et al., 2009b). Therefore, the influence of IQ on ToM deficits may differ when symptoms are more stable, as when remission is achieved (Ventura et al., 2013).

ToM abilities are significant predictors of social adjustment and transition to psychosis (Chung et al., 2008; Stanford et al., 2011). Moreover, since the social cognition and neurocognition are meaningful in terms of the general functioning and prognosis of individuals with psychotic disorders (Gard et al., 2009; Couture et al., 2011),

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research on the link between neurocognition and social cognition in UHR subjects may offer significant insights to the clinical groups. Thus, the present study used a linear regression model to determine the contribution of non-ToM cognition and intellectual functioning on the ToM ability of UHR individuals. Despite the increasing evidence for IQ-independent ToM deficits in individuals with autism spectrum and bipolar disorders (Ozonoff et al., 1991; Baron-Cohen et al., 1997; Kerr et al., 2003; Inoue et al., 2004), very little research has linked ToM and non-ToM cognition.

In the present study, we assessed verbal and nonverbal ToM tasks, general intelligence, and non-ToM cognition. We aimed to investigate the influence of the non-ToM cognitive abilities on the ToM performances using the linear regression analyses. In light of previous findings, we hypothesized that UHR individuals would utilize non-ToM cognitive abilities when performing ToM tasks.

2. Methods

2.1. Participants

Fifty-five UHR participants were recruited from the Seoul Youth Clinic according to the Comprehensive Assessment of At-Risk Mental States (CAARMS) criteria (Yung et al., 2005) between April 2005 and July 2010. The UHR subjects were included if the individual met 1 or more of 3 well-operated and validated criteria. The UHR group were those with attenuated psychotic symptoms ($n = 52$) and/or trait-plus-state risk factors ($n = 8$). Five subjects met criteria for both attenuated psychotic symptoms and trait-plus-state risk factors. Nine UHR subjects transitioned to psychosis after participating in the present study (mean duration for transition = 15.11 months ± 13.22). Additionally, 58 healthy controls (HCs) (Table 1) were recruited via Internet advertisement. Control subjects completed the non-patient form of the SCID (SCID-NP) (First et al., 1995). There were no significant differences between UHR and HC groups on age, sex, or IQ score. Although there was a group difference in the educational years (HCs = 14.62 ± 1.62; UHR = 13.46 ± 1.54; $P < .001$), the correlation between education and ToM performances was insignificant (all Ps > .08). Exclusion criteria for the present study included (i) head injury or medical or neurological disorders or alcohol or drug abuse; (ii) IQ < 80; or (iii) age < 18 years; and (iv) <12 years of education; to control for the possible effects it may cause on the data analysis. Written informed consent was obtained from all participants after they had been completely informed of the study protocols. This study was conducted in accordance with the guidelines provided by the Institutional Review Board at Seoul National University Hospital.

Table 1
Demographic and clinical characteristics of the study sample.

	Subjects at Ultra-high risk ($n = 55$)	Healthy controls ($n = 58$)	Statistics
Age, years	21.96 ± 3.29	23.10 ± 2.96	$t = 1.94, P = .055$
Sex (male/female)	37/18	29/29	$\chi^2 = 3.47, P = .063$
IQ	109.76 ± 14.2	110.74 ± 10.18	$t = .42, P = .677$
Duration of illness, years	2.62 ± 2.39		
CAARMS total	41.13 ± 15.34		
SIPS total	34.73 ± 11.92		
PANSS total	57.20 ± 12.28		
PANSS positive	12.54 ± 3.11		
PANSS negative	13.11 ± 4.38		
PANSS general	31.56 ± 7.42		

Data given as mean ± S.D.
CAARMS, Comprehensive Assessment of At-Risk Mental State; SIPS, Structured Interview for Prodromal Syndromes; PANSS, Positive and Negative Syndrome Scale.

2.2. Clinical assessments

All subjects at UHR underwent an intensive clinical interview using the Structured Clinical Interview for DSM-IV (SCID-IV) (First et al., 1995) to assess lifetime histories of psychiatric illness. The Comprehensive Assessment of At-Risk Mental States (Yung et al., 2005) and the Korean version of the Structured Interview for Prodromal Syndromes (Miller et al., 2003; Jung et al., 2010) were used to assess clinical status. Additionally, the Positive and Negative Syndrome Scale (PANSS), a widely used measure of the positive, negative, and general symptoms in schizophrenia spectrum disorder (Kay et al., 1987), was administered to subjects.

2.3. Neuropsychological assessments

We used an abbreviated form of the Korean version of the Wechsler Adult Intelligence Scale (WAIS) consisting of the Vocabulary, Arithmetic, Block Design, and Picture Arrangement subtests to estimate Full Scale IQ (IQ) (Lee and Kim, 1995). We adopted the abbreviated form to decrease participants' cognitive fatigue and improve their cooperativeness. Previous studies have shown that scores estimated based on these four scales are very highly correlated with IQ (.95 and .96 for the seven age groups) (Doppelt, 1956; Silverstein, 1982). Indeed, the four subtests in the short form provide the best and most reliable estimates of IQ, in the absence of statistically significant discrepancies, for psychiatric patients, including those with schizophrenia spectrum disorder (Boone, 1992; Missar et al., 1994). Consequently, a) the verbal IQ (VIQ), b) the performance IQ (PIQ) (Silverstein, 1982; Seo and Baek, 2007), and c) the IQ were calculated. In addition to the above four scales, d) digit span was also administered to measure verbal working memory.

The Wisconsin Card Sorting Test (WCST) was administered following the standardized guidelines provided in the test manual. The WCST has many variations and we selected the most representative scores based on previous research (Barceló and Knight, 2002). We examined the a) number of non-perseverative errors, which reflects the strength and management of representations in working memory (WCST-non-PSV errors), and the b) number of categories completed, which is associated with executive functioning (WCST-categories completed) (Heaton et al., 1993; Gooding et al., 1999).

The Korean version of the California Verbal Learning Test (CVLT) was used to assess verbal learning and memory (Kang and Kim, 1997). The CVLT has a target list, A, and an interference list, B, each of which is composed of 16 words. We used the two measures of short-term/working memory, a) total number of correct responses across five repetitive learning trials for list A (CVLT-list A) and b) the number of correct responses on a learning trial including interference list B (CVLT-list B), because short-term and/or working memory is necessary for performing verbal ToM tasks. Specifically, the former represents verbal working memory and the latter is associated with concentration on novel verbal stimuli (Stegen et al., 2009).

2.4. Theory-of-mind task

Theory of mind (ToM) is typically assessed with the use of short stories and cartoon tasks. In the present study, we used two verbal tasks, the false-belief and strange-story tasks, and one nonverbal cartoon task. The false-belief task, which consists of four short stories including first-order (Wimmer and Perner, 1983) and second-order (Perner and Wimmer, 1985) tasks, was used to evaluate the subject's understanding of one character's false belief about reality and a second character's false belief about a third character's mental state. The strange-story task consisted of eight ToM stories and eight physical stories (Happé et al., 1999). The ToM stories were composed of double bluffs, mistakes, persuasion, and white lies. The physical story did not require any inferences about the characters' mental states. We used only the ToM stories. The cartoon task included 28 original comic strips