Theory of mind and social judgments in people at clinical high risk of psychosis

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ABSTRACT

Background: Social cognitive deficits are consistently reported in psychotic populations. Few studies have longitudinally investigated social cognition in clinical high-risk (CHR) populations.
Aims: Longitudinally examine theory of mind (ToM) and social judgments in a CHR sample to investigate the stability of performance over time and potential ability to predict conversion to psychosis.
Method: 147 CHR individuals and 85 help seeking controls (HSC) were assessed for up to 2 years; 28 participants developed psychosis across both groups. Generalized linear mixed models for repeated measures were used to examine change over time for ratings on the three social cognitive indices of ToM, trustworthiness, and approachability. Hierarchical regression was used to test whether social cognitive variables explain more variance in conversion than IQ.
Results: CHR individuals showed a positive bias in approachability judgments over time compared to HSC. Baseline ToM performance significantly (p < .05) predicted later conversion beyond IQ scores. These results were attenuated when controlling for baseline symptom level.
Conclusions: Although ToM deficits might predate conversion to psychosis, one must consider initial symptoms as well. Social judgments were not associated with conversion to schizophrenia.

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1. Introduction

Similar to preventative work targeting medical illness, many research groups have focused on improving models of risk prediction in schizophrenia (Cannon et al., 2008). A central goal of this work is to enhance the understanding of factors related to conversion to psychosis and illness progression. Preliminary evidence suggests that social cognition (SC) may be a viable target, as deficits in SC are both present during the active illness phase and in populations at clinical high risk (CHR) for developing psychosis (Green et al., 2008; Thompson et al., 2011). Specifically, there is some support for deficits in emotion recognition and theory of mind (ToM) prior to illness onset. Thus, the assessment of SC deficits in individuals at clinical high risk (CHR) of developing schizophrenia warrants further exploration, as it may lead to the identification of a putative risk marker. The present study examines the SC domains of ToM and social judgments in a CHR population.

Individuals with first episode and chronic schizophrenia show consistent impairments in theory of mind (ToM) (Sprong et al., 2007). ToM typically refers to the ability to infer others' mental states (Green et al., 2008). In CHR individuals, there is mixed support for deficits in ToM. These studies are largely cross-sectional in design and administer a heterogeneous group of ToM tasks. Couture et al. (2008) found no significant differences in higher order ToM performance (Eyes Task) between CHR and healthy control (HC) groups. Stanford et al. (2011) also found no significant differences between CHR and HC groups in Eyes Task performance, nor with other first- and second-order ToM tasks (False Belief, Strange Story Tasks). Effect sizes (Cohen's d) computed from mean differences between HC and CHR groups were small in both studies (d = .06−.35) (Cohen, 1988). Conversely, Chung et al. (2008) utilized higher order, verbal tasks of ToM (False Belief and Strange Story Task) and found significant differences between CHR individuals and HCs matched on age and IQ. Recent studies provide further evidence of significant deficits in higher order ToM performance in CHR groups, although they were unable to draw conclusions about deficits' association with later conversion (Green et al., 2012; Thompson et al., 2012; Hur et al., 2013).

There is one prior study in CHR individuals that assessed ToM longitudinally to predict progression to psychosis. Kim at al. (2011) examined performance in four lower and higher order ToM tasks in 49

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ultra-high risk (UHR) individuals over time (mean = 2.8 years). They found significant differences between converters (n = 13) and non-converters (n = 36) at baseline in both higher order verbal (False Belief task; d = .74) and lower order non-verbal (Cartoon Task; d = .59) tasks. Further, there was not a significant relationship between ToM and symptoms, consistent with previous work (Couture et al., 2008; Stanford et al., 2011). Findings support the predictive value of ToM deficits in later conversion to psychosis. Taken together, this suggests that due to inconsistent findings and cross sectional design, further longitudinal investigation of ToM deficits in clinical high-risk groups is warranted.

There is a less extensive literature investigating social judgments in psychotic spectrum illnesses. Social judgments include trustworthiness and approachability ratings, which require usage of nuanced, subtle information conveyed in facial appearances. Social judgments require integration of various sources of information, such as facial expression and previous experiences with similar looking individuals (Couture et al., 2008). Such evaluations are antecedents in decision-making processes that directly influence social behaviors. In chronic schizophrenia, findings are mixed regarding social judgments assessed with the trustworthiness task (Adolphs, 1998), although individuals with non-paranoid schizophrenia tend to rate unfamiliar faces as more trustworthy and with greater variability than controls (Baas et al., 2008a, 2008b; Pinkham et al., 2008; Couture et al., 2010; Haut and MacDonald, 2010). Comparatively little work has focused on social judgments in CHR populations. Baas et al. (2008b) found that individuals at genetic risk of developing psychosis (first degree family members) rated faces significantly trustworthier than healthy controls. Similarly, Couture et al. (2008) found that CHR individuals judged a subset of untrustworthy faces as significantly trustworthier than healthy controls. Positive biases in social judgments are consistent with a body of established social cognitive deficits in schizophrenia, whereby patients have difficulty recognizing and applying appropriate social information (Baas et al., 2008b).

The aim of the present study is to longitudinally investigate ToM and social judgment performance in a group of CHR individuals compared to a group of help seeking control (HSC) individuals. Here, we assess whether ToM and social judgment performance (a) differentially changes over time as a function of risk status and (b) predicts conversion to psychosis at baseline.

2. Methods

2.1. Sample

The sample consisted of 147 participants (85 males, 62 females) at CHR of developing psychosis with a mean age of 19.8 (SD = 4.7) and 85 help-seeking control (HSC) participants (44 males, 41 females) with a mean age of 19.4 (SD = 4.1) years. All data was collected as a part of the PREDICT study conducted at the Universities of North Carolina (59 CHR, 21 HS), Toronto (60 CHR, 40 HS), and Yale (28 CHR, 24 HS). The methods are described in detail in Addington et al. (2012). All CHR participants met Criteria of Prodromal Syndromes (COPS) derived from the Structured Interview for Prodromal Syndromes (SIPS: McGlashan et al., 2010). A majority of CHR participants (N = 145) met criteria for attenuated positive syndrome (APSS). Only three participants met criteria for genetic risk and deterioration (GRD), which requires either an affected first degree relative or the subject having schizotypal personality disorder (SPD) and >30% drop in functioning on the General Assessment of Functioning (GAF) scale in the past 12 months.

The help-seeking control group (HSC) was comprised of individuals who had (1) responded to CHR recruitment and (2) presented with prodromal symptoms at phone screen but upon administration of the full interview did not meet prodromal criteria. The HSC group contains the following subgroups: (1) family high risk but no deterioration in GAF (n = 16) (2) long-standing attenuated symptoms present for >1 year (n = 39) (3) current prodromal symptoms but symptoms were clearly due to another disorder (n = 2) (4) had only negative symptoms (n = 4) and (5) symptoms that did not meet severity or frequency criterion (n = 24). HSC individuals were included as a clinically relevant control group that provides a more stringent test of conversion, as CHR and HSC individuals are more symptomatically similar to one another than to healthy controls.

The Structured Clinical Interview for DSM-IV (SCID-I: First et al., 1995) was administered to determine the presence of any axis I disorders. Exclusion criterion was: presence of an axis I psychotic disorder, IQ less than 70, or the presence of a clinically significant CNS disorder that may be related to CHR symptoms. Individuals were also excluded for history of antipsychotic treatment, as the PREDICT study aimed to examine predictors of conversion to psychosis without the confound of antipsychotics. After conducting comprehensive clinical assessments to determine inclusion, participants completed the ToM and social judgment tasks. Additionally, the number of subjects at follow-up is inconsistent, thus missing subjects are accounted for by (1) dropping out of the study, (2) missing the assessment, and (3) conversion to psychosis (Table 1).

2.2. Measures

2.2.1. Clinical measures

Prodromal syndrome and conversion criteria were assessed using the SIPS (McGlashan et al., 2010). Conversion meant that at least one of the five attenuated positive symptoms reached a psychotic level of intensity (rated 6) for a frequency of ≥ 1 h/day for 4 days/week during the past month or that symptoms seriously impacting functioning (e.g. severely disorganized or dangerous to self or others) (McGlashan et al., 2010). Symptoms were assessed with the Scale of Prodromal Symptoms (SOPS), which is comprised of 19 items in 4 symptom domains: positive, negative, general, and disorganized.

2.2.2. Theory of mind task

Theory of mind was assessed with the "Reading the Mind in the Eyes" task (Eyes Task: Baron-Cohen et al., 2001), a multiple choice task requiring the participant to infer mental/emotional states from 37 cropped photos of pairs of eyes. Participants are instructed to select one of four words that best describe what the person is thinking or feeling based on their eyes. They are provided with standardized definitions of word choices at their request. The Eyes Task was selected for its frequent usage in schizophrenia spectrum disorders (Pinkham et al., in press).

Table 1
Number of subjects at follow-up by group.

	Assessment (years)			
	0.5	1	1.5	2
Completed				
CHR	76	49	34	24
HSC	48	46	31	24
CHR and HSC	124	95	65	48
Study ended (drop outs)				
CHR	46	71	85	94
HSC	23	33	46	57
CHR and HSC	69	104	131	151
Missed assessment				
CHR	8	7	7	4
HSC	10	3	4	1
CHR and HSC	18	10	11	5
Converted				
CHR	15	20	22	25
HSC	3	3	3	3
CHR and HSC	18	23	25	28

2.2.3. Social judgment task

Social judgment was assessed with the Abbreviated Trustworthiness Task (Adolphs et al., 1998), in which participants viewed 42 unfamiliar faces and were asked to judge how much they would trust the pictured individual with their money or their life. They were also asked to judge how approachable these individuals appeared if they were to ask them for directions. They separately rated each face's trustworthiness and approachability on a 7 point scale ranging from −3 (very untrustworthy/unapproachable) to +3 (very trustworthy/approachable). The images were chosen from a larger set of stimuli that was rated by 47 healthy subjects (Adolphs et al., 1998). The 42 images were selected to yield a wide range of trustworthy and approachable faces (22 untrustworthy, 20 trustworthy; 24 unapproachable; 18 approachable). None of these tasks were timed. The Trustworthiness Task was selected for its frequent usage in schizophrenia spectrum disorders (Pinkham et al., in press).

2.2.4. Cognitive measures

IQ was assessed using the Wechsler Adult Intelligence Scale (WAIS-III: Wechsler, 1997) for participants age 16 and older (Arithmetic, Vocabulary, Information, Digit Span, and Block Design). The Wechsler Intelligence Scale for Children–Third Edition (WISC-III: Wechsler, 1991) was used for patients under 16 years of age (verbal and performance IQ). The Full Scale Intelligence Quotient (FSIQ) score was utilized as an indication of current cognitive function.

2.3. Procedures

The PREDICT study was a longitudinal study of predictors of conversion to psychosis. All raters were experienced research clinicians who demonstrated adequate reliability through the administration of routine reliability checks. Gold standard post-training agreements on the discrimination between high risk (5) and psychotic (6) levels of intensity on the positive symptom items (the critical threshold for determining both initial eligibility and subsequent conversion status) were excellent (kappa = 0.90). The DSM-IV diagnoses were established with the SCID-I. Interrater reliability was determined at the start of the study and subsequent annual retesting by 100% agreement on the diagnosis and at least 80% agreement for symptom presence. JA chaired weekly conference calls to review inclusion criteria for all individuals admitted to the study. DLP trained research assistants in social cognitive assessments. The study protocols and informed consents were reviewed and approved by the ethical review boards of all three sites.

2.4. Statistical analyses

All results were analyzed with IBM SPSS Version 19 and SAS version 9.2. The student t-test and chi-square test were used to compare baseline differences between CHR and HSC groups. Mann-Whitney U tests were used as indicated by significant Levene's test for equality of variances ($p < .05$). In regard to aim (a), generalized linear mixed model for repeated measures was used to examine change over time (baseline, 6 months, 12 months, 18 months, and 24 months) for ratings on the three social cognitive indices of ToM, trustworthiness, and approachability and for aim (b), hierarchical regression was used to test whether social cognitive variables explain more variance in conversion than IQ score. Exploratory analyses were conducted to test whether social cognitive variables explain more variance in conversion than symptoms.

3. Results

3.1. Sample characteristics

The majority of the sample was Caucasian and single. Fewer than 50% in each group had not completed high school and more than 40% in each group were either in or had completed post-secondary

education. There were no significant differences between HSC and CHR groups on any demographic variables or IQ score. The CHR group had significantly higher ratings than the HSC group on baseline total positive symptoms and general symptoms of the SOPS than the HC. There were no significant differences on negative or disorganized symptoms (Table 2).

Converters had significantly higher ratings than non-converters on all baseline SOPS symptom scales (positive, negative, disorganized, and general) (Table 2). There was a statistical trend such that the non-converters tended to have higher IQ scores than converters ($z = -1.87$, df = 176, $p = .061$).

Group comparisons between dropouts and non-dropouts were conducted to investigate potential relationships with demographic variables, clinical characteristics, and social cognitive performance. Dropouts were defined as individuals that did not return for the 6 month visit. Dropouts had a significantly greater number of males and tended to rate faces as significantly less trustworthy compared to the non-dropout group. There were no significant differences in age, race, IQ, baseline symptoms, approachability ratings, or performance on the Eyes Task (Table 3).

3.2. Longitudinal changes over time as a function of risk

Results of the mixed effects modeling demonstrated that there were no differences between the CHR group and the HSC group on ToM performance and trustworthiness judgments at baseline or at any of the follow-up assessments. However, there was a significant effect of time such that both groups' ToM performance improved over time ($F = 33.88$, df = 1434, $p < .001$). There was a significant difference between the CHR and HSC groups on ratings of approachability over time; a group × time interaction revealed that CHR approachability ratings tended to increase over time (except month 24) and HSC decreased over time ($F = 4.01$, $p < .05$) (Table 4).

3.3. Conversion to psychosis

Twenty-nine participants in the CHR group (14 male, 15 females) and 5 participants in the HSC group (2 males, 3 females) converted to psychosis. Baseline social cognitive data was only available for 25 CHR (13 male, 12 female) and 3 HSC (1 male, 2 females) participants. Data from all converters is used in subsequent analyses.

Regression was used to predict conversion from baseline ToM performance across both CHR and HSC groups. The model demonstrated that baseline ToM performance significantly predicted conversion across the whole sample ($F = 4.99$, df = 1230, $p < .05$). Converters ($n = 28$) performed more poorly on ToM than non-converters at baseline. In addition, there was a statistical trend whereby baseline trustworthiness predicted conversion in the CHR sample ($F = 2.95$, df = 1143, $p = .088$). Converters ($n = 24$) rated faces as higher in trustworthiness than non-converters (Table 5).

As ToM ability is mediated to some degree by general IQ score (Janssen et al., 2003; Harrington et al., 2005), hierarchical regression was used to determine if ToM or trustworthiness significantly predicted conversion beyond IQ score. Predictor variables were entered into the model in the following order: (1) IQ, (2) ToM or trustworthiness. ToM was found to be significantly associated with conversion after the effect of IQ was statistically removed, as indicated by change in R square ($F = 4.13$, df = 1175, $p < .05$). Trustworthiness was not significantly related to conversion after controlling for IQ (Table 5).

Evidence also suggests that there is an association between social cognitive performance and psychotic symptoms in both populations at risk for developing psychosis (Eack et al., 2010) and chronic schizophrenia (Marjoram et al., 2005; Shean et al., 2005; Hamm et al., 2012). Analyses were therefore conducted to evaluate the relationship between baseline total symptoms and ToM. ToM was significantly correlated with negative symptoms ($r(229) = -.23$, $p < .000$) and disorganized

Table 2
Baseline demographics, clinical characteristics, and social cognitive performance.

Variable	Clinical high risk (n = 147)	Help-seeking control (n = 85)	Converters (n = 28)	Nonconverters (n = 204)	P Prodromal and control converter and nonconverter
Sex, n (%)					
Male	85 (57.8%)	44 (51.8%)	14 (50.0%)	115 (56.4%)	X2 = 0.80 (df = 1)
Female	62 (42.2%)	41 (48.2%)	14 (50.0%)	89 (43.6%)	Z = −.64
Age, mean (SD)	19.79 (4.68)	19.41 (4.08)	19.68 (4.43)	19.45 (4.81)	t = −.607 (df = 225)
					t = .259 (df = 225)
Race, n (%)					
White	115 (78.2%)	65 (76.5%)	19 (67.9%)	161 (78.9%)	X2 = 1.26 (df = 4)
Black or African American	12 (8.2%)	8 (9.4%)	4 (14.3%)	16 (7.8%)	Z = −1.47
Canadian aboriginal/native American/American Indian or Alaskan Native	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
Asian	11 (7.5%)	4 (4.7%)	3 (10.7%)	12 (5.9%)	
Native Hawaiian or other Pacific Islander	1 (0.7%)	0 (0%)	0 (0%)	1 (0.5%)	
Mixed	8 (5.4%)	8 (9.4%)	2 (7.1%)	14 (6.9%)	
Spanish/Hispanic/Latino, n (%)					
Yes	11 (7.5%)	13 (15.3%)	1 (3.6%)	23 (11.3%)	X2 = 3.54 (df = 1)
No	136 (92.5%)	72 (84.7%)	27 (96.4%)	181 (88.7%)	Z = −1.25
Current marital status, n (%)					
Common law or legal married	7 (4.8%)	3 (3.5%)	3 (10.7%)	7 (3.4%)	X2 = .79 (df = 2)
Widowed	0 (0%)	0 (0%)	0 (0%)	0 (0%)	Z = −1.60
Divorced	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
Separated	1 (.7%)	0 (0%)	0 (0%)	1 (0.5%)	
Never married	139 (94.6%)	82 (96.5%)	25 (89.3%)	196 (96.1%)	
Currently living with a significant other, n (%)					
Yes	16 (10.9%)	5 (5.9%)	5 (17.9%)	16 (7.8%)	X2 = 1.64 (df = 1)
No	131 (89.1%)	80 (94.1%)	23 (82.1%)	188 (92.2%)	Z = −1.73
Education, n (%)					
Did not complete high school n (%)	64 (43.5%)	40 (47.1%)	14 (50.0%)	90 (44.1%)	X2 = 3.10 (df = 8)
GED/high school diploma, n (%)	1 (.7%)	0 (0%)	0 (0%)	1 (0.5%)	Z = −.15
Some college, did not graduate, n (%)	13 (8.8%)	9 (10.6%)	1 (3.6%)	21 (10.3%)	
Community college or technical school Degree, n (%)	50 (34.0%)	26 (30.6%)	7 (25.0%)	69 (33.8%)	t = 0.28 (df = 102)
College graduate, n (%)	7 (4.8%)	3 (3.5%)	2 (7.1%)	8 (3.9%)	Z = −.38
College graduate and some Master's level courses, n (%)	6 (4.1%)	4 (4.7%)	3 (10.7%)	7 (3.4%)	
Master's degree completed, n (%)	4 (2.7%)	1 (1.2%)	1 (3.6%)	4 (2.0%)	
Advanced degree courses, not graduated, n (%)	2 (1.4%)	1 (1.2%)	0 (0%)	3 (1.5%)	
Advanced degree completed, n (%)	0 (0%)	1 (1.2%)	0 (0%)	1 (0.5%)	
If you did not complete high school or obtain GED, indicate # of years of education: M (SD)	8.89 (1.86)	9.00 (2.03)	9.14 (1.75)	8.90 (1.95)	
Attended special education classes, n (%)					
Yes	23 (15.6%)	16 (18.8%)	5 (17.9%)	34 (16.7%)	X2 = 0.39 (df = 1)
No	124 (84.4%)	69 (81.2%)	23 (82.1%)	170 (83.3%)	Z = −.16
Failure to complete an educational program, n (%)					
Yes	36 (24.5%)	15 (17.6%)	8 (28.6%)	43 (21.1%)	X2 = 1.47 (df = 1)
No	111 (75.5%)	70 (82.4%)	20 (71.4%)	161 (78.9%)	Z = −.90
Parents education, n (%)					
Did not complete high school, n (%)	7 (4.8%)	7 (8.3%)	3 (10.7%)	11 (5.4%)	X2 = 5.16 (df = 9)
Unknown, n (%)	4 (2.7%)	2 (2.4%)	1 (3.6%)	5 (2.5%)	Z = −.21
GED/high school diploma, n (%)	20 (13.6%)	11 (13.1%)	2 (7.1%)	29 (14.2%)	t = .85 (df = 12)
Some college, did not graduate, n (%)	15 (10.2%)	12 (14.3%)	1 (3.6%)	26 (12.7%)	Z = −2.63**
Community college or technical school degree, n (%)	11 (7.5%)	7 (8.3%)	2 (7.1%)	16 (7.8%)	
College graduate, n (%)	41 (27.9%)	26 (31.0%)	11 (39.3%)	56 (27.5%)	
College graduate and some Master's level courses, n (%)	6 (4.1%)	2 (2.4%)	3 (10.7%)	5 (2.5%)	
Master's degree completed, n (%)	23 (15.6%)	8 (9.5%)	2 (7.1%)	29 (14.2%)	
Advanced degree courses, not graduated, n (%)	2 (1.4%)	2 (2.4%)	0 (0.0%)	4 (2.0%)	
Advanced degree completed, n (%)	18 (12.2%)	7 (8.3%)	3 (10.7%)	22 (10.8%)	
If he/she did not complete high school or obtain GED, indicate # of years of education: M (SD)	8.13 (2.61)	9.29 (2.43)	4.67 (.58)	9.82 (1.33)	
IQ score, mean (SD)	111.75 (19.03)	111.94 (17.12)	103.2 (22.23)	112.97 (16.87)	t = −.06 (df = 176)
					Z = −1.87
Baseline total SOPS symptoms, mean (SD)					
Negative symptoms	8.51 (5.86)	8.24 (6.32)	12.64 (6.38)	7.83 (5.75)	t = −.33 (df = 230)
Positive symptoms	10.90 (3.04)	6.47 (4.34)	11.11 (4.01)	9.03 (4.12)	t = −4.10 (df = 230)****
Disorganized symptoms	4.09 (2.77)	3.72 (3.15)	5.14 (2.64)	3.79 (2.92)	Z = −7.562****
Total general symptoms at baseline	6.94 (4.03)	5.16 (4.06)	8.61 (3.78)	5.97 (4.08)	t = −2.51 (df = 230)*
					t = −.93 (df = 230)
					t = −2.33 (df = 230)*
					t = −3.22 (df = 230)**
					t = −3.24 (df = 230)**
Baseline social cognitive performance					
Eyes Task (Theory of Mind)	25.05 (4.93)	25.11 (4.91)	23.14 (3.86)	25.33 (4.99)	t = .09 (df = 229)
Trustworthiness task: Trustworthiness	3.11 (32.28)	4.75 (30.67)	9.26 (38.27)	2.98 (30.68)	t = 2.23 (df = 229)*
Trustworthiness task: Approachability	17.98 (26.88)	22.84 (30.26)	16.63 (36.07)	20.19 (27.06)	t = .38 (df = 228)

Table 2 (continued)

Variable	Clinical high risk (n = 147)	Help-seeking control (n = 85)	Converters (n = 28)	Nonconverters (n = 204)	P Prodromal and control converter and nonconverter
Baseline social cognitive performance					t = −.97 (df = 228)
					t = .1.26 (d = 228)
					t = .62 (df = 228)

Mann-Whitney U tests were conducted if Levene's test for equality of variances was significant (p < .05), indicated by Z scores.
* p < 0.05.
** p < 0.01.
*** p < 0.001.
**** p < 0.0001.

Table 3
Baseline demographics, clinical characteristics, and social cognitive performance; non-dropouts and dropouts.

Variable	Non-dropout (n = 144)	Dropout (n = 69)	P
Sex, n (%)			
Male	70 (48.6%)	46 (66.7%)	$X2 = 6.13$** (df = 1)
Female	74 (51.4%)	23 (33.3%)	t = 1.359 (df = 211)
Age, mean (SD)	19.44 (4.44)	19.44 (4.44)	
Race, n (%)			
White	110 (76.4%)	58 (84.1%)	$X2 = 1.64$ (df = 1)
Non-white	34 (23.6%)	11 (15.9%)	
IQ score, mean (SD)	113.12	110.53	t = .86 (df = 165)
	(17.38)	(17.49)	
Baseline total SOPS symptoms, mean (SD)			
Negative symptoms	7.90 (5.61)	7.94 (6.04)	t = −.06 (df = 211)
Positive symptoms	9.03 (4.22)	9.36 (3.90)	t = −.56 (df = 211)
Disorganized symptoms	3.67 (2.62)	4.09 (3.34)	t = −.98 (df = 211)
Total general symptoms at baseline	6.27 (4.05)	5.58 (4.09)	t = 1.16 (df = 211)
Baseline social cognitive performance			
Eyes Task (Theory of Mind)	25.38 (4.85)	24.78 (5.45)	t = .80 (df = 210)
Trustworthiness task: Trustworthiness	7.44 (30.57)	−5.29 (32.62)	t = 2.78** (df = 209)
Trustworthiness task: Approachability	21.82 (26.60)	15.57 (28.31)	t = 1.57 (df = 209)

* p < 0.05.
** p < 0.01.
*** p < 0.001.
**** p < 0.0001.

symptoms (r(229) = −.26, p < .000) at baseline. The relationship between ToM and general symptoms approached statistical significance (r(229) = −.12, p = .07). ToM was not significantly associated with positive symptoms (r(229) = −.03, p = .63).

Table 4
Longitudinal changes over time as a function of risk.

Month	Approachability[a]		Trustworthiness	
	CHR Mean, SD	HSC Mean, SD	CHR Mean, SD	HSC Mean, SD
Baseline	17.98 (26.88) (N = 145)	22.84 (30.26) (N = 85)	3.11 (32.28) (N = 145)	4.75 (30.67) (N = 85)
Month 6	18.62 (26.13) (N = 78)	20.38 (31.22) (N = 48)	6.12 (28.50) (N = 78)	5.15 (23.59) (N = 48)
Month 12	20.48 (25.48) (N = 50)	20.87 (25.24) (N = 32)	12.14 (28.65) (N = 50)	6.46 (22.54) (N = 46)
Month 12	20.48 (25.48) (N = 50)	20.87 (25.24) (N = 32)	12.14 (28.65) (N = 50)	6.46 (22.54) (N = 46)
Month 18	20.94 (31.02) (N = 35)	16.97 (23.73) (N = 32)	8.40 (28.82) (N = 35)	4.13 (25.90) (N = 32)
Month 24	14.58 (21.62) (N = 26)	14.42 (21.79) (N = 24)	6.54 (24.22) (N = 26)	8.63 (29.61) (N = 24)

[a] Significant difference between the CHR and HS group on ratings of approachability over time, with a group by time interaction (F = 4.01, p < .05).

Following this, an additional hierarchical regression was conducted to determine if ToM significantly predicted conversion beyond total baseline symptoms. Predictor variables were entered into the model in the following order: (1) Total SOPS symptoms at baseline (positive, negative, general, and disorganized), (2) ToM. ToM was not found to be significantly associated with conversion after the effect of total baseline symptoms was removed, as indicated by change in R^2 (F = 1.95, df = 1228, p = .16) (Table 5).

4. Discussion

4.1. Overview

The aim of this study was to longitudinally investigate theory of mind and social judgments, and their relationship to later conversion to psychosis in a group of people at high risk of developing psychosis. Two main findings emerged from our study. First, we found that over time, CHR individuals tended to judge faces to be more approachable while HSC participants judged faces as less approachable. Second, baseline ToM performance significantly predicted conversion to schizophrenia beyond IQ. However, the contribution of ToM to conversion became non-significant after controlling for total baseline symptoms. These findings will be discussed below.

4.2. Longitudinal changes over time as a function of risk

On average, CHR individuals judged faces to be more approachable over time than HSCs. This finding for increasing approachability ratings over time may seem counterintuitive, as CHR status is often associated

Table 5
Prediction of conversion: regression based on theory of mind, trustworthiness, IQ and symptoms at baseline.

Regression	Non-converters M (S.D.)	Converters M (S.D.)	R2	F	df	P
Eyes Task (ToM)	25.33 (4.99) n = 204	23.14 (3.86) n = 28	.021	4.99	1230	.026[*]
Trustworthiness judgments	1.07 (31.46) n = 121	13.38 (35.02) n = 24	.020	2.95	1143	.088
Hierarchical regression with IQ and ToM						
Step 1: IQ	112.97 (16.87) n = 158	103.20 (22.23) n = 20	.030	5.52	1176	.020[*]
Step 2: ToM	25.33 (4.99) n = 204	23.14 (3.86) n = 28	.053	.053	1175	.044[*]
Hierarchical regression with IQ and trustworthiness						
Step 1: IQ	112.97 (16.87) n = 158	103.20 (22.23) n = 20	.027	3.22	1114	.075
Step 2: trustworthiness	1.07 (31.46) n = 121	13.38 (35.02) n = 24	.056	3.35	1113	.070
Hierarchical regression with ToM and symptoms						
Step 1: Total SIPS symptoms	26.62 (12.39) n = 204	37.50 (12.59) n = 28	.076	18.70	1229	.000[****]
Step 2: ToM	25.33 (4.99) n = 204	23.14 (3.86) n = 28	.083	1.95	1228	.164

[*] $p < 0.05$.
[**] $p < 0.01$.
[***] $p < 0.001$.
[****] $p < 0.0001$.

with paranoia. However, social judgments demand higher-level social cognitive processes through the interpretation of more nuanced, subtle social cues. It is suggested that patients with schizophrenia tend to rely less on normative social cues when making judgments, resulting in a positive bias (Haut and MacDonald, 2010). Our finding in CHR individuals is consistent with prior research indicating a positive bias in patients with non-paranoid schizophrenia (Couture et al., 2010) and in first-degree family members (Baas et al., 2008b).

There were no significant differences between CHR and HSC groups on ratings of trustworthiness over time. Similar to approachability judgments, there seems to be a trend whereby trustworthiness judgments are becoming more positive over time in the CHR group until month 12 (see Table 4). However, the HSC group showed a similar pattern, thus the interaction was not significant. This calls for further exploration of social decision-making through its possible relationship to symptoms, conversion, and implications for social competence and functioning.

4.3. Conversion to psychosis

The participants that converted to psychosis performed significantly worse at baseline than non-converters in Eyes Task performance. This relationship held when controlling for IQ, suggesting that ToM contributes independent variance beyond IQ in predicting conversion to psychosis. This relationship did not hold when controlling for baseline symptoms. Supplemental analyses indicated ToM was significantly correlated with total baseline disorganization and negative symptoms. This is inconsistent with previous findings using the Eyes Task, which indicate that ToM is not significantly related to symptoms (Couture et al., 2008; Stanford et al., 2011). However, some work suggests that higher-order ToM is significantly associated with negative and positive symptoms in individuals with prodromal risk syndrome (Green et al., 2012). A shared etiology between ToM and negative and disorganized symptoms has been suggested (Fett et al., 2013). Further, it has been theorized that social cognition and negative symptoms may have some conceptual overlap (Green et al., 2008). It is possible that early social cognitive deficits could be obscured or overshadowed by symptoms and functional decline. This is consistent with theoretical models of positive symptom development, which posit that delusions begin with

distortions in the perception of social information (Bentall et al., 1994). This calls for a better understanding of the relationship between SC and symptoms in both chronic schizophrenia and CHR groups.

The present study adds to a growing body of evidence exploring relationships between symptoms, social cognition, and neurocognition in predicting transition to psychosis in CHR individuals (Review: Niendam et al., 2009). Future prediction models of psychosis will likely incorporate multiple sources of information, including family history of psychosis, neurocognitive profile, and environmental factors (Review: Fusar-Poli et al., 2013).

4.4. Limitations

There are some limitations to the present study. First, the follow-up sample is small because several subjects were lost over time. This created difficulty in looking at social cognitive performance longitudinally, particularly regarding trustworthiness ratings, as dropouts rated faces significantly less trustworthy than non-dropouts. High dropout rates certainly limit conclusions that can be drawn concerning the stability of social cognitive performance in CHR samples. However, most studies of CHR individuals have similar difficulties in retaining participants. Given the high dropout rates, there may be potential converters that were not captured in the data. Further, as participants converted to schizophrenia, they were not included in subsequent assessments, thus data concerning stability of deficits over time is unavailable.

Additionally, the HSC is not a traditional healthy comparison group. The help-seeking control group is primarily comprised of family members of psychotic individuals and stable attenuated symptom populations; groups that evidence social cognitive deficits (Janssen et al., 2003; Addington et al., 2012). Comparing HSC with CHR individuals may provide a more rigorous test of differences in social cognitive performance, although the HSC group's low-level symptom deficits may be obscuring potential group differences. Difficulties in theory of mind and social judgments may be evident in individuals that report psychotic-like experiences regardless of whether full criteria are met for a prodromal syndrome.

Lastly, it must be acknowledged that current SC tasks often have significant conceptual and measurement-related overlap (Green et al., 2008; Pinkham et al., in press). The Eyes task prompts subjects to label

pictures of eyes with a word that best categorizes their interpretation of the person's experience (Baron-Cohen et al., 2001). This task is meant to assess ToM, but also likely involves aspects of emotion perception as well. Similarly, the trustworthiness task involves aspects of emotion recognition in ascribing trust or approachability ratings. Thus, it is difficult to make conclusions about specific SC domains and associations with conversion, IQ, and symptomatology.

4.5. Implications

The results and limitations lead to recommendations for future research. The present study indicates a need for further work investigating relationships between social cognition, neurocognition, and clinical state in individuals at high clinical risk for developing psychosis. This warrants further exploration of the vulnerability model, as improvement of underlying vulnerability may in itself help reduce risk for later psychosis and limit later functional disability (Cornblatt et al., 2003). Lastly, further work to investigate how these vulnerability markers can be used as treatment targets is critical to developing early intervention efforts.

Contributors

Author 1 (K. Healey), completed all statistical analyses and contributed substantially to all drafts of the manuscript. Author 2 (D. Penn) aided in study design and data collection, and contributed substantially to all drafts of the manuscript. Authors 3 (D. Perkins) and 4 (S. Woods) aided in study design and data collection, and obtained funding. Author 5 (J. Addington) aided in study design and data collection, obtained funding, and contributed substantially to all drafts of the manuscript. All authors have approved the final manuscript.

Conflict of interest

All authors declare that they have no conflicts of interest.

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