HHS Public Access

Author manuscript

Schizophr Res. Author manuscript; available in PMC 2017 March 01.

Published in final edited form as:

Schizophr Res. 2016 March ; 171(1-3): 176–181. doi:10.1016/j.schres.2016.01.017.

Social Cognition over time in Individuals at Clinical High Risk for Psychosis: findings from the NAPLS-2 cohort

Danijela Piskulic[1], **Lu Liu**[1], **Kristin S. Cadenhead**[2], **Tyrone D. Cannon**[3], **Barbara A. Cornblatt**[4], **Thomas H. McGlashan**[5], **Diana O. Perkins**[6], **Larry J. Seidman**[7], **Ming T. Tsuang**[2,8], **Elaine F. Walker**[9], **Scott W. Woods**[5], **Carrie E. Bearden**[10], **Daniel H. Mathalon**[11,12], and **Jean Addington**[1,*]

[1]Hotchkiss Brain Institute, Department of Psychiatry, University of Calgary, Calgary, Alberta, Canada

[2]Department of Psychiatry, University of California San Diego, La Jolla, California, United States

[3]Department of Psychology, Yale University, New Haven, CT, United States

[4]Department of Psychiatry, Zucker Hillside Hospital, Queens, NY, United States

[5]Department of Psychiatry, Yale University, New Haven, CT, United States

[6]Department of Psychiatry, University of North Carolina, Chapel Hill, NC, United States

[7]Department of Psychiatry, Harvard Medical School at Beth Israel Deaconess Medical Center and Massachusetts General Hospital, Boston, MA, United States.

[8]Institute of Genomic Medicine, University of California, La Jolla, CA, United States

[9]Department of Psychology, Emory University, Atlanta, GA, United States

[10]Departments of Psychiatry and Biobehavioral Sciences and Psychology, University of California, Los Angeles, Los Angeles, CA, United States

[11]Department of Psychiatry, University of California, San Francisco, San Francisco, United States

[12]Psychiatry Service, San Francisco, CA, United States

Abstract

Deficits in social cognition are well established in schizophrenia and have been observed prior to the illness onset. Compared to healthy controls (HCs), individuals at clinical high risk of psychosis

* Corresponding Author: Dr. Jean Addington, Mathison Centre for Mental Health Research & Education, University of Calgary, 3280 Hospital Drive NW, Calgary, Alberta T2N 4Z6 Canada. Ph. +1 (403) 210-6287; jmadding@ucalgary.ca.

Contributors

Dr. Piskulic and Ms. Liu undertook the statistical analysis, and Dr. Piskulic wrote the first draft of the manuscript. Dr. Addington was involved in writing of subsequent drafts of the manuscript. All of the authors listed were involved in study design and have contributed to and approved the final manuscript.

Conflict of interest

There are no conflicts of interest for any of the authors with respect to the data in this paper or for the study.

(CHR) are said to show deficits in social cognition similar to those observed in patients experiencing a first episode of psychosis. These deficits have been observed in several domains of social cognition, such as theory of mind (ToM), emotion perception and social perception. In the current study, the stability of three domains of social cognition (ToM, social perception and facial emotion perception) was assessed over time along and their association with both clinical symptoms and the later development of psychosis. Six hundred and seventy-five CHR individuals and 264 HC participants completed four tests of social cognition at baseline. Of those, 160 CHR and 155 HC participants completed assessments at all three time points (baseline, 1 year and 2 years) as part of their participation in the North American Prodrome Longitudinal Study. The CHR group performed poorer on all tests of social cognition across all time points compared to HCs. Social cognition was not associated with attenuated positive symptoms at any time point in the study. CHR individuals who developed a psychotic disorder during the course of the study did not differ in social cognition compared to those who did not develop psychosis. This longitudinal study demonstrated mild to moderate, but persistent ToM and social perception impairments in those at CHR for psychosis compared to HCs.

Keywords

social cognition; theory of mind; social perception; emotion perception; clinical high risk; psychosis

1. Introduction

The NIMH Workshop of Social Cognition in Schizophrenia defines social cognition as a function that involves the perception, interpretation and processing of information that underlies social interactions. Because of the emphasis on a direct association with social behavior and a number of real world outcomes, social cognition has become one of the major areas of interest in schizophrenia (Pinkham et al., 2014). This is not accidental or surprising given overwhelming reports of poor social and role functioning in schizophrenia. The Social Cognition Psychometric Evaluation (SCOPE) study (Pinkham et al., 2014), which was designed to achieve a consensus on the key domains of social cognition in schizophrenia based on the expert advice, identified four major domains of social cognition: 1) theory of mind (ToM) or the ability to attribute beliefs and intentions to oneself and others; 2) emotion perception (both prosodic and facial) or the ability to recognize other people's feelings from either facial expressions or vocal inflections and use them to guide behaviors; 3) social perception and knowledge or the ability to judge and be aware of cues and rules that occur in social situations; and 4) attributional style or bias, which refers to an individual's tendency to attribute the cause of an event to either oneself, others or the environment. Deficits in social cognition are well evidenced in schizophrenia, both in the established illness (Penn et al., 2008) and prior to the illness onset (Barbato et al., 2015; Green et al., 2012) suggesting that they are relatively stable (Horan et al., 2012).

Recent progress in risk identification methodology has made it possible to identify individuals who are at clinical high risk of developing psychosis (CHR) based on clinical phenomenology, in particular sub-threshold psychotic symptoms (Addington and Heinssen,

2012). In the past decade, there has been a surge of studies examining social cognition in CHR populations compared to healthy controls (HCs) and patients with psychosis. Although the findings from these studies are mixed, the majority report quantifiable deficits in social cognition in CHR populations relative to healthy controls. Furthermore, the severity of those deficits is often similar to patients with psychotic disorders (Green et al., 2012; Thompson et al., 2011). Two recent meta-analyses of social cognition in CHR, reported deficits in all domains of social cognition (Lee et al., 2015; van Donkersgoed et al., 2015). The largest cumulative deficits have been observed in attributional bias and ToM, with somewhat smaller effects for emotion perception and social perception. The overall magnitude of social cognitive deficits in those at CHR fell between that of schizophrenia patients and their non-affected relatives (Lee et al., 2015). However, despite relatively consistent findings of social cognitive deficits in CHR samples, some reports support (Bora et al., 2008; Healey et al., 2013) and others deny (Lee et al., 2015; van Donkersgoed et al., 2015) whether social cognitive deficits predict conversion to psychosis.

Most studies that have examined social cognition in CHR to date have been based on small samples and have examined only one or two social cognitive domains at a time. The North American Prodrome Longitudinal Study (NAPLS 2) group recently published baseline data on social cognition and its association with symptoms in a large group of CHR participants assessing three different domains: ToM, social perception and facial emotion perception. At study entry, the CHR group showed deficits in all domains of social cognition compared to age and gender matched HCs. These deficits however, were not related to attenuated positive and negative symptom severity (Barbato et al., 2015). The aim of the current paper is to examine: first, the stability of social cognition over time; secondly, the cross-sectional correlations between social cognition and clinical symptoms at each time point; and thirdly to examine whether there are differences in social cognition between those who develop psychosis and those who do not in the NAPLS 2 sample.

2. Methods

2.1. Participants

Participants were recruited as part of the multi-site NIMH funded NAPLS 2 that consisted of 764 CHR individuals (436 males, 328 females) and 280 HCs (141 males, 139 females) recruited across the eight NAPLS 2 sites. The majority, 743 CHR subjects, met the Criteria of Prodromal Syndromes (COPS) (McGlashan et al., 2010), however 21 CHR subjects were considered high risk due to presence of schizotypal features and age less than 18. Participants were excluded if they met criteria for any current or lifetime axis I psychotic disorder, IQ below 70 and past or current history of a clinically significant central nervous system disorder. Healthy controls were excluded if they had a first-degree relative with a current or past psychotic disorder. A more detailed description of recruitment procedures, ascertainment, and inclusion and exclusion criteria is provided elsewhere (Addington et al., 2015).

2.2. Measures

The Structured Interview for Psychosis-risk Syndrome (SIPS) (McGlashan et al., 2010) was used to determine whether an individual met COPS criteria. The Scale of Prodromal Symptoms (SOPS) consisting of 19 items in 4 symptom domains (i.e. positive, negative, general, and disorganized symptoms) was used to rate the severity of CHR symptoms.

Three well-established areas of social cognition were assessed in the current study; ToM, facial emotion perception and social perception, using validated measures (Pinkham et al., 2014). ToM was assessed using the Social Inference subscale of The Awareness of Social Inference Test (McDonald et al., 2003); facial emotion perception was assessed with the Penn Emotion Recognition task and the Penn Emotion Differentiation task (Gur et al., 2002); and social perception was assessed using the abbreviated version of the Relationship Across Domains (Sergi et al., 2009).

The Social Inference subscale of the TASIT includes 16 short video scenes, enriched with contextual cues, where actors are engaged in everyday conversations and use lies and sarcasm. In half of the vignettes the main speaker conveys a message that is contrary to what he or she believes (i.e., a lie), and in the other half the main speaker says something that is contrary to the actual meaning he or she wishes to convey (i.e., sarcasm). After each scene, participants answer questions about what the characters are thinking, doing, feeling and saying. Participants can answer “yes”, “no” or “don't know”. For each scene, the maximum score is four, yielding a maximum score of 64 as well as sub-scores for Lies and Sarcasm. The TASIT is an audiovisual measure with good psychometric properties and high ecological validity (McDonald et al., 2006) its efficacy in detecting ToM deficits has been proven with CHR individuals (Green et al., 2012).

To assess facial emotion perception, two well-established computerized tasks, the ER40 and the EDF40, were used. In these tasks, pictures representing facial expressions are shown in color. There are an equal number of male and female faces, and four races are represented (Caucasian, African-American, Asian and Hispanic). In the ER40, one face at a time is shown and participants have to choose the emotion that is represented from a list of five possibilities (anger, fear, neutral, happy and sad), shown on the right side of the screen. In the EDF40, two faces are shown and participants are asked to indicate which one shows an emotion (either happiness or sadness) more intensely. For the ER40 task, there is a total score ranging from 0 to 40, and individual sub-scores for happy, sad, angry, fearful and neutral facial expressions. For the EDF40 task, there is a total score ranging from 0 to 40, and two sub-scores for happy and sad facial expressions. Both of these tasks have been previously used with CHR individuals (Kohler et al., 2014).

The RAD is a measure of competence in relationship perception. We used the RAD-45 items, an abbreviated version of the RAD. The RAD-45 contains 15 vignettes each involving two characters whose interpersonal behaviors are consistent with one of the four relational models (Fiske, 2004). According to the relational model theory, people base their relationships on four implicit relationship models that regulate social behavior in several different domains of social life. Relationships conforming to the first model, named Communal Sharing, are based on the idea that the individuals have something in common

and are equivalent and undifferentiated. The second model is called Authority Ranking and refers to relationships where there is a hierarchy between the members, which can be classified into “decision makers” and “followers”. The third model is called Equality Matching and is based on relationships involving a one-to-one distribution of efforts and resources between members. In the fourth model, called Market Pricing, relationships are based on ratios and rates, and members are focused on proportionality based on their contribution to a certain activity or business. In the RAD, each vignette is followed by three statements that describe interactions between the same two characters in different situations, with each statement representing one of the relational models. Participants are asked to use the information they have learned from the vignette to judge (answering yes/no) whether the behaviors described in each statement are likely to occur. Performance is measured as the total number of correct responses (ranging from 0-45) and four sub-scores, one for each relational model named above. The RAD has good psychometric properties and was specifically developed and validated to assess perception of relationships in individuals with schizophrenia based on evidence showing a link between poor use of relationship models and vulnerability to psychosis (Sergi et al., 2009).

2.3. Procedures

Both CHR individuals and HCs were recruited for the study, which was approved by the Institutional Review Boards of all eight NAPLS 2 sites. Written informed consent, including parental consent, was obtained from all adult participants and parents/guardians of minors. Clinical raters were experienced research clinicians. Gold standard post-training agreement on determining the prodromal diagnoses was excellent (kappa=0.90) (Addington et al., 2012). Social cognition assessments at all sites were conducted by trained raters. Data were collected at three time points: baseline, 1 year and 2 years.

2.4. Statistical Analysis

All analyses were performed using IBM SPSS version 23 and SAS version 9.2. Between group differences on demographic variables were analyzed using Chi-square test and Student's t-test test. To accommodate for missing data at follow-up assessments and intra-participant correlation over time, a generalized linear mixed model (GLMM) for repeated measures analysis was used to examine changes over time (baseline, 1 year and 2 years) and group differences for social cognitive domains (i.e. ToM, social perception and facial affect). Specifically, the variable for time of assessment (3 levels, time_0 for baseline, time_1 for 1 year and time_2 for 2 years) and the variable for group (two levels, group_0 for HCs and group_1 for CHR) and their interactions were included as fixed effects with participants modelled as random effects using an unstructured covariance matrix. Least Square Means (LS-Means) and their 95% confidence intervals (CI) were obtained from the mixed models with Tukey-Kramer's adjustment for multiple comparisons. Spearman rank-order correlation coefficient with Bonferroni correction for multiple comparisons was used to examine cross-sectional correlations between social cognitive measures and clinical symptoms at each assessment point. Participants who received a diagnosis of a psychotic disorder during the course of the study were classified as converters. Group differences between converters and non-converters on baseline measures of social cognition were assessed using the Mann-Whitney U test (MWU) with Bonferroni correction for multiple comparisons.

3. Results

Six hundred and seventy-five CHR individuals (389 males and 286 females) and 264 HCs completed the social cognition assessments at baseline. Of those 675 CHR participants, 317 completed the one year follow-up, 188 completed the 2 year follow-up and 160 participants completed assessments at all three time points. Seventy-five CHR participants completed only the baseline assessment because they made the transition to psychosis within the first year. For the HCs, 115 participants completed all 3 assessments from 264 at baseline. The baseline characteristics of the sample are presented in Table 1. There were no differences in demographic characteristics or baseline social cognitive performance between participants that dropped out before the 24 month assessment and those that completed the study. Eighty-six CHR participants converted to psychosis during the two-year study period.

Results of the initial group comparisons on measures of social cognition across three time points are shown in Table 2. By appropriately modeling the intra-participant correlation over time, different variances across three time points and time-varying measures of social cognition, the results of the GLMM indicated that there were significant differences between the groups on all social cognitive measures at all time points. Furthermore, performance on all but one social cognitive test, the EDF40, improved over time in both groups (Table 3).

Total scores on all measures of social cognition were inter-related across all three time-points in both study groups. Cross-sectional correlations between social cognition and the SOPS total positive, total negative, total disorganized and total generalized symptoms in the CHR group were assessed at all three time-points using Spearman rank-order correlation coefficient with Bonferroni correction for multiple comparisons (Table 4). There were weak significant correlations between the social cognition measures and SOPS symptoms at baseline and the follow-up. However, after adjusting for multiple comparisons, there was only one negative correlation between ER40 and disorganization symptoms at baseline that survived the adjustment.

Results of the between group comparison on social cognitive tests at baseline for those who converted to psychosis and those who did not revealed no significant differences in medians between the converters and the non-converters on TASIT (53 vs. 54, U=21217.0, z= −1.0, p=0.29), RAD (31 vs. 32, U=21172.0, z=−0.44, p=0.65), ER40 (33 vs. 33, U=22047.5, z= −0.20, p=0.9) or EDF40 (24 vs. 25, U= 20884.0, z=−074, p=0.45). We further examined whether improvement occurred only for the non-converters. Since all conversions occurred before 2 years, we examined the change in social cognition from baseline to one year for the non-converters and converters using the GLMM (Table 5). Similar to the CHR group as a whole, the non-converters demonstrated improvement over time on all but one social cognitive test, EDF40. However, for the converters who converted after 1 year there was no improvement from baseline to 1 year on social cognition.

4. Discussion

The CHR group performed poorer on all tests of social cognition across all time points compared to HCs even though magnitudes of group differences varied depending on the

social cognitive domain and/or the assessment time point. Moderate differences between groups were noted in ToM and social perception at baseline and while these differences remained at follow-up assessments, the magnitude of differences decreased over time.

The observed deficit in ToM ability confirms previous evidence that individuals at CHR have difficulties with mental states attribution (Bora and Pantelis, 2013) and an earlier study using the TASIT, suggesting that CHR individuals show poor processing of counterfactual information (Green et al., 2012). The group differences in sarcasm detection suggest that impairment in processing counterfactual information starts early in the course of psychosis and may be considered as an indicator of vulnerability to psychosis. It may be that deficits in sarcasm detection impede social interaction and the establishment of peer-relationships, which can consequently adversely impact social functioning. However, given the reduction in effect sizes at follow-up these deficits may be less severe and less stable in CHR individuals compared to those with an established psychotic illness, with their performance in ToM intermediary to that of psychotic patients and HCs (Bora and Pantelis, 2013).

Although initially CHR individuals displayed poorer facial emotion perception compared to HCs, as previously reported (Addington et al., 2008; Amminger et al., 2012; Comparelli et al., 2013) these differences did not remain at follow-up. This may be due to practice effects that have been reported in relation to ER40 (Pinkham et al., 2015). Alternatively, there may be high variability when assessing facial emotion perception in youth as it has been suggested that facial emotion perception can vary significantly during the adolescent period due to continuous and non-linear development of the specific brain regions involved in facial emotion perception (Burnett et al., 2011). Previous studies have shown that CHR individuals had higher scores on facial emotion perception tasks compared to patients with schizophrenia but lower than HCs, without significantly differing from either group (Addington et al., 2008).

The observed impairment on social perception for the CHR group confirms findings from previous studies (Couture et al., 2008; Healey et al., 2013). The RAD specifically examines the understanding of social relationships. Poorer competence in relationship perception compared to HC participants observed in this study has previously been reported in CHR individuals (Green et al., 2012). Furthermore, inappropriate use of the relationship model, Authority Ranking, has been found to be associated with psychosis proneness (Allen et al., 2005), again fitting with our findings. It is important to note, however, that the RAD reportedly has weaker psychometric characteristics with pronounced floor effects in patients with schizophrenia (Pinkham et al., 2015), suggesting questionable utility of RAD as a repeated measure in clinical trials.

With one exception clinical symptoms were generally not associated with performance on measures of social cognition. Although significant, the strength of the association between facial affect recognition and disorganization symptoms at baseline was very low.

Although it has been suggested that CHR individuals who convert to psychosis were more prone to mislabeling neutral emotions as negative compared to their non-converter counterparts (even though face and voice emotion perception did not predict transition to

psychosis) (Allott et al., 2014) and exhibited poorer performance in ToM (Bora and Pantelis, 2013; Healey et al., 2013) in this study there were no differences in social cognition between those who made the transition to psychosis and those who did not make the transition. Poorer performance on social cognition may be indicative of being potentially vulnerable to developing psychosis. As a group, those at CHR of psychosis tend to exhibit poorer social cognition relative to healthy controls but not as poor as those with an established illness. Furthermore, CHR participants who converted to psychosis did not display the same improvements in social cognition over time that were observed in the non-converters and the healthy controls. It is possible that this result is a function of the smaller sample size in this group relative to the non-converting CHR sample. Alternatively, it is possible that for those that do go on to develop psychosis the difficulties may persist and possibly worsen with the actual onset of psychosis.

The strengths of the current study lie in its longitudinal design, a large, well-defined sample and the assessment of three domains of social cognition. Limitations are that each domain of social cognition was assessed with a single measure, there was limited follow-up assessment for those who converted, and attrition at follow-up assessments.

In summary, the current longitudinal study demonstrated mild to moderate, but persistent ToM and social perception impairments in those at CHR for psychosis compared to HCs. Future research would benefit from exploring associations between distinct social cognitive profiles and functional and cognitive outcomes in CHR.

Acknowledgements

The Authors would like to acknowledge Dr. Monica Calkins, Dr. Christian Kohler and Dr. Ruben Gur for their valued assistance with the facial affect tasks.

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Table 1

Demographic characteristics of the NAPLS 2 sample

Variable	CHR *n* = 764	Controls *n* = 280	Test Statistic	Effect Size
	Mean (SD)		*t*	*d*
Age in years	18.50 (4.23)	19.73 (4.67)	3.86**	0.28
Years of education	11.28 (2.82)	12.68 (3.58)	5.90**	0.43

	Frequency (%)		X^2	Cramer's V
Sex				
Male	436 (57.1%)	141 (50.4%)	3.73*	0.06
Female	328 (42.9%)	139 (49.6%)		
Race				
First Nations	13 (1.7%)	4 (1.4%)	5.24	0.07
Asian	54 (7.1%)	30 (10.8%)		
Black	118 (15.5%)	49 (17.5%)		
Latin America/Middle East/White	478 (62.6%)	167 (59.6%)		
Native Hawaiian or Pacific Islander	3 (0.4%)	1 (0.4%)		
Interracial	97 (12.7%)	29 (10.4%)		
Marital Status				
Single never married	720 (95.0%)	266 (95.0%)	5.60	0.08
Other[a]	39 (5.0%)	14 (5.0%)		
Currently working				
Yes	189 (25.0%)	129 (46.0%)	42.84**	0.20
No	568 (75.0%)	151 (54.0%)		
Currently enrolled as a student				
Yes	625 (82.5%)	227 (81.1%)	0.27	0.02
No	133 (17.5%)	53 (18.9%)		

* $p < 0.05$

** $p < 0.01$

[a] Married, divorced, separated, widowed or cohabiting with a significant other

Table 2

Generalized linear mixed model between HC and CHR group analysis for SC over time

Measure	BL ΔM* (SE)	95% CI	t	d	1 year ΔM* (SE)	95% CI	t	*d*	*2 years* ΔM* (SE)	t	95% CI	d
TASIT total	2.45 (0.43)	1.22,3.67	5.71***	**−0.42**	2.16 (0.46)	0.85,3.47	4.71***	**−0.34**	2.33 (0.45)	5.17***	1.04,3.61	**−0.26**
Lies	1.24 (0.26)	0.49,1.99	4.69***	**−0.35**	0.95 (0.28)	0.15,1.76	3.37*	**−0.28**	1.23 (0.29)	4.15***	0.38,2.07	**−0.26**
Sarcasm	1.21 (0.29)	0.39,2.02	424***	**−0.36**	1.22 (0.32)	0.30,2.14	3.79**	**−0.24**	1.01 (0.34)	2.99*	0.04,1.97	**−0.15**
ER40 Total	0.87 (0.24)	0.17,1.57	3.56**	**−0.26**	0.67 (0.28)	−0.14,1.50	2.34	−0.17	0.61 (0.32)	1.92	−0.29,1.52	−0.16
Anger	0.02 (0.11)	−0.27,0.32	0.22	−0.02	0.04 (0.12)	−0.31,0.39	0.36	0.02	−0.07 (0.15)	−0.5	−0.51,0.36	0.11
Fear	0.11 (0.09)	−0.16,0.38	1.14	−0.08	0.14 (0.11)	−0.17,0.456	1.29	−0.13	0.25 (0.12)	2.08	−0.09,0.58	−0.21
Happy	0.09 (0.05)	−0.05,0.229	1.83	−0.14	0.16 (0.06)	−0.00,0.32	2.84	0.24	0.00 (0.05)	0.06	−0.15,0.16	−0.02
Neutral	0.27 (0.11)	−0.05,0.61	2.35	−0.20	0.18 (0.12)	−0.18,0.54	1.46	−0.14	0.23 (0.15)	1.61	−0.18,0.65	−0.15
Sad	0.37 (0.09)	0.09,0.65	3.82**	**−0.27**	0.11 (0.11)	−0.20,0.43	1.04	−0.06	0.21 (0.13)	1.61	−0.16,0.58	−0.16
EDF40 Total	1.70 (0.42)	0.49,2.91	4.03***	**−0.26**	1.74 (0.51)	0.27,3.20	3.4**	**−0.23**	0.51 (0.61)	0.84	−1.23,2.24	−0.05
Happy Total	0.99 (0.27)	0.22,1.76	3.68**	**−0.25**	0.96 (0.34)	−0.02,1.92	2.85	−0.25	0.05 (0.39)	0.14	−1.05,1.17	−0.17
Sad Total	0.71 (0.20)	0.14,1.29	3.25**	**−0.29**	0.76 (0.24)	0.06,1.44	3.11*	**−0.26**	0.47 (0.30)	1.55	−0.39,1.33	−0.11
RAD Total	2.29 (0.37)	1.23,3.35	6.19***	**−0.44**	2.39 (0.42)	1.18,3.60	5.63***	**−0.39**	2.32 (0.49)	4.78***	0.94,3.71	**−0.29**
Communal	0.62 (0.14)	0.21,1.03	4.28***	**−0.30**	0.48 (0.16)	0.04,0.93	3.12*	**−0.23**	0.67 (0.16)	4.18***	0.21,1.12	**−0.31**
Market	0.19 (0.12)	−0.16,0.53	1.52	−0.11	0.50 (0.14)	0.09,0.90	3.55**	**−0.28**	0.45 (0.18)	2.47	−0.07,0.97	−0.23
Equality	0.54 (0.12)	0.19,0.89	4.39***	**−0.32**	0.42 (0.16)	−0.02,0.87	2.71	−0.19	0.49 (0.19)	2.65	−0.04,1.03	−0.22
Authority	0.97 (0.15)	0.54,1.39	6.49***	**−0.47**	0.85 (0.18)	0.34,1.37	4.74***	**−0.39**	0.44 (0.20)	2.16	−0.14,1.02	−0.12

CHR= clinical high group of psychosis; HC= healthy controls

ΔM*= least square means differences between groups; SE= standard error of the mean; *d*= Cohen's d

* p < 0.05

** p < 0.01

*** p < 0.001

Schizophr Res. Author manuscript; available in PMC 2017 March 01.

Table 3

Generalized linear mixed model within group analysis for social cognition over time

			CHR			
Measure	**BL ΔM* (SE)**	**BL M (SD)**	**1 year ΔM* (SE)**	**1 year M (SD)**	**2 years ΔM* (SE)**	**2 years M (SD)**
TASIT total	52.30 (0.23)	52.3 (6.10)	54.3 (0.26)*a****	54.54 (5.64)	55.2 (0.27)*a***b***	55.78 (5.10)
ER40 Total	32.79 (0.13)	32.79 (3.59)	33.48 (0.17)*a***	33.51 (3.60)	34.05 (0.19)*a***b**	34.12 (3.21)
EDF40 Total	24.29 (0.22)	24.29 (6.0)	24.36 (0.29)	24.62 (5.94)	24.66 (0.37)	24.71 (6.28)
RAD Total	31.63 (0.19)	31.68 (5.30)	32.96 (0.24)*a****	33.29 (5.32)	33.89 (0.29)*a***b***	34.15 (5.62)

			HC			
Measure	**BL ΔM* (SE)**	**BL M (SD)**	**1 year ΔM* (SE)**	**1 year M (SD)**	***2 years* ΔM* (SE)**	**2 years M (SD)**
TASIT total	54.80 (0.36)	54.80 (5.30)	56.4 (0.38)*a****	56.42 (4.50)	57.5 (0.36)*a***b***	57.08 (4.45)
ER40 Total	33.67 (0.21)	33.67 (2.79)	34.16 (0.23)	34.09 (2.69)	34.67 (0.25)*a***	34.61 (2.51)
EDF40 Total	25.99 (0.36)	25.97 (5.21)	26.09 (0.42)	26.19 (5.68)	25.17 (0.48)	25.38 (5.54)
RAD Total	33.93 (0.31)	33.95 (4.48)	35.35 (0.35)*a****	35.28 (4.27)	36.22 (0.39)*a****	35.67 (4.43)

Note: CHR= clinical high group of psychosis; HC= healthy controls

ΔM*= least square mean; SE= standard error of the mean; M= mean; SD= standard deviation

*p<0.05

**p<0.01

***p<0.001

a significantly different from baseline

b significantly different from 1 year

Table 4

Correlations between measures of social cognition and SOPS symptoms in CHR participants

Measure	CHR Scale of Prodromal Symptoms			
	Positive	**Negative**	**Disorganized**	**General**
Baseline				
TASIT total	.04	−.07	−.06	.07
RAD Total	.01	.00	.04	.03
ER40 Total	−.00	−.08*	**−.14*** **	−.04
EDF40 Total	−.02	−.10**	−.02	−.02
1 year				
TASIT total	−.02	−.05	−.01	.14*
RAD Total	.07	.02	.11	.13*
ER40 Total	−.12*	−.04	−.13*	−.01
EDF40 Total	.08	−.01	.09	.13*
2 years				
TASIT total	.09	.00	.07	.01
RAD Total	.08	.01	.07	.14
ER40 Total	−.01	.02	.07	.06
EDF40 Total	.07	−.21**	.11	−.05

Values shown are correlation coefficients.

TASIT=theory of mind task, RAD=social perception task, ER40 and EDF40= emotion perception tasks.

* $p < 0.05$

** $p < 0.01$

*** $p < 0.003$ following Bonferroni Correction at each time point.

Table 5

Generalized linear mixed model within group analysis for social cognition over time in converters and non-converters

	Non-converters		*converters*	
Measure	**BL ΔM* (SE)**	**1 year ΔM* (SE)**	**BL ΔM* (SE)**	**1 year ΔM* (SE)**
TASIT total	52.50 (0.25)	54.40 (0.28)***	51.07 (0.70)	53.43 (1.46)
ER40 Total	32.83 (0.14)	33.54 (0.18)***	32.51 (0.40)	33.01 (0.94)
EDF40 Total	24.32 (0.25)	24.34 (0.31)	23.95 (0.68)	25.46 (1.57)
RAD Total	31.65 (0.22)	33.04 (0.27)***	31.50 (0.61)	31.35 (1.35)

Note: ΔM*= least square mean; SE= standard error of the mean

*** p<0.001