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Social impairment and social language deficits in children and adolescents with and at risk for psychosis

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ABSTRACT

Intro: One of the more debilitating functional outcomes of schizophrenia-spectrum disorders is social impairment. Previous studies have identified impaired social functioning both in the prodromal phase of psychosis and after acute symptoms abate, suggesting that social impairment represents a core deficit in psychosis not directly linked to psychotic episodes or symptom severity. To date, research in this area has focused primarily on adult populations rather than children, and has not directly assessed social language in individuals across the psychosis continuum.
Methods: 81 youth ages 7–18 (N = 24 Typically Developing [TD], N = 36 Clinical High Risk [CHR], N = 21 Psychotic Disorder [PD]) were recruited. Youth participants were administered the Social Language Development Test (SLDT), and parent(s)/guardian(s) completed the Social Responsiveness Scale-II (SRS-II).
Results: Social language ability was not associated with social impairment. PD participants performed significantly worse on the SLDT than TD participants. CHR and PD participants were both rated as having experienced significantly greater social impairment than TD participants on every subscale of the SRS-II.
Discussion: Deficits in social language ability and social functioning are strong candidates for phenotypic markers of psychosis, and may be evident earlier in development than previous work has demonstrated. Additionally, the severity of social impairment did not differ between CHR and PD participants, further supporting that social cognitive deficits and social impairment, while related to symptom severity, are discrete deficits in individuals with and at risk for psychosis. These results highlight the importance of addressing social skills for individuals presenting in clinical settings with psychotic symptoms, including children.

1. Introduction

Schizophrenia-spectrum disorders are marked by a decline in functional outcome, including occupational impairment (Marwaha and Johnson, 2004), poor academic achievement (MacCabe et al., 2008), and social isolation (Michalska Da Rocha et al., 2018). In the last two decades, research has focused on identifying to what degree these impairments are present in the prodromal phase of psychosis. Individuals at clinical high risk (CHR; also known as "ultra-high risk" and "at risk mental state" [Yung et al., 1996]) are defined as a group experiencing psychotic-like symptoms, below diagnostic threshold, but at high risk for converting to psychosis due to positive psychotic-like symptoms (Miller et al., 2002). Mounting evidence indicates that CHR individuals experience impairments similar to those observed in individuals with psychotic disorders (PD), particularly in areas of social cognition and social functioning (Lincoln et al., 2017).

Social cognition is the psychological process involved in perceiving, encoding, retrieving, and regulating of information about other people (Green et al., 2008). Deficits in social cognition have been demonstrated extensively in individuals with schizophrenia-spectrum disorders (Savla et al., 2013), and more recently, in CHR individuals. A meta-analysis of over 1200 CHR participants identified deficits across multiple domains of social cognition, including theory of mind, social perception, attributional bias, and emotion processing, with the largest effect size for attributional bias (Lee et al., 2015). A recent review found similarly diminished social cognitive abilities among CHR individuals, but concluded that these deficits may be specific to more complex social cognitive tasks that require higher-order theory of mind processing

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(e.g., understanding and identifying figures of speech, irony, or faux pas). Importantly, the authors noted a lack of studies involving CHR children, which thus prevents understanding the potential developmental trajectory of these deficits (Lincoln et al., 2017).

Social cognition tends to underlie functional outcome, both in individuals with psychosis (Lee et al., 2015; Gold, 2004) and in CHR individuals (Cotter et al., 2014). Longitudinal designs show that CHR individuals who ultimately transition tend to exhibit a decline in performance over time on tests of social cognition, while CHR non-converters typically remain stable or improve (Cannon et al., 2008; Niendam et al., 2007; Jang et al., 2011; Piskulic et al., 2016). CHR populations also experience more social isolation (Lencz et al., 2004), social anxiety (Rietdijk et al., 2013), and social anhedonia (Velthorst et al., 2009) than healthy peers. Importantly, these problems are observed in at-risk states, first-episode psychosis, schizophrenia, and in remission states (Addington et al., 2008; Jaracz et al., 2015)—suggesting that social impairment represents a core deficit in psychosis, which is not directly tied to acute psychotic episodes or positive symptom severity. To date, research on social impairment during the CHR phase has focused primarily on late adolescent and adult populations. It remains unclear whether CHR children experience the same level of social impairment as older CHR cohorts. Additionally, the majority of studies have compared clinical to non-clinical populations, with only a handful comparing across psychiatric groups (Nitka et al., 2016; Ising et al., 2016; Masillo et al., 2016; Niendam et al., 2007; Lyngberg et al., 2015; Jang et al., 2011). Given the importance of a possible developmental trajectory of these abilities, comparing abilities across multiple stages of the psychosis continuum is important. In prior work, Addington et al. (2008) provided evidence that social impairments may be equally severe for CHR and psychotic individuals. They compared CHR participants, individuals with first-episode psychosis, and others with multi-episode schizophrenia, finding no difference in social functioning among the three groups. While an important step in understanding how these skills vary across disease-states, approximately half of this sample consisted of participants >18 years old; thus, these findings cannot generalize to children and thus cannot provide insight into developmental changes that may occur during childhood and adolescence.

Expressive language—the ability to convey wants, needs, and ideas to others—plays a fundamental role in successful interpersonal interactions, and is a strong predictor of social functioning (McCabe and Meller, 2004; Durkin and Conti-Ramsden, 2007). This concept is particularly relevant in understanding the relationship between psychosis and social impairment, as expressive language dysfunction is often characteristic of individuals on the psychosis continuum. Disorganized speech is a symptom of schizophrenia-spectrum disorders, but additional impairments such as poor semantic verbal fluency and poor verbal cohesion have also been observed in individuals with psychotic disorders (Szöke et al., 2008; Bokat and Goldberg, 2003; Bearden et al., 2011). CHR individuals exhibit a similar pattern of language dysfunction, particularly on semantic verbal fluency tasks (Fusar-Poli et al., 2012). Importantly, verbal fluency is associated with social functioning among individuals with schizophrenia (Green et al., 2000). While certain linguistic deficits (e.g., verbal fluency) appear to underlie social impairment in psychotic and pre-psychotic populations, other aspects of expressive language that may be more closely related to social functioning remain relatively understudied. Social language ability, in particular, involves the skills required to appropriately verbally express what another person is thinking or feeling within a social context. Solomon et al. (2011), investigating a similar construct, demonstrated significant deficits in social communicative abilities among CHR and PD adolescents and emerging adults. However, no studies to our knowledge have directly measured social language in CHR and PD children and adolescents using a performance-based instrument.

The current study seeks to fill the gap in the CHR literature by comparing typically developing (TD), CHR, and PD youth ages 7–18 years old on a parent-measure of social functioning and a performance-based measure of social language development. Secondary analyses explore social language ability and social impairment in children (ages 7–11 years old) and adolescents (ages 12–18 years old) separately. Prior research suggests that children with psychotic symptoms may have greater social impairment than adolescents with psychotic symptoms (Ribolsi et al., 2017) and thus age-related differences are important to consider. Among the CHR and PD groups, we also explore the relationship between social language and social functioning. Consistent with previous studies in adults (Birgenheir and Pepper, 2013; Savla et al., 2013; Addington et al., 2008), we expect CHR and PD youth to exhibit more social impairment and social language deficits than TD participants. We do not expect to see differences in social impairment or social language ability between the CHR and PD groups. We anticipate that social language in CHR and PD participants will be associated with social functioning, as is seen in psychotic (Piovan et al., 2016) and other clinical populations (Staikova et al., 2013; Struchen et al., 2008).

2. Materials and methods

2.1. Participants

Eighty-one (n = 81) participants, ages 7 to 18 years old, were recruited as part of a larger study of neuroplasticity and psychosis (Gonzalez-Heydrich et al., 2015). Participants being considered for inclusion in the TD group were recruited from the Greater Boston community via fliers and online advertisements. Clinical populations (CHR and PD youth) were referred to the study from clinicians in the Department of Psychiatry at Boston Children's hospital as well as other local clinics. Fig. 1 outlines the recruitment process and reasons for exclusions. Study procedures were approved by the Boston Children's Hospital Institutional Review Board, and all included participants and parents provided assent and consent, respectively. Exclusion criteria for all participants included neurological disorders, head injury resulting in loss of consciousness, medical illnesses that significantly impair neurocognitive function, a history of Autism Spectrum Disorder or Diagnostic and Statistical Manual 4th Edition (American Psychiatric Association, 2000) Asperger's Disorder, or substance abuse in the past month or substance dependence in the past 3 months.

2.1.1. Typically developing

TD participants had additional exclusion criteria including the presence of a lifetime history of a psychiatric disorder as assessed by the Schedule for Affective Disorders and Schizophrenia for School-Age Children—Present and Lifetime Version (KSADS-PL; Kaufman et al., 1997), or psychotic like symptoms as defined by a score of 3 or more on the positive symptom scales of the Structured Interview for Prodromal Syndromes (SIPS; Miller et al., 2003).

2.1.2. Clinical high risk

CHR individuals were identified as youth meeting criteria for the presence of at least one of the following psychosis risk syndromes, as defined by the SIPS: 1) Brief Intermittent Psychotic Symptom (BIPS) Syndrome; 2) Attenuated Positive Symptom (APS) Syndrome; and/or 3) Genetic Risk and Deterioration (GRD) Syndrome. CHR exclusion criteria included a DSM-IV diagnosis of a psychotic disorder as determined by the KSADS-PL, or psychotic-like symptoms better accounted for by substance use.

2.1.3. Psychotic disorder

For the PD group, individuals were included if they had a current psychotic disorder or an affective disorder with the presence of psychotic features, as determined by the KSADS-PL (Kaufman et al., 1997). Exclusion criteria for PD participants included psychotic symptoms better accounted for by substance use or a medical/non-psychotic condition.

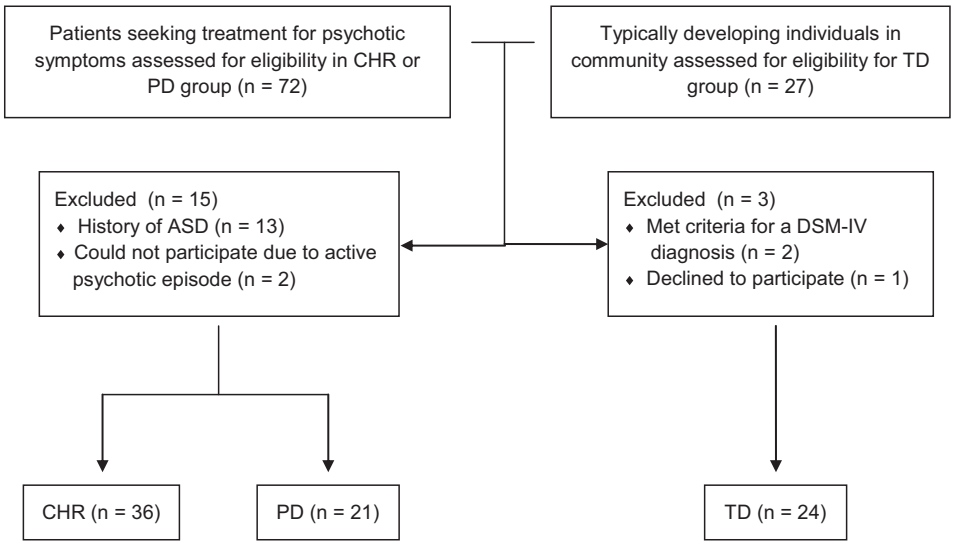

Fig. 1. CONSORT Flow Diagram.

2.2. Measures

2.2.1. Structured Interview for Prodromal Syndromes (SIPS)

The SIPS (Miller et al., 2003) is a structured interview that assesses psychotic-like symptoms in four categories: positive, negative, disorganized, and general symptoms. Participants could meet for one of three prodromal syndromes: 1) *Attenuated Positive Symptom Syndrome*: rating of 3–5 on any one of the Positive Symptoms items (P1–P5) with frequency > 1× per week in past month, and onset or worsening of symptoms over the past year; 2) *Genetic Risk and Deterioration Syndrome*: familial high risk status or Schizotypal Personality Disorder plus >30% decline in GAF compared to previous year; or 3) *Brief Intermittent Psychotic Syndrome (BIPS)*: rating of 6 on any one of the Positive Symptoms items, with symptoms too infrequent to meet criteria for psychosis; onset < 1 month, frequency < 1 h per day at an average frequency of <4 days per week. The SIPS has demonstrated excellent sensitivity (100%), specificity (74%), and interrater reliability for all four subscales (Miller et al., 2003).

2.2.2. Schedule for Affective Disorders and Schizophrenia for School-Age Children—Present and Lifetime Version (KSADS-PL)

The K-SADS-PL (Kaufman et al., 1997) is a semi structured interview used to diagnose psychiatric disorders in individuals >18 years of age. It was administered to youth participants as well as to a parent/guardian. For a handful of participants who were not able to complete testing, diagnostic information was collected via the K-SADS-PL from the parent/guardian only. The K-SADS-PL has demonstrated excellent interrater reliability (Kaufman et al., 1997). An additional study, focused specifically on children and adolescents with schizophrenia, found good convergent validity and moderate divergent validity (Lauth et al., 2010).

2.2.3. Social Responsiveness Scale—Parent Form (SRS)

The SRS (Constantino and Gruber, 2002) is a 65-item parent-report measure of social functioning for youth 5–18 years old. Traditionally used in the context of autism spectrum disorders (Chan et al., 2017) the SRS provides a normed *T*-score based on age and gender for each of 5 subscales: social awareness, social cognition, social communication, social motivation, and autistic mannerisms. The SRS has exhibited excellent reliability between mothers, fathers, and teachers, as well as excellent test-retest reliability (Constantino et al., 2003).

2.2.4. Social Language Development Test—Elementary and Adolescent Versions (SLDT)

The SLDT (Bowers et al., 2008; Bowers et al., 2010) assesses the language-based skills required to appropriately infer and express what another person is thinking or feeling within a social context. The test consists of four sections for the elementary version: Making Inferences, Interpersonal Negotiation, Multiple Interpretations, and Supporting Peers; and five sections for the adolescent version: Making Inferences, Interpreting Social Language, Problem Solving, Social Interaction, and Interpreting Ironic Statements. Participants receive a normed total *T*-score based on age and gender, which reflects general developmental refinement of social language comprehension and expression. The SLDT has demonstrated good test-retest reliability ($\kappa = 0.82$ and 0.79 for the adolescent and elementary version, respectively), excellent interrater reliability (85% and 84% agreement for the adolescent and elementary version, respectively), and good content and criterion validity (Bowers et al., 2008; Bowers et al., 2010).

2.3. Data analysis

Analyses were performed in IBM SPSS 23.0. SLDT data met the assumptions for parametric tests. Group differences on the SLDT were assessed using a one-way analysis of variance (ANOVA) with Bonferroni-corrected pairwise comparisons. Pearson correlations between SLDT and SRS total scores were conducted separately for all three study groups. SRS data were roughly normally distributed, with some exceptions; the Kolmogorov-Smirnov test of normality demonstrated non-significant *p*-values for all three study groups (i.e., they satisfied the assumption of normality), but the Shapiro-Wilk test revealed a significant *p*-value (.01) for the PD group and a near-significant *p*-value (.055) for the CHR group. In addition, Levene's test revealed significant heterogeneity of variance among study groups on SRS scores ($p < .001$). Due to these potential concerns, both parametric tests (one-way ANOVA) and equivalent non-parametric tests (Kruskal-Wallis) were performed for SRS total and subscale *T*-scores. The results of the non-parametric tests did not change any decision regarding the rejection/non-rejection of null hypotheses. Thus, only the results from the parametric tests are reported. Secondary group comparisons of social language ability and social impairment were conducted for children (ages 7–11 years old) and adolescents (ages 12–18) separately. For group comparisons that did not meet the assumption of homogeneity of variance, the Brown-Forsythe adjusted *p*-value is reported (Brown and Forsythe, 1974).

3. Results

3.1. Demographics

Eighty-one (81) youth met inclusion criteria for the study (mean age = 11.7 years, SD = 3.1 years). Participant demographic characteristics are detailed in Table 1. PD, CHR, and TD participants did not differ in age, gender, years of education, or household income ($ps > 0.13$). All CHR participants met criteria for Attenuated Positive Symptom Syndrome as the basis of their study inclusion. Diagnostic breakdown for PD participants was: schizophrenia (n = 7), schizoaffective disorder (n = 6), psychosis not-otherwise-specified (n = 6), bipolar disorder with psychotic features (n = 1), and major depressive disorder with psychotic features (n = 1).

3.2. Social language development

SLDT total *T*-scores showed a significant main effect of group ($F_{2, 75} = 4.01$, $p = .022$, $\eta^2 = 0.10$; Table 2). Bonferroni-corrected pairwise comparisons revealed that PD participants scored significantly lower than TD participants ($p = .018$), with low scores indicating poorer social language skills (Fig. 2). CHR and TD participants did not differ significantly in SLDT Total *T*-score ($p = .46$), nor did the CHR and PD groups ($p = .29$). Further evaluation of SLDT subtests revealed a significant difference in *T*-scores on the Supporting Peers subtest of the Elementary version ($p < .05$), such that TD participants scored higher than the CHR and PD group. TD adolescents scored higher than CHR and PD adolescents on Interpreting Ironic Statements, a difference that bordered on significance ($p = .057$). No other subtest scores revealed significant differences across study groups ($ps > 0.10$; Table 2). When analyzing children and adolescents separately, no significant differences in SLDT total *T*-score were observed. Among children, the Supporting Peers subscale revealed a significant group difference ($F_{2, 37} = 3.61$, $p = .038$, $\eta^2 = 0.17$). Bonferroni-corrected pairwise comparisons revealed that CHR participants performed worse than TD participants on this subscale, a difference that bordered on significance ($p = .058$).

3.3. Social impairment

Pearson correlations by study group revealed no significant associations between SRS and SLDT total *T*-scores ($p > .10$). SRS total *T*-scores differed significantly across study groups ($F_{2, 55.74} = 46.49$, $p < .001$, $\eta^2 = 0.52$; Table 2). Bonferroni-corrected pairwise comparisons demonstrated significantly higher scores in the CHR ($p < .001$, $d = 2.27$) and PD ($p < .001$ $d = 3.01$) participants relative to TD participants, indicating greater social impairment in the affected groups (Fig. 3). CHR and PD participants did not differ from each other on SRS Total *T*-score. Analyses of SRS subscales revealed the same pattern of significant differences, with CHR and PD participants scoring significantly higher than TD participants Social Awareness ($p < .001$, $\eta^2 = 0.31$), Social Cognition ($p < .001$, $\eta^2 = 0.45$), Social Communication ($p < .001$, $\eta^2 = 0.44$), Social Motivation ($p < .001$, $\eta^2 = 0.47$), and Autistic Mannerisms ($p < .001$, $\eta^2 = 0.51$) (Table 2). Analyzing SRS scores separately for children and adolescents revealed a similar pattern of significant differences. Children's SRS total *T*-scores differed significantly across study groups ($F_{2, 27.73} = 36.86$, $p < .001$, $\eta^2 = 0.67$), with Bonferroni-corrected pairwise comparisons revealing significantly higher scores in CHR children ($p < .001$) and PD children ($p < .001$) relative to TD children. CHR and PD children's SRS scores did not differ significantly. Among the children, this pattern of significant differences was observed for each SRS subscale ($Fs > 13.0$, $p < 001$, η^2s from 0.42 to 0.68) Similarly, Adolescents' SRS total *T*-scores differed significantly across study groups ($F_{2, 20.40} = 12.13$, $p < .001$, $\eta^2 = 0.39$), with Bonferroni-corrected pairwise comparisons also demonstrating significantly higher scores in CHR ($p < .001$) and PD adolescents ($p < .001$) relative to TD adolescents. CHR and PD adolescents scored significantly higher than PD participants on all subscales but Social Awareness, for which only PD adolescents (not CHR adolescents) scored significantly higher than TD adolescents ($Fs > 4.0$, $ps < 0.023$, η^2s from 0.18 to 0.40)

The SRS includes cutoff scores designed to aid in diagnosis of individuals with suspected autism spectrum disorder (ASD). Total *T*-scores ≤ 59 indicate social functioning within a developmentally typical range, whereas scores from 60 to 75 are in the mild to moderate range and indicate clinically significant deficits in social behavior that mildly to moderately interfere in psychosocial functioning, and scores ≥76 indicate clinically significant deficits in social behavior that severely impair psychosocial functioning. Results revealed that, on average, TD participants had typical social functioning with no variability extending to mild impairment (M = 43.9, SD = 4.6, Range = 35–56). In contrast, CHR (M = 68.8, SD = 14.8, Range = 42–90) and PD (M = 73.5, SD = 13.2, Range = 52–90) youth demonstrated mild to moderate impairment with considerable variability. Collectively, these results demonstrate both a statistical and clinically meaningful difference in social impairment between TD youth and CHR and PD youth.

Table 1
Demographics.

	TD (N = 24)	CHR (N = 36)	PD (N = 21)	Difference between groups
Gender (female/male/trans)	14/10/0	21/14/1	6/14/1	$\chi^2 = 6.16^*$
Age: mean (SD)	10.71 (3.24)	12.33 (2.90)	11.90 (3.22)	$F_{2,78} = 2.04$
Years of education: mean (SD)	6.17 (3.62)	6.97 (2.47)	5.76 (3.11)	$F_{2,64} = 1.02$
Household income				$\chi^2 = 4.66$
$0–$39,999	5 (25.0%)	5 (16.1%)	6 (31.6%)	
$40,000–$99,999	6 (30.0%)	12 (38.7%)	7 (36.8%)	
>$100,000	7 (35.0%)	12 (38.7%)	3 (15.8%)	
No response	2 (10.0%)	2 (6.5%)	3 (15.8%)	
Race/ethnicity (%)				N/A
White	12 (50%)	25 (69.4%)	9 (42.9%)	
Black	5 (20.8%)	1 (2.8%)	2 (9.5%)	
Asian American	1 (4.2%)	2 (5.6%)	0 (0%)	
Native American	0 (0%)	1 (2.8%)	2 (9.5%)	
Latino	2 (8.3%)	2 (5.6%)	2 (9.5%)	
Multiracial	3 (12.5%)	3 (8.3%)	5 (23.8%)	
No response	1 (4.2%)	2 (5.6%)	1 (4.8%)	

* $p < .05$.

4. Discussion

This study compared a particularly young sample of CHR, PD, and TD youth on social language development and social impairment. The hypothesis that CHR and PD participants would report more social impairment was confirmed. Hypotheses regarding group differences in social language development, however, were only partially confirmed. PD youth performed worse on a measure of social language ability than TD youth. No difference was found between CHR and TD participants or between CHR and PD participants. Analyzing children and adolescents separately revealed a similar pattern of social impairment in CHR and PD participants relative to TD participants. However, few significant group differences remained in social language ability after splitting the sample by age. Additionally, social language ability was not associated with social functioning among any of the three study groups. The findings overall are somewhat consistent with previous research on older CHR and PD children and adolescents which have demonstrated impaired performance on linguistic tasks (Bokat and Goldberg, 2003; Becker et al., 2010) and social functioning (Lee et al., 2015; Cotter et al., 2014), but deviate from other work suggesting that social language ability is one of the components that underlies social functioning in psychosis (Piovan et al., 2016). This study is unique in its focus on a younger sample (mean age = 11.7, SD = 3.1), extending the research in this area to children as young as 7 years old.

Table 2
Group differences in social impairment and social language development.

	TD (N = 23)	CHR (N = 34)	PD (N = 21)	*F*	η^2
SLDT total *T*-Score: mean (SD)	94.78 (13.08)	89.56 (12.88)	83.29 (14.13)	$F_{2, 75} = 4.01^{*}$	0.10
Elementary (ages 6–11 years)					
Making inferences	96.07 (13.18)	91.15 (6.89)	92.67 (14.19)	$F_{2, 38} = 0.61$	0.03
Interpersonal negotiation	93.14 (10.08)	89.08 (13.41)	83.83 (16.83)	$F_{2, 38} = 1.53$	0.08
Multiple interpretations	88.00 (10.43)	88.23 (13.15)	78.83 (14.05)	$F_{2, 38} = 2.28$	0.11
Supporting peers	107.4 (13.55)	95.77 (11.48)	97.00 (10.91)	$F_{2, 37} = 3.61^{*}$	0.17
Adolescent (ages 12–18 years)					
Making inferences	87.40 (15.81)	83.76 (13.02)	79.22 (12.79)	$F_{2, 39} = 0.85^{**}$	0.04
Interpersonal social language	95.20 (15.95)	93.67 (15.72)	84.00 (16.67)	$F_{2, 39} = 1.44$	0.07
Problem solving	97.30 (15.23)	92.90 (17.00)	92.60 (17.00)	$F_{2, 39} = 0.93$	0.05
Social interaction	97.50 (16.29)	96.76 (16.52)	90.33 (17.17)	$F_{2, 39} = 0.57$	0.03
Interpreting ironic statements	101.1 (13.87)	93.81 (15.66)	83.78 (15.56)	$F_{2, 39} = 3.09$	0.14
				Brown-Forsythe *F*	
SRS total *T*-Score: mean (SD)	43.88 (4.57)	68.81 (14.79)	73.52 (13.17)	$F_{2, 55.74} = 46.49^{***}$	0.51
Social awareness	46.29 (8.90)	59.78 (12.76)	64.57 (10.14)	$F_{2, 75.05} = 19.04^{***}$	0.31
Social cognition	44.00 (6.00)	66.33 (14.60)	71.0 (14.55)	$F_{2, 54.41} = 33.48^{***}$	0.45
Social communication	42.79 (5.69)	64.83 (15.54)	70.81 (13.83)	$F_{2, 57.88} = 34.81^{***}$	0.44
Social motivation	45.38 (6.32)	70.53 (14.74)	70.33 (12.73)	$F_{2, 61.71} = 39.50^{***}$	0.47
Autistic mannerisms	44.45 (5.10)	70.39 (14.62)	75.48 (14.69)	$F_{2, 52.02} = 44.24^{***}$	0.51

Pairwise comparisons for all Analyses of Variance (ANOVA) were assessed using a Bonferroni correction.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

The lack of difference between CHR and TD youth in overall social language ran contrary to our hypothesis. It is possible that our assessment of social language was not sensitive enough to detect potentially more subtle deficits in CHR individuals, whereas these deficits may be more prominent in PD individuals. Vicker (2003) points out that individuals with slight deficits may answer items correctly on self-report, performance-based tests of social communication based on information he/she can recall about a particular social situation. When analyzing performances on the subscales of the social language measure, only scores on Supporting Peers for elementary-school aged youth differed significantly across study groups, with TD participants performing better on average than the CHR and PD groups. It is not immediately clear why Supporting Peers was the only subtest that revealed significant differences in performance across study groups. However, it should be noted that group differences in subtest scores were run separately for children (ages 6–11 years old) and adolescents (ages 12–18 years old), since subtests on the SLDT are not equivalent for the Elementary and Adolescent version. Thus, the original sample size was reduced by approximately half for each ANOVA that was conducted, decreasing the power necessary to detect potential significant differences. This limitation may have contributed to the lack of significant differences found in subtest *T*-scores, despite the finding that participants' total mean *T*-score differed significantly across study groups.

Parent-reports of social functioning revealed robust differences between TD participants and both CHR and PD participants, such that the latter two groups demonstrated greater social impairment. In breaking down this finding, we observed specific deficits in social awareness, social cognition, social communication, social motivation, and autistic mannerisms. Importantly, PD participants were not significantly more impaired than CHR participants, suggesting that deficits in social functioning exist prior to the onset of a psychotic disorder and, thus, may reflect an underlying trait that is present before the development of a psychotic disorder. This finding is consistent with previous research in late-adolescent and adult at-risk populations (Addington et al., 2008), and in line with work suggesting that social impairment is more pronounced in childhood onset psychosis (Alaghband-Rad et al., 1995; Lin et al., 2016). Additionally, prior work demonstrates that social impairment is persistent in remitted states, after psychotic symptoms have abated (Mehta et al., 2013). Our findings provide further evidence to support the theory that social functioning may be a stable and discrete deficit in individuals across multiple stages of the psychosis continuum. Of note, deficits in social functioning were observed among

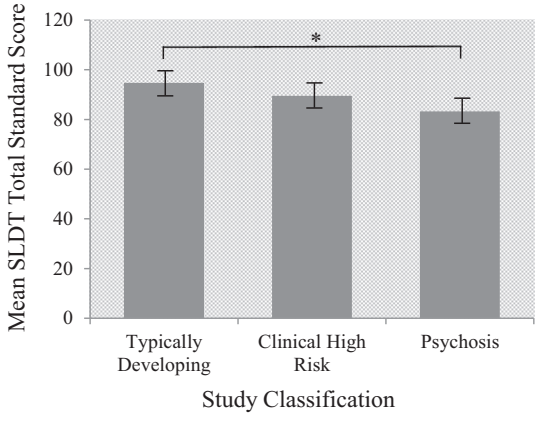

Fig. 2. Mean Social Language Development (SLDT) Score by Study Classification Psychotic disorder (PD) participants reported significantly lower mean SLDT total scores than typically developing (TD) participants. Clinical high risk (CHR) participants did not differ significantly lower than TD participants. Note: Higher scores = better performance. *$p < .05$.

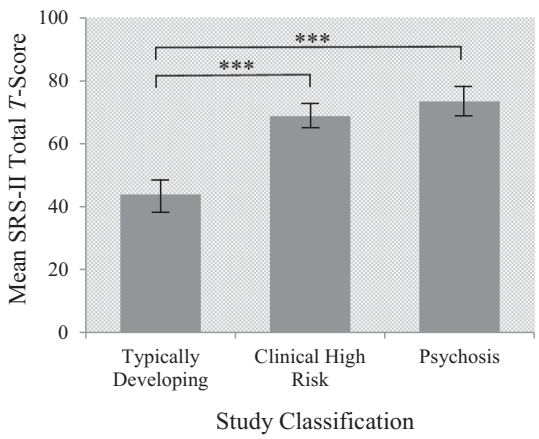

Fig. 3. Mean Social Responsiveness Scale (SRS-II) Score by Study Classification Clinical high risk (CHR) and psychotic disorder (PD) participants reported significantly higher mean SRS-II total scores than typically developing (TD) participants. Note: Higher scores = greater impairment *$p < .05$, **$p < .01$, ***$p < .001$.

the youngest subsample of CHR and PD participants, children ages 7–11 years old. While these results should be interpreted cautiously given the small sample size (n = 40 children), they suggest that social impairment may be a stable marker of psychosis that presents early in childhood and before the onset of acute symptoms. Additionally, these findings are consistent with work by Lin et al. (2016) who have found that deficits in social functioning may be more severe in childhood (prior to age 14) than adolescence. However, further studies with larger samples are necessary in order to make any definitive conclusions about the level of social functioning in young pre-psychotic children.

SRS scores for TD participants fell within the typical range for unaffected individuals within the general population, while mean SRS scores for CHR and PD participants were at levels characteristic of individuals with mild-moderate ASD. However, 30.6% of CHR and 52.4% of PD participants received *T*-scores ≥76, placing them within the severe range. Prospective participants were excluded on the basis of a previous ASD diagnosis, but were not formally assessed by our study. Therefore, the observed elevated SRS scores may reflect participants who, though undiagnosed, currently meet criteria for ASD. Notwithstanding this possibility, recent work has identified a substantial symptomatological overlap between ASD and schizophrenia-spectrum disorders. In particular, a 2017 meta-analysis by Kincaid el al. found that 9.6% to 61% of individuals with psychotic disorders display subthreshold autistic-like traits, suggesting the current findings may not be atypical. Furthermore, the SRS may lack reliably (i.e., specificity) when administered to psychosis-spectrum populations. In a different study of social functioning and psychosis risk, 40% of CHR participants and 31% of first-episode psychosis participants scored in the severe range on the SRS (Solomon et al., 2011). These rates are comparable to what was observed in the current sample. Assuming the diagnoses of our participants were accurate, these findings are particularly noteworthy in the context of psychosis risk-assessment for CHR individuals; previous work has identified social cognitive and social functioning deficits as predictors of transition in CHR populations (Kim et al., 2011; Addington et al., 2003), but no longitudinal study to date has tested the SRS as a predicative measure psychosis risk among CHR individuals. Future research should follow this severely socially impaired CHR sub-sample over time and determine whether they transition to psychosis at a higher-than-normal rate.

Despite excluding participants with a diagnosis of ASD, 75.9% of CHR and PD individuals received SRS total *T*-scores characteristic of individuals with high-functioning or severe ASD. Historically, autism and schizophrenia were thought of as a single disorder (King and Lord, 2011). Although subsequent research has since delineated the disorders into two distinct categories, substantial overlap in symptom presentation exists; specifically, deficits in social cognition and functioning (Couture et al., 2010; Eack et al., 2013). A number of etiological models offer potential explanations for the elevated co-occurrence of ASD and schizophrenia spectrum disorders (Chisholm et al., 2015). The associated liability model, for example, proposes that the two disorders are related by shared risk factors. Indeed, neurobiological studies have identified potential overlapping neural pathways that may confer risk for social processes in both autism spectrum disorders and psychotic disorders (Sugranyes et al., 2011). Alternatively, the diametrical model characterizes ASD and psychosis as opposite poles of a continuous spectrum, developing from diametrical alternations to a common risk factor. This model predicts that ASD and psychosis represent two extremes of a social-cognitive continuum; that the social cognitive deficits observed in ASD are the result of underdeveloped social cognition (hypomentalism), whereas deficits seen in psychotic disorders arise from hypermentalizing in social situations (Abu-Akel et al., 2015). While further work is needed to evaluate the potentially related etiologies of both disorders, the findings here reinforce some of their commonalities and underscore the clinical importance of employing differential diagnostic strategies when patients present with social impairment (Stevens et al., 2014).

Findings from this study should be considered in light of some limitations. First, the small sample size limited the power available to detect potential statistically significant relationships. Related, this study did not control for disorganized speech, a variable that may have exaggerated differences in social language skills and social impairment, particularly between PD and TD participants. The cross-sectional nature of this study precluded investigation of a causal relationship between social impairment and psychosis transition. It should also be noted that test-retest reliability for psychotic disorders typically falls in the moderate range, with schizoaffective disorder demonstrating the lowest kappa coefficients (Salamon et al., 2018; Santelmann et al., 2015). Future research should seek to replicate these numbers in larger samples of similar age, and should employ longitudinal designs in order to better assess diagnostic reliability among participants with psychosis and to investigate whether the "severely socially impaired" subset of CHR youth is at greater risk of transitioning to psychosis than other CHR individuals.

The present study showed that deficits in social language and social functioning are present in children with and at-risk for psychotic disorders. Building on prior work with adults (Savla et al., 2013; Lee et al., 2015), this study illustrates the importance of examining differences in social abilities across the psychosis spectrum. Critically, the participants recruited for this study had a mean age of 11.7 years, making this one of the younger cohorts ever to be investigated in a study of social language and functioning in psychosis and psychosis-risk. These results may have important implications for prevention efforts that assess social language and social functioning, as well interventions that target social skills for individuals with and at risk for psychosis, including young children.

Conflict of interest

In the past three years, Dr. Gonzalez-Heydrich has received grant support from the Tommy Fuss Fund and the Al Rashed Family. He holds equity in Neuro-motion, a company that develops emotion regulation training technology. In previous years, he has served as a consultant to Abbott Laboratories, Pfizer Inc., Johnson & Johnson (Janssen, McNeil Consumer Health), Novartis, Parke-Davis, Glaxo-SmithKline, AstraZeneca, and Seaside Therapeutics; has been a speaker for Abbott Laboratories, Pfizer Inc., Novartis, Bristol-Meyers Squibb; and has received grant support from Abbott Laboratories, Pfizer Inc., Johnson & Johnson (Janssen McNeil Consumer Health), Akzo-Nobel/Oregon and the NIMH. All other authors declare that they have no conflicts of interest.

Contributions

Drs. D'Angelo and Gonzalez-Heydrich designed the study and wrote the protocol. Dr. Lincoln, Ms. Graber, and Mr. Tembulkar completed assessments and data entry. Ms. Gaudet completed literature reviews. Mr. Morelli and Ms. Gaudet conducted statistical analyses. Dr. D'Angelo, Mr. Morelli, and Dr. Lincoln wrote the first draft of the manuscript. All authors contributed to and have approved the final manuscript.

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