Social cognition in young adults who have a first-degree relative with schizophrenia:
A preliminary case series study

by

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Abstract

Social-cognitive impairments in schizophrenia are markers that precede the illness and are present in first-degree relatives of patients. Adolescence and young adulthood are peak ages of risk for the onset of schizophrenia and are important windows to observe impairments that could signify the transition to schizophrenia. To explore these risk markers, this case series study described the social-cognitive profiles of young adults at familial high-risk (FHR) and investigated their relation to symptoms of schizophrenia and schizotypy. In this study, 13 controls and 4 participants at FHR completed assessments measuring symptoms, schizotypy, emotion regulation and recognition, theory of mind, and attributional style. Participants at FHR recognized fewer sad faces than controls but did not show other impairments. Furthermore, greater symptoms and schizotypy were associated with worse performance on some social-cognitive domains. Further investigation with larger samples is needed to explore if difficulty recognizing negative emotions is a risk marker for schizophrenia.

Keywords: schizophrenia, social cognition, familial high-risk, emotion regulation, emotion recognition, theory of mind, attributional bias
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Table of Contents

Abstract ........................................................................................................................................... ii
Acknowledgements ........................................................................................................................ iii
Table of Contents ........................................................................................................................... iv
List of Tables .................................................................................................................................. vi
List of Figures ................................................................................................................................... vii
List of Appendices ........................................................................................................................ viii
Introduction ..................................................................................................................................... 9

Social Cognition in Schizophrenia ................................................................................................. 11

Social Cognition in Youth at FHR for Schizophrenia ................................................................. 12

Emotion Processing ...................................................................................................................... 14
Theory of Mind ............................................................................................................................. 15
Attributional Style ......................................................................................................................... 16

Social Cognition, Prodromal Symptoms, and Schizotypal Traits .............................................. 16

Current Study ................................................................................................................................. 18

Method .......................................................................................................................................... 19

Participants ................................................................................................................................... 19

Social Cognition Assessments ...................................................................................................... 24

Procedure ...................................................................................................................................... 28

Statistical Analyses ....................................................................................................................... 30

Outlier Detection ........................................................................................................................... 31

Demographic and Clinical Data .................................................................................................... 32
List of Tables

Table 1. Demographic and Clinical Data for Control and FHR Participants ............................... 32
Table 2. Mean Scores, Standard Deviations, and Effect Sizes of Each Domain of Social Cognition for Control and FHR Participants ................................................................. 36
Table 3. Penn Emotion Recognition Mean Correct Scores for Each Emotion, Standard Deviations, and Effect Sizes for Control and FHR Participants ................................................... 37
Table 4. Mean Scores, Standard Deviations, and Effect Sizes of Psychosis Symptoms and Schizotypy for Control and FHR Participants ................................................................. 40
List of Figures

Figure 1. Scores on all Measures of Social Cognition for Control and FHR Participants .......... 35
Figure 2. Scores on Prodromal Symptoms and Schizotypy for Control and FHR Participants ... 39
Figure 3. Managing Emotions, Overall Symptoms, and Schizotypy Scores .......................... 41
Figure 4. Penn Emotion Recognition Response Times and Accuracy Scores, Overall Symptoms,
and Schizotypy Scores ............................................................................................................ 42
Figure 5. Hinting Task, Overall Symptoms, and Schizotypy Scores ...................................... 43
Figure 6. Attributional Bias, Overall Symptoms, and Schizotypy Scores ............................. 44
Figure 7. Scores on all Measures of Social Cognition and General Symptoms Scores .......... 46
List of Appendices

Appendix A: Informed Consent Form .......................................................................................... 84
Appendix B: Scores on Measures of Social Cognition ................................................................. 95
Appendix C: Scores on Prodromal Symptoms and Schizotypy Measures ................................. 96
Introduction

Schizophrenia is a chronic and debilitating psychiatric disorder that affects approximately 1% of the population worldwide (McGrath et al., 2008). It is one of the most disabling diseases with severe, long-term consequences for patients and their families, and places an immense economic and social burden on society (Green et al., 2015). The annual costs associated with this disorder ranges from $94 million to $102 billion in the United States, including costs of hospitalization, unemployment, and premature mortality (Chong et al., 2016). For example, unemployment rates can be as high as 80-90% (Haro et al., 2011; Marwaha & Johnson, 2004), and life expectancy can be reduced by as much as 10-20 years (Chesney et al., 2014). The extent of the economic burden that schizophrenia places on society reflects its chronic and disabling nature and emphasizes the need for better approaches to prevent and treat this disorder (Chong et al., 2016; Harvey et al., 2019).

Schizophrenia symptoms can be divided into three categories: positive symptoms, negative symptoms, and cognitive impairments (Green, 1996). Positive symptoms are psychotic behaviours such as hallucinations and delusions (Patel et al., 2014), and negative symptoms refer to a loss of normal functioning (Mitra et al., 2016). Cognitive symptoms include difficulties with attention, memory, executive functioning, and social cognition (Bowie & Harvey, 2006). Amongst these symptoms that people with schizophrenia experience, impairments in social cognition tend to be the most persistent and stable (Keshavan et al., 2010). Social cognition is the ability to understand and respond appropriately to others’ emotions, intentions, and behaviours (Green et al., 2008). It refers to cognitive processes such as the perception, encoding, storage, and retrieval of information about the social world, including inferring others’ thoughts and emotions and managing emotional reactions (Green et al., 2015). They are the primary cognitive
deficit in the prodromal period of schizophrenia (i.e., the first stage of the illness before the onset of psychotic symptoms), and remain present during remission (Keshavan et al., 2010).

The early onset and relatively stable nature of social-cognitive deficits has led to the possibility that these impairments are a trait rather than state characteristic of schizophrenia, related to a genetic vulnerability for the illness (Lavoie et al., 2013). Investigating people who have a first-degree relative (i.e., parents, siblings, children) with schizophrenia offers insight into this hypothesis. Having a family history of schizophrenia is one of the most significant risk factors for this illness (Martin et al., 2020). First-degree relatives share approximately 50% of their genes, placing them at high genetic risk for developing schizophrenia (Phillip & Seidman, 2008). Moreover, schizophrenia tends to emerge in adolescence or young adulthood, before age 35 (Gogtay et al., 2011; Rajji et al., 2009). These young individuals who are within the peak ages of risk are therefore more likely to exhibit social-cognitive indicators of risk for the illness compared to older adults, and these impairments could represent an endophenotype for schizophrenia. For this reason, examining the social-cognitive profiles of youth at familial high-risk (FHR) may help predict the predisposition of developing schizophrenia (Lavoie et al., 2013).

Unfortunately, relatively little is known about the social-cognitive profiles of young people at FHR. A better understanding of social-cognitive impairments as a potential risk marker for schizophrenia could eventually help with early detection and intervention of the illness (Lavoie et al., 2013).

Accordingly, the primary aim of this preliminary case series study was to provide an initial description of the social-cognitive profiles of young people at FHR for schizophrenia.
Social Cognition in Schizophrenia

Deficits in social cognition are some of the most consistent determinants of functional outcome and level of disability in people with schizophrenia (Green et al., 2000; 2016; Harvey et al., 2019). Impairments in social cognition can lead to misinterpreting others’ intentions and withdrawing from social interactions, having a negative effect on one’s social functioning (Green et al., 2015). Social cognition is therefore crucial for maintaining interpersonal relationships and employment, and impairments in this domain of cognition can have a detrimental effect on daily functioning (Fett et al., 2011; Green et al., 2015).

Research on social cognition has consistently identified three main domains that are impaired in schizophrenia: emotion processing, theory of mind, and attributional style (Mondragón-Maya et al., 2017; Penn et al, 2008; Pinkham, 2014). Emotion processing refers to how individuals use and perceive emotional information (Pinkham, 2014). It encompasses two subdomains: emotion regulation and emotion recognition. Emotion regulation refers to the skills needed to manage emotions, and emotion recognition is the ability to recognize emotions in facial expressions or tone of voice (Mondragón-Maya et al., 2017; Penn et al., 2008; Pinkham, 2014). Difficulties with facial emotion recognition have been described as one of the hallmark deficits of schizophrenia (Schneider et al., 2006; Yang et al., 2015).

Another domain of social cognition that is impaired in people with schizophrenia is theory of mind, the ability to attribute mental states to the self and others (Beaudoin et al., 2019; Penn et al., 2008). This domain includes skills such as understanding and interpreting intentions, false beliefs, faux pas, deception, metaphor, and irony (Penn et al., 2008; Pinkham, 2014). These theory of mind skills are crucial for predicting the behaviours, thoughts, and emotions of other people in social interactions (Liang et al., 2021). People with schizophrenia experience
significant impairments in all the skills included in this domain of social cognition, comparable to the performance of those with autism (Bora et al., 2009; Brüne, 2005; Craig et al., 2004; Harrington et al., 2005; Mondragón-Mayá et al., 2017; Sprong et al., 2007).

Finally, attributional style refers to how people interpret and make sense of the positive and negative social events in their lives (Green et al., 2019). People with schizophrenia tend to show a greater attributional bias compared to control participants (Aakre et al., 2009; Achim et al., 2016).

Social Cognition in Youth at FHR for Schizophrenia

Genetics are a major risk factor in determining the development of schizophrenia, which has a heritability estimated to be approximately 60-85% (Escudero & Johnstone, 2014). Findings from family, twin, and adoption studies show that schizophrenia has a strong genetic component, with the degree of risk associated with one’s genetic proximity to the relative with schizophrenia (Lo et al., 2020; Phillips & Seidman, 2008). First-degree relatives (i.e., parents, siblings, children) of people with schizophrenia share about 50% of their genes with their relatives and are therefore at increased risk of developing the disorder (Phillips & Seidman, 2008). The prevalence of schizophrenia in first-degree relatives is much higher than the general population, estimated to be around 6-13% (Phillips & Seidman, 2008). Findings from a recent meta-analysis revealed that the risk of developing schizophrenia was eight-fold for individuals who had one first-degree relative with the disorder, and 11-fold for those who had two first-degree relatives (Lo et al., 2020). This suggests that studying first-degree relatives at FHR is a valuable approach to examine the genetic underpinnings of schizophrenia.

Adult relatives of people with schizophrenia have similar impairments in social cognition (Eack et al., 2010). They tend to have difficulty managing their emotions and recognizing others’
facial emotions, especially negative emotions such as fear, sadness, anger, and disgust (Albacete et al., 2016; Martin et al., 2020). They also show impairments when completing theory of mind tasks compared to people without a first-degree relative with schizophrenia (Ay et al., 2016). For example, results from a meta-analysis indicated that first-degree relatives performed worse than controls on theory of mind tasks ($d = 0.37$; Bora & Pantelis, 2013). Another meta-analysis found similar results, with a moderate mean effect size for theory of mind tasks ($d = 0.48$). There is also some evidence that adults at FHR for schizophrenia have an attributional bias compared to control participants; however, this research is very limited (Kumar et al., 2020).

Although these studies have increased our understanding of the genetic basis of schizophrenia, they focus primarily on adults over age 35 who are not necessarily at high-risk of developing the illness given their age (Keshavan et al., 2010). The onset of schizophrenia tends to occur in adolescence and young adulthood, with patients who have been diagnosed with this disorder experiencing their first psychotic episode before the age of 35 (Gomes et al., 2017; Gogtay et al., 2011; Rajji et al., 2009). Adolescence and early adulthood are important developmental periods that are characterized by changes in cognition, emotions, and interpersonal relationships (Keshavan et al., 2014). Major changes in brain maturation and environmental factors can contribute to the heightened risk of mental illnesses emerging during these life periods (Keshavan et al., 2014). Young people who have a first-degree relative with schizophrenia have an additional genetic vulnerability, which further increases their risk of developing this disorder. These young relatives who are within this age range of risk for schizophrenia are more likely to display risk markers, such as social-cognitive impairments, compared to adults who have already passed this window. Studying the nature of social-cognitive deficits in younger people at FHR can therefore provide greater insight into the
endophenotypic role of social cognition and how it may predict the transition to psychosis (Agnew-Blais & Seidman, 2013; Keshavan et al., 2010).

Research on social cognition in youth at FHR also tends to focus on three domains of social cognition: emotion processing, theory of mind, and attributional style.

**Emotion Processing**

There are few studies that examine emotion regulation among youth at FHR for schizophrenia. Lee and colleagues (2008) examined mood repair, the ability to regulate mood from a positive to a negative state and found that it was impaired in youth at FHR compared to controls. Challenges in regulating emotions were also found in Nook’s (2018) study. Participants listened to audio recordings of critical, neutral, and positive comments, and were told to imagine that each comment was about them. Results indicated that participants at FHR experienced lower mood in the days after listening to critical comments (Nook et al., 2018). Findings from these studies reveal that youth at FHR for schizophrenia may have a harder time restoring their mood after a negative event occurs; however, there is not enough research on this specific domain of social cognition to draw any firm conclusions.

Prior studies have shown that high-risk youth have significantly worse emotion recognition skills compared to controls (Allott et al., 2015; Eack et al., 2010; Horton et al., 2017; Kohler et al., 2014; Yang et al., 2015). For example, Horton and colleagues (2017) had participants complete the Penn Emotion Recognition Test, a computer task that requires participants to label faces showing various emotions. Participants at FHR showed impaired performance in both accuracy and response time, where they were less accurate and slower than controls when identifying faces. Similarly, Kohler’s (2014) study found that youth first-degree relatives had fewer correct responses compared to a control group on an emotion recognition
task, and Eack (2010) found that youth at FHR were slower at completing the task in comparison to controls. However, there are also several studies that have not found any significant deficits in emotion recognition in youth at FHR (Barbour et al., 2010; 2012; Bölte & Poustka, 2003; Davalos et al., 2004; Diwadkar et al., 2012; Pulkkinen et al., 2015; Yang et al., 2017).

In terms of specific emotions, findings align with those for adult first-degree relatives. For example, Allott and colleagues (2015) examined facial emotion recognition in both parents and younger siblings of people with schizophrenia. When looking specifically at siblings, they showed significantly poorer recognition of fear relative to the control group. Other studies have found similar results for impaired fear recognition (Horton et al., 2017; Kohler, 2014). However, it is important to note that these findings have not been consistent (Yang et al., 2015; 2017). One study found a difference in the recognition of disgust between participants at FHR and control participants (Yang et al., 2015). In conclusion, there is a trend of an emotion recognition deficit in young first-degree relatives, specifically for negative emotions.

**Theory of Mind**

Less research has been conducted on theory of mind in youth at FHR for schizophrenia in comparison to emotion recognition. Findings from this research have been mixed, with significant differences being found for some theory of mind tasks and not for others. For example, Dodell-Feder and colleagues (2014) used a False-Belief task and a person-description task to measure theory of mind in youth at FHR. Although high-risk participants were significantly slower at completing the False-Belief task, their accuracy did not differ from controls, and no significant differences were found for the person-description task (Dodell-Feder et al., 2014). Another study found that high-risk siblings performed worse than controls on a second-order theory of mind task as well as on a Faux Pas task; however, no significant
differences were found for first-order theory of mind (Raju et al., 2019). In summary, although theory of mind has been well-researched in schizophrenia patients and in adults at FHR for schizophrenia, research examining theory of mind in adolescents and young adults at high-risk for schizophrenia is scarce.

**Attributional Style**

Very few studies have examined attributional style in youth at FHR. A recent study did not find any significant differences in attributional style between youth first-degree relatives and controls (Raju et al., 2019). When looking at other groups of youth who are at high risk of developing schizophrenia (i.e., clinical- and ultra-high-risk), significant differences in attributional style have also not been found (An et al., 2010; DeVylder et al., 2013). However, as these studies did not specifically examine first-degree relatives, results cannot be generalized. As little research has been conducted on this population, it is difficult to draw any conclusions on whether youth at FHR have an attributional bias. There is some evidence to suggest that an attributional bias may be present in adults at FHR for schizophrenia (Kumar et al., 2020), but further research must be conducted to determine if these deficits are also present in youth.

**Social Cognition, Prodromal Symptoms, and Schizotypal Traits**

Before the onset of the characteristic symptoms of schizophrenia (i.e., positive, negative, and cognitive symptoms), an individual may experience some attenuated symptoms of the illness. These are referred to as prodromal symptoms, and the time between the onset of these unusual behaviours and the first notable psychotic symptoms is referred to as the prodromal period (George et al., 2017). Prodromal symptoms can include mild or moderate disruptions in cognition, emotion, and communication (Larson et al., 2010). Individuals in the prodromal period may also show schizotypy personality traits, which include unusual perceptual
experiences, odd beliefs, and interpersonal difficulties (Matthews, 2012; Louise et al., 2015). These characteristics are similar to the symptoms of schizophrenia, although less severe (Louise et al., 2015). However, these symptoms may increase vulnerability to the onset of the illness (Matthews, 2012). Importantly, the prodromal period often occurs during adolescence and young adulthood (Larson et al., 2010).

People at FHR, particularly youth, can show prodromal symptoms and schizotypal traits, and research suggests that the presence of these symptoms and traits can predict the conversion to schizophrenia (Lavoie et al., 2013; Phillips & Seidman, 2008; Tandon et al., 2012). For example, one study found that youth at FHR who had prodromal symptoms of schizophrenia and schizotypy traits were 59 times more likely to transition to psychosis compared to individuals in the general population (Tandon et al., 2012). In another group of adolescents and young adults at FHR who had prodromal symptoms, 13% transitioned to psychosis after one year (Hormozpour et al., 2016).

Currently, little is known about the extent to which prodromal symptoms and schizotypy are related to deficits in social cognition in youth at FHR (Eack et al., 2010). There is evidence to suggest that individuals at FHR who have attenuated positive and negative symptoms of schizophrenia or schizotypal traits have greater social cognition deficits (Eack et al., 2010; Raju et al., 2019). In a meta-analysis that examined general neuro-cognitive functioning in youth at FHR, results indicated that the severity of neuro-cognitive impairments were modest, but that these impairments were more severe in those who displayed attenuated positive symptoms (Bora et al., 2014). As this study did not specifically examine social cognition, results may not be generalizable. In addition, one study did not find a significant correlation between facial emotion recognition abilities and positive and negative symptoms in youth at FHR (Allott et al., 2015).
Overall, the literature examining the association between prodromal symptoms, schizotypy, and social-cognitive impairments is scarce. Many studies compare social cognition in individuals at FHR to both controls and patients with schizophrenia, but only examine symptoms in patients. This makes it difficult to conclude if deficits in social cognition are correlated with prodromal symptoms in people at FHR (Bediou et al., 2007; de Achával et al., 2010; Ho et al., 2015). It is crucial that future research explores this association, as identifying the individuals at FHR who show prodromal symptoms and greater deficits in social cognition can help improve early identification of those who may be more at risk of transitioning to schizophrenia. The prodromal phase is a key period to implement early interventions, as this can delay the onset of schizophrenia, reduce symptom severity, and improve long-term outcomes (Hormozpour et al., 2016).

Current Study

Important limitations have been identified in the current literature. Although several studies have examined social cognition in patients with schizophrenia and adults at FHR, fewer studies have specifically examined youth (Tucci et al., submitted). Furthermore, research on how prodromal symptoms and schizotypal traits are related to impairments in social cognition in youth at FHR is also limited. Because schizophrenia tends to emerge during adolescence and young adulthood, adults at FHR have already passed the peak window of risk for developing the illness (Horton et al., 2017). It is important to examine potential deficits and their relation to symptoms in younger people at FHR as social-cognitive impairments and prodromal symptoms may be risk markers for the later transition to psychosis. The prognosis of schizophrenia tends to worsen as treatment is delayed, making it critical to identify individuals who are at the greatest risk of developing the illness (Picchioni & Murray, 2007). Targeting these individuals for early
Interventions can potentially reduce symptom severity or even prevent or delay the onset of schizophrenia (Picchioni & Murray, 2007).

Accordingly, the current preliminary case series study aimed to 1) describe performance on the three domains of social cognition in young people who have a first-degree relative with schizophrenia and in young people who do not have a first-degree relative with schizophrenia, and 2) explore the relation between social cognition, prodromal symptoms, and schizotypy. Based on previous literature, my hypotheses are that 1) young people with a first-degree relative with schizophrenia will exhibit lower social-cognitive abilities compared to those who do not have a first-degree relative with schizophrenia, and 2) young people at FHR who have more prodromal symptoms of schizophrenia or schizotypal traits will have poorer social cognition.

**Method**

**Participants**

The sample consisted of 17 young adults between the ages of 18 and 31, with 4 participants at FHR and 13 control participants. This is a subsample of a larger study that aims to recruit a total of 36 youth and young adults at FHR and 36 control participants.

Three young adults at FHR were recruited through name exchanges with other research labs at the Royal Ottawa. These individuals had participated in other research studies and had agreed to be contacted for future research. One participant at FHR had taken part in a past study conducted by our research team and agreed to participate in the current study. Control participants were recruited through advertisements in the community and on social media.

Individuals who have a family member with schizophrenia were included in the study if they met the following criteria: 1) between the ages of 15-35, 2) able to read and speak fluently in English, and 3) if the diagnosis of schizophrenia, schizoaffective disorder or schizophreniform
was confirmed for their first-degree relative by a referring psychiatrist or by two reliable informants using the Family Interview for Genetic Studies tool. These individuals were excluded if they have a diagnosis of epilepsy, an endocrine or immune disorder, or a neurological or medical disorder that led to cognitive impairment. Other exclusion criteria included having a previous head injury with current symptoms, a history of substance abuse, IQ lower than 70, inability to participate in an MRI scan, taking steroid medication or anti-inflammatories daily, and smoking cigarettes frequently. Control participants were included if they met the following criteria: 1) between the ages of 15-35, and 2) able to read and speak fluently in English. Control participants were also excluded for any of the reasons listed above, as well as if they had a family history of a psychotic disorder.

**Measures**

*Screening Assessments*

**Family Interview for Genetic Studies (FIGS) – revised.** The FIGS (Maxwell, 1992) is an assessment tool used for gathering information from family members about the presence of a mental illness in relatives. For the purposes of the current study, a shortened version of the FIGS was used to focus on the psychotic checklist. For example, a research assistant asked the participant if their relative with schizophrenia ever experienced visions, heard voices, or had beliefs that seemed strange or unreal. If the participant answered yes to any question, they were prompted to provide more details. After the assessment was administered, the interviewer made a judgment on the reliability of the information on a scale of 1 to 3, where 1 is “good”, 2 is “fair”, and 3 is “poor” to determine confidence of whether their relative has a diagnosis of schizophrenia. A second informant, such as another family member, was also assessed with the FIGS to confirm the diagnosis. The research team then judged the overall reliability of the
information provided by both the participant and a second informant to determine whether the participant should be included in the study. If obtaining information from a second informant was not possible, the individual could proceed to participate in the study if the reliability of the information they provided was good.

As the FIGS was developed as a guide for collecting information about relatives, there is little evidence for reliability and validity. Despite the scarce psychometric information, the FIGS is used in the current study as it is a common clinical tool used to identify first-degree relatives in genetic studies. This tool is commonly used in studies that examine social cognition in first-degree relatives of those with schizophrenia (Dodell-Feder et al., 2014; Gibson et al., 2010; Kohler et al., 2014; Lee et al., 2008; Nook et al., 2018; Taylor et al., 2020).

**Intelligence Quotient.** The Wechsler Abbreviated Scale of Intelligence – Second Edition (WASI-II; Wechsler, 2011) was used to measure intelligence. The WASI-II evaluates intellectual functioning in two areas: Verbal Comprehension and Perceptual Reasoning, as well as general intellectual ability. The WASI-II consists of four subtests: Block Design, Vocabulary, Matrix Reasoning, and Similarities. The Vocabulary and Similarities subtests make up the Verbal Comprehension Index, and the Block Design and Matrix Reasoning subtests are used to form the Perceptual Reasoning Index. All four subtests measure general intellectual functioning.

Evidence of convergent and discriminant validity have been found through correlations with the following scales: The Kaufman Brief Intelligence Test, the Wide Range Intelligence Test, The Weschler Adult Intelligence Scale-Fourth Edition, and The Weschler Intelligence Scale for Children-Fourth Edition. The WASI-II has also shown adequate test-retest reliability across all ages. In children and adolescents aged 6-16, reliability coefficients for the subtests ranged from .79 to .90. In adults aged 17 and older, reliability coefficients for the subtests ranged
from .83 to .94. Inter-rater reliability is strong for the Block Design and Matrix Reasoning as these subtests are objective, with scores ranging from .98 to .99. As the Vocabulary and Similarities subtests are more subjective in scoring, interscorer reliabilities were slightly lower, with a score of .95 for Vocabulary and .94 for Similarities. There is also evidence of strong internal consistency across all age groups for the subtests. For children and adolescents aged 6-16, the reliability coefficients ranged from .87 to .91 and from .90 to .92 in an adult sample.

**Clinical Symptoms and Cognitive Assessments**

**Prodromal Symptoms.** The Structured Interview for Psychosis-risk Syndrome (McGlashan et al., 2010) was used to screen participants for symptoms of schizophrenia. This interview assessment tool has three aims: 1) rule out a past and/or current psychotic syndrome, 2) rule in lifetime history of one or more of the three types of psychosis-risk syndromes, and 3) determine the status of each psychosis-risk syndrome that is present lifetime (McGlashan et al., 2010). This interview is organized in four sections: positive symptoms, negative symptoms, disorganized symptoms, and general symptoms. Within each of these sections, a series of questions are listed with space provided for recording responses (e.g., “do you ever feel like you are being singled out or watched?”). Each question is rated as yes, no, or no information. If a participant answers “yes” to a question, a series of qualifiers are listed to obtain more detailed information, including degree of distress, interference with life, and conviction/meaning. At the end of each section, there is a severity scale to measure the indicated symptoms. Positive symptoms are rated on one severity scale ranging from 0 to 6, where 0 is “absent” and 6 is “severe and psychotic”. Another severity scale is used to measure negative, disorganized, and general symptoms on a scale of 0 to 6, with 0 being “absent” and 6 being “extreme”.
The Structured Interview for Psychosis-risk Syndrome is a common assessment tool that is used to diagnose individuals who have a clinical high-risk for schizophrenia (Woods et al., 2019). Studies that examine the validity and reliability of this interview use it to compare diagnoses for individuals at clinical high-risk for schizophrenia and individuals who already meet criteria for psychosis. Individuals in the latter category would be expected to experience more symptoms, as clinical high-risk individuals have not yet experienced a first episode of psychosis. One review found six studies that examined this, and results indicated that patients experiencing psychosis scored higher than clinical high-risk participants on the positive, negative, and disorganized symptom subscales (Woods et al., 2019). These findings provide support for the construct validity of the Structured Interview for Psychosis-risk Syndrome. The same review found 16 studies that examined the inter-rater reliability of using this interview to diagnose clinical high-risk individuals and found a median kappa coefficient of .89 (Woods et al., 2019).

**Schizotypy Traits.** The Multidimensional Schizotypy Scale (Kwapil et al., 2018) is a self-report questionnaire that was used to assess positive, negative, and disorganized schizotypy. It consists of 77 items that are rated as either true or false (e.g., “I often worry that other people are out to get me”). The scoring key indicates the response (i.e., true or false) that is in schizotypic direction. Items that are answered in the keyed direction are given a score of 1, and items that are in the non-keyed direction are given a score of 0. The highest possible score for positive and negative schizotypy is 26, and the highest score for disorganized schizotypy is 25. Higher scores on each of the subscales indicate greater schizotypy traits for that respective subscale.
The positive, negative, and disorganized subscales have shown good construct validity (Kwapil et al., 2018). One study compared the Multidimensional Schizotypy Scale to the Schizotypal Personality Questionnaire, which is another measure of schizotypal traits that assesses cognitive-perceptual, interpersonal, and disorganized symptoms (Kwapil et al., 2018). These dimensions were significantly correlated with the positive (r = .73), negative (r = .53), and disorganized (r = .57) subscales of the Multidimensional Schizotypy Scale, respectively. Test-retest reliability is also strong, ranging from .84 to .90 for the subscales (Kemp et al., 2020). Several studies have found good-to-excellent internal consistency, ranging from .87 to .95 (Kemp et al., 2020; Kwapil et al., 2018).

Social Cognition Assessments

**Emotion Regulation.** Emotion regulation was measured by the Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT; Mayer et al., 2003). The MSCEIT is an ability test that measures four aspects of an emotional intelligence model developed by Mayer and Salovey (1997), including perceiving emotions, facilitating thought, understanding emotions, and managing emotions. For the purposes of this study, only the subscale for managing emotions was used to evaluate emotion regulation.

The MSCEIT consists of 141 items in total that are delivered in various styles. For the managing emotions subscale, participants read vignettes that describe a problematic social situation. The participant is then presented with four ways someone could react to this situation, with each option demonstrating varying levels of emotional reactivity. Participants then rate the effectiveness of each response on a five-point scale that ranges from “very ineffective” to “very effective” (DeTore et al., 2018). The MSCEIT yields several scores related to emotional intelligence, including an overall score and a score on each of the four branches of emotional
intelligence. MSCEIT scores are interpreted like traditional intelligent quotient scales, with the average score being 100 with a standard deviation of 15.

The MSCEIT displays good discriminant validity from personality trait measures. Regarding the Big Five Personality traits, MSCEIT scores were not significantly associated with neuroticism, extraversion, and conscientiousness, and were only moderately related to agreeableness and openness to experience (Bracket & Mayer, 2003). Because of their different definitions and measurement of emotional intelligence, the MSCEIT is weakly correlated with the Emotional Quotient Inventory \(r = .21\) and the Self-Report Emotional Intelligence Test \(r = .18\) (Bracket & Mayer, 2003).

The MSCEIT has demonstrated strong test-retest reliability \(r = .86\); Brackett & Mayer, 2003). The internal consistency of the four branch scores ranges from .76 to .91 (Mayer et al., 2003). The subscale for managing emotions has good internal reliability with a schizophrenia sample (Cronbach’s alpha = .81; Eack et al., 2010).

**Emotion Recognition.** Participants completed the Penn Emotion Recognition Task (Gur et al., 2002) to measure their facial emotion recognition abilities. This task involves asking participants to identify the correct emotion from 40 colored photographs of faces that express five emotions: happiness, sadness, anger, and fear, and a neutral facial expression (Carter et al., 2009). Eight photos of each emotion are presented. The Penn Emotion Recognition Task is a computerized task delivered through E-Prime 3.0 software (Psychology Software Tools, Pittsburgh, PA). The automated scoring system provides an overall accuracy score, an accuracy score for each emotion, and median response times.

This task shows good convergent and discriminant validity. Accuracy scores are more highly correlated with scores on the EmoDiff, a task that assesses recognition of happiness and
sadness, compared to tasks that assess other cognitive processes such as working memory, motor skills, and mental flexibility (Carter et al., 2009). Test-retest reliability is acceptable ($r = .76$; Carter et al., 2009).

**Theory of Mind.** The Hinting Task was used to assess participants’ theory of mind (Corcoran et al., 1995). This task involved reading 10 brief stories out loud to participants that presented an interaction between two characters, where each story ended with a comment that could be interpreted as a hint. Participants were then asked to infer what the characters in the story meant when they made those comments. For example, “Gordon goes to the supermarket with his mom. They arrive at the candy aisle. Gordon says, ‘Wow! That candy looks delicious!’ What does Gordon really mean when he says this?” The participant received two points if they answered correctly. If the participant provided an incorrect response, a second hint was delivered, and they received one point if this hint was answered correctly. No points were provided if the participant gave an incorrect response after the second hint. A maximum total score of 20 could be achieved. The Hinting Task has been frequently used as a measure of theory of mind for individuals with psychotic disorders (Corcoran et al., 1995).

The Hinting Task has displayed good psychometric properties and has been recommended for use in clinical research with schizophrenia populations (Ludwig et al., 2017; Pinkham et al., 2016). Despite these findings, there has been little research conducted on the convergent and discriminant validity of the Hinting Task. One study found low convergent validity and moderate discriminant validity in individuals with first-episode psychosis (Mallawaarachchi et al., 2019). Low correlations were found between the Hinting Task and other theory of mind measures, such as a False-Belief Task ($r = .53$) and a Picture Sequencing Task where participants had to form a story with a 4-card picture sequence ($r = .38$). Other studies
have found modest convergent validity of the Hinting Task with other theory of mind tasks (Janssen et al., 2003; Sullivan et al., 2013). Moderate discriminant validity was found with a facial and a prosody emotion recognition task ($r = .33; r = .41$). Other studies have observed small correlations between the Hinting Task and emotion recognition tasks in schizophrenia patients, which suggests a degree of discriminant validity (Bell et al., 2009; Pinkham & Penn, 2006).

The Hinting Task has adequate test-retest reliability in people with early psychosis ($r = .74$; Ludwig et al., 2017), which is a similar finding to what has been seen in individuals with schizophrenia ($r = .70$; Pinkham et al. 2016). Good internal reliability has also been found (Cronbach’s alpha = .81).

**Attributional Style.** Participants completed the Ambiguous Intentions Hostility Questionnaire to measure paranoia and hostile social-cognitive biases (Combs et al., 2007). This questionnaire consists of 15 items. A research assistant read a vignette to the participant, who had to imagine the scenario happening to them (e.g., “A friend of yours slips on the ice, knocking you to the ground”). Participants were then asked five questions after each scenario. The first question asked the participant to explain what they thought was the real reason why the other person acted that way. The research assistant coded this response on a scale of 1 to 5 to obtain a hostility bias score. The research assistant then used Likert scales to indicate whether the participant thought the person in the vignette performed the action on purpose (1 “definitely no” to 6 “definitely yes”), how angry it made them feel (1 “not at all angry” to 5 “very angry”), and how much they would blame the other person (1 “not at all” to 5 “very much”). Ratings for each of these questions resulted in an intentionality score, an anger score, and a blame score, respectively. Finally, the participant was asked how they would react if they were in this
situation. This response was coded on a scale of 1 to 5 to yield an aggression bias score. A composite score of all subscales was computed to yield an overall attributional bias score.

Psychometric analyses have shown evidence of validity of the Ambiguous Intentions Hostility Questionnaire. This measure is positively correlated with paranoia and hostility, as measured by the Paranoia/Suspiciousness Questionnaire and the Paranoia Scale, indicating good convergent validity (Combs et al., 2007). Discriminant validity was also supported as this measure was not correlated with measures of psychosis proneness, as measured by the Chapman Perceptual Aberration Scale and the Chapman Magical Ideation Scale. The Ambiguous Intentions Hostility Questionnaire therefore specifically measures hostility and blame rather than the presence of unusual beliefs and experiences (Combs et al., 2007). This questionnaire is also a reliable measure as it has demonstrated good interrater reliability (Combs et al., 2007). The internal consistency of the subscales ranges from .63 to .90 (Buck et al., 2017).

Procedure

Individuals who were interested in participating in the study emailed a research assistant to schedule a telephone screening appointment. A research assistant then called the participant to ask screening questions to determine whether the individual was eligible to participate in the study. For people at FHR, the relative’s diagnosis of schizophrenia must have been confirmed for the participant to take part in the study. The diagnosis had already been confirmed for two participants at FHR as they had taken part in a similar research study at the Royal Ottawa. Two participants had to be assessed with the FIGS to confirm their relative’s diagnosis of schizophrenia. We were not able to obtain information from a second informant for these participants; regardless, they were enrolled in the study as the reliability of the information they provided was good.
After eligibility was confirmed, participants were scheduled for their first visit. A research assistant called the participant 24 hours before their first visit to remind them of their appointment. All participants signed a consent form at the beginning of their first visit (see Appendix A). This consent form was approved by the Research Ethics Board at the Royal’s Institute of Mental Health Research and The Ottawa Hospital. The consent form included an optional section for a parent/guardian signature if the participant was under the age of 18; however, if the participant did not wish their parent/guardian to be involved, the study was able to proceed without the parental signature.

As this study was part of a larger study, participants in the control group had a total of two visits, and participants in the FHR group had a total of seven visits. For the purposes of this study, only data from the first two visits for all groups were used. The first visit consisted of the participant signing the consent form, and a research assistant providing a detailed description of the study and the participants’ role and responsibilities. The participant completed an IQ test, clinical assessments to determine the presence of any symptoms of schizophrenia or schizotypy personality (i.e., the Structured Interview for Psychosis-risk Syndrome and the Multidimensional Schizotypy Scale), and two social cognition tests (i.e., the MSCEIT and the Penn Emotion Recognition Task). The participant completed the rest of the social cognition assessments in the second visit (i.e., the Hinting Task and the Ambiguous Intentions Hostility Questionnaire). Each visit took approximately two and a half hours. As the clinical assessments and social cognition tasks are time-consuming, they were spread out over the course of two visits to reduce burden on the participants. Control participants received $40 for the first visit and $45 for the second visit, receiving a total compensation of $85. Participants at FHR also received $40 for their first study
visit and $30 for their second visit. If they completed all seven visits, they received a total of $155 in compensation.

My main role in this study was to conduct visit 1. This involved reviewing and explaining the consent form to the participant, conducting an interview to assess prodromal symptoms of schizophrenia, and administering social cognition, IQ, and schizotypy assessments. I also took saliva samples from the participant, which I processed and stored in the lab after the visit. My other major role in this study was recruitment, where I applied several strategies in attempt to recruit control and FHR participants. My minor roles included completing some telephone screening with potential participants to determine their eligibility for the study and occasionally observing a second research assistant conduct visit 2 to observe how the other social cognition assessments are administered.

Statistical Analyses

A preliminary case series design was adopted for this study. As case series studies are descriptive in nature, only descriptive statistics are used to summarize results (Kooistra et al., 2009). This was appropriate given the small sample size of the current study, as comparative tests yielding probability statistics may have presented misleading results (Kooistra et al., 2009). This type of design was suitable for an initial description of the social-cognitive profiles of youth at FHR, allowing us to generate hypotheses that can be examined more rigorously in the larger study or future studies in this area.

Study data was collected and managed using REDCap, a secure research database hosted at the Royal Ottawa Hospital (Harris et al., 2009). All data on REDCap was exported into R and SPSS for statistical analysis (IBM Corp, 2021; R Core Team, 2021). Descriptive statistics of
demographic information such as age, biological sex, education, and IQ were computed using means, standard deviations, and frequencies.

The first aim of the study was to compare social cognition in young people who have a first-degree relative with schizophrenia to young people who do not have a first-degree relative with schizophrenia. Overall scores, means, and standard deviations were calculated for each test of social cognition (i.e., the MSCEIT, Penn Emotion Recognition Task, Hinting Task, and the Ambiguous Intentions Hostility Questionnaire) for the control and FHR groups. Cohen’s d effect sizes were then calculated for each domain of social cognition. Means, standard deviations, and effect sizes were also computed for specific emotions on the Penn Emotion Recognition Task for both groups.

The second aim of the study was to examine if social-cognitive scores are associated with prodromal symptoms of schizophrenia and schizotypal traits. A composite score for each subscale on the Structured Interview for Psychosis-risk Syndrome and the Multidimensional Schizotypy Scale were computed for an overall symptom and schizotypy score, respectively. A series of scatterplots were then created to examine the relation between each domain of social cognition, symptoms, and schizotypy for both groups of participants.

Results

Outlier Detection

Control participant C5 misinterpreted questions about whether they experienced symptoms of schizophrenia and schizotypy, leading to unusually high scores on these measures. This participant was therefore removed from calculations of the means, standard deviations, and
effect sizes for prodromal symptoms and schizotypy, as well as analyses that examined the association between social cognition and prodromal symptoms and schizotypy.

**Demographic and Clinical Data**

The demographic and clinical data for each participant are presented in Table 1. The age range was 18 to 25 for the control group ($M = 22.00, SD = 2.45$) and 22 to 31 for the high-risk group ($M = 25.50, SD = 4.04$). Women made up 84.62% ($n = 11$) of the control group and 75% ($n = 3$) of the group at FHR. People who are Caucasian accounted for 69.23% ($n = 9$) of the control group and 50% ($n = 2$) of the high-risk group. Participants in both groups were either currently completing college or university (controls = 69.23%; FHR = 25%) or have already completed a college or university degree (controls = 30.77%; FHR = 75%). Control participants had a mean IQ of 112.23 ($SD = 9.74$), and FHR of 107.75 ($SD = 8.30$). Participants at FHR had a parent ($n = 2$) and/or a sibling ($n = 2$) with schizophrenia or schizoaffective disorder.

**Table 1**

*Demographic and Clinical Data for Control and FHR Participants*

<table>
<thead>
<tr>
<th>Participant #</th>
<th>Age</th>
<th>Sex</th>
<th>Race</th>
<th>Education</th>
<th>IQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>25</td>
<td>F</td>
<td>White</td>
<td>Graduate/Professional Degree</td>
<td>112</td>
</tr>
<tr>
<td>C2</td>
<td>25</td>
<td>F</td>
<td>Arab</td>
<td>Graduate/Professional Degree</td>
<td>100</td>
</tr>
<tr>
<td>C3</td>
<td>24</td>
<td>F</td>
<td>White</td>
<td>Undergraduate Degree</td>
<td>105</td>
</tr>
<tr>
<td>C4</td>
<td>24</td>
<td>F</td>
<td>White</td>
<td>Partial College/University</td>
<td>131</td>
</tr>
<tr>
<td>C5</td>
<td>22</td>
<td>F</td>
<td>Black</td>
<td>Partial College/University</td>
<td>100</td>
</tr>
<tr>
<td>C6</td>
<td>21</td>
<td>F</td>
<td>Aboriginal</td>
<td>Partial College/University</td>
<td>115</td>
</tr>
<tr>
<td>C7</td>
<td>21</td>
<td>F</td>
<td>White</td>
<td>Partial College/University</td>
<td>116</td>
</tr>
<tr>
<td>C8</td>
<td>18</td>
<td>M</td>
<td>White</td>
<td>Partial College/University</td>
<td>123</td>
</tr>
</tbody>
</table>
Social Cognition

Figure 1 shows scores on all measures of social cognition for each participant. The mean scores and standard deviations on each domain of social cognition and effect size differences between each group are presented in Table 2. Controls and participants at FHR performed similarly on the managing emotions branch of the MSCEIT (Figure 1 A). Two individuals from the control group had low scores, with control participants C2 and C5 scoring 77.44 (see Appendix B for social cognition scores for all participants). Overall, the mean score was lower for participants at FHR (M = 95.64, SD = 5.89) compared to control participants (M = 98.36, SD = 12.05); however, the size of this difference was small (d = 0.29).

Figure 1 B and C display performance on emotion recognition. Participants in both groups had similar response times, which resulted in a very small effect size (d = 0.07). Of note,
one participant at FHR had a high reaction time of 3142.5 milliseconds. Accuracy scores were also similar between groups, with the average score being slightly lower for participants at FHR ($M = 33.50, SD = 3.32$) in comparison to control participants ($M = 34.77, SD = 3.09$). The size of this difference was small-to-moderate ($d = 0.40$).

Individuals at FHR had higher scores on the theory of mind task than control participants, resulting in a large effect size ($d = 0.92$; Figure 1 D). Three controls had low scores: C5 had a score of 11, C6 scored 14, and C13 scored 13. One individual at FHR withdrew from the study before completing the theory of mind task.

Scores on attributional bias were alike between both groups (Figure 1 E). One control participant had a higher attributional bias compared to other participants, scoring 2.51. The size of the mean difference between control participants and individuals at FHR was small ($d = 0.23$).
Figure 1

Scores on all Measures of Social Cognition for Control and FHR Participants
Table 2

Mean Scores, Standard Deviations, and Effect Sizes of Each Domain of Social Cognition for Control and FHR Participants

<table>
<thead>
<tr>
<th>Social Cognition Domain</th>
<th>Controls (n = 13)</th>
<th>FHR (n = 4)</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotion Regulation</td>
<td>98.36 (12.05)</td>
<td>95.64 (5.89)</td>
<td>0.29</td>
</tr>
<tr>
<td>Emotion Recognition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response Time (ms)</td>
<td>1992.88 (244.97)</td>
<td>2030.88 (779.89)</td>
<td>0.07</td>
</tr>
<tr>
<td>n Overall Correct</td>
<td>34.77 (3.09)</td>
<td>33.50 (3.32)</td>
<td>0.40</td>
</tr>
<tr>
<td>Theory of Mind</td>
<td>16.85 (2.73)</td>
<td>18.67 (0.58)</td>
<td>0.92</td>
</tr>
<tr>
<td>Attributional Bias</td>
<td>1.84 (0.33)</td>
<td>1.77 (0.28)</td>
<td>0.23</td>
</tr>
</tbody>
</table>

Note. FHR = Familial High Risk; ms = milliseconds

Table 3 displays the mean number of correct responses for each emotion on the Penn Emotion Recognition Test and the effect size differences between each group. The size of the mean difference between control participants and participants at FHR was small for angry (d = 0.23) and very small for fearful (d = 0.01) and neutral (d = 0.06) faces. Control participants recognized fewer happy faces compared to participants at FHR, resulting in a medium effect size (d = 0.48). Participants at FHR recognized fewer sad faces than control participants (d = 1.75).
Table 3

_Penn Emotion Recognition Mean Correct Scores for Each Emotion, Standard Deviations, and Effect Sizes for Control and FHR Participants_

<table>
<thead>
<tr>
<th>Emotion</th>
<th>Controls (n = 13)</th>
<th>FHR (n = 4)</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anger</td>
<td>5.31 (1.38)</td>
<td>4.75 (3.21)</td>
<td>0.23</td>
</tr>
<tr>
<td>Fear</td>
<td>7.23 (1.01)</td>
<td>7.25 (1.73)</td>
<td>0.01</td>
</tr>
<tr>
<td>Happy</td>
<td>7.62 (1.12)</td>
<td>8.00 (0.00)</td>
<td>0.48</td>
</tr>
<tr>
<td>Neutral</td>
<td>7.31 (0.85)</td>
<td>7.25 (1.00)</td>
<td>0.06</td>
</tr>
<tr>
<td>Sad</td>
<td>7.31 (0.63)</td>
<td>6.25 (0.58)</td>
<td>1.75</td>
</tr>
</tbody>
</table>

_Prodromal Symptoms and Schizotypy_

Participant scores on symptoms of psychosis and schizotypy are presented in Figure 2, with the means, standard deviations, and effect size differences between each group shown in Table 4. Control participant C5 had oddly high scores on several measures, including negative symptoms, general symptoms, and positive, negative, and disorganized schizotypy. This participant was therefore removed from all analyses examining prodromal symptoms and schizotypy.

Most participants did not have any positive symptoms of schizophrenia, with only 16.67% of control participants and 25% of participants at FHR showing these symptoms (Figure 2 A). These control participants had low scores, while one participant at FHR had more positive symptoms compared to other participants (see Appendix C for scores for all participants). On average, greater positive symptoms were observed in individuals at FHR compared to controls, with the size of the difference being moderate (\(d = 0.59\)). Both groups had more negative than positive symptoms (Figure 2 B). Negative symptoms were present in 41.67% of the control
group and in half of the group at FHR. Individuals at FHR had a slightly higher overall average of negative symptoms ($M = 0.17$, $SD = 0.19$) compared to controls ($M = 0.13$, $SD = 0.19$). However, the size of this difference was small ($d = 0.21$). For disorganized symptoms of schizophrenia, 58.33% of control participants showed some symptoms, compared to only one out of four participants at FHR (Figure 2 C). The mean score was higher for the control group ($M = 0.19$, $SD = 0.19$) than the FHR group ($M = 0.13$, $SD = 0.25$), although this effect size was small ($d = 0.27$). Finally, general symptoms in both groups were observed more frequently than other symptoms of schizophrenia (Figure 2 D). These symptoms were present in 75% of those at FHR, compared to half of the control group. The mean score in the FHR group ($M = 0.75$, $SD = 0.54$) was higher than the control group ($M = 0.31$, $SD = 0.36$), resulting in a large effect size ($d = 0.96$).

Figure 2 E-G displays each participant’s score on domains of schizotypy. Positive schizotypy was not present or very low for almost all participants, with 33.33% of control participants and 25% of participants at FHR having positive schizotypy traits. Controls had higher positive schizotypy scores on average than participants at FHR, and the size of this difference was moderate ($d = 0.55$). Negative schizotypy traits were present in 58.33% of the control group and 75% of the FHR group, but no differences in average scores between the groups were observed ($d = 0$). Traits of disorganized schizotypy were present in half of the control group and in 25% of the FHR group, and the average was slightly higher in controls compared to participants at FHR. This effect size was small ($d = 0.25$).
Figure 2

Scores on Prodromal Symptoms and Schizotypy for Control and FHR Participants
Note: Blank columns indicate that the participant scored 0.

Table 4
Mean Scores, Standard Deviations, and Effect Sizes of Psychosis Symptoms and Schizotypy for Control and FHR Participants

<table>
<thead>
<tr>
<th>Measure</th>
<th>Controls (n = 12)</th>
<th>FHR (n = 4)</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Symptoms</td>
<td>0.03 (0.08)</td>
<td>0.20 (0.40)</td>
<td>0.59</td>
</tr>
<tr>
<td>Negative Symptoms</td>
<td>0.13 (0.19)</td>
<td>0.17 (0.19)</td>
<td>0.21</td>
</tr>
<tr>
<td>Disorganized Symptoms</td>
<td>0.19 (0.19)</td>
<td>0.13 (0.25)</td>
<td>0.27</td>
</tr>
<tr>
<td>General Symptoms</td>
<td>0.31 (0.36)</td>
<td>0.75 (0.54)</td>
<td>0.96</td>
</tr>
<tr>
<td>Positive Schizotypy</td>
<td>0.83 (1.40)</td>
<td>0.25 (0.50)</td>
<td>0.55</td>
</tr>
<tr>
<td>Negative Schizotypy</td>
<td>1.50 (2.35)</td>
<td>1.50 (1.00)</td>
<td>0</td>
</tr>
<tr>
<td>Disorganized Schizotypy</td>
<td>0.75 (0.97)</td>
<td>0.50 (1.00)</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Note: Control participant C5 was removed.

Social Cognition and Prodromal Symptoms

The association between overall symptoms of schizophrenia, schizotypy, and scores for each domain of social cognition are presented in Figures 3-6. For all participants, worse emotion regulation abilities were associated with greater symptoms and schizotypal traits. (Figure 3 A and B).
Figure 3

Managing Emotions, Overall Symptoms, and Schizotypy Scores

A) Managing Emotions Scores and Overall Symptoms Scores

B) Managing Emotions Scores and Overall Schizotypy Scores
Participants with a quicker response time tended to report more symptoms (Figure 4 A), but no trend could be observed between response time and schizotypy (Figure 4 B). There also appears to be negative associations between accuracy scores, symptoms, and schizotypy (Figure 4 C and D).

**Figure 4**

*Penn Emotion Recognition Response Times and Accuracy Scores, Overall Symptoms, and Schizotypy Scores*

The data shows that participants with a lower score on the Hinting Task tended to report more symptoms of schizophrenia and schizotypal traits (Figure 5 A and B). One participant at FHR dropped out of the study before completing the Hinting Task.
Figure 5

Hinting Task, Overall Symptoms, and Schizotypy Scores

A) Hinting Task Scores and Overall Symptoms Scores

B) Hinting Task Scores and Overall Schizotypy Scores
Figures 6 A and B display a trend where participants with lower attributional bias had more symptoms and schizotypal traits.

**Figure 6**

*Attributional Bias, Overall Symptoms, and Schizotypy Scores*
As participants at FHR had more general symptoms than control participants \((d = 0.96)\), the relation between these symptoms and each domain of social cognition was examined more closely (Figure 7 A-E). Overall, general symptoms had a negative association with all domains of social cognition.
Figure 7

Scores on all Measures of Social Cognition and General Symptoms Scores
Discussion

The purpose of this preliminary case series study was to explore social cognition in young people who have a first-degree relative with schizophrenia in comparison to young people who do not have a first-degree relative with schizophrenia. This study also examined the association between social cognition, prodromal symptoms of schizophrenia, and schizotypal traits in young people at FHR. To investigate these aims, control participants and participants at FHR underwent clinical and cognitive assessments at the Royal Ottawa Hospital.

Based on previous literature, it was expected that young people who have a first-degree relative with schizophrenia would perform more poorly on measures of social cognition compared to those who do not have a first-degree relative with schizophrenia. It was also predicted that young people at FHR who had more prodromal symptoms and schizotypal traits would have poorer social cognition.

The first hypothesis was only partially supported. Participants at FHR showed lower mean scores than controls on the emotion regulation task, but the effect size difference was small. Additionally, youth at FHR had a slightly higher response time compared to controls when recognizing emotions, but this effect size was also very small. As expected, young adults at high-risk recognized fewer emotions than control participants, resulting in a small-to-medium effect size. Although a large effect size was found for theory of mind, it was in the opposite direction than what was expected, with young adults at FHR having a higher mean score than controls. Control participants also showed more attributional bias than participants at FHR; however, this effect size was small.

The second hypothesis was also only partially supported. Participants who had worse emotion regulation, emotion recognition accuracy, and theory of mind tended to report greater
symptoms of schizophrenia and schizotypal traits. No trend was observed between emotion recognition response time and schizotypy. Lastly, participants with a lower attributional bias reported more symptoms and schizotypal traits. All results must be interpreted cautiously given the small sample size of this study.

**Emotion Recognition Impairments as a Risk Marker for Schizophrenia**

The only difference in social cognition that could be seen was in emotion recognition, where mean scores between the two groups differed moderately ($d = 0.40$). This effect size is consistent with what has been seen in prior research on emotion recognition in people at FHR. Kohler and colleagues (2014) examined emotion recognition in adolescents and young adults at FHR for schizophrenia and found a small effect size ($d = 0.31$) for overall accuracy compared to control participants. A meta-analysis on emotion recognition in both youth and adults at FHR for schizophrenia saw similar results for overall accuracy between high-risk and control individuals ($d = 0.38$; Martin et al., 2020). As impairments in emotion recognition tend to be consistent across studies, this deficit could represent an endophenotype for schizophrenia.

For specific emotions, we did not find any differences in neutral face recognition between participants at FHR and control participants. This is also in line with other studies, as young people at FHR usually do not show any impairments in recognizing neutral faces (Allott et al., 2015; Horton et al., 2017; Kohler et al., 2014; Pulkkinen et al., 2015). Unexpectedly, there was little difference between participants at FHR and controls in recognizing fearful faces. This finding is unanticipated as many studies tend to find that fear recognition is impaired in youth at FHR for schizophrenia (Allott et al., 2015; Horton et al., 2017; Kohler et al., 2014); but it is likely that this finding can be explained by the limited sample size of this study. Rather, we saw that participants at FHR recognized fewer sad faces than control participants. A recent study also
found that the recognition of sad faces was impaired in young adults who had a first-degree relative with schizophrenia (El Ray et al., 2022). This has been found in the general FHR population as well (Martin et al., 2020). While we only found small differences in the recognition of anger in young adults at FHR and controls, the FHR population in general tends to show difficulty recognizing angry faces in comparison to controls (Martin et al., 2020).

Altogether, there appears to be a trend that young people at FHR for schizophrenia have difficulty recognizing negative emotions. Martin and colleagues (2020) also suggested this in their meta-analysis, where they found strong evidence for impairments in recognizing emotions with a negative valence in people at FHR for schizophrenia. The specific negative emotion that is impaired seems to vary across studies. This may be due to the heterogeneity of emotion recognition tasks, as there is no standardized task that is used in this research. Tasks differ in the photographs that are used and the intensity of the emotion that is displayed, which may lead to inconsistent findings (Edwards et al., 2002). Nonetheless, impairments in recognizing emotions with a negative valence in first-degree relatives may be indicative of abnormal functioning in brain regions that are important for processing negative emotions, such as the amygdala (Adolphs et al., 1999; Adolphs & Tranel, 2004). There is evidence that young relatives of people with schizophrenia have an abnormal amygdala volume (Keshavan et al., 2002). Additionally, a recent study found that youth at FHR who later developed schizophrenia had an altered amygdala shape compared to youth who did not transition to psychosis (Guimond et al., 2022). These amygdala abnormalities may give rise to emotion recognition deficits (Aleman & Kahn, 2005). This evidence suggests that difficulty recognizing negative emotions and abnormalities in the brain regions associated with this ability could be a risk marker for the development of schizophrenia in first-degree relatives.
Comparing Social Cognition in Participants at FHR and Controls

The sample size in this study is too small to draw any meaningful conclusions on social cognition in young adults at FHR for schizophrenia. The problematic nature of this small sample can be illustrated by the effect that individual participants have on Cohen’s d. For example, removing participant FHR3 would result in a large effect size for emotion recognition accuracy of 0.84. This is compared to the small-to-moderate effect size of 0.40 that was found with this participant included. Additionally, removing this participant would lower the effect size for general symptoms from 0.96 to 0.60. As participant FHR3 did not complete the Hinting Task, it is possible that this missing data may have also influenced the effect size difference for theory of mind between participants at FHR and controls.

Many additional efforts were taken by myself and the research team to recruit more participants at FHR. For example, I presented this study to clients in the Schizophrenia Recovery Program at the Royal Ottawa Place to ask if they had eligible family members who would be interested in taking part in this study. In addition to the Royal Ottawa, the On Track program at the Ottawa Hospital provides care for young people experiencing their first episode of psychosis, so we decided to try recruiting participants through clients at this program. To do this, I had to obtain approval from the Research Ethics Board at the Ottawa Hospital, a process that took several months. Upon approval, we had plans to go in-person for a few hours each week to speak to clients and families; unfortunately, this was not possible given the COVID-19 pandemic restrictions. Instead, we left brochures and posters for clients and families passing through the clinic.

With COVID-19 restrictions preventing our team from doing in-person recruitment, many recruitment strategies were employed online. For example, I set up paid Facebook ads and
bi-weekly social media posts of this study through the Royal Ottawa, added our study information to the Royal Ottawa’s Actively Recruiting Studies website, and asked Carleton University to post about this study on their research Twitter account. I also took many efforts to leverage Carleton University staff, including asking: the graduate psychology department to circulate an email with the study information to graduate students, graduate student newsletters to include a section with a description of this study, and the Communications Officer to help advertise the study to students. Unfortunately, these additional efforts with Carleton University were unsuccessful as many staff refused to communicate with students about matters that were not directly related to university operations.

Additional efforts taken by other members of the research team included: outreach to community organizations for help on advertising the study, presenting study information to family support groups, and contacting service providers at the Royal Ottawa and the Ottawa Hospital (i.e., psychiatrists, nurses, social workers) to ask if they could discuss this study with clients and their families. Other research team members and I also contacted people with schizophrenia who had participated in our lab’s prior research studies to inquire if they had eligible family members who would be interested in participating. These additional efforts drew some interest, but we were not able to identify any eligible participants.

Despite these extensive efforts taken by myself and the research team, only a small number of FHR participants were recruited. The COVID-19 pandemic prevented us from doing more in-person recruitment, and the specific inclusion and exclusion criteria made it difficult to identify eligible participants within a short time frame.
The small sample size is the primary reason why this study did not find impairments in most domains of social cognition. In addition to this factor, there are several other possibilities for why we may not have identified greater impairments in social cognition.

**Representativeness of Study Sample**

The first consideration is that the participants at FHR in this study were less cognitively impaired and not representative of the FHR population. Self-selection bias may have been a factor as people who voluntarily chose to participate could differ in cognition from those who did not choose to participate. All the young adults at FHR in this study were recruited as they had taken part in other research at the Royal Ottawa Hospital and had agreed to be contacted for future studies. This group of participants may therefore have more intact cognitive abilities compared to other youth or young adults at FHR. It is possible that people with lower social-cognitive abilities may not be drawn to take part in research. Prior research has demonstrated that people with cognitive impairments are less willing to participate in clinical research and that these individuals tend to be difficult to recruit for study participation (Li et al., 2022). A larger number of participants recruited from different settings is needed to adequately assess social cognition in young people at FHR. As we continue to collect data for the larger study, greater emphasis will be put on recruiting participants from diverse settings.

**Task Sensitivity**

The second consideration is that certain measures were not sensitive enough to detect differences in relatives, given that first-degree relatives tend to show more subtle deficits in social cognition compared to people with schizophrenia (Ay et al., 2016). This reason may specifically apply to measures used to assess emotion regulation and theory of mind in this study.
The managing emotions subscale of the MSCEIT is a reliable and valid assessment of emotion regulation in people with schizophrenia (Eack et al., 2010). In fact, this subscale has been recommended by the National Institute of Mental Health Measurement and Treatment Research to Improve Cognition in Schizophrenia committee as a key measure of social cognition in people with schizophrenia (Eack et al., 2010). The managing emotions subscale is also included in the Matrics Consensus Cognitive Battery, an assessment that is widely used to measure cognition in people with schizophrenia (Nuechterlein et al., 2008). Although it has been extensively used in schizophrenia samples, there is far less research that has used the managing emotions subscale to measure emotion regulation in FHR samples. To date, this is the first study to measure emotion regulation with the MSCEIT in youth at FHR for schizophrenia. Some studies have used this test in samples of adults at FHR for schizophrenia, but results have been mixed (Albacete et al., 2016; Frajo-Apor et al., 2017). The possibility that this test is not sensitive enough to detect subtle impairments in people at FHR has also been suggested by other researchers (Fiori et al., 2014; Frajo-Apor et al., 2017).

The Hinting Task may also not be sensitive enough to detect differences in theory of mind in people at FHR. A study by Morozova and colleagues (2017) provides some support for this hypothesis. They assessed theory of mind in patients with schizophrenia using three measures: the Hinting Task, Faux Pas, and Reading the Mind in the Eyes. Patients had the most difficulty with the Reading the Mind in the Eyes task and the most ease with the Hinting Task, implying that the latter is a simpler measure to assess theory of mind. With these results in mind, the assumption could be made that this task is not complex enough for people at FHR for schizophrenia. The most consistent impairments in theory of mind in young people and adults at
FHR tend to be found for second-order theory of mind tasks (Mazza et al., 2008; Raju et al., 2019; Tikka et al., 2020). Second-order tasks tend to be more difficult because they require more sophisticated theory of mind skills compared to other tasks (Bora & Pantelis, 2009; Janssen et al., 2003).

Further support for the importance of task sensitivity can be seen in the literature on emotion recognition. Studies assessing this domain of social cognition either use an emotion identification or an emotion differentiation task. Emotion identification involves presenting a photograph of a face and identifying the given emotion from a list of options. On the other hand, emotion differentiation tasks have the participant determine whether the valence category (i.e., positive, negative, or neutral) on a given photo is the same as on the preceding photo. There is strong support that emotion identification tasks are harder than emotion discrimination tasks (Addington et al., 2006; 2008; Lavoie et al., 2013). Interestingly, Kohler and colleagues (2014) used both types of measures to assess emotion recognition in youth at FHR for schizophrenia, but significant differences were only seen for the emotion identification task. A strength of the current study is that an emotion identification task was used and was therefore sensitive enough to result in some discernible differences between young adults at FHR and controls, despite the small sample size.

Altogether, the evidence across these domains of social cognition suggests that complex measures are needed to evaluate social cognition in people at FHR. Future studies in this area must ensure that tasks are sensitive enough to pick up on any subtle impairments that may be present in people at FHR for schizophrenia.
Compensatory Mechanisms

The third consideration is that people at FHR may compensate by putting in greater effort when completing social-cognitive tasks to achieve the same level of performance as controls (Kozhuharova et al., 2020). In many neuroimaging studies of social cognition in youth at FHR, high-risk participants and control participants do not differ on behavioural measures of social cognition, but differences in brain activity between the two groups are observed (Barbour et al., 2012; Dodell-Feder et al., 2014a; Hart et al., 2013; Marjoram et al., 2006; Pulkkinen et al., 2015). For example, Marjoram and colleagues (2006) saw greater activation in prefrontal cortex regions in high-risk participants during the Hinting Task compared to control participants, but no differences were found between the groups on Hinting Task scores. Similar results have been found for emotion regulation, where greater activity in prefrontal regions can be seen in high-risk individuals compared to controls (Modinos et al., 2010). Increased activity may mean that more cognitive control is required to regulate negative emotions (Kozhuharova et al., 2020; Modinos et al., 2010). These differences in brain activation in people at FHR may indicate that compensatory mechanisms are at work to mitigate abnormalities in behavioural performance on social-cognitive tasks (Phillips & Seidman, 2008).

Social-Cognitive Impairments as Predictors of Schizophrenia

The fourth possibility of why comparable performance was found between people at high-risk for schizophrenia and controls is that people at FHR may not show impairments across all domains of social cognition. Rather, impairments in only some domains may be reliable predictors of vulnerability to schizophrenia.

This may be the case for attributional style, as most studies do not find any differences between people at FHR and controls (Raju et al., 2019; Sosa et al., 2013; Tikka et al., 2020).
Only one study has shown greater attributional bias in people at FHR (Kumar et al., 2020). The lack of significant findings in this domain of social cognition indicates that an attributional bias may not be present in people at FHR. Instead, a bias may only appear with the onset of schizophrenia. Janssen and colleagues (2006) provided evidence for this, where they found an attributional bias in patients with schizophrenia, but not in their first-degree relatives. Moreover, this bias was associated with the presence of positive symptoms such as delusions. Other research has also found that attributional bias is linked to positive symptoms of schizophrenia (Combs et al., 2007; An et al., 2010). This is expected, as having symptoms such as paranoid delusions can lead to a greater tendency to perceive hostility and blame others (An et al., 2010). These findings suggest that attributional bias may be a state rather than a trait characteristic of schizophrenia that emerges with the presence of positive symptoms (DeVylder et al., 2013; Janssen et al., 2006). Nonetheless, attributional style in people at FHR for schizophrenia remains under-investigated. Future studies must be conducted with schizophrenia patients and their first-degree relatives to further investigate whether attributional bias is a state or trait characteristic of schizophrenia.

On the other hand, the presence of emotion recognition impairments for negatively valanced emotions is very consistent across studies of both youth and adults at FHR for schizophrenia. This suggests that impairments in emotion recognition may be a more reliable risk marker for psychosis compared to other domains of social cognition such as attributional bias.

**Prodromal Symptoms and Schizotypy in Young Adults at FHR**

Participants at FHR for schizophrenia had moderately greater positive symptoms \( (d = 0.59) \) and more general symptoms \( (d = 0.96) \) compared to control participants. Prior research on
the presence of positive symptoms in first-degree relatives has been inconsistent, with some studies finding that people at FHR show greater positive symptoms than controls (Smith et al., 2008), while other studies have not found any differences in positive symptoms between the two groups (Allott et al., 2015). Greater general symptoms in participants at FHR was to be expected, as people who have a relative with schizophrenia tend to have a higher risk of experiencing psychopathology (Arajärvi et al., 2006; Verma et al., 2019).

Young adults at FHR did not have more schizotypy traits than controls. Prior literature shows contradictory evidence for the presence of schizotypy in relatives. Some research points to more schizotypy in people at FHR compared to controls (Lavoie et al., 2013), but other studies have not found that people at FHR experience more schizotypy than controls (Albacete et al., 2016).

When examining trends for all participants, greater symptoms of schizophrenia and schizotypy was associated with worse performance for emotion regulation, emotion recognition accuracy, and theory of mind. We were unable to look at trends specifically for participants at FHR as the small sample size makes it unlikely that any meaningful trends in the data would be observed. It is also important to note that the level of symptoms and schizotypy in this group of high-risk participants was low. Prodromal symptoms were scored on a scale of 0 to 6, with a score of 6 indicating extreme symptoms. The highest score for schizotypy could be 25 or 26, where higher scores indicate greater schizotypy traits. The average scores for each measure in the high-risk group were very low, with some participants at FHR not showing any symptoms or schizotypy. Interestingly, the level of prodromal symptoms found in this sample of FHR participants is very similar to what was reported in Hormozpour and colleagues’ (2016) study. Using scores from the Structured Interview for Psychosis-risk Syndrome, young people at FHR
for schizophrenia were divided into a high- and a low-risk for psychosis group. Scores on this measure for the group of participants at FHR in the low-risk category were similar to what was found in our study. This indicates that although our sample of participants at FHR had some more positive and general symptoms than controls, they can generally be considered low risk.

Self-selection bias could also be a factor for why this group of young adults at FHR had low levels of symptoms and schizotypy. It is possible that relatives who experience some symptoms such as suspiciousness, interpersonal difficulties, or thought disorganization may be less willing to participate in research (Albacete et al., 2016). Nonetheless, our data still shows a trend where people with more symptoms and schizotypy perform worse on certain domains of social cognition. If nonclinical populations display this association, it is likely that this trend will also be observed in future studies with larger samples of high-risk participants that have more symptoms.

**Strengths and Limitations**

This study has several strengths. Research on social cognition in youth at FHR for schizophrenia has typically only focused on emotion recognition. The present study examined other domains of social cognition as well, including emotion regulation, theory of mind, and attributional style. Additionally, there is limited research investigating how prodromal symptoms of schizophrenia and schizotypy are associated with social-cognitive abilities in youth at FHR. Previous studies tend to only measure prodromal symptoms in patients with schizophrenia to examine how they are related to social cognition. The current study explores if this association is present in those at FHR.

Despite these strengths, the results from this study must be interpreted with caution. Due to the COVID-19 pandemic, participant recruitment was not completed. The study was halted for
several months, and restrictions prevented us from recruiting participants in-person. Moreover, one participant in the FHR group dropped out and did not complete the Hinting Task to assess theory of mind. These results are therefore limited to a small sample size, particularly for participants at FHR. To mitigate this limitation, we presented these findings as a preliminary case series study and calculated effect sizes rather than reporting statistical significance. This study is ongoing, and a sufficient number of participants will be recruited to ensure that results can be interpreted reliably.

An additional limitation of this study concerns the representativeness of the sample. Most participants in both groups were female and over the age of 18. Only two control participants and one participant at FHR were male, and we were not able to recruit participants in the younger portion of the desired age range. These demographic factors are important to consider when examining social cognition. For example, gender differences have been found in social cognition, where females tend to have greater social-cognitive skills than males (Gur et al., 2012). Subsequent data collection as part of the larger study will focus on recruiting a more diverse sample with people of different ages and genders. This includes doing more in-person recruitment at the Royal Ottawa and the Ottawa Hospital as COVID-19 restrictions ease. We will also continue doing name exchanges with other labs and leveraging service providers to communicate this study with clients and families.

Future Directions

The larger study will address the limitations present in this preliminary case series study by ensuring that a sufficient and representative sample of participants are included. If impairments in social cognition are not found with a larger sample size, this may provide additional evidence for the importance of having sensitive social-cognitive measures for studies
involving people at FHR. For example, the Reading the Mind in the Eyes Task may be a more suitable theory of mind measure for use in FHR populations given the complexity of this task in comparison to the Hinting Task (Morozova et al., 2017). Despite expert committees recommending the MSCEIT for use in schizophrenia samples, it unclear if this measure is appropriate for FHR populations. Other studies of youth at FHR that have used different assessments to measure emotion regulation have found more consistent results. Youth at FHR had more difficulty repairing their mood after a negative event as measured by the Trait Meta-Mood Scale (Lee et al., 2008) and daily diary assessments (Nook et al., 2018). These measures may have been more sensitive to detect subtle deficits in emotion regulation in youth at FHR for schizophrenia. Future studies may consider using these other tools to assess emotion regulation if impairments on the MSCEIT are not found with a larger sample size.

**Implications**

Further studies are needed with larger sample sizes, more consistent and sensitive measures of social cognition and neuroimaging techniques to confirm that impairments in social cognition are true risk markers for schizophrenia. Such studies can provide promising evidence for the importance of early intervention and preventative training programs.

There are currently several of these programs that are aimed at improving social cognition in people with schizophrenia. For example, Social Cognition and Interaction Training is a widely used group-based intervention that is designed to increase social-cognitive skills and social functioning (Penn et al., 2007). It encompasses three phases: emotion recognition training, figuring out situations (i.e., problems with jumping to conclusions, distinguishing between facts and guesses), and integrating these skills into real-world situations. Social Cognition and
Interaction Training has repeatedly been shown to improve emotion perception, theory of mind, and attributional bias in people with schizophrenia (Bartholomeusz et al., 2013; Combs et al., 2007). This training is also effective at improving social cognition and everyday functioning in young people with first-episode psychosis (Bartholomeusz et al., 2013; Rocha et al., 2020).

Cognitive Enhancement Therapy also aims to improve neurocognition and social cognition in people with schizophrenia. For the social cognition training, individuals complete structured social-cognitive group sessions where they learn how to take others’ perspectives, read non-verbal cues, and manage emotions (Hogarty et al., 2006). Cognitive Enhancement Therapy has consistently been shown to improve social cognition in people with schizophrenia, especially in younger patients with early course schizophrenia (Eack et al., 2007; 2009).

It is particularly interesting that these training programs are effective in improving social cognition and daily functioning in younger people with schizophrenia who are in the initial stages of the illness. This suggests that early intervention may be a protective factor that could alter the course of the disease (Barlati et al., 2013). If social-cognitive impairments are indeed precursors to schizophrenia and linked to prodromal symptoms, it is reasonable to assume that applying these approaches to people at FHR can also be effective in improving social cognition and functional outcomes. Unfortunately, these interventions have not yet been tested in young first-degree relatives at high risk for schizophrenia. It would be of interest to study if these training programs demonstrate similar preventative efficacy in young people at FHR as they do in people with early course schizophrenia (Barlati et al., 2013). The application of these approaches in youth at FHR could alter the deteriorating course of the illness and the extensive economic burden that accompanies it (Eack et al., 2010).
Conclusion

The purpose of this preliminary case series study was to explore social-cognitive impairments, prodromal symptoms, and schizotypy in young people who are at FHR for developing schizophrenia. Few differences were found in the mean scores on most social cognition tasks between participants at FHR and controls, but young adults at FHR recognized fewer emotions, particularly sad faces, compared to controls. These findings support previous reports showing that difficulty recognizing negative emotions is impaired in people at FHR; however, these findings must be interpreted with caution given the very small sample size. Future research should continue to investigate this as a potential risk marker for schizophrenia. Results also showed a trend where people with more symptoms and schizotypy tend to perform worse on certain domains of social cognition. Future studies with larger samples are needed to continue exploring this relation in high-risk participants.

As schizophrenia is a chronic and disabling psychiatric illness that places an economic burden on society, better approaches are needed to treat and prevent this disorder. The current study is an initial step in investigating possible risk markers of schizophrenia that could be an important target for early intervention.
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Appendix A: Informed Consent Form

Informed Consent Form for Participation in a Research Study
(Participant Copy)

Study Title: Social cognition in youth who have a first degree relative with schizophrenia
REB Number: #2019033
OHSN-REB Number: #20210764-01H

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Sponsor/Funder(s): NARSAD Young Investigator Grant

INTRODUCTION
You are being invited to participate in a research study. You are invited to participate in this study
because you have a 1st degree relative (i.e., parent or sibling) with a confirmed diagnosis of
schizophrenia or schizoaffective disorder. Before agreeing to take part in this project, it is
important that you read the information in this research consent form. This consent form provides
you with information to help you make an informed choice. It includes details we think you need
to know in order to decide if you wish to take part in the study. If you have any questions, please
ask one of the study researchers. You should not sign this form until you are sure you understand
the information. A research assistant will always be available in the laboratory should you need
any help. All your questions should be answered to your satisfaction before you decide whether
to participate in this research study.

Please take your time in making your decision. You may find it helpful to discuss it with your
friends and family.

Taking part in this study is voluntary. Deciding not to take part or deciding to leave the study
later will not result in any penalty or affect current or future health care or employment.
You can discuss the study with your family doctor, a family member or close friends. If you decide to participate, it is important that you are completely truthful about your health history and any medications that you are taking.

**IS THERE A CONFLICT OF INTEREST?**
There are no conflicts of interest to declare related to this study.

**WHY IS THIS STUDY BEING DONE?**
The purpose of this study is to improve our understanding on emotion processing and related brain activity in individuals who have a first degree relative with schizophrenia. This study also aims to determine whether emotion recognition can improve in individuals who have a first degree relative with schizophrenia. With a better understanding of the brain regions and processes implicated in schizophrenia development, we hope to test the efficacy and potential preventative power of a combined emotion recognition training program. We are also interested in exploring the effects of social media use and stress on the brain. Previous research has shown that problematic social media use has many implications for mental health and well-being. This study aims to determine how social media affects the reward pathways in the brain and if these effects can change depending on the individual’s stress and coping strategies.

**HOW MANY PEOPLE WILL TAKE PART IN THIS STUDY?**
It is anticipated that about 72 people will take part in this study, from research sites located in Ottawa, Ontario.
This study should take a total of 3 years to complete, and the results should be known at the end of the 3rd year.

**WHAT WILL HAPPEN DURING THIS STUDY?**
If you qualify and choose to take part in this research study, you will undergo these research procedures:

- If your relative with schizophrenia is not currently being followed by a psychiatrist at the Royal Ottawa or the On Track clinic at The Ottawa Hospital, we will be asking you questions about your relative during the screening process to confirm their diagnosis. We will also require another informant (e.g., another family member) to provide us with information about this relative. We will then determine whether or not we can confirm the diagnosis based on the information you provide us.
- Once you have been screened and are eligible for participation, you will be assigned an ID code. This ID will be used to represent your anonymized study data. Any information linking your personal information to your study ID will be maintained in a master-code list that is secured, encrypted and maintained by the principal investigator.
- We will collect information about you from various assessments and questionnaires, and we will enter this information into an electronic database and on paper. The data will be securely stored and will be maintained by the principal investigator and research staff. The database can only be accessed by people who are involved in the research.
- We will invite you for your first visit, where we will continue to assess your eligibility through various assessments. You will be asked to participate in clinical based and cognitive assessments. This first visit should take about 2.5 hours.
In the next visit, we will then ask you to participate in a functional magnetic resonance imaging (fMRI) scan that will last for about 60 minutes. During this scan, we will ask you to complete some social cognitive and emotion-based assessments within the scanner and outside the scanner. You will also complete questionnaires related to your social media use, stress, and coping strategies. This visit will also take about 2 hours and 15 minutes. At the end of this visit, the researcher will provide you with an iPad and an iPad charger for you to use for the following 4 training sessions.

We will then invite you to participate in 4 training sessions using the iPad provided to you. There are two groups for training, where each group will have a different version of the training program. You will be placed into one of two training groups at random (randomized) – similar to flipping a coin. Depending on the type of training group, you will complete different computerized exercises. These sessions will take 1 hour each, which will take place 2 times a week for 2 weeks (4 sessions total). During these sessions, you will be practicing various training exercises on the iPad.

At your final visit, we will invite you to have another fMRI (30 minutes), as well as to perform some final emotional recognition related assessments both in and outside the scanner.

During each visit, we will ask for your feedback related to the training exercises and general study experience.

In total, your participation in this study will last for about 1 month, in which all the visits will be held. Please talk to the research team if there is information that you do not feel comfortable sharing. In the section below, your participation outline will be explained by visit number, week of visit based from first visit, as well as a summary of each visit.

**Outline of each visit**

<table>
<thead>
<tr>
<th>Visit</th>
<th>Week</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visit 1</td>
<td>Week 1</td>
<td>(2.5 hours) Consent form, detailed description of study and their role and responsibilities as a participant, enrollment, clinical assessments, cortisol sampling, cognitive tests, emotional intelligence and social functioning assessment</td>
</tr>
<tr>
<td>Visit 2</td>
<td>Week 1</td>
<td>(~2 hours, 15 minutes) Baseline fMRI scan (~60 minutes), social cognitive assessments, social media use assessment, stress and coping assessments, iPad given to participant</td>
</tr>
<tr>
<td>Visit 3</td>
<td>Week 2</td>
<td>Training Session #1 (1 hour): computerized exercises</td>
</tr>
<tr>
<td>Visit 4</td>
<td>Week 2</td>
<td>Training Session #2 (1 hour): computerized exercises</td>
</tr>
<tr>
<td>Visit 5</td>
<td>Week 3</td>
<td>Training Session #3 (1 hour): computerized exercises</td>
</tr>
<tr>
<td>Visit</td>
<td>Week</td>
<td>Activity</td>
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<td>---------</td>
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</tr>
<tr>
<td>Visit 6</td>
<td>Week 3</td>
<td>Training Session #4 (1 hour): computerized exercises</td>
</tr>
<tr>
<td>Visit 7</td>
<td>Week 4</td>
<td>(1.5 hours) Final fMRI scan (30 minutes) 1 week from previous session, social cognitive assessments, participants will be briefed regarding their completion of the study</td>
</tr>
</tbody>
</table>

The first visit and all visits that require a fMRI scan (i.e., Visit 2 and Visit 7) will be held at The Royal Ottawa Mental Health Centre. All other visits will be held remotely on an iPad under secure virtual supervision via Zoom for healthcare by the PI and research team.

**fMRI imaging component**
During this study, you will be asked to have two fMRI scans in two different visits. These scans will assess your brain activity and brain metabolic function in the scanner. This scan is already used in medical care but would not normally be done unless a health care provider would like to look at an individual’s brain in more detail. For these scans, we would ask you to remove all metal jewelry or clothing (change into a hospital gown and pants) before entering into the imaging room. We will then ask you to lie down on the scanner as we prepare you for the scan. During the scan, we ask that we remain as still as possible. Even the slightest head movements alter the scan. You will be given an emergency button, as well as a button to press when answering questions within the scanner. We will be able to hear and see you at all times in the scanner.

The brain imaging scans are being done for research purposes only and will not be used to guide your medical care.

**Cortisol sampling component**
Cortisol is an important hormone in the body that can show your body’s response to stress. For a cortisol measure you will be asked for a two saliva samples, 15 minutes apart, during the first visit. This will be done by placing a swab in your mouth to 2 minutes. The swab will then be kept in a salivette tube to be stored. For the saliva sample you are required not to drink, eat or chew gum 1 hour before the collection and refrain from drinking caffeine 2 hours before collection. We also ask that you limit any intense exercise and refrain from smoking the day of the study.

**How long will the investigators be permitted to use information and samples collected from me in this research study?**
The investigators will store saliva samples in a secure location at the ROMHC and a code number will be assigned. Information linking this code number to your name will be kept in a password protected computer at the ROMHC in separate and secure location. Your saliva samples will only be tested for cortisol. The results of the test will only be made available to the research team in a coded form. The results will not be made part of your medical record. Saliva samples will be destroyed after analyses.
You can refuse to provide your saliva samples if you do not feel comfortable doing so. Upon request, you can also withdraw your saliva samples after providing them if you no longer wish for them to be used. They can be withdrawn at any time before the study results are published.

**Questionnaires**
You will be provided with questionnaires at each visit. During each visit, we will use the information from each questionnaire for various purposes. The purpose of the questionnaires is for continued eligibility assessment, for emotion recognition and social cognition assessment, and for general feedback. Each individual questionnaire/assessment will vary in time, lasting anywhere from about 5 to 45 minutes each.

The questionnaires/tests and assessments that you will complete throughout this study are:

Visit 1
- Clinical subthreshold symptom assessments
- Cognitive Assessment
- Emotional Intelligence social functioning assessments
- Cortisol sampling

Visit 2
- Emotion recognition and regulation assessments
- Theory of mind assessment
- Attribution bias questionnaire
- Neuroimaging assessments during fMRI scan
- Social media use assessment
- Stress and coping assessments

Visit 7
- Emotion recognition assessments
- Neuroimaging assessments during fMRI scan

The information you provide is for research purposes only. Some of the questions will ask you for personal information. Please notify research staff if you feel uncomfortable. You may choose not to answer certain questions if you wish.

Even though you may have provided medical/personal information on a questionnaire(s), these responses will not be reviewed by your physician/health care team. If you wish them to know this information, please bring it to their attention.

**WHAT ARE THE RESPONSIBILITIES OF STUDY PARTICIPANTS?**
- If you choose to participate in this study, you will be expected to:
  - Attend all study sessions
  - Answer all questions as truthfully and honestly as possible
  - Engage to the best of your ability in all training sessions
  - Notify research staff if you have any questions or concerns, at any point in the study
  - Do not discuss with other participants any information you learn in the training sessions.
  - This includes information about other activities and any opinions or comments that are shared between the research staff and yourself.
HOW LONG WILL PARTICIPANTS BE IN THE STUDY?
Your participation in this study will last for about 1 month, which will include 7 participation visits.

Overall, this study should take a total of 3 years to complete, and the results should be known at the end of the 3rd year.

CAN PARTICIPANTS CHOOSE TO LEAVE THE STUDY?
You can choose to end your participation in this research (called withdrawal) at any time without having to provide a reason. If you choose to withdraw from the study, you are encouraged to contact the research team.

You may withdraw your permission to use information that was collected about you for this study at any time by letting the research team know. However, this would also mean that you withdraw from the study.

CAN PARTICIPATION IN THIS STUDY END EARLY?
Your participation on the study may be stopped early, and without your consent, for reasons such as:

- New information shows that the research is no longer in your best interest. The research team decides to stop the study
- The research ethics board withdraw permission for this study to continue
- If you are removed from this study, the research team will discuss the reasons with you.

WHAT ARE THE RISKS OR HARMS OF PARTICIPATING IN THIS STUDY?
There are no medical risks to you from participating in this study but taking part in this study may make you feel uncomfortable. Individuals who experience intense fear and anxiety for small and confined spaces (claustrophobic) may experience difficulty within the MRI machine.

Individuals in the machine will be given an emergency panic button that will signal to the study staff and MRI technician that they require immediate assistance or leave of the MRI machine.

Potential risks – An MRI machine does not emit any form of radiation, therefore there is no risk of exposure during this study. MRI procedures cannot be performed on individuals with metal containing implants or objects within their body or on their person. The MRI machine contains a strong magnet within and may cause fatal injuries if the metal object passes into range of the MRI machine. To prevent this occurrence, all participants will be required to disclose all information regarding implants/surgeries/procedures in which metal objects may be permanently in or on their person during the eligibility screening process.

Overall, this study is considered to be low risk.

WHAT ARE THE BENEFITS OF PARTICIPATING IN THIS STUDY?
You may not receive direct benefit from participating in this study. We hope the information learned from this study will help research and health care professionals in the search to improve
emotion regulation in individuals at risk for mental illness. We hope to learn more about the brain, its function, and how its functioning may change in people at-risk or with a mental illness.

**HOW WILL PARTICIPANT INFORMATION BE KEPT CONFIDENTIAL?**
Staff from the Research Ethics Board may look at your research record to check that the study is following the proper laws and guidelines. You may be contacted by staff from the Research Ethics Board to answer questions about your experience in the study. This is done to improve the quality of our research work.

If you decide to participate in this study, the research team will only collect the information they need for this study.

Records identifying you at this centre will be kept confidential, to the extent permitted by applicable law, and will not be disclosed or made publicly available except as described in this consent document. Your personal information, including results from the questionnaires, assessments and brain imaging data will be kept strictly confidential except as required or permitted by law. Any information that would indicate that a child was being harmed or at risk of such harm, would not be kept confidential and instead be disclosed as appropriate to offset that risk. Even though you may have provided medical information on a questionnaire, these responses will not be reviewed by your physician/health care team – if you wish them to know this information please bring it to their attention.

The data produced from this study will be stored in locked filing cabinets in a secure office at the ROMHC. Electronic data will be stored in password-protected files on secured computers at the ROHCG. A log linking your name to your anonymous research code will be kept separately from the rest of your data. Only members of the research team will have access to the information. After the study completion, the data will be kept for 10 years after the last publication of this study. They will then be destroyed.

You will not be identified in any publication or presentation of this study.

If the results of this study are published, your identity will remain confidential. It is expected that the information collected during this study will be used in analyses and will be published/presented to the scientific community at meetings and in peer-reviewed scientific journals. The same anonymized information collected during this study will be shared (upon request) on our website and can as well accompany the publication of a manuscript.

Even though the likelihood that someone may identify you from the study data is very small, it can never be completely eliminated.

**STUDY RESULTS**
You will receive a copy of the final study results if you provide the required information in the signature pages below. Findings from this study are expected to be reported at scientific conferences, published in scientific journals and provided openly on our lab website. Your identity will remain confidential. Even though the likelihood that someone may identify you from the study data is very small, it can never be completely eliminated.
WHAT IS THE COST TO PARTICIPANTS?
Taking part in this study may result in added costs to you. For example:

- You may miss work or school as a result of participation in this study.

To avoid this, we will try to book you at the most convenient time for you. Participation in this study will not involve any additional costs to you related to your private health care insurance or current level of care. All brain imaging data collected in the study is for research purposes only and will not involve any additional costs to you.

ARE STUDY PARTICIPANTS PAID TO BE IN THIS STUDY?
If you decide to participate in this study, you will receive $155 in total at the end of the study. Study compensation may assist you with transportation costs (i.e., bus tickets). If you require assistance for obtaining a parking pass or additional transportation ticket, please inform the study staff.

If you decide to leave the study, you will receive a prorated payment for participating in the study.

It is possible that the research conducted using your study data may eventually lead to the development of new software and intervention programs. There are no plans to provide payment to you if this happens.

COMPENSATION FOR INJURY
If you suffer a physical injury from equipment used in this study, medical care will be provided to you in the same manner as you would ordinarily obtain any other medical treatment. In no way does signing this form waive your legal rights nor release the study doctors or involved institutions from their legal and professional responsibilities.

In the case of research-related side effects or injury, medical care will be provided by your doctor or you will be referred for appropriate medical care.

PARTICIPATION AND WITHDRAWAL
Participation in any research study is entirely voluntary. If you decide to participate in this study you can change your mind without giving a reason, and you may withdraw from the study at any time without penalty. There will be no penalty or consequence if you decide to withdrawal at any point during this study. All data collected will halt at the time of your withdrawal and will cease to continue. Ongoing consent will be obtained at the beginning of every interview or focus group. You will be asked about your willingness to proceed with the study at the start of each visit. This will be documented in your participant file.

WHAT ARE THE RIGHTS OF PARTICIPANTS IN A RESEARCH STUDY?
You will be told, in a timely manner, about new information that may be relevant to your willingness to stay in this study. You have the right to be informed of the results of this study once the study is complete. Your rights to privacy are legally protected by federal and provincial laws that require safeguards to ensure that your privacy is respected. By signing this form, you
do not give up any of your legal rights against the researcher or involved institutions for compensation, nor does this form relieve the researcher or their agents of their legal and professional responsibilities.

WHAT IF RESEARCHERS DISCOVER SOMETHING ABOUT A RESEARCH PARTICIPANT?
During the study, the researchers may learn something about you that they didn’t expect. For example, the researchers may view something on your brain imaging scan that you may have not known was there.

If any new clinically important information about your health is obtained as a result of your participation in this study, you will be given the opportunity to decide whether you wish to be made aware of that information.

The brain imaging scan is being done for research purposes only and will not be reviewed for clinical purposes. The technical staff involved in the study are not trained or qualified to diagnose pathologies. During brain imaging procedures however, there is a small chance of discovering a potential abnormality during the scan. In the rare case of an unexpected finding, your images will be reviewed by a radiologist. If follow-up is deemed necessary, you will be contacted directly by the principal investigator and asked to provide permission for the findings to be shared with your primary physician. Your physician can then provide you with a referral for further testing and clinical follow-up. If you do not have a primary physician, a study physician will provide you with a referral and follow-up.

A copy of the signed consent form will be provided to you.

RESEARCH ETHICS BOARD CONTACT
This study has been reviewed and approved by the Royal’s Institute of Mental Health Research REB as study #2019033. If you have any ethical concerns about the study, or the way it is conducted, please contact the REB office: kristi.wilde@theroyal.ca

The study protocol and consent form have been reviewed by a committee called the Research Ethics Board at the ROHCG. The Research Ethics Board is a group of scientists, medical staff, people from other backgrounds (including law and ethics) as well as members from the community. The Board is established by the ROHCG to review studies for their scientific and ethical merit. The Board pays special attention to the potential harms and benefits involved in participation to the research participant, as well as the potential benefit to society. The Board is also required to do periodic review of ongoing research studies.

WHOM DO PARTICIPANTS CONTACT FOR QUESTIONS?
If you have questions about taking part in this study, or if you suffer a research-related injury, you can talk to the research team, or the person who is in charge of the study at this institution. That person is:

Dr. Synthia Guimond (613) 722-6521 Ext. 6586
Name Telephone
**Study Title:** Social cognition in youth who have a first degree relative with schizophrenia

**SIGNATURE PAGE**

The research project has been explained to me, and my questions have been answered to my satisfaction. I have the right not to participate and the right to withdraw without penalty at any time. The potential harms and benefits (if any) of participating in this research study have been explained to me.

I have been told that I have not waived my legal rights nor released the investigators or involved institutions from their legal and professional responsibilities. I know that I may ask now, or in the future, any questions I have about the study. I have been told that records relating to me will be kept confidential and that no information will be disclosed without my permission unless required by law. I have been given sufficient time to read the above information.

I also understand that all de-identified and anonymized data can accompany the publication of the findings in peer-reviewed scientific publication to promote open and transparent science. Any personal information that could identify you, such as your name will never be associated with the publication of the data.

In summary:

- All of my questions have been answered,
- I understand the information within this informed consent form,
- I do not give up any of my legal rights by signing this consent form,
- I understand that my family doctor/health care provider may be informed of study participation, if I choose

- I consent to participate in this study. I have been told I will be given a signed copy of this consent form.
- I agree that my contact information can be shared with other IMHR researchers to be contacted for other research opportunities
- I agree that all de-identified data collected in this study can be shared with other IMHR Researchers. The Principal Investigator (Dr. Synthia Guimond) will be the main person responsible for the data and its distribution.

____________________________   ______________________               _________________
Signature of Participant                      PRINTED NAME                                Date

**Principal Investigator Signature**

I, Synthia Guimond, am the Principal Investigator responsible for conducting this study at the Royal Ottawa Mental Health Center, and I have delegated the explanation of this study to this participant to ____________________________ (name of person conducting the consent discussion).
Signature of Investigator                          Date

Request to be informed of final study findings

*I would like to receive summaries of the study findings

Initials of Participant

Participant’s email (or postal) address:

Study Registration
This study will be registered as an interventional randomized control trial as per TCPS2 guidelines under Health Canada. You may find this registered study on clinicaltrials.gov. To find this study, please use the following information.

Clinical Trial Registration Number (NCT):  NCT04681807
### Appendix B: Scores on Measures of Social Cognition

<table>
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<th>Participant #</th>
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*Note. FHR= Familial High Risk; ms = milliseconds; RT = Response Time*
Appendix C: Scores on Prodromal Symptoms and Schizotypy Measures

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<th>Participant #</th>
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<th>Negative Symp</th>
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<th>Positive Schiz</th>
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*Note. FHR = Familial High Risk; Schz = Schizotypy; Symp = Symptoms*