Implicit and Explicit Social Cognition in Schizotypy

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Introduction

Background

Schizotypy is a dimensional personality trait that demonstrates some similarities to the illness of schizophrenia (Vidal et al., 2015). The exact relationship between schizotypy and schizophrenia remains unknown, but recent research suggests it is a continuous trait normally distributed throughout the general population and may represent genetic vulnerability to mental illness, including psychosis (Nelson et al., 2013; Rawlings et al., 2008). Thus, studying schizotypy may allow us to examine mechanisms that may also underlie the experience of schizophrenia, as well as factors that influence the development of psychosis.

One widely used measure of schizotypy is the Schizotypal Personality Questionnaire – Brief Revised (SPQ-BR; Cohen et al., 2010), which is a 32-item questionnaire that measures unusual experiences that resemble positive symptoms of schizophrenia, cognitive disorganization, and negative symptoms. Several studies have demonstrated the dimensionality, reliability, and validity of the SPQ-BR in college students and in culturally diverse adult community samples, which support its continued use for studying schizotypy (Cohen et al., 2010; Davidson, Hoffman, & Spaulding, 2016; Foncesca-Pedrero et al., 2017). Questions on the SPQ-BR bear qualitative similarity to some of the experiences of psychotic illnesses, including unusual or positive-like experiences such as “I often hear a voice speaking my thoughts out loud,” negative-symptom like or cognitive disturbances such as “I sometimes forget what I am trying to say,” and disorganized thinking, such as “I sometimes jump quickly from one topic to another while speaking.”

Beyond characterizing and measuring the phenomenology of schizotypy, there has been increasing interest in examining social cognition deficits in this population. It is widely known that individuals with psychotic disorders exhibit deficits in multiple areas believed to be related to social cognition, such as emotion perception, social cue perception, theory of mind, attributional style, and empathy, which have been shown to significantly impact community functioning (Mancuso et al., 2011). Similarly, individuals high in schizotypy appear to display some difficulty in the same core areas of social cognition, such as emotion perception, theory of mind, and empathy (Morrison, Brown, & Cohen, 2013; Horan et al., 2008; Cohen et al., 2011), tend to have lower levels of social functioning, and endorse higher levels of anhedonia in both social and non-social domains (Henry et al., 2008; Cohen et al., 2011, Blanchard et al., 2009). However, it remains unclear what specific aspects of social cognition are impaired in this population, how they relate to social functioning, and how this may be related to the unusual experiences endorsed by individuals with varying levels of schizotypy.

Conceptual Framework

A recent review by Happé, Cook, and Bird (2017) proposed a framework of social cognition that posits several key underlying processes are involved in adaptive functioning in this domain. Specifically, they argue that empathy, false-belief understanding, imitation, action recognition, emotion recognition, and representation of self and other are abilities that form over the course of development, and work together in determining one's ability to navigate social situations. Also within this framework is the role of dual process theory, such that each of these proposed core abilities may involve two routes. The first is an implicit pathway that is "automatic, cognitively efficient… [and] relies on heuristics and learned associations" and a second, more explicit "deliberate reasoning process…" (Happé, Cook, & Bird, 2017, p. 257).

Given what is known about the relationship between deliberate reasoning and neurocognitive functioning, Happé, Cook, and Bird hypothesize that the explicit pathway may rely more heavily upon working memory and executive functioning, and the implicit pathway may recruit more cognitive resources related to attention, reward learning, and social contextual learning. As such, many proponents of dual-process theory have posited that the implicit system is domain-specific while the explicit system may rely on more generalized cognitive processes, including executive functions (Evans et al., 2008). Additionally, a review by Van Overwalle & Vandekerckhove (2013) concluded that implicit and explicit social cognition tasks may actually recruit different brain areas along a common social metalizing pathway, suggesting that these may be distinct processes.

Dual processing is thought to be both adaptive and necessary to perform social cognitive tasks. A review by Evans et al., 2008 discussed many ways in which these processes may recruit different cognitive resources; for example, slower, more effortful, conscious processes may rely more heavily on working memory and explicit learning, whereas faster, automatic, implicit processes may not involve working memory and instead utilize associative learning. Other studies suggest that the main differences between these two systems are the level of consciousness they employ, and whether an action or judgment happens automatically or more deliberately (Satpute & Lieberman, 2006). Contextual factors may also play a role in whether one process or another is engaged, such as the level of risk or novelty, which may determine the use and availability of prior knowledge and the speed of decision-making required (Evans, 2002). In general, dual processes are believed to involve different cognitive resources as well as varying depending on contextual factors.

Dual process theory has also been proposed as a framework to understand deficits in disorders with social cognitive dysfunction, such as Autism Spectrum Disorder (ASD) and schizophrenia (Happé, Cook, & Bird, 2017). A study by Senju et al. (2009) asked individuals with Autism Spectrum Disorder (ASD) to watch videos of an adaptation of the Sally-Anne false-belief test (Wimmer & Perner, 1983). Eye-tracking data was then obtained of individuals with ASD observing this task to assess whether they displayed anticipatory eye movements consistent with understanding a false belief. Results indicated that individuals with ASD did not display eye-movements consistent with the false belief, indicating impairment in rapid perspective-taking, or spontaneous theory of mind. However, they were able to correctly identify the false belief when explicitly verbally asked, indicating intact explicit understanding of theory of mind and false beliefs. The authors hypothesize that this may be due to compensatory learning strategies that occur in the absence of the ability to spontaneously attribute others' mental states.

In schizophrenia, the opposite appears to be true, suggesting deficits in explicit theory of mind. A study by Speechley et al. (2010) used a modified version of the false belief "beads task" where participants are shown two lakes containing different amounts of two kinds of fish, and then asked to determine how likely it is that a specific type of fish pulled out came from one lake or another. Participants with schizophrenia who had delusions made quicker and more confident decisions as to the source lake, but made more errors than healthy controls, displaying difficulty engaging the more explicit decision-making system (judging probabilities) and relying more heavily on fast, intuitive judgments. These faster judgments are most susceptible to jumping to conclusions (JTC) bias and increased need to seek closure, resulting in attribution errors and incorrect conclusion, which broadly have been shown to be associated with delusion proneness, even in non-clinical individuals (Colbert & Peters, 2002; Moritz & Woodward, 2005).

While individuals with schizophrenia tend to exhibit overreliance on intuitive processing, we do not see these same difficulties when using emotional stimuli. A study examining dual processing of emotional prosody found that explicit recognition (identify the emotion in a voice recording) was impaired in individuals with schizophrenia, while more implicit processing in a Stroop-like task (positive and negative emotional valence words pronounced with congruent or incongruent vocal prosody) was not impaired (Roux, Christophe, & Passerieux, 2010). Thus, individuals may vary in use of each of the dual processes of social cognition depending on the content of the stimuli used.

However, to date, findings are mixed as to whether there are differences in these processes in schizotypy. For false beliefs and delusionality, some studies have shown that individuals who endorse more items on the SPQ-BR related to magical thinking, ideas of reference, and unusual perceptions, tend to display greater belief in conspiracy theories, urban legends, and paranormal concepts (Dagnall et al., 2017; Barron et al., 2018). These beliefs bear similarity to delusional thinking, which is associated with overreliance on implicit, intuitive judgments, jumping to conclusions, and increased errors. For emotion processing, the Empathic Accuracy task (EA; Hall & Schmid, 2007) is often used to examine explicit attributions, where participants view videos of people describing emotional events and provide deliberate, moment-to-moment ratings of the person's emotional state. On this task, individuals with Schizotypal Personality Disorder (SPD), characterized by clinical levels of schizotypal traits and functional impairment, display lower accuracy than healthy controls (Ripoll et al., 2013). However, this is only on negatively valenced trials, and there are no differences between individuals with SPD and healthy controls on positively valenced trials. Further research suggests that individuals with SPD do not differ from healthy controls on the Reading the Mind in the Eyes Task (RMET),

where participants must provide an emotion label to a picture solely of an individual's eyes (Ripoll et al., 2013). But when asked to complete a standard emotion recognition task, the Penn Emotion Recognition Test, individuals show impairment only when labeling neutral faces, showing a tendency to label neutral faces as displaying negative emotions (Brown & Cohen, 2010). More broadly, some studies have shown that impaired emotion processing is associated with general psychosis proneness (van't Wout et al., 2004; Kerns, 2005; Germine & Hooker, 2011). Thus, results pertaining to dual processing in individuals with schizotypy are mixed, and more research is needed to understand how social cognitive performance varies with increasing schizotypy.

Measurement of Dual Processes in Social Cognition

There are a plethora of measures used in social cognition research; however, little information exists regarding their psychometric properties. In addition, there has been limited research critically evaluating multiple measures of the same concept (Pinkham et al., 2014). Studies examining more explicit social cognitive processes often use measures that involve direct naming or recognition, and deliberate decision-making (Evans, 2008) such as the Penn Emotion Recognition Task (ER-40, Kohler et al., 2003), and The Awareness of Social Inference Task (TASIT; McDonald, Flanagan, & Rollins, 2002). Many of these measures ask participants to examine socially relevant stimuli and make explicit judgments about other's emotions and intentions, as well as describe potential responses and actions to these situations. Additionally, studies often utilize self-report questionnaires, such as the Interpersonal Reactivity Index (IRI; Davis, 1980) to measure empathy, the Need for Closure Scale to measure tolerance of social ambiguity, and the Social Intelligence Scale (Silvera, Martinussen, & Dahl, 2001) to measure

perceived social skills. Many of these measures have been used to understand social deficits in ASD and psychotic disorders.

Researchers have also aimed to develop objective, performance-based measures of social cognition that may aid in understanding clinical levels of impairment in social cognition. One of the only measures that currently exists that is used to examine social cognition in both clinical and research contexts is the Advanced Clinical Solutions social cognition battery for the Wechsler Adult Intelligence Scale–Fourth Edition and the Wechsler Memory Scale–Fourth Edition (ACS, Pearson, 2009). Developed as a free-standing addition to complement intelligence testing with the WAIS-IV and WMS-IV, this test examines multiple areas of social cognition with three main subtests: social perception, which comprises affect naming (matching an emotion label to a face), prosody (matching a face with the prosody of a voice), pairs (matching a picture of two individuals to an audio recording of a conversation, subsequently providing an emotion description, and determining if the meaning changed based on contextual factors, e.g.,,, recognizing sarcasm); faces, which evaluates the processing of facial features, face recognition, and facial memory; and names, which examines association memory between names and faces, as well as memory for emotional faces. The pairs section of the social perception subtest includes conditions which both tie into explicit social cognition (matching the appropriate picture to the conversation audio) as well as implicit conditions (providing a verbal label of the emotional content, and determining whether the meaning of the conversation changed, that might indicate things like sarcasm or deceit).

The social perception section of the ACS (ACS-SP) has been used to examine social cognition in ASD and schizophrenia (Kadalaft et al., 2012), such that individuals with schizophrenia performed worse than healthy controls on the prosody and pairs subtests,

individuals with ASD performed worse than controls on the prosody subtest, and individuals with schizophrenia performed worse than those with ASD on the pairs subtest. The ACS-SP has also been found to be associated with performance on other widely used measures, such as the Ekman60 facial expression recognition test (Young et al., 2002), the Wechsler Memory Scale: Memory for Faces Subtest (WMS-Faces; Wechsler, 1997), the Reading the Mind in the Eyes test (Baron-Cohen et al., 2001), and the Triangles test (Abell, Happé, & Frith, 2000).

To date, there has only been one study that utilized the ACS-SP in psychometrically defined high schizotypy (Davidson, 2014). This study examined how ERP responses to emotional faces are associated with various social and non-social cognition measures in a sample of college undergraduates high in schizotypy, and found a trend-level negative correlation between P300 amplitudes and the ACS-SP prosody subtest, and no correlations between any of the ACS-SP subtests and N170 amplitudes. However, the relationship between performance on the ACS-SP and schizotypy was not explored. Further research is needed to determine how individuals with varying levels of schizotypy perform on this task, as well as how performance on the ACS-SP may relate to other aspects of social cognition.

Implicit social cognitive processing is studied using a variety of methods. One of the most common and widely used tools is the Implicit Association Test (IAT, Greenwald, McGhee & Schwartz et al., 1998), which in its purest form aims to measure unconscious biases and attitudes, and has also been used to measure social attitudes and preferences as well as self-esteem (Karpinski & Steinman, 2006). Priming tasks have also been used extensively with socially relevant stimuli, and used to measure attentional biases, social cognitive flexibility, and associative learning (Cameron et al., 2012). Many other performance-based implicit measures such as the silent animations task (Abell, Happé, & Frith, 2000) for theory of mind and the

Mayer-Salovey-Carusco Emotional Intelligence Test (MSCEIT; Mayer, Salovey, & Carusco, 2002) for emotion perception have also been used to understand automatic, and spontaneous social cognitive processes. A similarly wide array of self-report questionnaires also exists for implicit social cognition, such as the Ambiguous Intentions and Hostility Questionnaire (AIHQ; Combs et al., 2007). Many of these measures have been used to study individuals with social dysfunction.

A newer method gaining traction for studying social cognitive processing is lexical analysis. The way in which people use words can provide insight into the way people think about themselves, others, and the world, and may provide insight into a variety of social cognitive processes, such as attitudes, attribution styles, theory of mind, emotion processing, and general social functioning. This technique has been utilized widely across clinical, cognitive, and social psychology, to study various phenomena such as alexithymia (Vanheule, Meganck, & Desmet, 2011), in ASD (Nguyen, Phung, & Venkatesh, 2013), social language use and social neuroscience (O'Donnell, Falk, & Lieberman, 2015), and autobiographical memory (Greenberg, Bishara, & Mugayar-Baldocchi et al., 2017). Multiple studies have utilized this method specifically to examine social cognition and functioning in schizophrenia (Minor et al., 2015; Cohen et al., 2009; Cohen et al., 2015; Marini et al., 2008). Given that speech can involve naturalistic, spontaneous processes, and may provide information about an individual's underlying mental state, there is potential for its use in studying implicit social cognitive processes.

In one study, Minor and colleagues (2015) asked individuals with schizophrenia and schizoaffective disorder open-ended questions about their life and illness, and then examined word use in these interviews using the Linguistic Inquiry Word Count software (LIWC;

Pennebaker et al., 2015). They examined word use in all categories from the LIWC dictionary, and found that affective and social words were most strongly associated with clinical variables (positive and negative symptoms, social functioning). Additionally, these most strongly predicted metacognition, as measured by the Metacognition Assessment Scale (MAS-A; Lysaker et al., 2005) and anhedonia, such that greater use of these words was associated with better metacognition and reduced anhedonia. In addition, they found that greater use of negative emotion words was positively correlated with overall symptoms of schizophrenia, and social word use positively correlated with metacognition. This suggests that that word use may be a useful method to examine cognitive and social-cognitive processes underlying this disorder.

However, to date, there are few published studies that have used lexical analysis to examine social and affective processing in individuals with schizotypy. A study by Najolia, Cohen, & Minor (2011) examined affective dysfunction both at the state and trait level, for psychometrically defined schizotypy as measured by the SPQ-BR. Trait affect was measured via the Positive Emotion and Negative Emotion subscales of the Positive and Negative Affect Schedule (PANAS; Watson et al., 1998), whereby participants rated the extent to which they experienced different emotional states over the last week. State affect was measured through an affect induction protocol, where participants viewed positive, negative, and neutral photos from the International Affective Picture System (IAPS; Lang et al., 2005), and verbally reported their emotion levels as well as rated their emotion levels using the Self-Assessment Manikin. Results showed that high schizotypy participants, as compared to participants lower in schizotypy, had higher negative trait affect and lower positive trait affect, as well as higher negative state affect and lower positive state affect. Lexical analysis with the Linguistic Inquiry and Word Count software LIWC (Pennebaker et al., 2015) revealed that individuals higher in schizotypy, only for

the pleasant picture conditions, used significantly fewer positive affect words and more negative affect words than controls when verbally describing their emotional state. Additionally, low trait positive affect was significantly positively correlated with SPQ-BR score. Thus, there appears to be a relationship between use of affect-related words, trait and state affect, and schizotypy.

Another study examining schizotypy and word use (Abplanalp et al., 2017) employed a modified version of the Indiana Psychiatric Illness Interview (IPII; Lysaker et al., 2002) to examine differences in affective word use for individuals high in schizotypy and control participants while they discussed experiences of distress, and how their word use correlated with depression and quality of life measures. Results showed that individuals high in schizotypy, as compared to controls, used significantly more negative affective words, and reported lower quality of life and greater depression. It was also found that there was a significant inverse relationship between use of negative affective words and quality of life, and a trend level relationship between negative word use and depression. Therefore, there appears to be an overall trend between increased schizotypy, higher use of negative affective words, lower quality of life, and higher depression.

While both of these studies examining schizotypy and word usage employed lexical analysis, one to responses to affective pictures and the other on discussions of individuals' experiences of distress, it remains unclear how individuals with different levels of schizotypy may differ in their use of words when providing a full verbal autobiography, i.e., when not asked to focus on specific emotional situations. More specifically, studying how schizotypy relates to word use while describing personally relevant experiences at length and tests of social cognitive ability may provide a more comprehensive picture to understand social cognition in this population.

Proposed Study and Hypotheses

This study seeks to understand how varying levels of schizotypy relates to implicit and explicit social cognitive processing. More specifically, we examined how individuals with varying levels of schizotypy spontaneously use words related to social and emotional processes when providing their verbal autobiographies, as well as how they perform on a widely used neuropsychological test of social cognitive ability, the Advanced Clinical Solutions for the Wechsler Adult Intelligence Scale–Fourth Edition Social Cognition test – Social Perception subtest (ACS-SP; Pearson, 2009). In contrast to previous studies, we looked at word usage in a full autobiography interview, which asks participants to recall details of personally salient memories. This involves more spontaneous and naturalistic speech processes, compared to many previous tasks that require describing affective pictures, as the participants in this study select what people, life events, and emotions they choose to share. Additionally, we examined word use in a verbal autobiography as a model for implicit social cognitive processing. More specifically, we propose that using more negative or and few positive affect words may indicate altered spontaneous emotion processing, and few social words may be a result of less spontaneous thinking about social interactions, suggesting impairment in spontaneous social cognition. Lastly, by including a performance-based measure of social cognition like the matching subtests of the ACS-SP, we can compare implicit social cognitive processing in participants' autobiographies to explicit processes required by the ACS-SP. By building a model of both implicit and explicit social cognition measures, we can obtain more detailed information about the specific processes of social cognition that may be impaired in schizotypy.

Hypotheses

1. Given that it is believed schizotypy and schizophrenia are related and may share underlying etiology, as well as past findings concerning dual process social cognition in schizophrenia, we hypothesize that individuals higher in schizotypy display difficulty in the slower, decision-making, greater cognitive-load processes of the ACS-SP than individuals lower in schizotypy. More specifically, schizotypy will be associated with low performance on all subtests of the ACS-SP.
2. Based on past studies examining social words and symptoms of schizophrenia and impaired metacognition, we hypothesized that use of social words, positive emotional words, and negative emotional words would significantly predict schizotypy. More specifically, that schizotypy would be associated with lower use of social words, higher use of negative emotional words, as well as decreased use of positive emotional words.
3. Based on studies examining dual processing in schizotypy and schizophrenia, we hypothesize that both implicit and explicit social cognition will predict schizotypy. Therefore, a model that includes both word use and performance on the ACS-SP will predict a significantly greater portion of the variance in schizotypy than word use or ACS-SP performance alone or word use alone.

Methods

Participants

The participants of the study consisted of 101 (66 female, 35 male) undergraduates enrolled in an introductory psychology class at the University of Illinois at Chicago with a mean age of 19.4 years (SD = 2.56 years). Participants completed the Schizotypy Personality Questionnaire, Brief – Revised (SPQ-BR; Cohen et al., 2010), were administered the ACS-SP, and completed a verbal autobiography task (described below).

Measures

Wechsler Advanced Clinical Solutions Social Cognition Social Perception Test (ACS-SP; Pearson, 2009)

Trained clinical psychology doctoral students and advanced undergraduate students at the University of Illinois at Chicago administered participants the three matching subtests of the ACS Social Perception module: affect naming, prosody, and pairs. In the affect naming task, participants are presented with a picture of an individual with an emotional (or neutral) facial expression and asked to identify the emotion that is being expressed in the picture. The prosody task requires participants to listen to an audio recording of speech and select a facial expression that best matches the emotion expressed by the speaker. Prosody pairs (pairs) matching subtest presents participants with audio recordings of a conversation and asks them to select pairs of photographs of people that best match the interaction. For the pairs subtest, we only utilized information from the matching condition, and did not examine the emotion/tone or meaning change conditions. This allowed us to only examine the more explicit social cognition conditions of this task for construct validity. For this study, we utilized scores for each of the three subtests

(affect naming, prosody, and pairs) independently to determine how performance on each subtest is associated with schizotypy.

Autobiography Task/ Lexical Analysis with LIWC

Participants generated their verbal autobiography (adapted from the IPII; Lysaker et al., 2002) for which they are given the following instructions, "I'd like you to tell me the story of your life, in as much detail as you can, from as early as you can remember up to now. If it helps you to organize your story, you can divide it into chapters or sections." The resulting narrative was then audio-recorded and transcribed into text, and cleaned according to the formatting required for lexical analysis with the Linguistic Inquiry and Word Count software (LIWC; Pennebaker, 2015), which includes spelling out instances of abbreviations, eliminating use of nonfluences, and coding filler words with the special characters "rr."

Each cleaned autobiography was then processed using LIWC. In line with previous research using lexical analysis in schizotypy and schizophrenia, from the LIWC analysis output, we utilized participant's overall word count, and use of social process words (e.g.,,,,, talk, friend, family), and affect words, specifically positive (e.g.,,,,, happy, pretty, good) and negative emotional words (e.g.,,,,, hate, worthless, afraid). With the exception of overall word count, each word category in the LIWC analysis output provides a percentage of the individual's use of words in a given category relative to the overall number of words in their autobiography. We assessed how each of these three word categories (social words, negative emotional words, and positive emotional words) were associated with level of schizotypy, while controlling for overall autobiography length.

Statistical Analyses

We used hierarchical multiple linear regression examining how control (demographic variables), explicit (ACS-SP), and implicit measures (LIWC variables) predict total schizotypy score on the SPQ-BR in the following manner. First, all social cognition measures were mean-centered to allow for better interpretation of regression intercepts. Model 1 examines the influence of control variables, which include gender and age on schizotypy. Model 2 then tests the first hypothesis, to see how the specific subtests of the ACS-SP (affect naming, prosody, and pairs) while controlling for age and gender, predict schizotypy. Model 3 tests hypothesis 2 to see how word use predicts schizotypy, by examining positive and negative emotional words and social words, while controlling for the overall autobiography length, age, and gender. Model 4 builds a model for testing hypothesis 3 then adds back in the specific subtests of the ACS-SP to examine how both word use and ACS-SP performance predict schizotypy. To test hypothesis 3 and determine whether both implicit (word use) and explicit (ACS-SP) social cognition predict a significantly greater portion of the variance than implicit or explicit variables alone, we used the *anova* function in R to test the fits between models 2, 3, and 4. We used the statistical software *R* (Version 3.4.3; R Core Team, 2017) and the R-packages *car* (Fox & Weisberg, 2011), *effects* (Version 4.0.0; Fox, 2003), *ggplot2* (Version 2.2.1; Wickham, 2009), *dplyr* (Version 0.8.1; Wickham et al., 2019), *psych* (Version 1.8.4; Revelle, 2018), *lme4* (Bates et al., 2015), *stargazer* (Hlavac, 2018), and *MASS* (Venables & Ripley, 2002) for all analyses.

Covariates

Several studies have demonstrated sex differences in social cognition, including that women demonstrate higher interest in social information, higher empathic attitudes, and rate

images of faces more positively and more arousing than males (Eagly & Wood, 1991; Proverbio, 2017). Additionally, studies examining performance on social cognition tasks in childhood through late adolescence have found age and sex differences on accuracy and reaction time, specifically finding that males compared to females in the 18-19 and 20-21 age groups were significantly slower on emotion identification tasks, and significantly slower and less accurate on emotion differentiation tasks than females (Gur et al., 2012). Further, many studies have found sex differences in language and speech Therefore, we collected demographic information on age and gender of participants, and initially examined the influence of these factors in our analyses.

Results

Model 1

Means and standard deviations for all models are depicted in Table 1. Results of Model 1 indicated that control variables of age $\beta = -1.43$, $p = 0.071$ and gender, $\beta = 3.01$, $p = 0.476$, were not significant predictors of schizotypy, $F(2,98) = 1.84$, $p = 0.164$, $R2 = 0.036$ (Table 2). Because neither age nor gender were significant predictors, they were removed from all subsequent analyses.

Model 2

The overall regression model to test hypothesis 1, which included the ACS-SP subtests and control variables, was not significant, $F(3,97) = 0.48$, $p = 0.696$, $R2 = 0.015$ (Table 2). Results indicated that performance on subtests of the ACS-SP, affect naming, $\beta = 0.39$, $p = 0.56$, prosody, $\beta = 0.80$, $p = 0.487$, and pairs, $\beta = -0.10$, $p = 0.916$, were not significant predictors of schizotypy score.

Model 3

When examining hypothesis 2 to determine the relationship between word use and schizotypy alone, the overall regression model was significant, $F(4,96) = 1.75$, $p = 0.146$, $R2 = 0.068$ (Table 2). The overall autobiography word count $\beta < 0.001$, $p = 0.957$, as well as proportion of social words, $\beta = -0.02$, $p = 0.789$, and positive emotional words, $\beta = -2.47$, $p = 0.210$ used were not significant predictors of schizotypy. However, a higher proportion of negative emotional words used, $\beta = 8.16$, $p = 0.018$, was significantly associated with higher schizotypy.

Model 4

When examining hypothesis 3, to determine the influence of word use and ACS-SP performance altogether, the overall regression model was not significant, $F(7,90) = 1.32$, $p = 0.249$, $R_2 = 0.093$ (Table 2). All variables remained not significant predictors of schizotypy, except negative emotional words, which similar to Model 3, greater use of negative emotional words was significantly associated with higher schizotypy, $\beta = 7.78$, $p = 0.012$.

Model Fit

As none of the regression models were significant, the fit between models was not calculated.

Data Distribution and Multiple Regression Assumptions

While none of the models were significant, we tested for the assumptions for multiple regression were checked for Model 4, which included all variables of interest. First, normal distribution of the outcome variable of SPQ-BR score was checked using the *qqnorm* function in R, which provided a Quantile-Quantile plot of theoretical values from a normal distribution and our sample values (Figure 1). Visual inspection of this plot indicated that this plot was close to linear, indicating that this assumption was likely met, and that our sample comes from a population that is normally distributed. Multicollinearity was checked by calculating the variance inflation factor for linear models for each independent variable (positive words = 1.13, negative words = 1.23, social words = 1.43, overall word count = 1.37, ACS pairs = 1.68, ACS prosody = 1.78, ACS affect naming = 1.16) all of which were under the recommended cutoff of 4. To check for homoscedasticity of residual values to the fitted values of the linear regression, we used the Non-Constant Variance Score test, which indicated that homoscedasticity was met (χ_2 (1, N = 101) = 0.04 , $p = 0.831$). To check for linearity of residuals, we visually inspected a Quartile-Quartile plot (Figure 2) as well as a histogram of residuals plotted alongside a normal distribution (Figure 3) which determined that this assumption was met Lastly, to check for

outliers, we removed values with a Cook's Distance value greater than 4. The above results as well as the results in Table 2 depict the Model 4 statistics after outliers were removed.

Discussion

Overall, neither the implicit nor explicit social cognitive measures used in this study were significantly associated with schizotypy. There are a number of potential explanations for this finding, including that individuals with high levels of schizotypy have intact implicit and explicit social cognitive abilities, or potentially that our measures were not sensitive or specific enough to tap into subtle difficulties in these areas. The measures used in this study, both word use in individuals' autobiographies as well as performance on the ACS-SP, are primarily objective measures: on the ACS-SP, individuals are given a score based on whether they answer each item correctly or incorrectly and in LIWC, individuals are given automated counts of the number of words used in each category in their autobiography. Given that individuals with high schizotypy are not experiencing clinical levels of symptoms of a psychotic disorder, impairment in social cognition may not exist or may not be behaviorally expressed. Recent schizotypy research has also suggested that this may be the case with overall functioning, referred to as the "paradox of schizotypy" (Cohen et al., 2014) such that self-reported impairment for individuals with high schizotypy is similar to individuals many years into a severe mental illness, but scores on an objective quality of life measures are more similar to healthy controls. Perhaps individuals with higher levels of schizotypy experience lower subjective, self-reported levels of social cognitive ability and social functioning, which may be related to subtle changes in processing social information (e.g.,,, processing emotional faces, prosody, making attributions, perspective-taking, etc.) that they may perceive as more impairing than is outwardly expressed. Thus, future studies should also use subjective measures to better characterize how individuals higher in schizotypy characterize their own social cognitive ability.

Further, individual subtests of the ACS-SP as well as individual word categories from the autobiography task did not significantly predict individuals' level of schizotypy, with the exception of negative emotional words. Even after accounting for performance on the ACS-SP, greater use of negative emotional words was significantly associated with higher schizotypy. This is consistent with findings from Najolia, Cohen, & Minor (2011) as well as Abplanalp et al., 2017, which found that individuals with high schizotypy tend to use more negative emotional words when describing emotional pictures as well as personal life experiences. This could mean that while neither implicit or explicit processing more broadly are predictive of schizotypy, higher negative affect may be associated with higher schizotypy. Past research has demonstrated that using more negative emotional words is indicative of higher levels of depression and anxiety (Rude, Gortner, & Pennebaker, 2004; Junghaenel, Smyth, & Santner, 2008).

Additionally, individuals higher in schizotypy tend to report higher levels of depression and negative affect (Lewandowski et al., 2006; Kwapil et al., 2012). As such, because this study did not include measures of depression or anxiety, it is unclear whether this variable captures a unique aspect of schizotypy, or could be attributed to depression and anxiety levels of participants in the sample. Future studies should include additional measures of depression, anxiety, as well as social and occupational functioning, to determine how social cognition may relate to schizotypy and psychological functioning more broadly.

Further, on the ACS-SP, individuals were not at ceiling on any of the subtests, affect naming, prosody, or pairs. In fact, most individuals scored in the average range of all of these subtests, indicating that our sample is reflective of what would be expected from this age group in the general population. However, we only examined matching conditions of this task, which may not capture the complexity of performance on this task. More specifically, determining how

individuals made false alarms on the affect naming task (e.g.,,, labeled a neutral face with an emotion), or made consistent mislabels (e.g.,,, happy as surprised, angry as afraid) could have provided more detailed information about affect recognition in schizotypy. Individuals high in schizotypy tend to also display higher apophenia, or the tendency to perceive meaning or patterns in events that are unrelated, which is often conceptualized as a propensity towards making more false alarms (Fyfe et al., 2008). Additionally, on the pairs task, this study only looked at how individuals matched faces to the audio recordings. Further information as to how they provided an emotional label to the conversation stimuli, and determined whether there was a change in the meaning of the conversation, could provide more detailed information about performance on these tasks, and allow us to contrast emotion labeling and prosody identification of an individual vs. a pair of individuals engaged in a conversation.

In addition, there were methodological challenges with the design of our study that pose challenges with interpreting our results. The first is our measurement of schizotypy score. Recent literature in schizotypy research have utilized the Multidimensional Schizotypy Scale (MSS; Kwapil et al., 2018), which is based on a clearer conceptual framework of positive, negative, and disorganized dimensions of schizotypy and have suggested that this measure has stronger psychometric properties as compared to the SPQ-BR. Thus, utilizing a three-factor structure or the MSS may be a more reliable and valid tool to measure schizotypy. Further, like the current study, other published studies of schizotypy have also used college-aged participants. However, often, participants scoring in the top 94% or 95% on the positive, negative, and disorganized subfactors on the SPQ, an earlier and longer form of the SPQ-BR, were selected to comprise the "schizotypy group," which was then compared to a "non-schizotypy group" comprising individuals who scored below the mean on the scale (Najolia et al., 2011; Abplanalp et al.,

2017). Additionally, studies often do not report the overall score cutoffs that determined which group the participant was in, nor the means and standard deviations for schizotypy scores for each group, which could greatly differ depending on the sample. Thus, it remains unclear exactly how our sample of schizotypy compares to other published studies.

Second, there are longstanding challenges with the way that LIWC conducts lexical analysis. When using LIWC, the linguistic characteristics one can use for analysis is extremely limited; the result after processing is a simple count of words in predefined categories. Some cognitive and linguistic psychologists argue that a count of words may not capture the complexity of human speech (Iliev, Dehgani & Sagi, 2015; Qiu, Chan & Chan et al., 2018), as there are many other elements to the way we speak other than the words we use (syntax, tone, speech rate, volume, tangentiality, pauses, etc.). It is possible that use of words is not capturing important aspects of social cognition, or that the use of this tool or the word categories we chose are not capturing linguistic differences present in individuals with high schizotypy. Newer methods of automated text analysis, such as the Natural Language Toolkit (NKI; Corcoran et al., 2018) show promise at its use in understanding cognition in the psychosis spectrum.

Lastly, we did not obtain information from participants on languages spoken, country of origin, and race and ethnicity. Cultural, language, and race/ethnicity have been shown to be associated with differences in speech and lexical use (Schrauf & Sanchez, 2004; Ji, Zhang, & Nisbett, 2004). Future studies should obtain more demographic information to determine the influence of cultural differences on word use, as well as how these variables may influence social cognition more broadly.

Overall, while we did not find evidence of broad changes in implicit or explicit social cognitive processing with increasing levels of schizotypy, our study had several strengths. First,

we utilized a full autobiography task, which provided a rich dataset to examine word use with LIWC to understand social cognition. Second, we replicated previous findings that higher schizotypy is associated with using more negative emotional words when discussing one's life story (Najolia, Cohen, & Minor, 2011; Abplanalp, 2017). Thirdly, this is one of the first studies to date to look at dual processing of social cognition in schizotypy as well as to utilize the ACS-SP to examine how different levels of schizotypy are associated with performance on this task. However, this study also has limitations, including the absence of mood and anxiety measures that may have helped to explain the results, the limits of lexical analysis, the measurement of schizotypy, and the overall use of more objective rather than subjective measures of social cognition.

Taken as a whole, it appears as though use of more negative words is associated with higher schizotypy, emphasizing the importance of negative affect in this population. Dual process theory may be a useful framework in understanding social cognition in this population, but perhaps using more subjective rather than objective measures. Future studies of social cognition should further examine the relationship between negative affect and specific aspects of schizotypy as well as in other populations, such as individuals at clinical high risk for psychosis (CHR). Additionally, use of more subjective measures, measuring other psychopathology, examining differences in each factor of schizotypy, as well as other automated text analysis techniques may offer more sensitivity and specificity to study social cognition in schizotypy.

Appendix A

Table 1

Means and Standard Deviations for Study Variables

	M	*SD*
Positive Words	2.32	1.06
Negative Words	1.03	0.65
Social Words	8.52	3.42
Overall Word Count	1468.72	1387.41
ACS Affect Naming	8.42	3.25
ACS Prosody	9.53	2.35
ACS Pairs	9.19	2.70
Age	19.40	2.56
SPQ-BR	65.33	20.20

Table 2

Summary of Hierarchical Regression Analysis for Variables Predicting Schizotypy (N = 101)

	Dependent variable:			
	Schizotypy			
	(1)	(2)	(3)	(4)
Age	-1.430			
	(0.785)			
Gender	3.003			
	(4.197)			
ACS Pairs		-0.102		0.522
		(0.960)		(0.849)
ACS Prosody		0.799		0.395
		(1.144)		(1.004)
ACS Affect Naming		0.391		-0.042
		(0.661)		(0.587)
Positive Words			-2.467	-2.672
			(1.956)	(1.783)
Negative Words			8.155*	7.778*
			(3.397)	(3.021)
Social Words			-0.183	-0.144
			(0.682)	(0.622)
Overall Word Count			-0.0001	-0.0004
			(0.002)	(0.001)
Constant	63.364***	65.327***	65.327***	66.211***
	(3.390)	(2.026)	(1.981)	(1.767)
Observations	101	101	101	98
R^2	0.036	0.015	0.068	0.093
Adjusted R^2	0.017	-0.016	0.029	0.023
Residual Std. Error	20.031 (df = 98)	20.357 (df = 97)	19.904 (df = 96)	17.465 (df = 90)
F Statistic	1.841 (df = 2; 98)	0.482 (df = 3; 97)	1.745 (df = 4; 96)	1.323 (df = 7; 90)
Note:				*p<0.05; **p<0.01; ***p<0.001

Table depicts standardized beta weights and standard errors for each variable predicting schizotypy.

Appendix B

Figure 1

Quantile-Quantile Plot Depicting Sample and Theoretical Quantiles for SPQ-BR Score

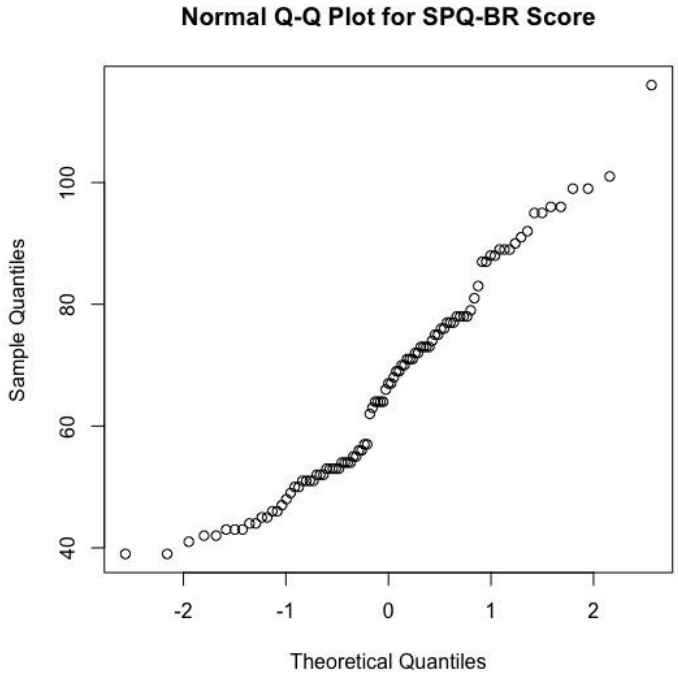


Figure 2

Quantile-Quantile Plot Depicting Standardized Residual Values and Quantiles for Model 4

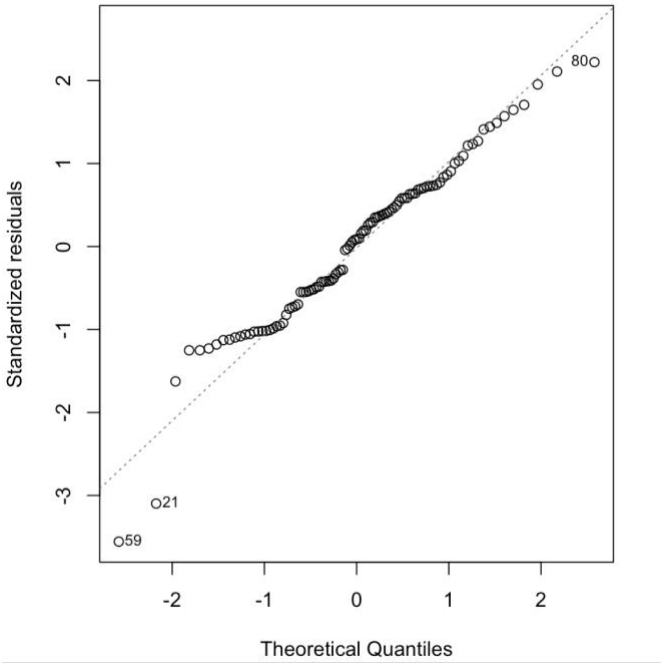
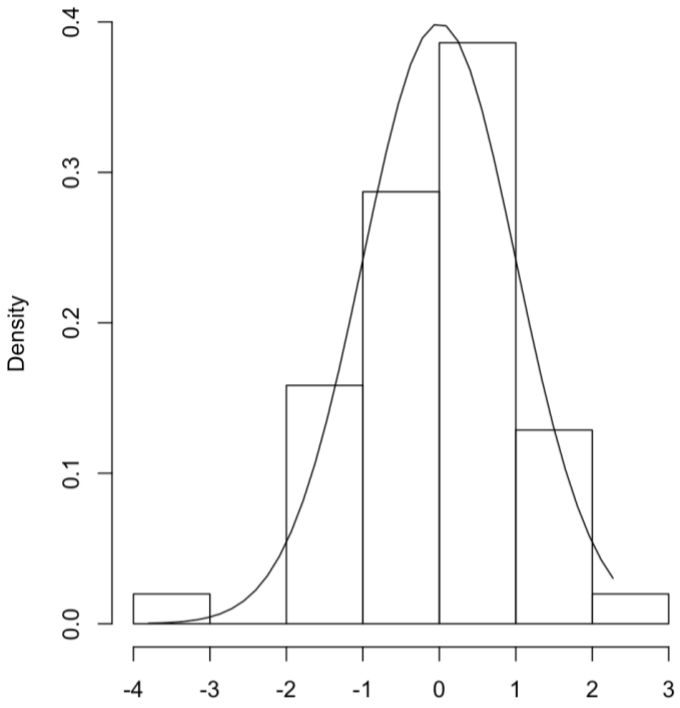


Figure 3

Density Plot of Residual Values for Model 4 and Normal Curve



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Education

M.A., Clinical Psychology (October 2019)
The University of Illinois at Chicago, Chicago, IL

- Advisor: Dr. Ellen Herbener
- Master's thesis: *Implicit and explicit social cognition in schizotypy*
- Preliminary exam: *Neural changes in theory of mind associated with computerized social cognitive training in individuals with schizophrenia*

B.S., Psychology (May 2015)
Arizona State University, Tempe, AZ.

- Cum Laude
- Honors Thesis: *Barriers and facilitators to implementation in state-run systems for serious mental illness: A case study*

Publications, Presentations, and Awards

Publications

1. Kim, D., Lokey, S., & Ling, S. (2017). Elevated arousal levels enhance contrast perception. *Journal of Vision*, *17*(2), 14-20.
2. Vernet, M., Japee, S., Lokey, S., Ahmed, S., Zachariou, V., & Ungerleider, L. G. (2017). Endogenous visuospatial attention increases visual awareness independent of visual discrimination sensitivity. *Neuropsychologia*.
3. Iwanski, C.I., Lokey, S., Galindo, B., Hooker, C.I., & Herbener, E.S. (in prep). Theory of mind across the schizophrenia spectrum.
4. Iwanski, C.I., Lokey, S., Demos, A.P., Herbener, E.S. (submitted). Social judgments impair gambling task performance in individuals with schizophrenia.

Published Conference Abstracts

1. Lokey, S., Japee, S., Baker, C., & Ungerleider, L. (2016). Emotion processing deficits in Moebius Syndrome. *Journal of Vision*, *16*(12), 1256-1256.
2. Kim, D., Lokey, S., Guo, J., Pestilli, F., & Ling, S. (2015). Human visual response gain increases with arousal. *Journal of Vision*, *15*(12), 567-567.

Poster Presentations

1. Lokey, S., Haut, K.M., Lee, A.A., Galindo, B.N., Pridgen, S., Saxena, A., and Hooker, C.I. Changes in the neural theory of mind network associated with computerized social cognitive training in individuals with schizophrenia. *Society for Neuroscience Annual Meeting*. October 2019. Chicago, IL.
2. Lee, A., Lokey, S., Haut, K.M., Pridgen, S., Hooker, C.I. Investigating the relationship between paracingulate sulcus length and verbal source monitoring in individuals at

clinical high risk for psychosis. *Society for Research in Psychopathology Annual Meeting.* September 2019. Buffalo, NY.

3. Lokey, S. B., Huddleston, A., Iwanksi, C.I., Reina, W., Harnisch, N., Gandhi, K., Rameshkumar, S., Lynch, J., and Herbener, E.S. Implicit and explicit social cognition in schizotypy: A lexical and psychometric analysis. *International Consortium for Schizotypy Research Annual Meeting.* May 2019. New Orleans, LA.
4. Lokey, S., Haut, K.M., Lee, A.A., Galindo, B.N., Pridgen, S., Saxena, A., and Hooker, C.I. Neural changes in theory of mind associated with computerized social cognitive training in individuals with schizophrenia. *Society of Biological Psychiatry Annual Meeting*. May 2019. Chicago, IL.
5. Haut, K., Galindo, B., Lee, A., Lokey, S., Nahum, M., & Hooker, C. Changes in Emotion Processing Network Following Social Cognitive Training in Individuals With Schizophrenia. *Society of Biological Psychiatry Annual Meeting.* May 2019. Chicago, IL.
6. Jordan, J., Lokey, S., Baker, C.I., Ungerleider, L.G., & Japee, S.J. Exploring the facial feedback hypothesis in Moebius syndrome. *Society for Neuroscience Annual Meeting,* November 2018. San Diego, CA.
7. Vernet, M., Japee, S, Zachariou, V., Ahmed, S., Lokey, S., Ungerleider, L.G. Visual awareness: the gradual build-up and sharp stabilization of visual percepts. *Society for Neuroscience Annual Meeting,* November 2017. Washington, DC.
8. Japee, S, Lokey, S., Jordan, J., Ungerleider, L.G. Emotion processing in Moebius Syndrome. *Society for Neuroscience Annual Meeting,* November 2017. Washington, DC.
9. Lokey, S., Japee, S., Baker, C., Ungerleider, L.G. Emotion processing in Moebius Syndrome patients. *NIMH Division of Intramural Research Programs Day,* September 2016. Leesburg, VA.
10. Lokey, S., Japee, S., Baker, C., Ungerleider, L.G. Emotion processing in Moebius Syndrome patients. *Society for Neuroscience Annual Meeting,* November 2016. San Diego, CA.
11. Vernet, M., Lokey, S., Japee, S, Ungerleider, L.G. Orienting of endogenous spatial attention can impact subjective awareness more than objective performance. *Society for Neuroscience Annual Meeting,* November 2016. San Diego, CA.
12. Lokey, S., Japee, S., Baker, C., Ungerleider, L. G. (2016). Emotion processing deficits in Moebius Syndrome. *Vision Sciences Society,* May 2016. St. Pete Beach, FL.
13. Lokey, S., Japee, S., Baker, C., Ungerleider, L. G., Emotion processing in Moebius Syndrome. *National Institute of Health Post-Baccalaureate Poster Day.* April 2016. Bethesda, MD.
14. Lokey, S., Mauricio, A., Berkel, C. A case study of barriers to implementation in a state-run organization for serious mental illness. *Academy Health 8th Annual Conference on the Science of Dissemination and Implementation.* December 2015. Washington, D.C.

Fellowships/Grants

National Science Foundation – Graduate Research Fellowship Program recipient. Spring 2019.

Title: *Prefrontal cortex and its role in emotion regulation: An electrocorticography and direct cortical electrical stimulation study*

Talks

Enhancing diversity and inclusion in our psychology community. *University of Illinois at Chicago Clinical Psychology Brown Bag Series.* October 2019.

The effect of reward on the visual system. *CELEST Summer Undergraduate Program at Boston University.* August 2014.

Awards

Outstanding Poster Award at NIH Post-Baccalaureate Poster Day, May 2016 — "Emotion processing in Moebius syndrome".

Teaching Experience

Teaching Assistant, Community Psychology Lab, Spring 2019
Department of Psychology, the University of Illinois at Chicago

- Created and graded course assessments

Teaching Assistant, Personality Psychology, August 2017- Fall 2018
Department of Psychology, the University of Illinois at Chicago

- Created and graded course assessments

Teaching Assistant, Introduction to Psychology, August 2017-May 2018
Department of Psychology, the University of Illinois at Chicago

- Prepared lectures and class activities teaching a wide variety of psychology-related topics
- Created and graded course assessments

Professional Service

Co-Chair, Diversity Advancement Committee Student Advisory Board (DAC-SAB), May 2018-Present

- Co-created a graduate-undergraduate psychology mentorship program, with the goal of encouraging more UIC undergraduates to pursue academic careers
- Assisted with setting requirements for a new diversity statement from prospective faculty members and graduate students
- Organized a biannual diversity colloquium, during which speakers from the community and across the country speak about diversity-related topics and hold a discussion with faculty, staff, and students
- Led a new initiative to spread use of resources through the National Center for Faculty Development and Diversity (NCFDD), aimed at professional development for underrepresented students and faculty
- Planned social events for students from underrepresented backgrounds and allied students and faculty