SCHIZOTYPAL TRAITS AND PATTERNS OF VISUAL FIXATIONS ON SELF AND STRANGER FACES

By

Ashley Cheyanne Myers, B.S., B.A.

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Committee Members:

Katherine Rice Warnell, Chair

Jennifer Clegg

Kristen Tooley

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DEDICATION

I dedicate this thesis to my family who have supported me throughout my education.

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I would like to acknowledge my graduate advisor, Dr. Katherine Warnell, and thank her for helping me with this process. I would also like to acknowledge the Social Cognition and Development Lab for helping me collect data.

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ABSTRACT

Schizophrenia is a long-term mental illness that involves altered social perceptions, including altered self-awareness. Past research has found that individuals with schizophrenia show slower and less accurate self-face recognition and look at faces differently than neurotypical individuals. Further, individuals high on schizotypal traits show diminished fixation on the eyes of strangers. To date, however, no study has examined the relationship between schizotypal traits and attention to one's own face. Thus, in the current study, 52 undergraduate college students completed a measure of schizotypal traits designed to capture variability in the typical population. We also collected eye-tracking data while participants viewed photographs of themselves and of strangers in two emotional states: neutral and happy. We did not find any correlations between number of eye fixations and level of schizotypal traits for self or stranger faces in either emotional state. Although we did not find a relationship between schizotypal traits and patterns of visual attention to faces, our findings still contribute to the literature for understanding face processing in clinical and non-clinical populations, potentially suggesting that subclinical traits are not related to altered social attention. Future research should examine larger samples and a wider variety of emotional expressions to better understand the relations between schizophrenia, schizotypal traits, and visual attention.

I. INTRODUCTION

Humans are social beings who rely on face processing, including decoding familiar and unfamiliar faces, in order to interact socially. Thus, if one was unable to process faces accurately, it could drastically hinder sociability and be a key indicator for possible cognitive dysfunctions (Pascalis et al., 2011; Marwick & Hall, 2008). Schizophrenia is a psychiatric disorder that involves altered social perceptions, but little is known about how people with schizophrenia and schizophrenia spectrum disorders look at faces compared to healthy controls (Darke et al., 2013).

Schizophrenia and Face Recognition

A majority of past research on face processing has examined typically functioning participants, resulting in relatively less literature about how people with schizophrenia and similar disorders process faces. Schizophrenia is defined as a long-term mental illness where one is out of touch with reality (Kircher et al., 2007). There are positive symptoms (hallucinations, delusions, and disorganized speech) and negative symptoms (anhedonia, avolition, and apathy) of schizophrenia; however, it is still unclear if there is a relationship between symptom type and face processing. In addition, the disruption of cognitive processes (attention, memory, etc.) in schizophrenia may explain why individuals with schizophrenia spectrum disorders have an altered sense of self-awareness (Kircher et al., 2007; Laroi et al., 2007). An important part of self-awareness involves how we process representations of ourselves, such as photographs.

Past research has found that individuals with schizophrenia performed poorly on tasks requiring self-recognition (Phillips & David, 1997; Daprati et al., 1997). Participants had a difficult time labeling self and other facial expressions and

distinguishing between self and other (Daprati et al., 1997; Marwick & Hall, 2008; Martin et al., 2005). For example, patients with schizophrenia who experience hallucinations and delusions were more likely to perceive their hand as belonging to a stranger (Daprati et al., 1997). Moreover, participants with diagnosed schizophrenia showed slower and less accurate self-face recognition than healthy controls (Irani et al., 2006; Kircher et al., 2007). People with schizophrenia were more likely to label their own face as a familiar face or unfamiliar face instead of labeling it as their own face, suggesting a detachment in self-face processing (Irani et al., 2006). To date, however, most of the schizophrenia literature discusses face processing in regard to accuracy or reaction time, but few studies have used eye-tracking to look at participants' eye movements.

Schizophrenia and Eye-Tracking

Eye-tracking is crucial for studying visual attention to faces because it gives us moment-by-moment insight into face processing. According to O'Driscoll, Lenzenweger, & Holzman (1998), identifying dysfunctional scanning patterns is a valid way to detect possible behavioral problems. Fixations are defined as a period of time someone's gaze is relatively still on an area (Hooge & Erkelens, 1997). In healthy adults, when participants are shown faces, they tend to fixate on the eyes, indicating that the eyes are important for face processing (Walker-Smith et al., 1977).

Individuals with schizophrenia do not show the same patterns of visual attention as typical adults. In a recent study, Bortolon et al. (2016) showed participants unfamiliar, familiar, and self faces with neutral expressions for seven seconds and measured fixation number and duration. People with schizophrenia were more likely to fixate outside of the

face, specifically for self faces. Additionally, participants with schizophrenia showed overall longer fixations on the photographs, but, unlike controls, showed no difference between fixation length on the eyes versus other parts of the face. Interestingly, no deficits in explicit facial recognition were found. Gabel et al. (1987) found that patients with more severe positive symptoms of schizophrenia had fewer fixation durations in general than those with negative symptoms. Adding on further, Phillips & David (1997) found participants with positive symptoms of schizophrenia had abnormal scan paths and fixated more on white space (area other than facial features) compared to controls but were equally as accurate at recognizing familiar faces (Phillips & David, 1997). Although patients with positive schizophrenia symptoms had abnormal viewing patterns, negative symptom participants also exhibited some altered scanning behavior (Phillips & David, 1997). Further, altered gaze behavior in schizophrenia is distinct from other similar (e.g. bipolar) disorders (O'Driscoll, Lenzenweger, & Holzman, 1998), suggesting unique underlying mechanisms. Thus, an important question is whether schizophrenic traits—as opposed to the categorical disorder—might also relate to abnormal face scanning and poor self and other face recognition.

Schizotypy and Face Recognition

Although schizophrenia is often considered a categorical disorder (i.e., one has a diagnosis or does not), schizotypal traits--a personality disorder characterized by severe social anxiety, strange behavior, unusual beliefs, and paranoia (Raine, Lencz, & Mednick, 1995; Chan et al., 2019)--can be measured on a continuum in the general population. Schizotypal Personality Disorder is one spectrum of schizophrenia (Laroi et al., 2007). Other spectrums of schizophrenia are schizoaffective disorder,

schizophreniform, delusional disorder, and brief psychotic disorder. Schizotypal personality disorder is classified as a Cluster A Personality Disorder in the DSM V, and it occurs within 10% of the population (Callaway et al., 2014). It is very similar to schizophrenia because both conditions present with odd social behaviors, disorganized speech, strange beliefs, and paranoid ideations (Lewandowski et al., 2006). Schizophrenia, on the other hand, has symptoms of hallucinations and delusions whereas schizotypy does not experience psychotic episodes (Torgersen et al., 2001).

Although Schizotypal Personality Disorder is a clinical diagnosis, it can also be measured at the trait level. These traits cluster along several dimensions: interpersonal concerns, cognitive perceptual issues, and disorganized thought. Within interpersonal, there are three subtypes: social anxiety, constricted affect, and no close friends. Cognitive perceptual has subtypes of suspiciousness/ideas of reference, unusual perceptions, and magical thinking. Lastly, disorganized has traits of eccentric behavior and odd speech (Cohen et al., 2010). Past research has shown that there is a strong neurobiological and cognitive overlap between schizotypy and schizophrenia, indicating they operate similarly in the brain (Chan et al., 2019). There are different questionnaires to measure schizotypy in a non-clinical sample. One of the most popular scales is the Schizotypal Personality Questionnaire (SPQ) (Raine, 1991). This questionnaire is designed to assess the three main factors of schizotypal traits: interpersonal, disorganized, and perception (Raine, 1991).

Similar to schizophrenia, participants with schizotypal traits experience more of a challenge recognizing faces than healthy controls. For instance, Laroi et al. (2007) discovered non-clinical participants who scored high on cognitive-perceptual and

disorganized schizotypy dimensions had a harder time recognizing self and other faces. Interestingly, there was no relationship between high interpersonal schizotypy scores and recognizing self or other faces (Laroi et al., 2007). This finding suggests certain dimensions of schizotypy are more related to face processing than other dimensions (Laroi et al., 2007). Platek & Gallup (2002) performed a study where they showed participants with high schizotypal traits a sequence of photos of themselves and strangers. The participants were told to hit a button whenever they saw their own face. They found that those who scored higher than 21 on the Schizotypal Personality Questionnaire (SPQ) had a slower reaction time compared to participants who scored lower on the SPQ for the face recognition task. Relatives of patients with schizophrenia were more accurate at recognizing self, familiar, and unfamiliar faces compared to participants with schizophrenia, but controls were the best at recognizing the three types of faces (Irani et al., 2006). Given the genetic components of schizophrenia, these findings may indicate that even broader traits interfere with face processing. This finding illustrates that even a non-clinical sample of people with schizotypal traits show some impairment in face processing (Platek & Gallup, 2002).

Schizotypy and Eye-Tracking

There is limited eye-tracking research examining links between schizotypal traits and visual attention to faces. A study by Hill, Eaton, & Pake (2016) had 30 non-clinical undergraduate students observe a blank screen for one second followed by a random stranger face for two seconds. After the participants observed the photograph for two seconds, there was a blank screen for one second and then a photograph with two faces on it. The participants were required to pick the face that matched with the previous face.

The team found a negative correlation between schizotypal scores and fixation time on the eyes (Hills, Eaton, & Pake, 2016). Correspondingly, there was a positive relationship with schizotypy and fixation time on the chin and cheeks. They did not find a significant correlation between facial recognition and time fixating on each region of the face (Hills, Eaton, & Pake, 2016).

Outside of attention to faces specifically, Siever et al. (1990) found schizotypal personality disorder patients and schizophrenia patients had more impaired eye-tracking (measured by how accurate they were at watching a pendulum swing back and forth) compared to those with non-schizophrenic disorders and healthy controls. This finding suggests schizophrenia spectrum disorders are more related to scanning deficiencies compared to other disorders such as bipolar disorder. In another study, 55 participants took a schizotypy questionnaire and completed a smooth pursuit eye tracking task and an antisaccade task (O'Driscoll, Lenzenweger, & Holzman, 1998). Participants who scored high on the schizotypes scale had a lower percentage correct on the antisaccades task compared to the controls, indicating possible dysfunction of the frontal lobe. No previous studies of schizotypy, however, have examined visual attention to one's own face.

Unusual Perceptions

Unusual perceptions are a core component of schizotypy. Within the Schizotypal Personality Questionnaire-Brief Revised (SBQ-BR; Cohen, 2010), there are three higher order factors: Cognitive Perceptual, Interpersonal, and Disorganized. The cognitive perceptual factor is made up three lower order factors: ideas of reference/suspiciousness (e.g. thinking everyone is looking at you), magical thinking (e.g. being superstitious) and unusual perceptions (e.g. mistaking noises for voices). The cognitive perceptual factor is

most associated with positive symptoms of schizotypy (Davidson, Hoffman, & Spaulding, 2016; Barrantes-Vidal et al., 2013). Unfortunately, there are very few studies exploring the relationship between unusual perceptions and face processing in people with schizotypal traits. However, Laroi et al. (2007) performed a study where they had 170 non-clinical participants take the Self-Face Recognition Questionnaire (SFRQ) and the Schizotypal Personality Questionnaire (SPQ) to see if there was a relationship between schizotypal traits and face recognition. They found certain schizotypal traits correlated with three self-face recognition factors. Cognitive perceptual and disorganized higher order schizotypal factors correlated with difficulties recognizing self faces, unusual perceptions of self and stranger faces, and issues recognizing stranger faces (Laroi et al., 2007).

Additionally, a study by Martin et al. (2005) had 20 patients with schizophrenia and 20 controls. Both sets of participants completed two tasks. The first task had participants identify whether the two faces shown displayed the same emotion, and the second task required them to report if the two faces were the same person. It was reported that people with schizophrenia performed worse than controls on both facial processing tasks, and there was a negative correlation between errors on face/emotion matching and severity of negative symptoms (e.g. constricted affect). On the contrary, Phillips & David (1997) found participants with positive symptoms of schizophrenia had more fixations outside the face compared to those with negative symptoms or no symptoms of schizophrenia. Therefore, more research on unusual perceptions and schizotypal traits needs to be conducted to determine the relationship between the two variables.

Social Anxiety

Social anxiety is a key characteristic of schizotypy (Lewandowski et al., 2006) and may affect how participants processes self and stranger faces. Claudino et al. (2019) conducted a meta-analysis looking at the relationship between eye-tracking and social anxiety broadly. They concluded that participants with social anxiety disorder (SAD) avoided areas of the face, especially the eyes, when witnessing negative expressions such as fear and anger. Not only that, participants had fewer and shorter eyes, nose, and mouth fixations. However, this phenomenon only occurred in person and not in virtual reality (Claudino et al., 2019).

To our knowledge, only one study has examined face processing and social anxiety in the context of schizotypal traits. This study found those who scored high in social anxiety on the Schizotypal Personality Questionnaire (SPQ) had reduced accuracy on a facial affect recognition task (Abbott & Green, 2012). Therefore, in addition to investigating schizotypal traits generally, investigating relations between social anxiety and face processing may also be informative.

Emotional Processing

Research has suggested people with schizophrenia have a harder time interpreting emotion which results in social difficulties (Marwick & Hall, 2008). Currently, all facial recognition and eye-tracking studies in schizophrenia that have examined self-processing (i.e., looking at one's own face) have used photographs with neutral expressions. However, there is substantial literature examining how emotional processing is altered in those with schizophrenia. Brown & Cohen (2010) showed people with schizotypal personality disorder and healthy controls pictures of people displaying a variety of

emotions. The subjects were instructed to rate the emotion on a 1-5 Likert scale ranging from strongly disagree to strongly agree. Participants with schizotypy defined the facial expressions less accurately than the controls. Interestingly, participants with schizotypy found distinguishing neutral expressions as most challenging. Not only that, those who had higher disorganized schizotypal scores were more likely to rate the emotion as negative (Brown & Cohen, 2010). Compared to participants with schizoaffective disorder and healthy controls, schizophrenia patients performed the worst when asked to distinguish between expressions of happy and fear (Chen et al., 2012). In another study, Strauss et al. (2010) discovered people with schizophrenia were worse at discriminating and labeling facial expressions than those without a clinical diagnosis of schizophrenia. Similar to Brown & Cohen (2010), Strauss et al. (2010) revealed participants with schizophrenia more accurately labeled negative facial expression than positive, happy emotions.

An eye-tracking study found that individuals with schizophrenia and schizoaffective disorder were equally as likely to fixate on emotional faces than neutral faces (Jang et al., 2016). However, the schizophrenia and schizoaffective group showed diminished fixations when a negative emotion was displayed. People who showed more positive symptoms of schizophrenia avoided looking at angry faces and participants with more depressive symptoms avoided fixating on angry faces (Jang et al., 2016). Another study had patients with schizophrenia participate in an Emotion in Context task, finding that people with schizophrenia had a decrease in affect recognition compared to controls (Sasson et al., 2016). Thus, evidence shows people with schizophrenia process facial

expressions differently, but more research needs to be conducted to determine if facial emotion impacts visual attention to self-photographs in schizophrenia.

Gaps in the Literature

Overall, there are multiple gaps in our knowledge of how traits related to schizophrenia influence visual attention to faces. Few existing studies have employed eye-tracking. Tracking eye movements can provide more insight on how and why people on the schizophrenia spectrum process faces differently. In particular, there is a lack of literature on schizotypy and patterns of visual fixations on self and stranger faces, especially self faces. There is also little research on how social anxiety, unusual perceptions, and how the emotion displayed on the face relates to face processing in people with high schizotypal traits.

To close these gaps, I looked at the relationship between schizotypal traits and visual attention to self vs stranger faces. In this study, participants were eye-tracked while looking at photos of themselves and a stranger. Given potential influences of emotion on visual attention (Germine & Hooker, 2010; Eisenbarth & Alpers, 2011), both smiling and non-smiling (i.e., neutral) photographs were presented for both images of the self and images of strangers. I recruited non-clinical college participants, looking at the schizotypal spectrum broadly. Schizophrenia spectrum disorders show up in early twenties for men and late twenties for women, which makes college students an important age range (Häfner, 2003). Additionally, studying a non-clinical sample was beneficial because we did not have to test for confounds such as antipsychotic use, chronic psychosis, and long-term hospitalization (Chan et al., 2019). Research has shown that self-report rating of schizotypy appear to be consistent with clinical diagnoses and

using a self-report schizotypal questionnaire is effective for identifying schizotypal personality traits (Chan et al., 2019).

Although eye-tracking studies yield rich data about attention to many parts of the face, I decided to focus on attention to the eyes. Schizotypy is associated with deficits in visual processing. Researchers have found that people with schizophrenia and similar disorders have abnormal eye movements, and that is one explanation as to why they have trouble decoding faces (Hills, Eaton, & Pake, 2016). The eyes are important for research because they provide valuable information about a person. The eyes provide subtle cues about how someone is feeling and people's mental states (Emery, 2000). In addition, a key characteristic of schizotypy is social anxiety and lack of close friends. Because past research has found a relationship between eye avoidance in individuals with higher social anxiety, we decided focusing on the eyes would provide the most robust results (Claudino et al., 2019).

Hypotheses

I have formed five hypotheses. My first two hypotheses relate to how overall schizotypal traits influence eye looking. I predict that participants who score higher on schizotypal traits would have fewer eye fixations on photographs of themselves displaying a neutral expression than participants with lower schizotypy scores. I also predict that this correlation will be stronger than the correlation between schizotypal traits and eye fixations on neutral photographs of strangers. Although past research has shown that participants with schizophrenia spent a longer amount of time looking at self faces when asked if they recognized the person (Irani et al., 2006), eye-tracking research has found that during passive viewing, participants with schizophrenia showed more fixations

outside the face when looking at self-pictures as compared to familiar or unfamiliar others (Bortolon et al., 2016). Thus, I predicted that schizotypal traits would be more strongly related to scanning one's own face.

My third and fourth hypotheses relate to the specific subscales of the Schizotypal Personality Questionnaire-Brief Revised. I predict that participants who score high on the social anxiety portion will have fewer fixations on the eyes of both themselves and strangers. I also predict that participant scores on the unusual perception portion of the Schizotypal Personality subscale will be negatively related to the number of fixations at the eyes.

My final hypothesis was that the difference in eye fixations between self-smiling and self-neutral faces would be negatively related to scores on the SPQ-BR. That is, participants with higher levels of schizotypal traits would show less discrimination in visual attention based on facial emotion, consistent with findings of generally flatter affect and difficulty processing emotions in schizophrenia.

II. METHOD

Participants

This study was approved by the local Institutional Review Board. Sixty-five college students between the ages of 18-32 years of age (M = 19.91, SD = 2.33) participated in the study, but after excluding six for poor quality eye-tracking data, three for no eye-tracking data, three for failing an attention check, and one who had poor eye-tracking data and failed an attention check, we had a total of 52 participants. There were eight males and 44 females. Due to restrictions on collecting in-person data, I was unable to recruit more male participants. Twenty-two of the students were Caucasian, 10 were African-American, 13 were Hispanic, one was Asian-American, and six were Mixed Race. All participants had normal or corrected-to-normal hearing and vision. Participants were recruited through two avenues. First, participants were recruited via the Texas State human subject pool associated with introductory psychology. Second, participants were recruited directly from classes and participated for extra credit.

Procedure

When the participants arrived at the lab, they received a consent form outlining the study, including the benefits and potential risks. They were required to read over and sign the form before beginning the experiment. Next, the participants took a pre-assessment survey which included demographic measures such as ethnicity, age, race, and gender. Participants then completed the eye-tracking and behavioral measures detailed below. The entire duration of the experiment was approximately 30-45 minutes.

Eye-Tracking Setup

Upon arrival in the lab, participants completed a 20-minute eye-tracking paradigm. Participants sat 25” from a 22” computer monitor, on which an SMI REDn was mounted to the bottom of the screen. Before viewing experimental stimuli, participants completed a 5-point calibration, followed by a 4-point validation. Participants repeated this process before viewing the second block of eye-tracking stimuli, described below. If the eye-tracker calibration error was higher than 1.00 degrees for the left or right eye, we would repeat the calibration process two more times to try to receive a calibration less than 1.00 degrees. If we were unable to calibrate the eye-tracker, we excluded the data. Additionally, data which were excessively jumpy or unstable were excluded, which was operationalized via participants who had fewer than 60% usable data (i.e., fixations). In total, we excluded seven participants for poor or non-existent eye-tracking data.

Eye-Tracking Stimuli

Before beginning eye-tracking, we took two photos of each participant: one smiling and one neutral. Participants sat in a chair against a white wall while we took photographs of them from the chest up. Participants were approximately three feet away from the camera. Afterwards, we cropped the photos to mostly show their face and the tops of the shoulders, similar to a passport photo. After initial calibration, participants viewed each photo for 30s. The order of the emotions was always the same (neutral followed by smiling). After viewing the photographs of themselves, participants answered questions about various social and cognitive variables outside the scope of this thesis. No eye-tracking data were collected during these questionnaires.

We then began the second block of eye-tracking data collection. We calibrated participants again and showed them photographs of strangers, each presented for 30 seconds. Each stranger photo was similar in composition to the self-photos as they depicted individuals against a white background from the shoulders up. The stranger photos were cropped to be the same size as the participants' photos. There were three female photographs and three male photographs. Of the female photographs, one was Caucasian, Indian-American, and African-American. For the three male photographs, one was Caucasian, Asian-American, and African-American. Each stranger was presented as smiling and not smiling, for a total of 12 photographs. In between each photograph participants saw a black cross in the middle of the screen to direct their attention. The order of these photos was randomized. Two participants did not provide eye-tracking data for the stranger faces, but their data is still included in analyses of viewing images of oneself.

Eye-Tracking Analysis

For the stranger and self-photographs, we created ovoid areas of interest (AOIs) corresponding to the eyes, mouth, nose, and whole face. BeGaze eye-tracking software was used to obtain the percent dwell time and number of fixations for each participant on each of these AOIs. Our specific analysis was focused on visual attention to one's own eyes and strangers' eyes. We had two dependent variables: dwell time and number of fixations. Dwell time is defined as the percentage of time spent looking at a particular AOI out of total fixation time (Becker, 2011), while number of fixations is the number of times the participants fixated on a particular AOI (Eckstein et al., 2017). Thus, a participant who stared only at the eyes for the full 30s a photograph was on screen would

have dwell time percentage of 100% on that AOI, but a fixation count of only 1. In contrast, a participant who darted back and forth between the eyes and the mouth would have a lower dwell time on the eyes AOI, but a much higher fixation count (Bortolon et al., 2016; Russell et al., 2008). For the stranger faces, I averaged these two variables across all faces showing the same emotion (i.e., smiling and neutral) to create a composite average fixation number and dwell time number. My main hypotheses relate to the number of fixations on the eyes, but I will also calculate total dwell time on the eyes and outside the face for potential exploratory follow-up analyses.

Schizotypal Trait Measurement

After completing both eye-tracking blocks, the participants completed a final set of questionnaires which included the main behavioral questionnaire used in this project: The Schizotypal Personality Questionnaire-Brief Revised (SPQ-BR; Cohen, 2010). The SPQ-BR is a 32 question self-report questionnaire. The SPQ-BR has a wider range of schizotypy traits compared to past measurements (Callaway., 2014). The questionnaire is intended for adults and each item is answered on a 5-point Likert Scale, varying from strongly disagree to strongly agree. Scores can range from 32 to 160. This questionnaire is current and has well-established validity and reliability (Davidson, Hoffman, & Spaulding, 2016; Callaway et al., 2014; Cohen et al., 2010; Fonseca-Pedrero et al., 2017). The SPQ-BR produces variability in typical populations and is correlated with a variety of traits and behaviors, including social anxiety, constricted affect, close friendships, and magical thinking.

In addition to producing a composite score, the SPQ-BR has several subscales which are of particular interest here. The scale produces three higher order factors:

Cognitive Perceptual, Interpersonal, and Disorganized. Within the Cognitive Perception order, there are four subfactors: Ideas of Reference, Suspiciousness, Magical Thinking, and Unusual Perceptions. The Interpersonal higher order has three subfactors: No Close Friends, Constricted Affect, and Social Anxiety. The Disorganized order has two subfactors: Eccentric Behavior and Odd Speech. For this project, I hypothesize that the Unusual Perceptions and Social Anxiety scales will be most closely related to eye-looking because past research has revealed there is a disruption of cognitive processes in people with schizophrenia spectrum disorders (Kircher et al., 2007). Unusual Perceptions are most likely to be linked to eye looking because other researchers have noted that deluded patients have abnormal scanning behaviors (Phillips & David, 1997). Likewise, I predict people who score high on Social Anxiety will fixate less on the eyes because they are more nervous (Claudino et al., 2019). Thus, I will calculate total scores and also the scores for the two subscales of interest (social anxiety and unusual perception).

III. RESULTS

Both our eye-tracking and schizotypy measures produced a wide range of performance (Table 1). We first examined our eye-tracking variables. Patterns of visual attention were relatively consistent across stimulus type, such that the number of fixations to the eyes in one condition (e.g., self neutral) were correlated with fixations to the eyes for another stimulus type (e.g., stranger neutral). All interstimulus correlations were significant (rs>.38, ps<.01). We next examined the influence of stimulus type on fixation to the eyes in a 2 (self, stranger) x 2 (smile, neutral) repeated measures ANOVA. We found a significant effect of identity ($F(1,49)=6.12$, $p=.017$) and emotion ($F(1,49)=24.45$, $p<.001$), as well as an interaction ($F(1,49)=16.98$, $p<.001$), such that eye fixations were elevated when viewing a neutral photograph of oneself as compared to the other three conditions (Figure 1).

Table 1. Descriptive Statistics for Study Variables.

Variables	Mean	St. Dev	Min	Max
Age	19.96	2.32	18	32
Total SPQ-BR Score	89.31	16.98	57	135
Social Anxiety	12.21	3.73	4	20
Unusual Perceptions	9.88	2.86	4	17
Eye Fixations: Self Neutral	17.96	7.02	6	35
Eye Fixations: Self Smiling	13.73	5.91	3	26
Eye Fixations: Stranger Neutral	13.99	7.08	2	35.67
Eye Fixations: Stranger Smiling	13.40	6.92	2	33.50

Note: This table shows the descriptive statistics for each variable. Schizotypal traits, social anxiety, and unusual perception were retrieved using the Schizotypal Personality Questionnaire Brief-Revised (SPQ-BR; Cohen, 2010). The range of possible scores for the SPQ-BR were 32-160. Two participants did not provide eye-tracking data for the stranger condition.

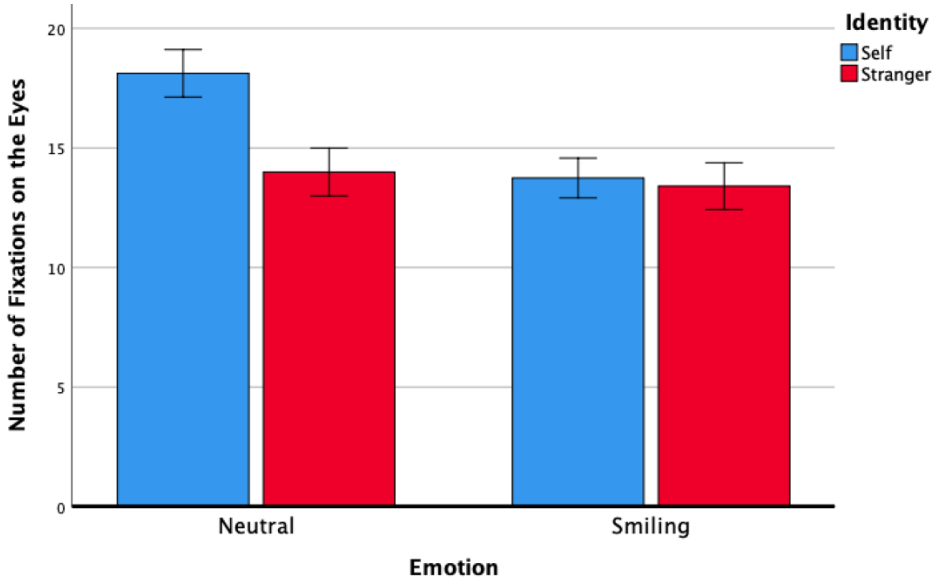

Figure 1. Effects on Facial Identity and Emotion on Eye Fixations.
Note: The main effects of emotion and identity were significant (*p*s<.05) as was their interaction (*p*<.001).

The first hypothesis was SPQ-BR scores would be negatively related to the number of eye fixations on the neutral self-photograph. We tested this hypothesis by using a Pearson correlation. Results showed a negative correlation, but it was not significant, $r(48)= -0.157$, $p = 0.268$. For the second hypothesis, a Pearson correlation was used to examine the link between total SPQ-BR scores and the number of eye fixations on the neutral stranger photograph, averaged across all stranger photographs. Results again showed a negative non-significant correlation, ($r(50) = -0.198$, $p = 0.168$). These two correlations were not significantly different from each other (z=.264, p=.792).

For the third and fourth hypothesis, we examined relations specifically with the social anxiety and unusual perception subscales. Although these two scales measured very different constructs, they were correlated ($r(50)$=.419, p=.002). For the third hypothesis, we calculated scores on the social anxiety subscale and ran two correlations. First, we examined relations between this subscale and the number of eye fixations on the neutral self-photo. Results showed a negative correlation, but it was not significant, ($r(50) = -0.129$, $p = 0.362$). Next, we examined relations between the social anxiety subscale and the number of eye fixations on the neutral stranger photo (averaged across all stranger photos). Results showed another negative correlation, ($r(50) = -0.203$, $p = 0.157$). As we predicted, the correlations were not significantly different from each other (z=.475, p=.635). The pattern was the same for the unusual perception subscale, which was not significantly correlated with fixations on neutral self ($r(50)$=-.017, p=.906) or neutral stranger ($r(48)$=-.140, p=.333) eye regions. Again, these relations were not significantly different from each other (z=.779, p=.436).

For our final hypothesis, we created a difference score by subtracting the number of eye fixations to the neutral self-photograph from the number of eye fixations to the smiling self-photograph. We took the absolute value of this difference, such that smaller values indicated smaller differences between the two conditions. Given difficulties with emotion processing in schizophrenia, we predicted that those higher on the SPQ-BR total will show smaller differences between the two conditions, resulting in a negative correlation. Results showed a negative correlation, but again it was not significant, $r(50) = -0.177$, $p = 0.210$.

Finally, we conducted exploratory analyses examining two different dependent measures: fixation time on the eyes and fixation time on the regions outside the face. None of the relations between these measures and the social anxiety subscale, unusual perceptions subscale, or the total schizotypal trait scale were significant (rs<.17, ps>.25).

IV. DISCUSSION

The goal of the proposed study was to understand if schizotypal traits in a non-clinical sample were related to visual attention to self and stranger faces. Past studies of schizotypal traits have looked at the reaction time to recognizing self and stranger faces and tracked eye movements on stranger faces but have not examined visual attention to one's own face. Literature from individuals with schizophrenia suggests that attention to self-photographs may be uniquely impacted, but this question has not been examined at the trait level. In this study, we did not find relations between schizotypal traits and visual attention to the eyes in either stranger or self faces.

Before examining relations with schizotypal traits, we first examined the eye-tracking data. We found that eye-looking was strongly correlated across stimulus type, indicating that certain participants tend to fixate more on the eyes than other participants. This is consistent with research showing developmental consistency in looking patterns across different types of stimuli (Constantino et al., 2017) and increases confidence in the robustness of our measures. In spite of these stable individual differences, we still found significant effects of emotion and identity on eye fixations, as well as a significant interaction, driven by participants' increased fixations on the eyes when viewing a neutral photograph of themselves. The exact mechanism driving this finding is unclear. Other literature suggests that mouth fixations increase when viewing happy expressions (Einsbarth & Alpers, 2011), but this does not explain the lack of difference between happy and neutral expressions for the stranger faces. Future studies could involve participants rating the relative happiness displayed by each stranger face to see if that influenced mouth fixation time (which tends to be inversely related to eye fixation time).

Our first two hypotheses—that schizotypal traits (as measured by the SPQ-BR) would be negatively related to the number of eye fixations to both the neutral self and neutral stranger photographs—were not supported by the data. Both correlations were negative, but non-significant. This finding is surprising, given past research regarding eye-tracking individuals with schizophrenia. There are several potential explanations for our null results.

First, we may have simply lacked the power to find significant relations. Our in-person data collection was stopped due to COVID-19, which prevented us from increasing our sample, specifically of males. Ideally, we would prefer to have the same number of male and female participants to be able to generalize our findings to a broader population. Research has said that males tend to be at a higher risk for developing severe schizophrenia and similar disorders (Castle & Murray, 1991) while females are more likely to develop bipolar or other mood disorders (Payne, 2003). One possible explanation for our null findings is that schizotypal traits are higher in males and that the relations between eye-tracking data and schizotypy are only significant in males (Castle & Murray, 1991). Unfortunately, we did not have the power to test this possibility, as we only had eight males in our sample. Future work should include larger samples with even numbers of males and females to test gender as a moderator. In our sample, males were not significantly different than females on their total schizotypy score. However, increasing the male sample size in the future might lead to more conclusive results.

In addition to the limited size and gender representation of our sample, most of our participants were psychology majors or freshmen taking an Introduction to Psychology course. It is possible that students familiar with concepts from

psychopathology may answer questions on the schizotypal scale differently. Additionally, Introduction to Psychology classes typically have students around the ages of 18-19. Because schizophrenia and similar disorders emerge in early or late twenties (Häfner, 2003), our results may be different with a wider age range. Expanding our sample to have an equal distribution of all majors and ages would be more representative.

Another explanation for our null correlation between schizotypal traits and eye fixations is that we did not have a clinical population. Relations between schizophrenia and eye-tracking may simply not replicate in a population with low levels of schizotypal traits. Further, having a clinical population would provide new information for people living with schizophrenia. Past studies have found more eye-tracking impairments in clinical samples of schizotypal personality disorder and schizophrenia compared to healthy controls (Siever et al., 1990; Lencz et al., 1993; Keefe et al., 1989). Another study by Keefe et al. (1997) found similar results to us. They looked at eye-tracking deficits in nonpsychotic relatives of patients with schizophrenia who also had some schizotypal personality traits. Although participants showed some traits of schizotypy, the researchers did not find a correlation between schizotypal symptoms and eye tracking deficiencies in participants who were related to someone with schizophrenia (Keefe et al., 1997).

We also found null results for our third and fourth hypotheses relating to specific subscales of the SPQ-BR, potentially due to a combination of some of the same general reasons (e.g., low sample size), as well as measure-specific issues. In testing our third hypothesis, we found that social anxiety and eye fixations were not correlated. This may be our most surprising null result, given robust previous literature (e.g., Abbott & Green,

2012; Claudino et al., 2019), including studies which have examined sub-clinical populations. This null finding may be driven by the scale we used, which is a subscale of the SPQ-BR, rather than a scale designed specifically to capture subclinical anxiety (e.g., the Social Anxiety Scale for Adults; Caballo, Salazar, Irurtia, et al., 2010). Another reason we might not have found a significant relationship is because looking at photographs might not be realistic enough. A more naturalistic stimuli such as videos or real people instead of photographs might have produced more conclusive data. Past research has found that virtual reality might not capture social anxiety. For instance, people with social anxiety looked at strangers' eye more online than they did in person (Claudino et al., 2019).

Our final hypothesis involved looking at the difference between the two self photographs (self-smiling and self-neutral) to determine if larger differences in eye fixations between the emotions would be related to lower SPQ-BR scores. We developed this hypothesis because neurotypical adults alter their scan patterns depending on facial emotion (Einsbarth & Alpers, 2011) and we hypothesized adults with more schizotypal traits would adjust their scan patterns less. However, we did not find a significant relationship between visual sensitivity to emotion and schizotypy. One potential explanation for this null finding is that self-photographs were always presented with neutral followed by smiling while the stranger photos were completely random (due to experimental questions outside the scope of this thesis). Thus, a comparison of smiling and neutral faces is confounded with experimental order. Another potential issue is that we only looked at two types of emotions- smiling and neutral. It would have been interesting to include other emotions such as sadness or anger, especially since past

research has found that schizotypal participants with high social anxiety looked less at the eyes of people exhibiting negative emotions (Claudino et al., 2019).

Another broader explanation for the null findings of the current study is that eye fixations were too simplistic a measure to capture the dynamics of facial scanning. Although our exploratory analyses also found null relations with percent dwell time, it is possible that the temporal dynamics of gaze are most informative in schizotypy (e.g., where did participants look for the first three seconds versus the last three seconds). Faces were presented for thirty seconds each, which is longer than some past studies, and different windows of analysis may produce different results. More detailed analyses could also look at the stranger faces separately, given evidence for effects of race and gender on face scanning patterns (e.g., Man & Hills, 2016; Wu, Laeng, & Magnussen, 2012).

Future research should also implement a facial recognition task. Past research on schizophrenia has typically included a behavioral test in addition to collecting eye-tracking data (Phillips & David, 1997; Daprati et al., 1997). Including a facial recognition task might have been helpful to see if participants are able to recognize self and stranger faces while also distinguishing between different facial expressions. One possibility is that although eye-tracking data was not related to schizotypal traits in this study, such traits would be related to performance on a behavioral test.

Another direction for future work is to consider how theory of mind or executive functions such as working memory play a role in visual attention for people who score high in schizotypal traits. Past research in schizotypal traits have found deficits on theory of mind tasks, mental state attribution tasks, explicit memory and spatial working

memory tasks (Platek & Gallup, 2002), and these impairments might serve as confounds and affect the outcome in our study. For example, relations between schizophrenia and face processing in clinical samples may be driven by differences in theory of mind or executive function—rather than schizophrenia symptoms per se. If this is the case, then our work examining schizotypal traits and face processing would expect to find null results and our future projects should examine these other traits.

In addition, future research should explore visual attention in children and adolescents. Eye-tracking and face processing research could potentially tell us who might be at risk for developing mental health concerns later in life. For example, even though we had null findings, it is possible that at younger ages, those at risk for developing schizophrenia do show differences in processing faces. Potentially by adulthood, our college student sample has developed compensatory mechanisms or strategies such that even individuals with higher schizotypal biases still show typical looking patterns to faces.

Lastly, a majority of the current literature does not disclose if the patients with schizophrenia were taking antipsychotic medications. It would be interesting for future researchers to conduct a study exploring the differences between people with schizophrenia who are medicated and who are not on any antipsychotic medications. One possibility is that those who are on medication would perform better on facial recognition tasks compared to those do not take daily medication for schizophrenia symptoms.

V. CONCLUSION

This study looked at the relationship between schizotypal traits and visual processing of self and stranger faces. Due to the lack of eye-tracking research examining schizotypal traits, this study provided important insight into the social and cognitive mechanisms potentially underlying schizotypy. Although we did not find relations between traits and eye-tracking measures, our findings still contribute a better understanding of face processing in clinical and non-clinical populations, potentially suggesting that subclinical traits are not related to altered social attention.

REFERENCES

Abbott, G.R., & Green, M.J. (2012). Facial affect recognition and schizotypal personality characteristics. *Early Intervention in Psychiatry, 7*(1), 58-63.

Barrantes-Vidal, N., Gross, G.M., Sheinbaum, T., Mitjavila, M., Ballespi, S., & Kwapil, T.R. (2013). Positive and negative schizotypy are associated with prodromal and schizophrenia spectrum symptoms. *Schizophrenia Research, 145,* 50-55.

Becker, S. (2011). Determinants of dwell time in visual search: Similarity or perceptual difficulty? *PLOS One, 6*(3), 1-5.

Bortolon, C., Capdevielle, D., Salesse, R.N., & Rafford, S. (2016). Self-face recognition in schizophrenia: An eye-tracking study. *Frontiers in Human Neuroscience, 10*(3), 1-10.

Brown, L.A., & Cohen, A.S. (2010). Facial emotion recognition in schizotypy: The role of accuracy and social cognitive bias. *Journal of the International Neuropsychological Society, 16*, 474-483.

Caballo, V.E., Salazar, I.C., Irurtia, M.J., Arias, B., Hofmann, S.G. (2010). CISO-A research team measuring social anxiety in 11 countries: Development and validation of the Social Anxiety Questionnaire for Adults. *European Journal of Psychological Assessment. 26*(95), 107.

Callaway, D.A., Cohen, A.S., Matthews, R.A., & Dinzeo, T. (2014). Schizotypal personality questionnaire-brief revised: Psychometric replication and extension. *Personality Disorders, 5*(1), 32-38

Castle, D.J., & Murray, R.M. (1991). The neurodevelopmental basis of sex differences in schizophrenia. *Psychological Medicine, 21,* 565-575.

Chan, C.C., Bulbena-Cabre, A., Rutter, S., Benavides, C., McClure, M.M., Calabrese, W., Rosell, D.R., Koenigsberg, H.W., Goodman, M., New, A.S., Hazlett, E.A., Perez Rodriguez, M.M. (2019). Comparison of self-reported and clinician-rated schizotypal traits in schizotypal personality disorder and community controls. *Schizophrenia Research, 209*, 263-268.

Chen, Y., Cataldo, A., Norton, D., & Ongur, D. (2012). Distinct facial processing in schizophrenia and schizoaffective disorders. *Schizophrenia Research, 134*(1), 95 100.

Claudino, R.G., Soares de Lima, L.K., Bonifacio de Assis, E.D., & Torro, N. (2019). Facial expressions and eye tracking in individuals with social anxiety disorder: A systematic review. *Psychology Research, 32*(9), 1-10.

Cohen, A.S., Matthews, R.A., Najolia, G.M., & Brown, L.A. (2010). Toward a more psychometrically sound brief measure of schizotypal traits: Introducing the SPQ brief revised. *Journal of Personality Disorders, 24*(4), 516-537.

Daprati, E., Franck, N., Georgieff, N., Proust, J., Pacherie, E., Dalery, J., & Jeannerod, M. (1997). Looking for the agent: An investigation into consciousness of action and self consciousness in schizophrenic patients, *Cognition, 65*(1), 71-86.

Darke, H., Peterman, J.S., Park, S., Sundram, S., & Carter, O. (2013). Are patients with schizophrenia impaired in processing non-emotional features of human faces? *Frontiers in Psychology, 4*(529), 1-8.

Davidson, C.A., Hoffman, L., & Spaulding, W.D. (2016). Schizotypal personality questionnaire brief revised (updated): An update on norms, factor structure, and item content in a large non-clinical young adult sample. *Psychiatry Research, 238,* 345-355.

Eckstein, M.K., Guerra-Carrillo, B., Singley, A. T. M., & Bunge, S. A. (2017). Beyond eye gaze: What else can eye tracking reveal about cognition and cognitive development? *Developmental Cognitive Neuroscience, 25,* 69-91.

Eisenbarth, H., & Alpers, G.W. (2011). Happy mouth and sad eyes: Scanning emotional facial expressions. *Emotion, 11*(4), 860-865.

Emery, N. J. (2000). The eyes have it: the neuroethology, function and evolution of social gaze. *Neuroscience & biobehavioral reviews*, *24*(6), 581-604.

Engbert, R., & Kliegl, R. (2003). Microsaccades uncover the orientation of covert attention. *Vision Research, 43*, 1035-1045

Fonseca-Pedrero, E., Cohen, A., Ortuño-Sierra, J., Pérez de Álbeniz, A., & Muñiz, J. (2017). Dimensional structure and measurement invariance of the schizotypal personality questionnaire – brief revised (SPQ-BR) scores across American and Spanish samples. *Journal of Personality Disorders*, *31*(4), 522-541.

Gaebel, W., Ulrich, G., & Frick, K. (1987). Visuomotor performance of schizophrenic patients and normal controls in a picture viewing task. *Biological Psychiatry, 22*, 1227-1237.

Germine, L.T., & Hooker, C.I. (2010). Face emotion recognition is related to individual differences in psychosis proneness. *Psychological Medicine, 41*(5), 937-947.

Goldstein, A. G., & Mackenberg, E. J. (1966). Recognition of human faces from isolated facial features: A developmental study. *Psychonomic Science, 6*, 149-150.

Gooding, D. C. (1999). Antisaccade task performance in questionnaire-identified schizotypes. *Schizophrenia Research, 35*(2), 157–166.

Häfner, H. (2003). Gender differences in schizophrenia, *Psychoneuroendocrinology*, *28*(2), 17-54.

Hessels, R.S., Niehorster, D.C., Nystrom, M., Anderson, R., & Hooge, I.T.C. (2018). Is the eye movement field confused about fixations and saccades? A survey among 124 researchers. *Royal Society Open Science, 5*(8), 1-23.

Hills, P.J., Eaton, E., & Pake, J.M. (2016). Correlations between psychometric schizotypy, scan path length fixations on the eyes and face recognition. *The Quarterly Journal of Experimental Psychology, 69*(4), 611-625.

Hooge, I.T., & Erkelens, C.J. (1997). Adjustment of fixation duration in visual search. *Vision Research, 38*(9), 1295-1302.

Howells, T. H. (1938). A study of ability to recognize faces. *Journal of Abnormal Psychology*, *33*, 124-127.

Jang, S., Kim, S., Kim, C, Lee, H., & Choi, K. (2016). Attentional processing of emotional faces in schizophrenia: Evidence from eye tracking. *Journal of Abnormal Psychology, 125*(7), 894-906.

Keefe, R.S.E., Siever, L.J., Mohs, R.C., Peterson, A.E., Mahon, T.R., Bergman, R.L., & Davis, K.L. (1989). Eye tracking, schizophrenic symptoms, and schizotypal personality disorder. *European Archives of Psychiatry and Neurological Sciences, 239*, 39-42.

Keefe, R.S.E., Silverman, J.M., Mohs, R.C., Siever, L.J., Harvey, P.D., Friedman, L., Roitman, S.E.L., DuPre, R.L., Smith, C.J., Schmeidler, J., & Davis, K.L. (1997). Eye tracking, attention, and schizotypal symptoms in nonpsychotic relatives of patients with schizophrenia. *Archives of General Psychiatry, 54,* 169-176.

Kircher, T.T., Seiferth, N.Y., Plewnia, C., Baar, S., & Schwabe, R. (2007). Self-face recognition in schizophrenia. *Schizophrenia Research*, *94*(1-3), 264-272.

Laroi, F., D'Argembeau, A., Bredart, S., & Van Der Linden, M. (2007). Face recognition failures in schizotypy. *Cognitive Neuropsychology, 12*(6), 554-571.

Lencz, T., Raine, A., Scerbo, A., Redmon, M., Brodish, S., Holt, L., & Bird, L. (1993). Impaired eye tracking in undergraduates with schizotypal personality disorder. *The American Journal of Psychiatry, 150*(1), 152-154.

Lewandowski, K.E., Barrantes-Vidal, N., Nelson-Gray, R.O., Clancy, C., Kepley, H.O., & Kwapil, T.R. (2006). Anxiety and depression symptoms in psychometrically identified schizotypy. *Schizophrenia Research, 83*, 225-235.

Malpass, R. S., & Kravitz, J. (1969). Recognition of faces of own and other race. *Journal of Personality and Social Psychology*, *4*, 330-334.

Martin, F., Baudouin, J., Tiberghien, G., & Franck, N. (2005). Processing emotional expression and facial identity in schizophrenia. *Psychiatry Research, 134*(1), 43 53.

Marwick, K., & Hall, J. (2008). Social cognition in schizophrenia: A review of face processing. *British Medical Bulletin, 88,* 43-58.

McKelvie, S. J. (1976). The role of eyes and mouth in the memory of a face. *The American Journal of Psychology, 89*(2), 311–323.

O'Driscoll, G.A., Lenzenweger, M.F., & Holzman, P.S. (1998). Antisaccades and smooth pursuit eye tacking and schizotypy. *Archives of General Psychiatry, 55*(9), 837 843.

Pascalis, O., Vivies, X., Anzures, G., Quinn, P.C., Slater, A.M., Tanaka, J.W., & Lee, Kang. (2011). Development of face processing. *Cognitive Science, 2*(6), 666-675.

Payne, J.L. (2003). The role of estrogen in mood disorders in women. *International Review of Psychiatry, 15*, 280-290.

Phillips, M.L., & David, A.S. (1997). Abnormal visual scan paths: A psychophysiological marker of delusions in schizophrenia. *Schizophrenia Research, 29,* 235-245.

Platek, S.M., & Gallup, G.G. (2002). Self-face recognition is affected by schizotypal personality traits. *Elsevier Science, 57,* 81-85.

Raine, A. (1991). The SPQ: A scale for the assessment of schizotypal personality based on DSM-III-R criteria. *Schizophrenia Bulletin, 17*(4), 555–564.

Russell, T.A., Green, M.J., Simpson, I., & Coltheart, M. (2008). Remediation of facial emotion perception in schizophrenia: Concomitant changes in visual attention. *Schizophrenia Research, 103,* 248-256.

Sasson, N.J., Pinkham, A.E., Weittenhiller, L.P., Faso, D.J., & Simpson, C. (2016). Context effects on facial affect recognition in schizophrenia and autism: Behavioral and eye tracking evidence. *Schizophrenia Bulletin, 42*(3), 675-683.

Siever, L. J., Keefe, R., Bernstein, D. P., Coccaro, E. F., Klar, H. M., Zemishlany, Z., Peterson, A. E., Davidson, M., Mahon, T., Horvath, T., & Mohs, R. (1990). Eye tracking impairment in clinically identified patients with schizotypal personality disorder. *The American Journal of Psychiatry, 147*(6), 740–745.

Strauss, G.O., Jetha, S.S., Ross, S.A., Duke, L.A., & Allen, D.N. (2010). Impaired facial affect labeling and discrimination in patients with deficit syndrome schizophrenia. *Schizophrenia Research, 118,* 146-153.

Torgersen, S., Edvardsen, J., Oien, P.A., Onstad, S., Skre, I., Lygren, S., & Kringlen, E. (2001). Schizotypal personality disorder inside and outside the schizophrenic spectrum, *Schizophrenia Research, 54,* 33-38.

Walker-Smith, G. J., Gale, A. G., and Findlay, J. M. (1977). Eye movement strategies involved in face perception. *Perception*6, 313–326.

Yin, R. K. (1970). Face recognition by brain-injured patients: a dissociative ability? *Neuropsychologia, 8*, 395-402.