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People with Schizophrenia Do Not Show the Normal Benefits of Social Versus Nonsocial Attentional Cues

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Abstract

Objective: Schizophrenia is associated with impairments in social motivation. Social attention has been proposed as an underlying mechanism for social motivation. However, studies in schizophrenia have rarely examined social attention, and none of these studies examined the effects with rapidly presented stimuli.

Method: The current study examined whether individuals with schizophrenia have reduced social attention and whether reduced social attention was related to social motivation deficits (measured with the Clinical Assessment Interview for Negative Symptoms; CAINS) and decreased social functioning (Role Functioning Scale; RFS). Thirty-seven outpatients with schizophrenia and 29 healthy participants completed a gaze cueing task with directional social cues (eye gaze) and nonsocial cues (arrows) at varying stimulus onset asynchronies.

Results: As predicted, schizophrenia participants had reduced social attention relative to nonsocial attention, compared with healthy participants. Healthy participants were quicker to respond to social cues than nonsocial cues, but schizophrenia participants did not exhibit this same pattern. Schizophrenia participants showed higher accuracy when targets appeared in the same location as a directional cue (i.e. congruency) for nonsocial, but not social, cues. Contrary to expectations, reduced social attention was not significantly correlated with clinically rated social motivation deficits or decreased social functioning in the schizophrenia group.

Conclusion: These findings provide evidence for social attention deficits in schizophrenia, but without a clear mapping of its influence on social motivation.

Keywords

schizophrenia; social orienting; gaze cueing; social attention; social motivation

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1. Introduction

Schizophrenia is associated with disturbances in social motivation, such as a diminished interest in social interaction and a reduced desire for close interpersonal relationships (Bleuler, 1911). Despite evidence that social motivation is a critical determinant of poor social functioning (Blanchard, Mueser, & Bellack, 1998; Milev, Ho, Arndt, & Andreasen, 2005), little is known about the underlying causes of these impairments (Lee & Green, 2016; Green et al., 2018; Fulford, Campellone, & Gard, 2018). Social attention has been proposed as a mechanism of social motivation in other disorders (see Chevallier et al., 2012) and may similarly contribute to social motivation deficits in schizophrenia. Social attention broadly refers to the attentional processes involving social information, including orienting to social cues. Social attention can be observed in how people orient to gaze cues. During social interactions, people detect gaze shifts from their social partners, orient their own attention to the gazed location, and use the gaze information to make inferences about their partner’s goals and intentions (Nummenmaa & Calder, 2009). Failure to orient attention to gaze cues may result in unsatisfactory interactions, and over time, individuals may be less likely to initiate social contact (social approach) and/or may be more likely to isolate from others (social avoidance) (Gable & Gosnell, 2013).

The gaze cueing paradigm (Friesen & Kingstone, 1998; Langton & Bruce, 1999), an adaptation of the spatial cueing paradigm (Posner, 1980), has been the primary method to study social orienting. In these tasks, automatic shifts of attention are triggered by a brief presentation of directional, central cues. Participants respond to peripheral targets that are spatially in the same location as indicated by the cue (congruent) or in the opposite direction (incongruent). Faster reaction times (RTs) and more accurate performance on congruent trials compared with incongruent trials indicate attention shifts to the cued location. In healthy samples, the congruency effect is often evident for both social and nonsocial cues, even under conditions when the cues do not predict the target location (Frischen, Bayliss, & Tipper, 2007). Arrows are commonly selected as nonsocial directional cues and they are quite potent (Brignani et al., 2009; but also see Friesen & Kingstone, 1998, 2003a). Congruency effects can also be impacted by the time interval between the onset of the cue and the onset of the target (i.e., the stimulus onset asynchrony; SOA). The congruency effect fades after approximately 300ms and reverses at longer SOAs due to inhibitory effects (i.e., the inhibition of return; IOR); Posner, Rafal, Choate, & Vaughan, 1985; Frischen, & Tipper, 2004).

There are two distinct attention systems in the brain (Corbetta & Shulman, 2002; Corbetta et al., 2008). The dorsal network involves voluntary, effortful attention that is goal-driven (i.e., “top-down”). This network is organized bilaterally and includes the medial intraparietal sulcus (IPS; a region of the posterior parietal cortex between the superior parietal lobule and supramarginal gyrus), and the inferior frontal junction (IFJ; a region in the posterior lateral frontal cortex, with the frontal eye fields) (Vossel et al., 2014). The ventral network involves reflexive, reorienting of attention that is stimulus-driven (i.e., “bottom-up”). This network is right lateralized and includes the temporal parietal junction (TPJ), anterior cingulate cortex (ACC), and anterior insula (AI) (Vossel, et al., 2014). In spatial cueing tasks, the ventral network is involved in attention reorienting after targets appear in unexpected locations.

Importantly, social and nonsocial cues appear to involve similar neural mechanisms, although different studies show varying degrees of overlap (see Joesph et al., 2015; Callejas et al., 2014; Lockhofen et al., 2014; Engell et al., 2010; Hietanen et al., 2006).

Despite well-documented deficits on effortful attention tasks, schizophrenia participants have an intact ability to reflexively orient their attention on spatial cueing tasks with nonsocial cues. For example, there is a reaction time and accuracy advantage on congruent trials compared with incongruent trials, indicating that there is increased attentional processing at cued locations compared to uncued locations (Luck & Gold, 2008). It is possible that people with schizophrenia hyperfocus, meaning they more narrowly focus their attention on cued locations compared with healthy individuals (Luck et al., 2019; Spencer et al., 2011).

Direct investigations specifically of social attention in schizophrenia have been scarce. Only a handful of studies have used the gaze cueing paradigm. Some studies found intact social orienting in schizophrenia (Langdon et al., 2006, 2016; Magnée, et al., 2011; Seymour et al., 2017), whereas other studies found decreased social versus nonsocial orienting compared with healthy individuals (Akiyama et al., 2008; Dalmaso, et al., 2013). Discrepant findings likely reflect differences in methodological factors, including the social cues (i.e., schematic drawings versus photographs), trial presentations (i.e., block designs versus event-related designs), and comparison conditions (or lack thereof). Overall, these methodological differences make findings on social orienting in schizophrenia challenging to meaningfully interpret.

Moreover, previous studies on social attention in schizophrenia had some key limitations. In real life, gaze cues from others are fleeting. People must quickly orient their attention in response to rapid gaze shifts to detect what the person was looking at. Of the studies that used the gaze cueing paradigm (Akiyama et al., 2008; Magnée, et al., 2011; Dalmaso et al., 2013; Seymour et al., 2017; Langdon et al., 2006, 2016), none of them fully captured the rapid nature of changing social cues for a few reasons. First, in all of these studies, cues were presented for a relatively long time (up to 800 ms), which does not mimic real world conditions. Second, these studies presented the target at the same time as the cue, but in real life people see the cue and target in succession. These design features do not approximate natural conditions for rapid orienting of social attention and, thus, limit conclusions that can be drawn.

Another gap in our knowledge about social attention in schizophrenia is that we do not know how gaze cue orienting is related to real-world social motivation or functional outcome. In the literature on healthy individuals, social attention is discussed as a behavioral manifestation of social motivation. That is, individuals preferentially attend to social information over nonsocial information (Langton et al., 2008), and this preference is evident early in life (Farroni et al., 2004; Gluckman, & Johnson, 2013). However, no studies to our knowledge with healthy samples have directly examined whether social attention is related to motivated social behavior in the real world. In schizophrenia, several gaze cueing studies examined clinician-rated negative symptoms, which include social motivation, but no studies found evidence of an association with social orienting (Seymour et al., 2017;

Langdon et al., 2006, 2016). Of note, these studies used negative symptom measures that did not parse the unique contribution of motivational versus expressive deficits (Blanchard & Cohen, 2006; Horan et al., 2011). No studies to our knowledge have examined the impact of social attention on broader social functioning in schizophrenia.

The aims of the current study were three-fold. First, we examined group differences in people with schizophrenia and healthy participants in orienting to directional social and nonsocial cues, using an adaptation of the gaze cueing paradigm. We hypothesized that individuals with schizophrenia would exhibit less orienting to social versus nonsocial cues, compared with healthy participants. Second, we examined several different SOA's to explore group differences in the time course of orienting to social and nonsocial cues. Third, we examined whether poorer social attention measured by the task was related to social motivation deficits and decreased social functioning in schizophrenia.

2. Methodology

2.1 Participants

The sample included 37 clinically stable, chronic outpatients with schizophrenia and 29 healthy participants. Schizophrenia participants were recruited from outpatient clinics at University of California Los Angeles (UCLA), the Veterans Affairs Greater Los Angeles Healthcare System (GLA), and local board and care facilities in Los Angeles. Diagnosis was established with the Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (SCID-5) (First et al., 2015). All clinical interviewers were trained through the Treatment Unit of the VA VISN 22 MIRECC to a minimum intra-class correlation coefficient (ICC) of 0.80. All schizophrenia participants were on a stable medication regimen of constant doses and types for at least six weeks, and all were taking antipsychotic medication.

Healthy participants were recruited from website advertisements. Healthy participants were screened with the SCID-5 and were excluded if they met criteria for a schizophrenia-spectrum personality disorder (including avoidant, paranoid, schizotypal, or schizoid personality disorders), psychotic disorder, bipolar disorder, and recurrent major depressive disorder. Healthy participants were also excluded for a family history of a psychotic disorder among their first-degree relatives. All participants denied clinically significant neurological disease (e.g., epilepsy), history of serious head injury (i.e., loss of consciousness more than 15 minutes), developmental disability, severe or moderate substance use disorder in the past 3 months, and current mood episode. All participants were between the ages of 20 and 60.

The Institutional Review Boards at UCLA (IRB 14–000557, titled "Social Preference System and Social Cognition in Schizophrenia") and GLA (PCC 2015–080841 titled "Social Preference System and Social Cognition in Schizophrenia") approved the protocol. All participants were evaluated for the capacity to give informed consent before providing written informed consent. Participants received financial compensation for their participation.

2.2 Clinical Symptoms, Nonsocial Cognition, and Social Cognition

Doctoral-level raters completed clinical assessments. Interview training was conducted through the Treatment Unit of the Department of Veterans Affairs VISN 22 Mental Illness Research, Education, and Clinical Center. Brief descriptions of each measure are included below.

The Clinical Assessment Interview for Negative Symptoms (CAINS) (Kring et al., 2013) is widely used to assess negative symptoms in two domains: motivation and pleasure (MAP; 9 items) and expression (EXP; 4 items) (Blanchard & Cohen, 2006; Horan et al., 2011). Each item is rated by an interviewer on a scale ranging from 0 to 4 with higher scores reflecting greater impairment during the previous week. The MAP subscale is based on motivation, interest, and reported engagement in relevant social, vocational, and recreational activities. The EXP subscale is based on interviewer ratings of affective and verbal expression. In the current study, the CAINS-MAP was used to measure motivation and pleasure.

The 24-item expanded version of the Brief Psychiatric Rating Scale (BPRS) (Overall & Gorman, 1962; Ventura et al., 1993) was used to assess psychiatric symptoms. The presence and severity of each symptom was rated on a scale ranging from 1 (not present) to 7 (extremely severe). The BPRS generates a total score and four subscale scores based on a factor structure derived by Kopelowicz and colleagues (2008), including positive symptoms, negative symptoms, agitation/mania, and depression/anxiety.

The Role Functioning Scale (RFS) (Goodman, Sewell, Cooley, & Leavitt, 1993) was used to assess functional status. It is based on a semi-structured interview with the participant and includes subscales for work/school, independent living, family relations, and social functioning. The ratings range from 1 (severely impaired functioning) to 7 (optimal functioning). Each subscale provides anchored descriptions for all levels of functioning in that domain.

The gaze cueing task requires general cognitive skills (e.g., attention/vigilance, processing speed, and working memory). Hence, the MATRICS Consensus Cognitive Battery (MCCB) (Nuechterlein & Green, 2006) was administered to characterize the cognitive status of the patient sample and to evaluate their comparability to other clinically-stable outpatients with schizophrenia. The MCCB has gone through extensive review and a detailed selection process (Nuechterlein et al., 2004; Green et al., 2004). The MCCB includes ten tests to measure seven domains of cognition: speed of processing, attention/vigilance, working memory, verbal learning, visual learning, reasoning and problem solving and social cognition. Here we report Neurocognition Composite, which includes all of the nonsocial domains, and the Social Cognition domain score.

2.3 Gaze Cueing Task

Participants performed a version of gaze cueing task with nonsocial cues and social cues (see Figure 1). The two cue types were selected to be relatively similar in terms of shape, size, and amount of detail. At the beginning of each trial, participants were alerted with a blinking fixation cross for 400 ms. Then, the fixation cross became stationary and two empty placeholder boxes were presented on the left and right side of the screen for 700 ms. The cues were presented in the center of the screen at the location of the fixation cross for 150 ms. Directional cues pointed to the right or left, whereas non-directional cues did not point in either direction. Then, the target (an "X") appeared in one of the two boxes. Cue-to-target SOA's were presented at 150, 250, 350, and 750 ms. Cues were uninformative such that the direction of the cue was consistent with the target location on half of the trials (i.e., congruent) and inconsistent on the other half (i.e., incongruent). Participants were instructed to focus their attention on the center of the screen for the entire time and to respond as quickly and accurately as possible when the target (an "X") appeared on the screen. Participants were not made aware of the cues, nor were they informed that the cues were non-predictive of target location. Similar to other gaze cueing tasks, there were some non-directional (i.e. direct eye gaze) cues that were not relevant to the goals of this paper and were not part of the analyses.

The task was programmed using E-prime (Psychology Software Tools). Participants completed 15 practice trials before completing the main task. There were a total of 448 trials divided into two blocks in which cue type presentation was randomized within each block. There were fewer total non-directional trials (64) compared with congruent and incongruent trials (192 each). All conditions (cue type, SOA, and cue congruency) were counter balanced and presented in a random order. Participants were provided breaks as needed. Performance feedback was not provided.

2.4 Data Analysis

Anticipations (RTs < 100 ms), timed-out trials reflecting lapses in concentration (RTs > 1,000 ms), and incorrect responses were classified as errors. RT cutoffs were chosen a priori based on previous research using similar paradigms with healthy participants (Hayward & Ristic, 2013) and schizophrenia participants (Akiyama et al., 2008). Accuracy rates and mean RTs (correct trials only) were computed for each cue type (social, nonsocial), cue congruency, and cue-target SOA per participant. Participants were considered outliers and were removed from subsequent analyses if they had a high overall error rates (> 2 standard deviations below the sample mean, defined as 20% errors). A total of 1 healthy participant and 3 schizophrenia participants were excluded based on these criteria. The final sample is reflected in Table 1.

One-way ANOVAs and chi-squares were used to test for differences between schizophrenia and healthy groups in demographic characteristics. Normality of reaction time and accuracy data was evaluated using Shapiro-Wilk tests (Shapiro &Wilk, 1965). Main analyses were conducted in two steps. First, a 2 (group) x 2 (cue type: social, nonsocial) x 4 (SOA: 150, 250, 350, 750 ms) x 2 (cue congruency: congruent, incongruent) repeated-measures analysis of variance (rm-ANOVA) was conducted separately with accuracy rates and mean RTs. Second, Pearson's correlations were conducted to examine the relationship between social attention bias on the task, clinically rated social motivation (from the CAINS-MAP), and social functioning (from the RFS). A social attention bias score was computed for each participant to index the extent to which social cues captured attention relative to nonsocial cues (mean RTs nonsocial trials [congruent and incongruent] – mean RTs social trials [congruent and incongruent]). A positive score reflects that social cues captured attention more than nonsocial cues.

3. Results

As shown in Table 1, the groups did not significantly differ in age, and were comparable in race and gender distribution. The schizophrenia group had lower personal education levels, but the groups did not differ in parental education. Additionally,the schizophrenia group performed significantly worse than the healthy group on the MCCB Neurocognitive Composite at roughly 1 standard deviation below the mean of the normative sample for this battery (Kern et al., 2008; 2011). This level is similar, though slightly less impaired, than what is typically seen in clinical trials of clinically-stable outpatients with schizophrenia (see Keefe et al., 2011), suggesting that their performance on the task is likely generalizable to other outpatient samples of schizophrenia. Mean RTs and accuracy rates for each group and condition are presented in Table 2.

3.1 Reaction Times

After truncating the data to eliminate outliers (i.e., excluding trials < 100ms and > 1,000ms), no statistically significant deviations from normality were found for either group or cue type (i.e., social versus nonsocial). There were significant main effects of congruency, $F_{1, 64} = 52.141$, $p < .001$, $\eta_p^2 = .449$, SOA, $F_{3, 192} = 52.162$, $p < .001$, $\eta_p^2 = .449$, and group, $F_{1, 64} = 8.856$, $p = .004$, $\eta_p^2 = .122$. There were also significant interaction effects of congruency x cue type, $F_{1, 64} = 8.725$, $p = .004$, $\eta_p^2 = .120$, congruency x SOA, $F_{3, 192} = 8.089$, $p < .001$, $\eta_p^2 = .112$, and group x cue type interaction effect, $F_{1, 64} = 4.299$, $p = .042$, $\eta_p^2 = .063$.

Across samples, the main effect of congruency was because RTs were faster on congruent trials than incongruent trials. This main effect was qualified by the significant congruency x cue type interaction. Paired-samples *t*-tests showed the difference between congruent and incongruent RTs was greater for nonsocial cues ($M = 25.47$, $SD = 30.58$), $t(65) = 6.768$, $p < .001$, Cohen's $d = .846$, than social cues ($M = 14.17$, $SD = 21.72$), $t(65) = 5.30$, $p < .001$, Cohen's $d = .658$. Additionally, the main effect of SOA was because RTs were faster for longer SOA's than shorter SOA's. This main effect was qualified by the significant congruency x SOA interaction. Pairwise comparisons revealed that, on congruent trials, RTs were faster on the three later SOAs compared to the shortest SOA (150 ms), $F_{3, 62} = 40.484$, $p < .001$, $\eta_p^2 = .662$, and on incongruent trials, RTs were significantly faster with each increase in SOA, $F_{3, 63} = 41.007$, $p < .001$, $\eta_p^2 = .665$.

Between samples, schizophrenia participants had slower overall RTs than healthy participants. As shown in Figure 2, this main effect was qualified by the significant group x cue type interaction. Paired-samples *t*-tests showed that healthy participants had faster RTs for social cues ($M = 455.648$, $SD = 74.138$) compared with nonsocial cues ($M = 460.411$, $SD = 72.834$), $t(28) = -2.151$, $p = .040$, Cohen's $d = .400$, whereas schizophrenia participants had similar RTs for both cue types (social: $M = 525.358$, $SD = 96.564$; nonsocial: $M = 523.640$, $SD = 94.170$), $t(36) = .797$, $p = .430$, Cohen's $d = .132$. The significance is due, in part, to high correlations between reaction times on social and nonsocial trials (r's > .90 for each group). The fact that social and nonsocial trials were interspersed and not administered in blocks helps to account for the high correlations. No other effects were significant.

3.2 Accuracy Rates

We found significant departures from normality for both groups due to high performance (*p's*< .01). An arcsine transformation did not significantly normalize the distributions. The task was designed to be relatively easy, so the high levels of performance were expected from both groups. There were significant main effects of congruency, $F_{1, 64} = 7.365$, $p =$ .009, $\eta_p^2 = .103$, and group, $F_{1, 64} = 8.856$, $p = .004$, $\eta_p^2 = .122$, and significant interaction effects of group x congruency, $F_{1, 64} = 7.759$, $p = .007$, $\eta_p^2 = .108$, and group x cue type x congruency, $F_{1, 64} = 5.921$, $p = .018$, $\eta_p^2 = .085$.

Across samples, the main effect of congruency was because there were higher overall accuracy rates on congruent trials than incongruent trials. Between samples, healthy participants (*M* = .975, *SD* = .040) had higher overall accuracy than schizophrenia participants (*M* = .937, *SD* = .058). As shown in Figure 3, the three-way interaction was because schizophrenia participants had a significant cue type x congruency interaction, $F_{1, 36} = 4.887$, $p = .034$, $\eta_p^2 = .120$, but healthy participants did not, $F_{1, 28} = 2.118$, $p = .157$, $\eta_p^2 = .070$. Paired-samples *t*-tests showed that schizophrenia participants were more accurate on congruent trials (*M* = .946, *SD* = .056) than incongruent trials (*M* = .922, *SD* = .072) with nonsocial cues, $t(36) = -3.622$, $p = .001$, Cohen's $d = .599$, but not for social cues (congruent: *M* = .942, *SD* = .060; incongruent: *M* = .938, *SD* = .061), $t(37) = -.794$, $p =$ .433, Cohen's $d = .132$. Healthy participants were highly accurate overall (> 96% on average across all conditions). No other effects were significant.

3.3 Correlations with social attention, and clinically rated social motivation and social functioning in the schizophrenia group

We examined associations between social attention, social motivation, and social functioning in the schizophrenia group. There were no significant correlations between the social attention bias score, social motivation (CAINS-MAP), or social functioning (RFS) in the schizophrenia group (all *r*'s < .216, *p*'s > .198).

4. Discussion

The present study investigated social versus nonsocial attention in schizophrenia using an adaptation of the gaze cueing paradigm. Our paradigm was designed to capture the rapidity of changing social stimuli as they occur in face-to-face interactions. These real world conditions were approximated by using brief stimulus presentations and varying cue-to-target SOAs. The results were generally supportive of our hypothesis regarding this paradigm, and indicated that schizophrenia participants had decreased social attention relative to nonsocial attention, compared with healthy participants. With regard to reaction times, healthy participants responded relatively faster to social cues compared with nonsocial cues, whereas schizophrenia participants did not exhibit this pattern. With regard to accuracy rates, the schizophrenia participants showed a congruency effect for nonsocial but not for social cues. Healthy participants did not show a congruency effect for accuracy for either cue type, likely because they performed close to ceiling due to the easy nature of the task. Hence, the interaction for accuracy is not easily interpretable. Although schizophrenia participants had slower overall reaction times and less accuracy than healthy participants, the effects of SOA were comparable across groups with both cue types. Further, we did not find significant associations between reduced social attention and social motivation or social functioning in the schizophrenia sample.

Our interpretation of the reaction time results is based on two significant 2-way interactions. First, the group by cue type interaction showed that healthy participants gathered information more quickly from social cues compared with nonsocial cues (irrespective of its direction), but schizophrenia participants did not show this advantage. The 3-way interaction (group by cue type by congruency) was not significant. As shown in Figure 2, our effect was very subtle, likely because social and nonsocial reaction times were highly correlated (r's > .90 within both groups, as the trials were interspersed). It is unclear whether such a small reaction time difference has meaningful real-world consequences. However, the results suggest that healthy adults have a social preference (Farroni et al., 2004; Gluckman, & Johnson, 2013; Langton et al., 2008), but patients do not (Lee & Green, 2016).Humans attend to social over nonsocial information because it is essential to inform our behavior in everyday interactions (Nummenmaa & Calder, 2009). The primary findings from this study come from reaction time data instead of accuracy. Because the task was designed to minimize cognitive demands for the schizophrenia sample, the accuracy data were very high and that made it difficult to determine whether healthy participants had an advantage for social versus nonsocial cues.

Second, there was a significant cue type by congruency 2-way interaction. Results indicated that there was a larger congruency effect for nonsocial cues than social cues, suggesting the nonsocial cues were more potent and difficult to overcome. In this study, the directional cues were non-informative for target location and were therefore irrelevant to the goal of the task (i.e., to respond quickly and accurately to the target). In fact, the best strategy to maximize performance was to ignore the directionality of the cue as much as possible. It was not the goal of the study to match the potency of the two cue types (see Brignani et al., 2009), as we were primarily interested in group effects and interactions. Nonetheless, we acknowledge that our social cues were visually impoverished and may be less potent than real world social cues. It needs to be determined whether the current finding can be replicated with more ecologically valid and potentially more potent social cues. It will be useful to use dynamic stimuli, such as videos of people moving their eyes towards or away from the participant, that capture the natural conditions for rapid orienting of social attention (Pfeiffer, Vogeley, & Schilbach, 2013).

Here, we show that the selective attention bias towards social cues over nonsocial cues may not be present to the same extent in schizophrenia. The next step is to examine the cause(s) of reduced social attention in schizophrenia. Reduced social attention, as measured by reaction times and accuracy rates, may stem from aberrant stimulus encoding, decision-making, and/or response preparation/execution (Ratcliff, Smith, Brown, & McKoon, 2016). Neurophysiological indices may be valuable to provide a more fine-grained assessment of social attention. For example, previous studies have employed pupillometry (van der

Wei & van Steenbergen, 2018), electroencephalography (Wascher & Tipper, 2004), and eye-tracking (Mansfield et al., 2003) to systematically parse impairments in attentional processes.

We expected that social attention would be related to social motivation in schizophrenia, but we did not find evidence of that association. There are several possible explanations for this lack of association. First, the gaze cueing paradigm captures reflexive orienting of attention that is stimulus-driven (“bottom-up”) (Vossel et al., 2014). The task does not capture goal-driven, or deliberate efforts to attend to specific aspects of one’s social environment (“top-down”) (Vossel et al., 2014), which also influences social motivation. For instance, people who desire close relationships voluntarily direct their attention towards positive social cues (e.g., smiling expressions) that signal social approach (Hayward, Pereira, Otto, & Ristic, 2017). For these individuals, positive social cues are given attentional priority because they are associated with rewarding outcomes (e.g., social connection).

Alternatively, it is possible that we did not find an association between social attention and social motivation because we measured social motivation with a clinician-rated interview. Clinician-rated interviews provide a cross-sectional snapshot of social motivation based on the patients’ retrospective self-report. Other measures, such as digital phenotyping via smartphones, collect active (Ecological Momentary Assessment [EMA]) and passive (Global Positioning System measures of mobility in the community) indices of real-world social behaviors that may be highly informative (Onnela, & Rauch, 2016; Torous, Onnela, & Keshavan, 2017). Digital phenotyping can provide a more fine-grained, ecologically valid assessment of social motivation in real time than what is available on clinical interviews (see Torous et al., 2018).

There are several limitations of the current study. First, the generalizability of our results is limited because the sample was chronically ill people with schizophrenia. It is not known whether we would find similar results in the early course of the illness. Second, our results were obtained from a task that included simplistic social stimuli. Social cues in the real world are more complex—they are exchanged through reciprocal interaction, and influenced by the surrounding context (Cañigueral, & Hamilton, 2019). Third, our social and nonsocial cues were not matched on low-level visual features—they were only roughly comparable in terms of shape, size, and amount of detail. Thus, our results may be confounded by differences in visual complexity between the two different cue types. Lastly, as we did not assess eye movement, we are not sure where participants were looking during the task, so it is possible they made eye movements prior to target onset (Friesen, & Kingstone, 2003b; Chica, Bartolomeo, & Lupiáñez, 2013). Despite these limitations, the current results add to the sparse literature on social attention in schizophrenia, and provide new findings about social attention deficits in the context of rapidly changing social cues.

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Public Significance Statement:

Individuals with schizophrenia exhibit impaired social motivation, which interferes with social connections and everyday social functioning. Here, we examined social attention, a proposed mechanism of social motivation. Our study found evidence of reduced social attention to rapidly changing social cues (eye gaze shifts) in schizophrenia, although we did not find correlates with social functioning in the real world.

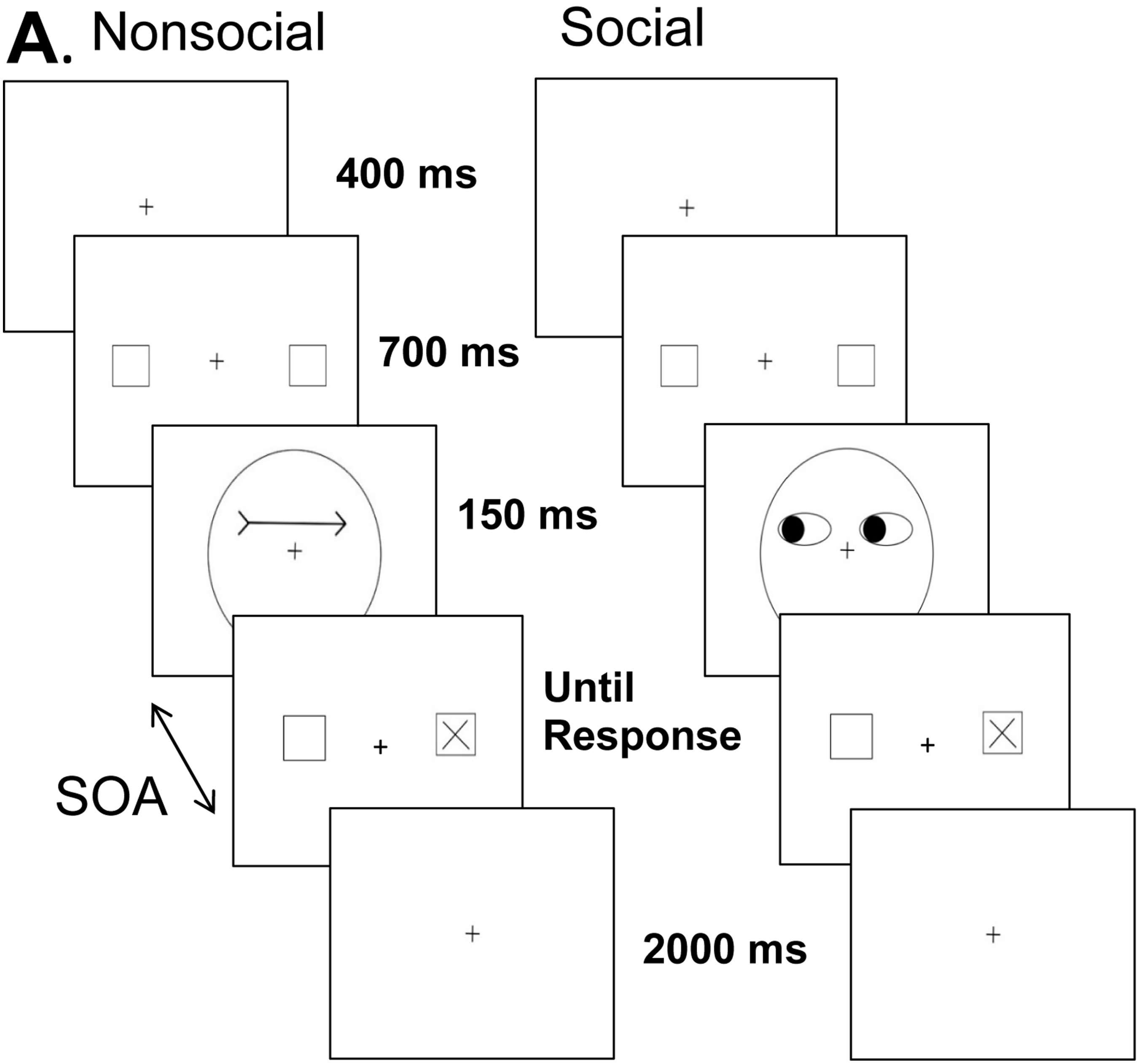

Figure 1.
Spatial cueing task. After each cue, participants were asked to identify the location of a target presented on the right or left side of the screen. Targets were spatially in the same location as indicated by the cue (congruent) or in the opposite direction (incongruent). Cue-to-target stimulus onset asynchronies (SOA's) were presented at 150, 250, 350, and 750 ms.

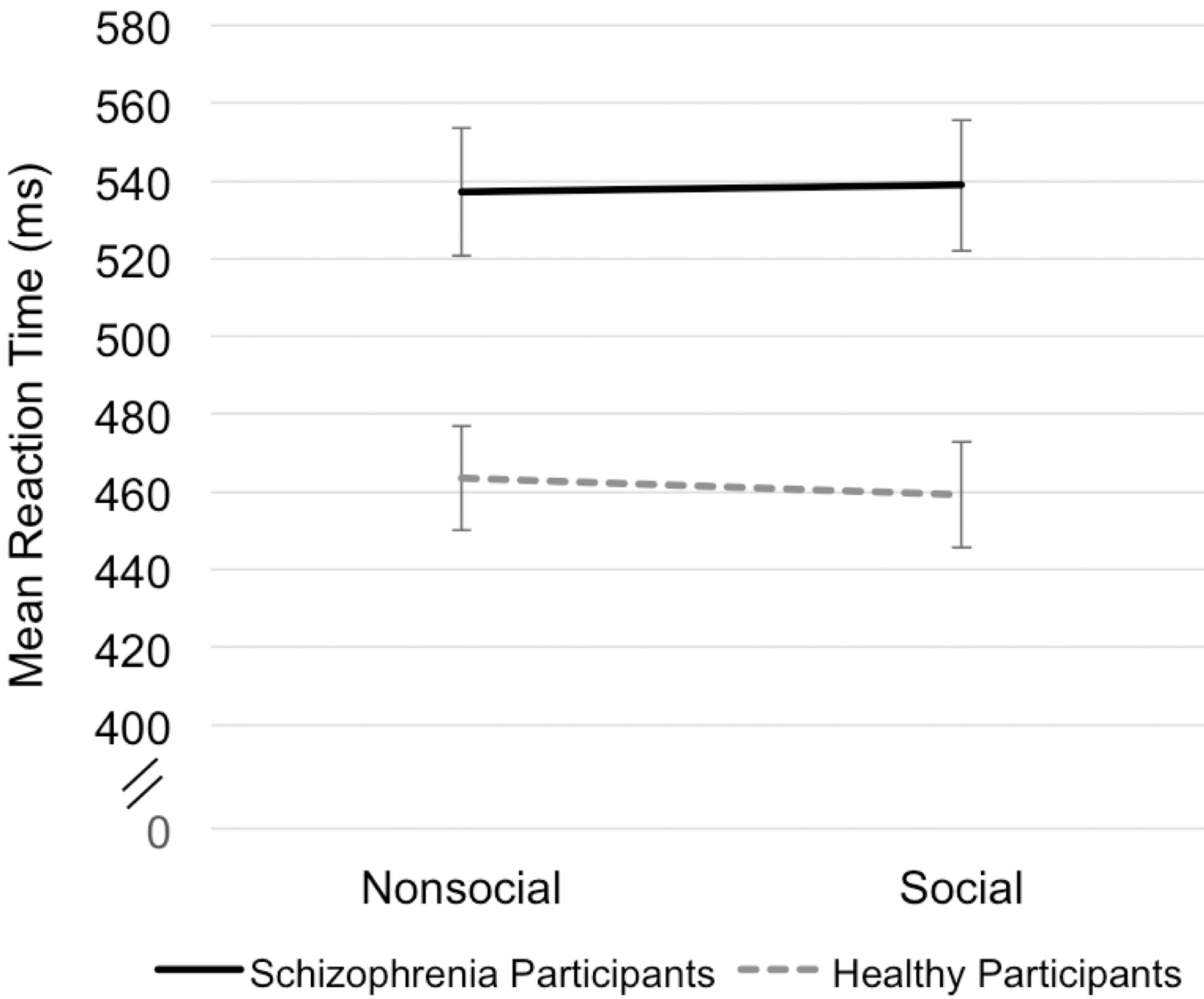

Figure 2.

Reaction times by group and cue type. Healthy participants (n = 29) responded relatively faster to social cues compared with nonsocial cues (Cohen's d = .40), whereas schizophrenia participants (n = 37) did not exhibit this pattern (Cohen's d = .13). Error bars +/− 1 SE.

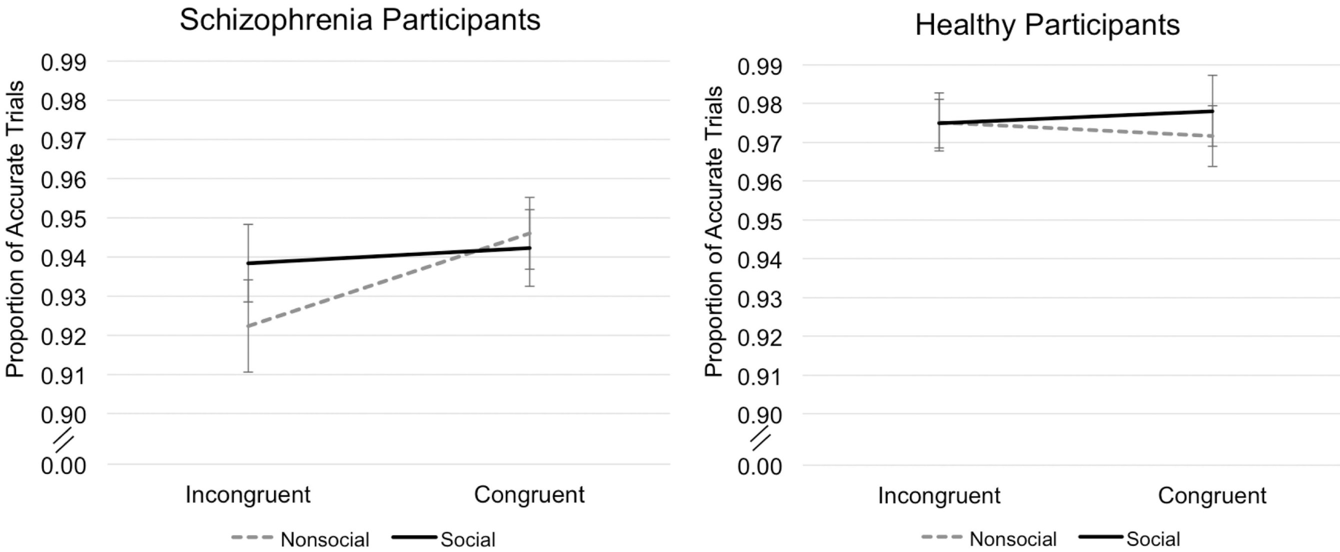

Figure 3.

Accuracy rates by group, cue type, and congruency. The schizophrenia participants ($n = 37$) showed a congruency effect for nonsocial but not for social cues. They were more accurate on congruent trials than incongruent trials with nonsocial cues, but not for social cues. Healthy participants ($n = 29$) did not show a congruency effect for either cue type. Error bars +/− 1 SE.

Table 1.

Demographic and clinical characteristics.

	Schizophrenia Participants (*n* = 37)	Healthy Participants (*n* = 29)	Statistic	*p-value*
Age	45.81 (10.41)	46.586 (9.17)	$F(1, 64) = 0.10$	.75
Participant Education	13.16 (2.14)	14.690 (1.80)	$F(1, 64) = 9.51$	<.01
Parental Education	13.70 (3.22)	14.172 (2.29)	$F(1, 57) = 0.42$	.52
Male, *n*(%)	62.16%	68.97%	$\chi^2 = 0.57$	.61
Race, *n*(%)			$\chi^2 = 1.51$	.68
African-American	45.95%	31.03%	--	--
Caucasian	32.43%	41.14%	--	--
Asian	13.51%	17.24%	--	--
Mixed/Other	8.11%	10.34%	--	--
Ethnicity (% Hispanic)	16.20%	24.10%	--	--
RFS Total	18.14 (3.83)	--	--	--
CAINS	--	--	--	--
MAP	1.54 (.65)	--	--	--
EXP	.95 (.85)	--	--	--
BPRS	--	--	--	--
Positive	2.21 (.93)	--	--	--
Depression	1.64 (.59)	--	--	--
Negative	1.93 (.91)	--	--	--
Agitation	1.10 (.18)	--	--	--
Illness duration (years)	18.30 (9.59)	--	--	--
Antipsychotic medication	--	--	--	--
Typical (%)	5.6%	--	--	--
Atypical (%)	88.90%	--	--	--
Both (%)	2.8%	--	--	--
None (%)	2.8%	--	--	--
MCCB				
Nonsocial Cognition	42.11 (8.52)	50.85 (7.75)	$F(1, 64) = 18.52$	<.001
Social Cognition	38.24 (11.014)	50.35 (10.36)	$F(1, 64) = 20.66$	<.001

Note. RFS = Role Functioning Scale; CAINS = Clinical Assessment Interview for Negative Symptoms; MAP = Motivation and pleasure subscale; EXP = Expression subscale; BPRS = Brief Psychiatric Rating Scale; MCCB = MATRICS Consensus Cognitive Battery.

Table 2.

Accuracy and reaction times by group.

	Schizophrenia Participants		Healthy Participants	
	Accuracy	**Mean RT**	**Accuracy**	**Mean RT**
Non-Social				
Incongruent				
0	.93 (.07)	566 (98)	.98 (.03)	509 (80)
100	.92 (.08)	535 (107)	.98 (.04)	465 (77)
200	.92 (.10)	535 (109)	.97 (.05)	461 (82)
600	.92 (.08)	518 (89)	.98 (.04)	448 (81)
Congruent				
0	.95 (.08)	536 (97)	.97 (.05)	478 (68)
100	.94 (.10)	506 (103)	.98 (.06)	437 (74)
200	.95 (.05)	495 (105)	.96 (.07)	440 (83)
600	.94 (.07)	498 (95)	.98 (.04)	446 (70)
Social				
Incongruent				
0	.94 (.07)	559 (103)	.98 (.03)	492 (69)
100	.94 (.07)	538 (106)	.97 (.05)	461 (76)
200	.94 (.08)	523 (102)	.98 (.05)	449 (83)
600	.94 (.07)	516 (102)	.97 (.07)	443 (75)
Congruent				
0	.94 (.08)	543 (104)	.98 (.04)	473 (71)
100	.95 (.07)	508 (106)	.98 (.04)	442 (82)
200	.95 (.08)	503 (95)	.97 (.05)	438 (82)
600	.94 (.07)	514 (100)	.97 (.05)	449 (76)

Note. Standard deviations are given in parentheses. RT = reaction time for correct trials.