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Examining the External Misattribution Bias in Schizophrenia

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Abstract

Schizophrenia is a debilitating mental illness affecting 1% of the adult population. A cardinal feature of schizophrenia is misattributing internal thoughts, emotions, and actions to an external source. In the current study, we examined the underlying cognitive bases of this bias during mental simulation of real-world actions. Previously, it has been found that healthy adults take on an observer's (external) perspective when reading simple, action statements preceded by "He" and a performer's perspective (internal) perspective when reading statements preceded by "You" (Brunye et al., 2009). We predicted that patients with schizophrenia would be prone to adopt an observer's perspective, regardless of the pronoun preceding the action statement. Methods: Patients with schizophrenia, schizoaffective disorder, and bipolar disorder were recruited from the Psychosis and Bipolar Disorder Unit at McLean Hospital. Healthy controls were recruited from Craiglist.org. Participants read simple, real-world action statements preceded by the pronoun "You" or "He." Following each statement, participants were instructed to verify whether a picture, depicted in either a performer's or observer's perspective, matched the action described in the sentence. Results: Unlike healthy controls and patients with bipolar disorder, patients with schizophrenia and schizoaffective disorder were faster at verifying pictures from an observer's perspective relative to pictures from a performer's perspective, regardless of the preceding pronoun. Conclusions: We extend previous findings of an external misattribution bias in patients with schizophrenia using a task that did not rely on patients' explicit judgments of their subjective experiences. Although it appears that this bias is related to diagnosis, more research is needed to determine the extent to which this bias is influenced by specific symptoms.

Examining the External Misattribution Bias in Schizophrenia

Schizophrenia is a mental disorder affecting approximately 1% of the population. This debilitating illness is characterized by a myriad of symptoms and cognitive impairments, often presenting in young adulthood (American Psychiatric Association [APA], 2000; Jayaswal, 1988). The term schizophrenia was first coined by Bleuler (1911/1950) and was conceptualized as a "loosening of associations." Clinical symptoms can be described as an excess or distortion of normal functioning, termed positive symptoms, and others are described as the absence of certain characteristics that healthy people display, termed negative symptoms (Savage, 1917 Positive symptoms include delusions (a false personal belief that is firmly held despite evidence of the contrary) and hallucinations (perception of a sensory experience without an external stimulus), which, in schizophrenia, are experienced as a voice, or auditory verbal hallucinations, 70% of the time (World Health Organization, 1973). Negative symptoms include a lack of motivation, paucity of spontaneous and voluntary behavior, a lack of caring, and blunted or inappropriate affect.

An overarching feature of schizophrenia is the tendency to misattribute internal experiences to an external source. This bias is often linked to deficits in the self-monitoring mechanism, often seen in the positive symptoms mentioned above, and is known as an external misattribution bias (Ditman & Kuperberg, 2005). With respect to language, this manifests itself as auditory verbal hallucinations, in real-world actions as passivity experiences, and in emotion as paranoid delusions. (Ditman & Kuperberg, 2005).

Frith (1992) postulated that this external misattribution bias could stem from impairments in the cognitive self-monitoring system. Self-monitoring deficits in schizophrenia point to a lack of awareness of self-initiated activity. Frith described the central monitoring system in two steps:

first, self-generated events and those caused by another source are distinguished by monitoring the relationship between actions and external events; second, monitoring our intentions allows us to differentiate between our willed actions and those responding to the environment. This monitoring is imperative in recognizing the sources of our actions. Any abnormalities in this system could result in the abnormal sensory events experienced by some schizophrenic patients. Specifically, if one were to be unaware of the initiation of their thoughts, he may, in turn, fail to recognize them as his own and misattribute them to an external source. In the same vein, actions may be attributed to external sources if one is unaware of his intention to initiate that act, as in passivity phenomena. As a result, patients may only be aware of their actions due to peripheral feedback or when they observe the consequences of their action. This failure to recognize self-initiated thoughts, emotions, or actions and subsequent misattribution to external agents is then often interpreted in the context of the individual's wishes or fears. Thus, all positive symptoms, such as hallucinations, delusions, or passivity experiences, may be related to this cognitive deficit (Frith, 1992).

A number of behavioral and neuroimaging studies support this self-monitoring theory (Frith, 1992). The first piece of evidence comes from studies examining subvocal speech during hallucinations (Gould, 1948; Gould, 1949; Green & Preston, 1981; Bick & Kinsbourne, 1987). The logic is that when patients produce inner speech during hallucinations, they are unaware of doing so. This speech is then misattributed to an external source (Maudsley, 1886). In support of this, studies have shown movement in vocal musculature during hallucinations (Gould, 1948; Green & Preston, 1981) and the content of the discernable speech is, at times, analogous to the content of hallucinations (Gould, 1949). In addition, Bick and Kinsbourne (1987) found that if schizophrenia patients with active hallucinations performed a task that disabled them from

moving their mouths (i.e., keeping mouth wide open) relative to other tasks that did not involve the mouth (i.e., clenching fists or shutting eyes tightly), hallucinations decreased significantly. Together, these studies support the idea that the phenomenon of hallucinations may be the result of a misattribution of inner speech to an external source.

The second piece of evidence for a self-monitoring impairment comes from studies examining memory. These studies generally involved a study phase and a testing phase. During the study phase, participants were presented with a list of words, half of which they read aloud and the other half were read to them by the experimenter. During the testing phase, which occurred after a delay, participants were presented with a new list of words that included the previously seen words as well as distracter words. Participants were asked to determine whether the word was new, read aloud, or heard. Bentall, Baker, and Havers (1991) found that hallucinators relative to the non-hallucinators, delusional patients, and healthy controls were more likely to misattribute self-generated terms, which were in response to cues requiring higher cognitive self-monitoring, to the experimenter after a one-week delay. Similarly, Brebion, Smith, Gorman, and Amador (1997) examined reality monitoring, the ability to discriminate between external and internal events, in patients with schizophrenia. A five-minute delay was inserted between study and test phases of the experiment. Results showed that patients with schizophrenia had a higher propensity to false alarms, indicating a new object was actually previously stated, as well as a higher propensity to misattribute the source of an internally generated object to an external source. Additionally, Brebion et al. (2000) later found that hallucinators were more likely than healthy controls to misattribute self-generated objects to the experimenter. Results also showed a correlation between PANSS hallucination scores and the increased tendency towards false alarms. Similarly, using a five-minute delay, Franck et al. (2000) found that

schizophrenia patients were more likely than controls to indicate that they had spoken words that had only been read silently. This impairment was more severe in patients who were currently hallucinators in comparison to patients who were not. Allen et al. (2004) examined schizophrenic patients currently experiencing verbal hallucinations and delusions, schizophrenic patients not experiencing hallucinations or delusions, and healthy volunteers. Results showed that the tendency to attribute self-generated, distorted words to an alien source was also correlated with severity of hallucinations.

Anselmetti et al. (2007) replicated these results and extended these findings by examining correlations between these source monitoring impairments and basic neuropsychological performance. The misattribution of self-generated items to the experimenter was significantly correlated to poor executive and planning performance in the Tower of London task (Anselmetti et al., 2007).

Stephane, Kuskowski, McClannahan, Surerus, and Nelson (2010) used a similar paradigm to examine the self-monitoring deficits in schizophrenia with two additional manipulations: the manipulation of pronouns and a component in which sentences read aloud were done so by both a male and female voice to determine whether gender influenced the self-other distinction. During the presentation phase, participants were presented ten sentences. Five of the sentences were shown on a computer screen that they were required to read aloud, while five of the sentences were read to them in a neutral tone by the computer while the screen remained blank. These sentences were read aloud alternately by male and female voices. All of the sentences began with “I,” “You,” or “He” in equal proportions. During the test phase, the ten sentences were presented randomly on the computer screen again along with five new distracter sentences. The participant was then asked to determine whether the sentence was read, heard, or

new. Results showed that patients did significantly worse than controls in distinguishing self-generated and other-generated speech and had a tendency of attributing self-generated speech to others.

Each of these studies has examined impairments in self-monitoring in the form of speech generation and reception. Mlakar, Jensterle, and Frith (1994) devised a unique study that investigated self-monitoring impairments through visuospatial tasks, namely drawings. Participants were asked to generate a drawing of a shape, presented on a card, on a computer screen using either a joystick or four keys on a keyboard. After this portion, participants had to reproduce the shapes from memory using paper and pencil. Findings showed that all participants were able to remember the drawings after the task, so any errors made could be attributed to the self-monitoring system rather than trouble with remembering the shape. Both groups of schizophrenic patients - hallucinating and nonhallucinating - performed worse recognizing the shape they drew amongst identical shapes drawn by someone else than the other two groups - psychiatric controls and healthy controls. The schizophrenic group currently experiencing positive symptoms did show an increasing number of errors as higher degrees of self-monitoring were required to complete the task. This supports the idea of an external misattribution bias even in areas beyond speech – visuospatial cognition, in this case, and suggests that self-monitoring deficits improve as symptoms improve.

Finally, in a study by Allen, Freeman, Johns, and McGuire (2006), healthy participants were examined to determine whether proneness to hallucinations and delusional behavior is related to an external misattribution bias, regardless of diagnosis. Healthy participants completed the Launay-Slade Hallucination Scale (Launay & Slade, 1981), which is a self-report questionnaire that measures one’s vulnerability to hallucinatory experiences. The participants

also completed the Peters Delusions Inventory (Peters, Joseph, & Garety, 1999), which measures delusional ideation in the normal population, assessing distress, preoccupation, and conviction with respect to delusional ideation. Participants then completed a self-monitoring task in which they listened to a series of words that varied in source (i.e. self-generated or generated by experimenter) and distortion across trials. Results demonstrated a correlation between severity of delusional ideation and a tendency to misattribute the source of distorted speech to an external source. There was no correlation between hallucinatory proneness and external misattributions, though there was a trend in the same direction. This study is particularly interesting, as healthy participants do not have the global and executive cognitive deficits that may influence results concerning self-monitoring systems.

Overall, these memory studies support self-monitoring impairments and the external misattribution bias, but are limited in the sense that memory, specifically recall, recognition, (Aleman, Hijman, de Haan, & Kahn, 1999) and auditory sensory memory (Catts et al., 1995), is known to be impaired in patients with schizophrenia. Therefore, this may confound assessments of cognitive tasks involving memory. In addition, these studies are only addressing self-monitoring deficits that occur after the fact as opposed to real-time self-monitoring impairments. However, encouragingly, Allen, Freeman, Johns, and McGuire, (2006) showed similar relationships between symptoms and an external misattribution bias in healthy adults who do not presumably have these same general memory impairments.

The third piece of evidence of a self-monitoring impairment in schizophrenia comes from studies examining *immediate* source monitoring, rather than relying on memory. In these paradigms, participants immediately determined the source of a stimulus without a delay. One of the first studies to investigate this was by Mintz and Alpert (1972). In this study, vividness of

auditory imagery and the ability to accurately repeat auditory statements were examined. Hallucinating schizophrenic patients, non-hallucinating schizophrenic patients, and healthy controls were asked to imagine different scenarios involving auditory imagery. After thirty seconds, participants were asked to give a rating of whether they heard the scenario and whether they believed it was actually occurring. Then, participants heard a series of recorded phrases with background noise. The participants were to repeat back what phrases they heard and were to rate their level of confidence in the statement. Results showed that the hallucinating group had significantly higher scores of vividness than the other two groups. In addition, the schizophrenia patients with high vividness scores were more confident in their responses, despite their low accuracy of response. The authors speculated from these findings that the formation of hallucinations in patients required vivid auditory imagery and defective reality testing, but these factors were not necessarily causal.

Other researchers have taken a different approach to examine immediate source recognition. This approach involved having participants read words as they simultaneously heard their own voice, an experimenter's voice, their own distorted voice, or an experimenter's distorted voice through headphones (Cahill, 1996; Johns et. al., 2001; Johns, Gregg, Allen, & McGuire, 2006). The logic is that when we speak, we recognize that what we are hearing our own voice due to the external sensory feedback and the intention to speak. If self-monitoring is impaired in schizophrenia, then recognition and identification of the voice relies entirely upon the external sensory feedback. Results of these studies showed that patients with schizophrenia were more likely to misattribute their own distorted voice to an alien source. Cahill (1996) found that the frequency of making these external attributions was directly related to the amount of pitch distortion and to the severity of delusional ideation in patients. Johns (2001) found that

hallucinators were particularly likely to misattribute their distorted voice to that of the other person, particularly with negatively valenced words.

Self-monitoring deficits and subsequent misattribution to an external source has also been examined using other sensorimotor modalities. Daprati et al (1997) examined schizophrenic patients with and without positive symptoms and their ability to make self-other distinctions with respect to hand movements. Participants included patients experiencing hallucinations, patients experiencing delusions of control, patients not experiencing hallucinations or delusions, and healthy controls. Participants were asked to carry out several finger and wrist movements without direct visual perception of their hand. On a TV screen, participants watched an image of either their hand or an alien hand executing the same or different movement that was instructed. Participants were instructed to determine whether the hand on the screen was theirs or that of another person. Results showed that all patients made significantly more recognition errors than the control group. Patients presenting delusions of control made more errors than the other groups, supporting self-monitoring deficits when differentiating between self and other.

Finally, Stirling Hellewell, and Quraishi (1998) examined this impairment in self-monitoring and externalization bias using neuropsychological tests. Schizophrenic patients and healthy volunteers were asked to complete a battery of neuropsychological tests analyzing four different aspects of self-monitoring: the odd-even test and the left-right test, intended for predisposed testers to make anticipatory errors that must be corrected, along with drawing tests that required participants to identify their own drawings amongst other identical ones. Patients' severity of symptoms was compared to performance on these tests. Overall, patients performed worse than controls and patients currently experiencing delusional ideation of control were prone

to have greater difficulty on the self-monitoring tasks independent of cognitive or neuropsychological performance.

The fourth piece of evidence of a self-monitoring impairment and an external misattribution bias comes from neuroimaging studies. These studies have demonstrated that similar brain regions are activated when patients experience auditory verbal hallucinations and during speech production, whether internal or external (Cleghorn et al., 1992; Copolov et al., 1992; McGuire, Murray, & Shah,1993; McGuire et al., 1995; McGuire et al., 1996; Silbersweig et al., 1995; Dierks et al., 1999; Shergill Brammer, Williams, Murray, & McGuire, 2000; Ait Bentlab, Beauregard, Liddle, & Stip, 2002; Brunelin et al., 2005). This suggests that auditory verbal hallucinations may be a misattribution of inner speech to an external source. In addition, as theorized by Feinberg (1978), brain areas that are involved in differentiating between self-initiated and externally initiated events (e.g., right inferior parietal lobule) show abnormal activation (Spence et al., 1997; Blakemore, Rees, & Frith, 1998; Ragland, Valdez, Loughead, Gur & Ruben, 2006; Mechelli et al., 2007).

Overall, the studies reviewed above have demonstrated that patients with schizophrenia have an impaired self-monitoring mechanism that caused them to misattribute internal events to an external source. These self-monitoring deficits may be related to specific positive symptoms associated with schizophrenia, such as hallucinations, delusions, and passivity phenomena. However, these studies have several limitations discussed below that the present research addressed.

The first limitation is the fact that many of these studies examine correlations either exclusively across diagnostic groups or exclusively across symptom groups. Each of these approaches has limitations. When comparing participants across diagnoses, an assumption is

made that each patient presents the same symptoms within a given disorder. However, many mental illnesses, particularly schizophrenia, are heterogeneous in nature. That is, one patient with a diagnosis of schizophrenia could present very different symptoms than the next patient with schizophrenia. Even the symptoms within schizophrenia are very different, from positive to negative symptoms. Therefore, comparing exclusively across diagnoses groups is not the most conclusive way to assess a population. Comparing exclusively across symptom groups may help to have some standardization. In fact, some researchers have argued that self-monitoring impairments are related to severity of a psychotic state as opposed to a standing predisposition unique to schizophrenia (Johns, 2006). Supporting this, Johns (2006) found a correlation between symptom severity and performance on tasks requiring self-monitoring. However, this approach is also limited in that it assumes the experience of a given symptom, say hallucinations, has the same etiology across different diagnostic groups. A patient that has schizophrenic hallucinations versus a patient with hallucinations in the context of an affective disorder could have two very different underlying neurological mechanisms. This limitation may account for the many inconsistencies in the research alluding to various symptoms and whether or not they are implicated in an external misattribution bias, i.e. hallucinations, auditory verbal hallucinations, delusions, delusions of control, thought insertion, etc. The current study addressed this limitation by comparing across both diagnostic and symptoms groups.

Another limitation is that this external misattribution has primarily been investigated using self-report. In other words, participants have explicitly been asked to determine the source of words or actions. By relying on participants' self-report and judgment, investigators may not be obtaining an accurate representation of cognitive performance. The current study avoids this altogether by examining the objective measure of response times.

The aim of the current study was to directly examine the underlying cognitive basis of external biases during the mental simulation of real-world actions in patients with schizophrenia (compared with those with bipolar disorder and healthy controls), without relying on subjective responses. By using a patient control group (bipolar patients), we were able to examine source attributions, taking into account diagnosis and symptoms. We employed a novel paradigm previously used to examine perspective taking during reading comprehension in healthy adults (Brunye, Ditman, Mahoney, Augustyn, & Taylor, 2009).

In this previous study, participants read action statements beginning with the pronoun "I," "He," or "You" (Brunye, Ditman, Mahoney, Augustyn, & Taylor, 2009). Immediately following each sentence, participants determined whether the subsequent picture matched the action described in the sentence. Pictures were depicted in the internal (actor's) perspective or from the external (observer's) perspective (See Figures 1-4). Participants were told not to pay attention to the picture perspective in their responses. Results showed that when the sentence began with either the pronoun "I" or "You," participants were significantly faster in responding to pictures presented from the internal perspective as opposed to pictures presented in the external perspective. These results suggest that participants had mentally simulated a similar scenario and they are therefore faster in responding to that picture than one that did not match their mental simulation. When sentences began with the pronoun "He," participants were significantly faster responding to pictures presented from the external perspective as opposed to pictures presented from the internal perspective.

Given previous findings of an external misattribution bias in patients with schizophrenia, we hypothesized that schizophrenic patients would be prone to take the external perspective after reading action statements, regardless of the pronoun that preceded this action statement. In

addition, we predicted that severity of symptoms such as hallucinations and delusions would correlate positively with this selective deficit. We predicted that patients with bipolar disorder that exhibit psychotic symptoms such as hallucinations or delusions would also take an external perspective in both conditions.

Methods

Participants

Twenty-six patients were recruited from McLean Hospital, Belmont, MA. Twelve patients met diagnostic criteria for bipolar disorder (DSM IV; APA, 2000), six of whom were inpatients. The remaining fourteen of the patient group met diagnostic criteria for either schizoaffective disorder or schizophrenia (DSM IV; APA, 2000), five of which were inpatients. These patients were grouped together, as they are similar in predisposition to positive symptoms, and, therefore, an external misattribution bias, to have a more substantial sample size. One patient with schizophrenia was excluded for being left-handed.

Thirty-six healthy volunteers, without any history of a psychiatric illness as assessed by the Mini-Structured Clinical Interview for DSM-IV (Mini-SCID; APA, 2000) were recruited through Craigslist advertisements and through control databases at McLean Hospital. Ten healthy controls were excluded due to failure to pay attention during the task.

Patients and healthy control participants were matched on age, level of education, and pre-morbid IQ, measured by the North American Adult Reading Test (A-NART; Blair & Spreen, 1989), as verified by one-way between-subjects ANOVAs conducted on each of these variables (all *ps* > .05). All participants were native English speakers who had not learned any other language prior to the age of 5. Participants were right-handed as measured by the Edinburgh

Handedness Inventory (EHI; Oldfield, 1971), without any history of neurological disorder, substance abuse within the previous 3 months, substance dependence, or head trauma. Participants received monetary compensation for their participation ($15-$20). Written informed consent was obtained according to guidelines provided by the McLean Hospital and Tufts University Institutional Review Board.

Patients were clinically assessed using the Multnomah Community Ability Scale (MCAS; Barker, 1994), the Young Mania Rating Scale (YMRS; Young, 1978), Montgomery Asberg Depression Rating Scale (MADRS; Montgomery & Asberg, 1979) the Positive and Negative Symptom Scale (PANSS; Kay, 1987), the Scale for the Assessment of Positive Symptoms (SAPS; Andreasen, 1989a), and the Scale for the Assessment of Negative Symptoms (SANS; Andreasen, 1989b). Please refer to Table 1 for all demographic information.

Design

The design of the experiment conformed to a 3 (Group: healthy controls, bipolar patients, schizophrenia patients) x 2 (Half: first half, second half) x 2 (Pronoun: you, he) x 2 (Picture perspective: internal, external) mixed factorial Design. All variables other than Group were manipulated within-subjects. We included the factor Half in the design in order to more closely compare the present findings with the results of Brunye et al. (2009). In the original study, only half of the items used in the present study were included. In order to increase the number of trials per condition, we doubled the number of items but wanted to ensure that this would not alter the experiment in other ways (e.g., by increasing fatigue and/or practice effects). Picture verification response times and accuracy were measured.

Stimuli

Simple, real-world action statements beginning with the pronoun "You" and "He" were presented for 3.5 seconds each on a laptop computer screen using Superlab (Abboud, 1997). Following each sentence, a picture was displayed (See Figures 1-4). The pictures were approximately four inches by six inches in size and were taken by digital camera by the experimenters. By using Adobe Photoshop, the background was reduced to white so the only things in the frame were a male's hands and wrist holding various household items. The pictures were taken at approximately a 45-degree angle from about eye-level to simulate a protagonist's perspective.

Overall, sixty-four trials were presented. Half of the sentences began with the pronoun "You" while the other half began with the pronoun "He." Each sentence was around five words in length using the structure "subject" are/is "verb" the "object." Of these trials, thirty-two were the experimental trials, while the remaining thirty-two were filler trials. Of the filler trials, sixteen were 'non-performing' pictures and sixteen were mismatching pictures. A 'non-performing' picture constituted hands holding objects that correspond with the described action, but no action was being performed with those objects (Refer to Figure 2). A mismatched picture consisted of hands holding objects that did not match the described action at all. These filler trials allowed for the assessment of false-positive tendencies. Trials were presented in a pseudorandom order, which ensured that no more than three of the same trial conditions appear consecutively. Conditions were counterbalanced using six lists across participants using a Latin square design.

Procedure

Participants were seated in front of a PC laptop computer and were instructed to select "Yes" or "No" on the keyboard, indicated by labeled stickers on the *C* and *M* keys, in response to stimuli on the computer screen. They were asked to keep their index fingers resting above each key so that they did not have to look down and to ensure standardization in response times. Participants were unaware that reaction time was being recorded, but were informed to respond as quickly and as accurately as possible. Participants engaged in a practice sequence prior to the actual experiment to make sure all participants understood the task.

Participants read simple action statements such as "You are slicing a tomato" for 3.5 seconds. After each statement, they verified whether a picture matched or mismatched the action statement. The picture was presented for 3.5 seconds and once a participant responded, the next trial would begin. If the subject waited too long to respond, the time would elapse and go to the next trial recording that response at incorrect. A picture was considered to match the statement when it depicted the described action from either a performer's or observer's perspective and the protagonist was performing the action (Refer to Figures 1, 3**)**. Participants were instructed to ignore the perspective from which the picture was taken and to merely indicate whether the action described in the sentence was taking place in the picture. Pictures that did not match the action statement either depicted the same objects involved in the description without an action performed (Refer to Figure 2, 4) or depicted objects that were unrelated to the objects and actions described in the action statement. In the original pilot study by Brunye et al. (2009), there were only thirty-two trials. In the current study, the number of trials in order to increase the number of items per condition. However, as we did not know whether doubling the number of items would alter the results in any other way, we examined the results in two halves to

determine if there was a difference in performance between the first and second half. For instance, performance may differ from the first to the second half if subjects develop strategies as the experiment goes on. In total, this experimental portion took about 6-7 minutes to complete. At that point, participants were instructed to take a five-minute break and complete a word search in order to occupy their mind from thinking about the task they had just completed. This avoided any carryover effects from the previous experiment to the subsequent recognition experiment.

At the end of the five minutes, participants completed a 1-minute recognition component in which participants were instructed to respond to action phrases presented on the computer screen and determine whether or not the action phrases, such as "slicing the tomato," appeared in the previous experimental portion. Sixty-four of these phrases were presented and of these, half were distracters that displayed action phrases that were not presented in the previous portion. Participants selected "Yes" if they remembered the action phrase or "No" if they did not. The action phrases were presented and participants were to respond to stimuli immediately using the same "Yes" and "No" keys.

Results

Response Times

A 3 (Group: healthy controls, bipolar patients, schizophrenia patients) x 2 (Half: first half, second half) x 2 (Pronoun: you, he) x 2 (Picture perspective: internal, external) mixed factorial analysis of variance (ANOVA) was conducted on the response time data.

In this ANOVA, the only thing that reached statistical significance was a Group x Half x Picture perspective interaction ($F(2,47) = 4.15$, $p < .05$), demonstrating that results differed from

the first half of the experiment to the second half. To follow up this interaction, a simple effects ANOVA examining each half of the experiment separately was conducted. In the first half of the experiment, we found a Group x Picture perspective interaction ($F(2, 48) = 5.91$, $p < .01$) and no other main effects or interactions (all *ps* > .05). Follow-up contrasts examining each group separately revealed that patients with schizophrenia were faster at responding to pictures from an external perspective (main effect of Picture perspective $F(1, 12) = 5.02$, $p < .05$). Bipolar patients, on the other hand, exhibited the opposite pattern, with faster responses to pictures from an internal perspective relative to those depicted from an external perspective ($F(1, 11) = 7.16$, $p < .05$). Response times in healthy controls did not differentiate between the picture perspectives ($F(1, 25) < 1$).

No main effects or interactions reached statistical significance in the second half of the experiment (all ps > .05). Please refer to Figures 6-8.

Accuracy

We also conducted a 3 (Group: healthy controls, bipolar patients, schizophrenia patients) x 2 (Half: first half, second half) x 2 (Pronoun: you, he) x 2 (Picture perspective: internal, external) mixed factorial analysis of variance (ANOVA) on the accuracy data. No main effects or interactions reached statistical significance (all *ps* > .05). Please refer to Figure 5.

Correlations

In order to examine whether an external misattribution bias could be accounted for by clinical symptoms in the patient groups, we conducted Spearman Rho correlations between PANSS hallucinations score, PANSS delusions score, total PANSS preoccupation score, total

PANSS score, total MCAS score, and total MADRS score and a measure of an external misattribution bias in both patient groups combined. The external misattribution bias measure was calculated by subtracting response times to external perspective pictures from internal perspective pictures for "He" action statements, then doing this subtraction for response times to "You" action statements, and then averaging these difference scores together. No correlation reached statistical significance (all *ps* > .05).

Discussion

The objective of this study was to examine self-monitoring in patients using a simple task that did not rely on participants' subjective responses. Results demonstrated that only patients with schizophrenia exhibited an external misattribution bias. Specifically, response times in healthy controls were not modulated by pronoun or picture perspective. However, in schizophrenia patients, we found faster overall response times to verify external perspective pictures relative to internal perspective pictures, regardless of the pronoun. This finding is evidence of an external misattribution bias, as faster response times indicate a similar mental simulation of that scenario. Interestingly, this bias was not present in all patients; patients with bipolar disorder showed the opposite pattern with faster response times to pictures from an internal perspective, regardless of pronoun. These differences cannot be attributed to inability to perform the task or a speed-accuracy trade-off, as all groups had high accuracy that was not significantly different from one another. Also, these differences between the patient groups were not correlated with specific clinical symptoms although the schizophrenia group had more delusions than the bipolar group. I discuss these points in more detail below.

The finding that patients with schizophrenia were faster at responding to pictures from an external perspective following action statements is consistent with an external misattribution bias in this patient group and is in line with previous research (Bentall et al., 1991; Brebion et al., 1997, 2000; Franck et al., 2000; Cahill, 1996; Johns et al., 2001). Previous studies using delayed memory tasks have demonstrated that patients with schizophrenia are prone to erroneously attribute the source of a word to an external agent (Bentall et al. 1991; Brebion et al., 1997, 2000; Franck et al., 2000). Similarly, studies using immediate source verification have found the same external misattribution bias in patients with schizophrenia (Cahill, 1996; Johns et al. 2001, 2006; Allen et al., 2007). However, all of the previous studies have relied on participants' self-report. This is problematic because self-report responses may be subject to conscious processes that could contaminate the true results. For example, self-report data may be contaminated by participants' desire to please the experimenter. This may be especially problematic in a patient population. Additionally, self-report relies on the subjective judgment of the participant. The present study was able to examine source attributions without relying on subjective responses. Instead, in the present study, we were able to implicitly examine source attributions through responses on a picture verification task. Participants' responses were more likely to reflect immediate source-monitoring and were not influenced by demand characteristics. The current study extends the extant literature by demonstrating this external misattribution bias using an immediate task and objective responses.

With regard to bipolar patients, results showed that they were faster to verify pictures from the internal (actor's) perspective relative to the external (observer's) perspective. This internal misattribution bias may be a result of some typical symptoms of bipolar disorder, including preoccupation (autistic, self-absorbed experiences), and grandiosity (inflated sense of

self) (APA, 2000). Tackett et al (2008) reported that bipolar disorder was one of several "internalizing" disorders where patients often become preoccupied with internal thoughts and emotions, having a self-absorbed perception of their environment (Tackett et al, 2008). Though no correlations were found between symptoms, including preoccupation, and response times, with a larger participant pool, we may find some correlations between cardinal symptoms of bipolar disorder and an internal misattribution bias. We had hypothesized that this external misattribution bias would be related to symptoms of hallucinations and delusions in both patient groups. However, this prediction was not supported. There were no correlations found between clinical symptoms and response times. Despite this, patient groups did differ in delusional severity such that schizophrenia patients had more delusions than bipolar patients. Thus, it is possible that this symptom may be related to our observed external misattribution bias in the schizophrenia patient group relative to the bipolar group. Specifically, delusions may arise as a result of internal emotions misattributed to an external source. Collecting additional participants (which we are currently in the process of doing) may help us examine the relationship between diagnosis, symptoms, and an external misattribution bias with more reliability.

Alternatively, differences between the patient groups may have been the result of the influence of different medications. In the patient groups, 89% took antipsychotic medications, 46% took mood stabilizers, 32% took antidepressants, and 3% took stimulants. These medications could have affected the results and reactions times as psychotropic medications can both improve and hinder cognitive functioning (APA, 2000). To address this limitation, futures studies could look at first-time psychotic patients that have not yet been exposed to medication. Another option would be to try and keep medications constant between patient groups. Ultimately, this limitation is an unlikely confounding variable given that medications would

most likely either aid or impair performance across the board. In the present case, we observed a specific impairment (independent of overall response time) and tendency to respond faster to pictures from an external perspective whereas patients with bipolar disorder had a specific bias to respond faster to pictures from an internal perspective. In addition, groups did not differ in accuracy, demonstrating that there were no differences in ability to perform the task (where you might expect to see medication effects).

Finally, the healthy controls did not display any difference in perspective preference in either the "You" or "He" condition. This is contrary to results found by Brunye et al. (2009), in which healthy subjects were faster when verifying the internal perspective I response to sentences that began with "You" and faster when verifying the external perspective in response to sentences that began with "He." One reason for this discrepancy in findings may be due to the differences in participant population. The study by Brunye et al (2009) used a fairly homogenous group of participants who were currently attending college. In the current study, however, the healthy control population was very heterogeneous and the demographics were vastly different from the Brunye et al. (2009) article. Within the control population, there was a great deal of variability in age, education, and premorbid IQ, however, this was necessary in order to match these participants to the patient groups. One of these variables may have influenced task results. For example, healthy controls in the present study may have developed a strategy to ignore the pronoun of each action statement as it was not integral to their given task. One way to avoid this in the future is to present the sentences word by word, assuring that the subjects read every word in the sentence before moving on to their given task. In addition, future studies should examine whether potential subclinical symptoms in a matched healthy control group may account for variability in the data that would obscure the results.

Future directions

In order to further examine an external misattribution bias in patients, future studies should examine brain activity associated with perspective taking. Previous studies have shown abnormal activation in patients with schizophrenia when they are making source attributions (Brunelin et al., 2005; McGuire et al., 1993, 1995, 1996; Copolov et al., 1992). Specifically, these studies have found abnormal activation in brain areas associated with determining whether an action is self-initiated or externally-initiated (Spence et al., 1997; Blakemore, Rees, & Frith, 1998; Ragland, Valdez, Loughead, Gur & Ruben, 2006; Mechelli et al., 2007). However, as mentioned previously, these studies relied on participants' self-report rather than an objective measure of perspective taking.

Future studies should also examine whether this external misattribution bias is a result of state (related to current severity of symptoms) or trait (a genetic predisposition) characteristics (Schiffman et al., 2004, Johns et al. 2006). In the future, recruiting first-degree family members to complete the same task would be a step in determining whether self-monitoring impairments are predisposed. If an external misattribution bias is related to trait (regardless of symptoms), then one would expect to observe a similar bias in healthy first-degree family members.

Finally, previous studies (Stephane et al., 2010; Baker & Morrison & Haddock, 1998; Morrison, 1997; Ensum & Morrison, 2004; Costafreda, Brebion, Allen, McGuire, & Fu, 2008) have shown that when words have an emotional connotation, patients with schizophrenia show an external misattribution bias with negatively valenced words in particular. Thus, it is important to examine whether the bias we observed in the present study would be exacerbated when stimuli are negative. We are beginning to examine this question using negatively valenced sentences

like, “You are stabbing the rabbit,” in which pictures contain the objects (e.g., knife) to match the actions described in the sentence.

Conclusion

Overall, we extend previous findings of an external misattribution bias in patients with schizophrenia using a task that did not rely on patients’ explicit judgments of their subjective experiences. Identifying the underlying cognitive basis for these debilitating symptoms of schizophrenia may ultimately help in the creation of a successful treatment plan. Others have successfully employed techniques such as transcranial magnetic stimulation (TMS) to treat source-monitoring deficits (Brunelin et al., 2005) in patients with schizophrenia. Hopefully, our findings can be informative and assist in the treatment of source-monitoring and other symptoms in schizophrenia.

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Appendix

	Controls	Schizo Patients	Bipolar Patients
N	26	13	12
Male/Female	15/11	9/4	3/9
Age	39.08 (10.22)	41.00 (9.95)	30.42 (9.55)
Premorbid IQ	108.66 (8.21)	108.37 (13.37)	106.53 (9.74)
Inpatient/Outpatient	--	5/8	6/6
Education Level	14	13	13
PANSS Delusions	--	3.83 (2.29)	2.58 (1.51)
PANSS Hallucinations	--	2.75 (1.66)	2.08 (1.83)
PANSS Preoccupation	--	1.64	1.60
PANSS Positive	--	17.82	17.83
PANSS Overall	--	56.25 (20.03)	58.58 (27.09)
MCAS	--	37.00 (13.69)	45.33 (8.52)
MDRS	--	6.58 (7.55)	11.08 (9.89)

Table 1: Demographic information for all participants

Figure 1: Actor's (internal) perspective, performing action.

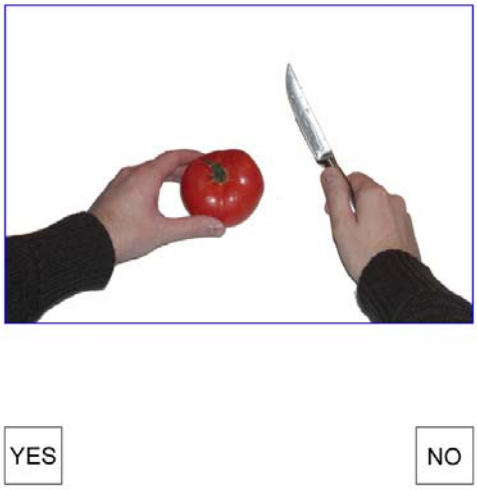

Figure 2: Actor's (internal) perspective, not performing action.

Figure 3: Observer's (external) perspective, performing action.

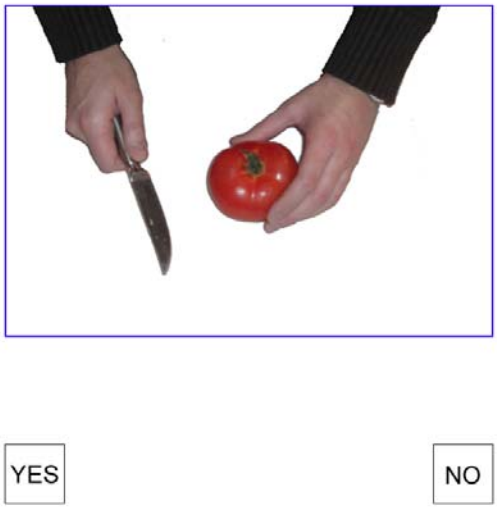

Figure 4: Observer's (external) perspective, not performing action.

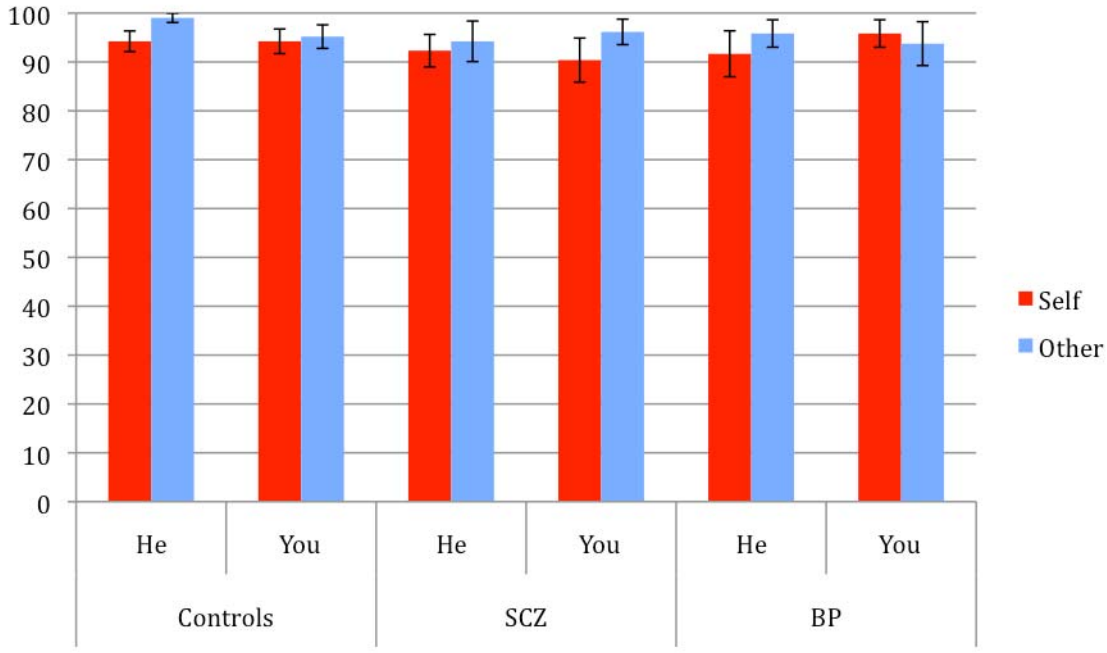

Figure 5: Accuracy data for all groups.

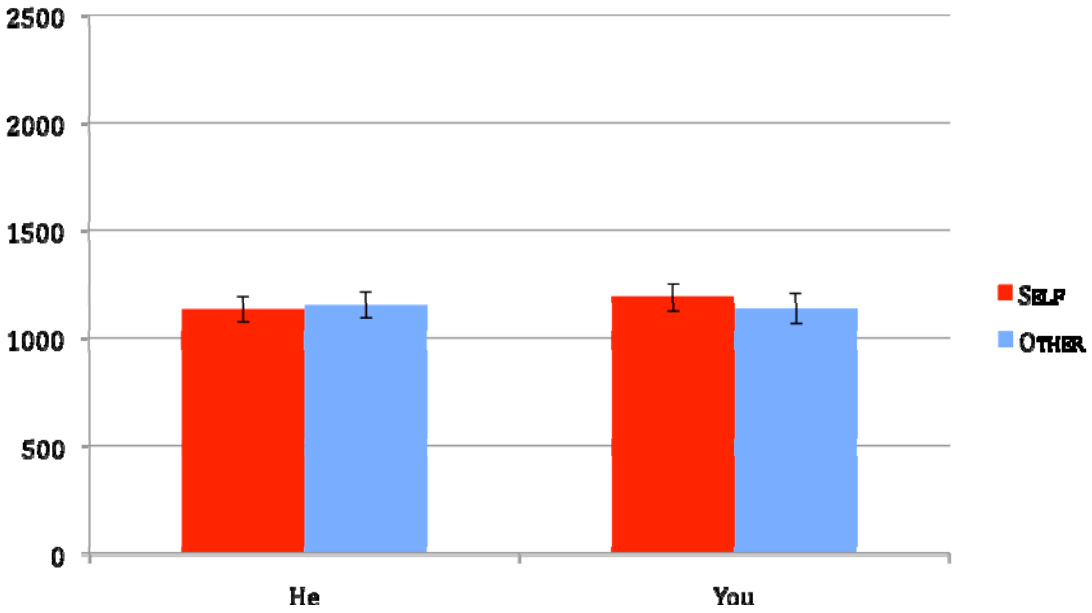

Figure 6: Response times for healthy control group.

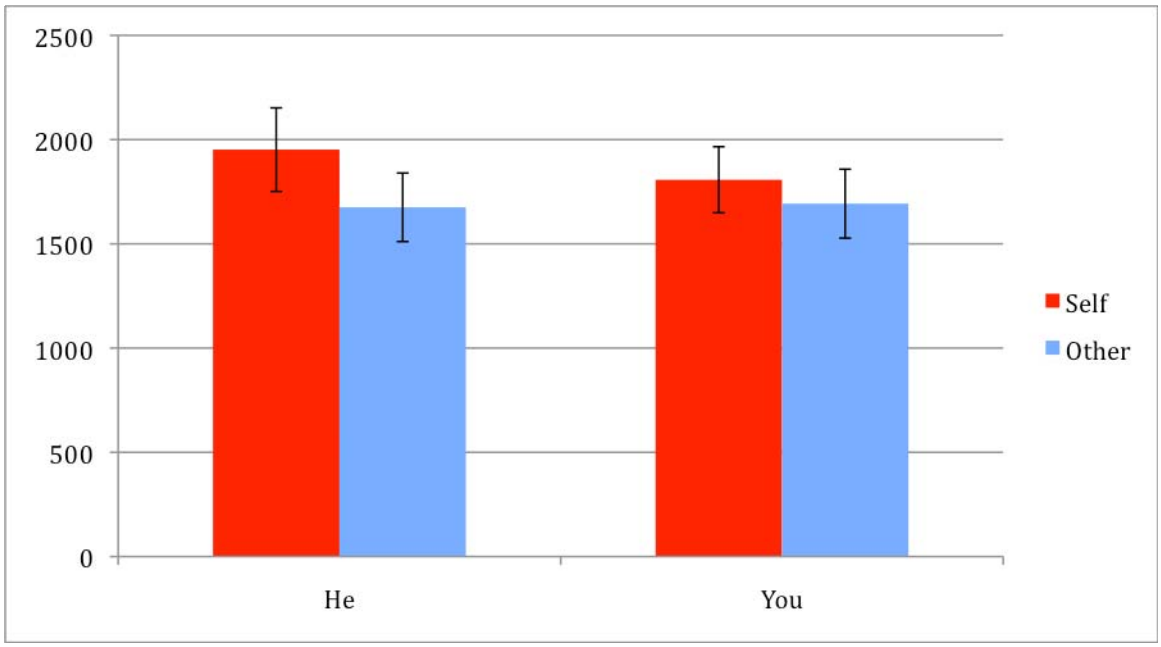

Figure 7: Response times for schizophrenia group.

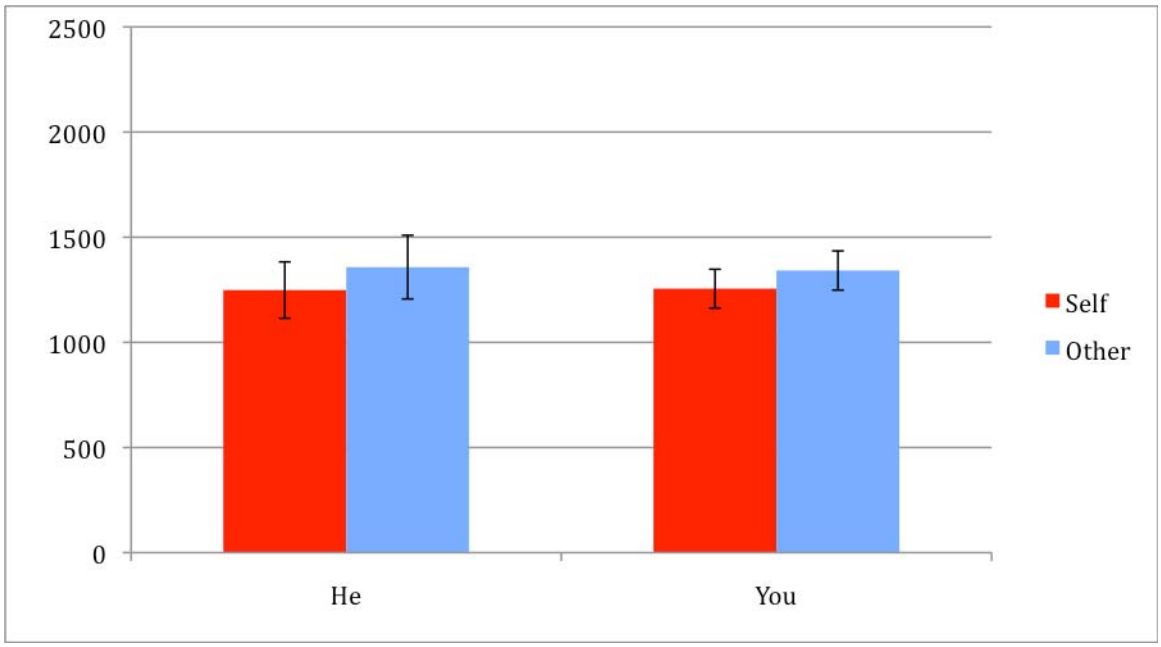

Figure 8: Response times for bipolar group.

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