

Converging Evidence for Reality Monitoring Deficits as a Critical Component in Understanding Schizophrenia Symptomatology and Etiology

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Abstract

Cognitive deficits have long been recognized in the phenomenology of schizophrenia, but only recently have these deficits been explored as a potential factor contributing to psychotic symptoms. One such deficit that has risen to the forefront of this research concerns reality monitoring, which refers to the ability to maintain a distinction between internally and externally generated information. The present review summarizes the findings from this exciting new direction in the field of psychopathology, and argues that research concerning deficits in reality monitoring holds promise in unlocking some of the mysteries of how schizophrenia develops. Current gaps in the literature on reality monitoring in schizophrenia are also discussed, and future research directions targeted at filling in these gaps are explored.

Generalized cognitive deficits have long been identified as a critical component of schizophrenia (Weinberger, Aloia, Goldberg, & Berman, 1994). Impaired reasoning skills often become manifest when schizophrenics are asked to perform a task, such as the Wisconsin Card Sorting Test (WCST), that requires the application of higher order processes associated with the prefrontal cortex (PFC) (Weinberger & Berman, 1996). Indeed, this disparity between the cognitive reasoning ability of schizophrenics and that of healthy individuals is so great and consistent that some clinical researchers believe it should be reflected in the diagnostic criteria for the disorder (Stip, 2006).

A number of theories of schizophrenia have arisen from research into this generalized impairment, the most prominent of which has been the theory of

hypofrontality. According to this theory, generalized cognitive impairment in schizophrenia occurs because the PFC does not become sufficiently activated during the performance of cognitive tasks (Weinberger et al., 1994). Theories of hypofrontality, however, have suffered from several major shortcomings. These theories are often too vague to make precise and meaningful predictions concerning the specific types of cognitive impairment suffered by schizophrenics. Furthermore, hypofrontality theories are unable to specify any relationship between the observed cognitive impairment and the symptoms of schizophrenia. Consequently, they have added little to our understanding of the disorder.

Recently, theories concerning cognitive impairment in schizophrenia have become increasingly focused and qualified, with specific types of cognitive impairment relevant to PFC functioning being identified. One such theory that has risen to the forefront of this research implicates reality monitoring in the symptomatology and etiology of schizophrenia. Reality monitoring refers to the process of maintaining a mental distinction between information that has been generated internally by one's self and information that has been generated by an external source. Errors in reality monitoring occur when self-generated information is wrongly attributed to an external source. The following review summarizes the converging evidence for a deficit in reality monitoring as a major component in the cognitive deficits observed in schizophrenia, and argues that this deficit can be used to explain both the genesis of the disorder and how it improves with treatment. While recent research suggests that this may provide a promising account of schizophrenia, much more has yet to be learned about the role of reality monitoring in the disorder and these gaps in the literature are later discussed.

Evidence from Behavioral Studies

In the traditional source monitoring task, participants are asked to generate words and commit them to memory. They are also shown certain words by the experimenter and asked to commit those words to memory as well. Later, words that were both generated by the participant and provided to the participant by the experimenter are presented in the context of a recognition test along with new words that the participant neither saw nor generated. The participant is tasked with both identifying whether or not a test word is new as well as specifying the source of all test words identified as old. Two types of memory error can be measured using this task. The first is error in recollection, which reflects general memory functioning. The second is error in source attribution. When the source of a self-generated word is incorrectly attributed to the experimenter, an error in reality monitoring is said to have occurred.

When performance on the source monitoring task was measured for individuals diagnosed with schizophrenia, these individuals were found to make a significantly

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larger number of reality monitoring errors than healthy controls (Moritz, Woodward, & Ruff, 2003). Furthermore, schizophrenics were significantly more confident in their erroneous source attributions when confidence was measured, suggesting that they were, in fact, more likely than controls to believe their erroneous source attributions to be correct (Moritz et al., 2003). However, schizophrenics were no more likely than healthy controls to make errors in old-new judgments, nor were they any more likely to make other source monitoring errors such as falsely remembering words that were presented by the experimenter as having been self-generated (Moritz et al., 2003). This suggests that schizophrenics show a memory deficit that is specific to reality monitoring and results in faulty judgments concerning source attribution rather than uncertainty and incorrect guessing.

In further support of memory impairment in schizophrenia specific to the source of information, Moritz, Woodward, and Rodriguez-Raecke (2006) showed that schizophrenics were no more likely than healthy controls to produce false memories in the false memory paradigm. In this paradigm, words are presented to the participant and recognition is later tested. In the recognition test, critical lures are added that are highly related semantically to several of the previously presented words. These critical lures produce a significant amount of false recognitions in psychiatrically healthy individuals (Roediger & McDermott, 1995), but are no more likely to do so in schizophrenics (Moritz et al., 2006). This is meaningful because it shows that, even in a task sensitive to false recollection, schizophrenics do not produce more false memories that are unrelated to reality monitoring than healthy controls.

Furthermore, it was also found that schizophrenics again showed more confidence in their false memories than healthy controls in the false memory paradigm, as well as less confidence in their correct memories (Moritz et al., 2006). As the subjective richness of a memory is thought to give rise to the degree of confidence in the validity of that memory (e.g., Moritz et al., 2003), this suggests a general deficit in how information is both personally experienced and stored in schizophrenia and has fascinating implications regarding why a deficit in reality monitoring occurs. A generally accepted concept in memory research is that people make internal source monitoring distinctions based on the richness of their memories; more detailed memories suggest that a remembered event was perceived (externally generated) and not imagined (internally generated) (e.g., Moritz et al., 2003). If subjective confidence in the validity of a memory is closely related to the richness of that memory, it stands to reason that individuals with schizophrenia might blur the distinction between perceived and imagined experiences (Aleman, Hijman, de Haan, & Kahn, 1999). With little difference between internally and externally generated material on the dimension critical for

making source attributions, it would be expected that reality monitoring errors would be more likely to occur.

Evidence from fMRI

Behavioral evidence for a deficit in reality monitoring in schizophrenia is corroborated by evidence using functional magnetic resonance imaging (fMRI). In psychiatrically healthy individuals, the right prefrontal cortex, left inferior frontal cortex, and the parahippocampal and cerebellar cortex are normally highly active during the production of inner speech (i.e., talking to one's self silently), while the temporal cortex is bilaterally hypoactive (Frith et al., 1995; Shergill et al., 2003). These brain areas are believed to be critical in the processes of monitoring this kind of speech and differentiating it from externally generated speech (Frith et al., 1995; Shergill et al., 2003). Consistent with a reality monitoring deficit, these same brain areas do not show comparable levels of activation in schizophrenic patients when they generate inner speech (P. McGuire et al., 1995; Shergill et al., 2003). Furthermore, in psychiatrically healthy individuals, activity in the right angular gyrus and insula cortex is correlated with the degree of control over an object (Farrer et al., 2004). This same modulation was not found in schizophrenic patients, however, suggesting that they are less able to distinguish between the relative contributions of internally and externally generated commands in producing action (Farrer et al., 2004).

When psychiatrically healthy individuals engage in internally generated processes such as daydreaming and making evaluative judgments, the medial prefrontal cortex (mPFC) is highly engaged (Gusnard, E., Shulman, & Raichle, 2001; P. K. McGuire, Paulesu, Frackowiak, & Frackowiak, 1996; Zysset, Huber, Ferstl, & von Cramon, 2002). This area of the brain is believed to be critical in maintaining an attentional balance between externally and internally generated information. It also contributes to both the monitoring of source in real time and whether or not the source of information will later be remembered correctly (Burgess, Dumontheil, & Gilbert, 2007). Consistent with a reality monitoring deficit, when schizophrenic individuals later recall the source of internally generated information in the traditional source monitoring task, this same brain area is much less active than it is in healthy controls (Vinogradov, Luks, Schulman, & Simpson, 2008). This difference exists even though performance is accounted for, so it does not reflect the process of erroneous recall per se and rather seems to reflect a more general process upon which source judgments are based. The aforementioned findings corroborate the theories of hypofrontality mentioned in the introduction, and take a step forward by defining this deficit in terms of a more specific brain region and affected cognitive functioning.

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Evidence from Psychopharmacological Studies

Successful treatment with antipsychotic medication has been shown not only to reduce psychotic symptoms, but also to improve reality monitoring ability in schizophrenics (Keefe, Poe, McEvoy, & Vaughan, 2003). This suggests that the two phenomena are related and may be governed by either the same or related brain systems. Furthermore, successful treatment with antipsychotic medication increases PFC activity to normal levels (Honey et al., 1999), and hypoactivity in this area of the brain is implicated in reality monitoring deficits in schizophrenia (Vinogradov et al., 2008). In addition, higher dosages of antipsychotic medication are associated with less severe deficits in reality monitoring even when symptoms remain above diagnostic threshold (Moritz et al., 2003). This suggests that changes in the ability to effectively monitor reality that accompany successful treatment do not merely reflect an epiphenomenon of symptom improvement.

Evidence from Genetics Studies

It has long been understood that schizophrenia genesis can be explained, in part, by hereditary factors. The American Psychiatric Association (2000) estimates that individuals with a first degree relative who has schizophrenia are roughly ten times more likely to develop the disorder themselves. Furthermore, research that summarized the findings of several studies showed that the concordance rate for schizophrenia among monozygotic twins and dizygotic twins was 48% and 17%, respectively (Gottesman, 1991). The offspring of either of two monozygotic twins discordant for schizophrenia are equally likely to develop schizophrenia themselves (17%) (Gottesman & Bertelsen, 1989). This does not hold true for the offspring of dizygotic twins discordant for schizophrenia, however, as the offspring of the affected twin are much more likely to develop the disorder (17% and 2%, respectively) (Gottesman & Bertelsen, 1989).

Should deficits in reality monitoring be related to the etiology of schizophrenia, it would be expected that this deficit would also contain a heritable component. Indeed, a larger proportion of psychiatrically healthy first degree relatives of schizophrenics than is found in the general population show deficits in reality monitoring (Brunelin et al., 2007). Furthermore, these unaffected family members with reality monitoring deficits show a level of impairment intermediate between those diagnosed with the disorder and healthy individuals without a family history of schizophrenia (Brunelin et al., 2007).

Research into the genetic components of cognitive deficits in schizophrenia is only beginning, and, as a consequence, it has provided little conclusive evidence. One study identified a total of 63 types of messenger RNA that were differentially expressed in the PFC of schizophrenics, the area of the brain implicated in cognitive deficits generally and reality monitoring deficits specifically (Dean,

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Keriakous, Scarr, & Thomas, 2007). Most of these differentiations indicated below normal levels of expression, although their specific impact on the brain and behavior are not yet understood. In another study, one gene in particular was found to be differentially expressed in the PFC to a lesser degree in schizophrenics than in either healthy controls or patients with clinical depression, a gene that is specific to white matter genesis (Bertram et al., 2007).

Genes for synaptic vesicle genesis are not differentially expressed in the PFC of schizophrenics, suggesting that deficits in reality monitoring observed in schizophrenia are not the result of vesicle-dependent reductions (Glantz, Austin, & Lewis, 2000). Messenger RNA for parvalbumin, a calcium-binding protein, was expressed to a significantly lesser degree in GABA-containing neurons of the PFC of schizophrenics, however, possibly increasing inhibitory activity (Hashimoto et al., 2003). Genetic expression of the GABA synthetic enzyme glutamic acid decarboxylase 67 has also been shown to be abnormally low in the PFC of schizophrenics (Straub et al., 2007). Additionally, a specific single nucleotide polymorphism (SNP) within the gene that encodes for catechol-O-methyltransferase (COMT), a key enzyme involved in regulating dopamine transmission within the PFC, is often found in schizophrenics (Woodward, Jayathilake, & Meltzer, 2007); it is associated with reduced levels of extracellular dopamine and cognitive impairment (Stein, Newman, Savitz, & Ramesar, 2006).

Relation to Schizophrenia Symptomatology and Etiology

Since schizophrenic individuals are more likely than healthy controls to falsely remember internally generated material as arising from an external source, it is possible that this tendency is related to the development of delusional beliefs from imagined experiences (Moritz, Woodward, Whitman, & Cuttler, 2005). Certain imagined experiences could come to be understood as having actually occurred in the event that the source of those experiences is misplaced. The psychotic experience of thought insertion and delusions of control are particularly relevant to this hypothesis, as they exemplify a source misattribution. Furthermore, it has been suggested that hallucinations might arise from a tendency to attribute thoughts and words to other individuals or entities (Bentall, Baker, & Havers, 1991). In some ways, hallucinations might be understood as an extreme example of what might happen when the source of common internally generated experiences such as daydreaming is misplaced onto the external world. As would be predicted by the causal role of reality monitoring deficits in the development of schizophrenic symptoms, treatment with antipsychotic medication tends to not only alleviate psychosis but also improve performance on measures of reality monitoring ability (Keefe et al., 2003).

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Given these relationships between reality monitoring and schizophrenia symptomatology, in combination with the findings from genetics studies, there exists a possible role for a deficit in reality monitoring as providing the foundation for a schizophrenia diathesis. There is substantial evidence that both reality monitoring deficits and schizophrenic symptoms possess a hereditary component (Brunelin et al., 2007; Gottesman, 1991; Gottesman & Bertelsen, 1989). It is also clear that both reality monitoring deficits and psychotic symptoms exist on a continuum, and that these two variables are positively correlated (Brunelin et al., 2007). More severe schizophrenic symptoms are associated with greater reality monitoring deficits (Brunelin et al., 2006; Garrett & Silva, 2003), and healthy individuals who possess sub-threshold psychotic-like features show a deficit in reality monitoring intermediate between those who meet diagnostic criteria for schizophrenia and healthy individuals without psychotic-like features (Allen, Freeman, Johns, & McGuire, 2006). Such findings are consistent with the hypothesis that the degree of deficit in reality monitoring is impacted by genetic factors and related to the likelihood of developing psychotic symptoms under stress, with a greater deficit making schizophrenia genesis both more probable and more severe.

Conclusions and Future Directions

As has been shown, a deficit in reality monitoring represents a core feature of schizophrenia. Furthermore, this deficit can be used to provide a promising explanation of the symptomatology and etiology of the disorder. However, as far as research into reality monitoring in schizophrenia has progressed in recent years, far more has yet to be understood. Although reality monitoring seems to be linked logically to the onset of psychotic symptoms, a temporal relationship between the two has never been demonstrated. While healthy individuals with a family history of schizophrenia are more likely than other healthy individuals without such a history to show a moderate deficit in reality monitoring, such a deficit represents a point on a continuum that may not be relevant to psychotic symptoms. Therefore, it cannot be logically precluded that there is something about being schizophrenic that further impairs reality monitoring; a further deficit in reality monitoring might essentially be a phenotype of the disorder. While this may not seem likely, some form of evidence demonstrating that a severe deficit in reality monitoring, in fact, tends to precede frank psychotic symptoms is needed. Providing such evidence presents significant challenges, however, as an ambitious longitudinal design would be warranted.

Furthermore, the leading theory that explains how a deficit in reality monitoring arises emphasizes a blurring of the distinction between perceived and imagined experiences as a function of the richness of memories. This theory lacks adequate

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specificity, as there are three different ways that it can account for a deficit in reality monitoring. The first is that the richness of memories specific to internally generated information is diminished, making these memories more like those specific to externally generated information. The second is that the richness of memories specific to externally generated information is enhanced, making these memories more like those specific to internally generated information. The third involves some combination of the previous two. Future research needs to investigate which is correct in order to more fully elucidate how a reality monitoring deficit manifests itself, as well as why it is far less common for schizophrenics to attribute externally generated information to the self.

Another issue relevant to accounting for how a deficit in reality monitoring manifests itself in schizophrenia involves distinguishing between an error in encoding and an error in memory processes. Specifically, it is unclear whether a deficit in reality monitoring occurs as a consequence of how information is entered into and made sense of in the brain upon presentation, or whether this deficit occurs as a consequence of how properly encoded information is entered into and later retrieved from memory. This is a critical question for schizophrenia research to address, as one suggests a disorder of memory that, in turn, affects perception while the other suggests a disorder of perception that, in turn, affects memory. The author is unaware of any research that addresses this issue directly.

Should a deficit in reality monitoring indeed represent a schizophrenia diathesis, it would be of benefit to investigate the circumstances under which this diathesis comes to manifest as frank psychosis. Does a deficit in reality monitoring pose a valid risk factor for developing schizophrenia? If so, how strong of a predictor is it? What kinds of stressors and degrees of stressors tend to interact with a reality monitoring deficit to produce schizophrenia? The answers to these and similar questions are not only relevant to understanding the disorder, but also to developing potential means by which to help prevent it.

Research using fMRI has also yet to clarify how the brain activity of schizophrenics differs from the brain activity of psychiatrically healthy individuals who also show a deficit in reality monitoring. While it is not a theoretical necessity that these two types of individuals differ, such differences might reveal how and why some go on to develop the disorder while others do not. Similarly, it would be interesting to analyze differences in brain activity across various sub-types of schizophrenia to see if certain types of symptoms are related to certain activation patterns.

Finally, the genetic bases for both reality monitoring deficits and schizophrenia more generally are only beginning to be understood. However, certain differences in genetic structure and gene expression between schizophrenics and healthy individuals have been identified, and these differences need to be explored. The

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findings from this research will shed much light on who is at risk for developing schizophrenia, and may pave the way for more targeted treatments that will better address the underlying causes of the disorder.

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