

Understanding Psychosis: An Examination of Language Comprehension Impairments in Schizophrenia and the Cognitive Neuroscience Model of Memory

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ABSTRACT

The purpose of the present literature review was to assess language comprehension in adults with schizophrenia. Impairments in this area have been largely attributed to problems in semantic and working memory. The former deficits are linked to poor semantic memory networks and working memory issues, which lead to disturbances in incorporating contextual cues as well as a decrease in memory capacity. In this review, it is proposed that these two well-known theories are not as independent as past research has suggested, but mutually interact to better explain the nature of the presenting deficits.



“With his left hand, Thomas enacted each of the steps he’d rehearsed in his mind. Slicing at the point of his right wrist, he crunched through the bone, amputating his hand cleanly with the sharp knife ... When you’re the sane brother of a schizophrenic identical twin, the tricky thing about saving yourself is the blood it leaves on your hands ” (Lamb, 1998, p. 5). In every sense, Thomas’ erratic behavior lies at the heart of the psychiatric term, psychosis. Initially introduced into psychiatric literature and used synonymously with psychic neurosis, psychosis was derived from the Greek word psyche, meaning soul (Bürgy, 2008). Subdivided into two groups, one of which was entitled schizophrenia disorders by Kraepelin and Bleuler, psychosis developed a slightly new meaning and led to the development of a complex dichotomous disorder (Bürgy, 2008).

Described as a challenge to psychology and affecting approximately one percent of the world’s population, schizophrenia, affects human behavioral, perceptual and cognitive

characteristics. The complex nature of the disorder has left linguists, neurolinguists and psycholinguists dumbfounded by the true essence of language dysfunction in schizophrenia (Kuperberg & Caplan, 2003; Titone, 2010). Researchers have managed to extensively document language production abnormalities, but language comprehension impairments have received much less attention as the problems are more subtle and difficult to document (Kuperberg, 2010a). Still, findings have isolated a relationship or interplay between language processing deficits and underlying memory networks (Condray, Yao, Steinhauer, van Kammen, Reddy, & Morrow, 2008). Simply, the role of semantic and working memory deficits will be explored in explaining dysfunctions in language comprehension in adults with schizophrenia through a review of past studies. Also, an examination of the role of these abnormalities in enhancing understanding of the cognitive neuroscience model will also be discussed.

Two of the most prominent and well-known theories credit deficits in the structure and function of semantic memory deficits, as well as the inability to apply contextual working memory cues to language communication impairments (Kuperberg, 2010b). Disturbed language function shows an abnormal activation of words or concepts stored in semantic memory, and is likely due to the inability at matching a word when the word is placed in a given context (Salisbury, Shenton, Nestor, & McCarley, 2002). On the other hand, working memory issues refer to specific task deficits, capacity and context in assessing language comprehension (Salisbury et al., 2002). As explained by Baddeley, there is an independent context which does not hinder semantic interpretations of the target words or sentences, and an interactive context which highlights the mutually-dependent role of context and semantic interpretation of targets (Bazin, Perruchet, Hardy-Bayle, & Feline,

2000). Thus, semantic and working memory theories may not be as mutually exclusive as was initially thought but share a complementary union instead (Niznikiewicz, Mittal, Nestor & McCarley, 2009).

Proper semantic network functioning in a healthy individual depends on the ability to activate related networks and to disregard unrelated ones through automatic priming and cognitive skills. Patients with schizophrenia have difficulty doing so (Kuperberg, 2010; Niznikiewicz et al., 2009). This difficulty is not necessarily because of disturbances in semantic memory or working memory but of a combined impairment. A patient with schizophrenia tends to have difficulty in determining whether or not a word is appropriate even when placed in a meaningful sentence (Kuperberg & Caplan, 2003).

Under experimental conditions using short Stimulus Onset Asynchrony (SOA; i.e. interval between the onset of the prime and target words), semantic networks are activated and depend on semantic context and automatic priming abilities (Mathalon, Faustman, & Ford, 2002; Kuperberg, 2010a). Especially in indirect priming cases, whereby the prime word *lion* is “semantically associated” with the target word *stripes* through an unmentioned word *tiger*, a semantic connection is due to automatic skills (Kuperberg, 2010a). In this sample, the majority of patients with schizophrenia (1 woman, 17 men, $M_{age} = 40.0$) did show reduced semantic priming effects at long SOAs. At long SOAs, the patient is not time restricted and has the opportunity to use cognitive strategies, which are more dependent on working memory (Mathalon et al., 2002). In these scenarios, the patient has trouble semantically categorizing related target words, and shows working memory deficits in holding information in their memory over time. Simply, processes that promote priming are overtaken by working memory deficits. (Condray, Siegle, Keshavan & Steinhauer, 2010; Kuperberg, 2010b; Mathalon et al., 2002).

In a recent study, normal participants (7 women, 7 men, $M_{age} = 31.4$) and participants with schizophrenia (7 women, 7 men, $M_{age} = 34.4$) were presented with word pairs that differed in terms of semantic association and frequency (Condray et al., 2010). Immediately after the word pair, letter probes were shown that were completely unrelated to the initial word pair (Condray et al., 2010; Kuperberg, 2010a). In comparison to the control group, the schizophrenia group showed a lower N400 amplitude in response to semantic relatedness and word frequency. The N400 is the most important component in terms of semantic meaning and processing, and is sensitive to errors or semantic anomalies (Fernández & Cairns, 2010, p. 89). These patients also seemed to have a lot of difficulty identifying and selecting the semantically-associated word pairs over the

non-associated word pairs (Condray et al., 2010). Evidence from this study suggests that schizophrenia patients exhibit a semantic deficit, as shown by the failure to effectively select meaningful target words in response to the prime. This same group also has poor working memory by not accounting for word frequency in their target selection choice.

For the most part, language as a whole is typically associated with the left hemisphere in adults; however, it has been suggested that language comprehension is a process belonging to the right hemisphere too (Joss & Virtue, 2009). During semantic priming tasks, unclear words tend to have more activation in the right hemisphere, as compared to clearer words which show larger activation in the left hemisphere (Joss & Virtue, 2009). In one study, healthy adult subjects (7 women, 8 men, $M_{age} = 24$) and schizophrenia adult patients (5 women, 9 men, $M_{age} = 26$) took part in a lexical decision task (Mohr, Pulvermüller, Rockstroh, & Endrass, 2008). In this task, participants were shown letter strings with meaningful or pseudo-type words. The data implied that the left hemisphere plays a greater role in the processing of word stimuli, but that schizophrenia patients definitely show an impaired transfer of information between both hemispheres (Mohr et al., 2008). More importantly, words presented bilaterally did not activate both hemispheres. The dominant left hemisphere did not play such a prominent role in schizophrenia patients either, illustrating that the right side does not successfully transfer information to the left. A few explanations have been hypothesized to account for this discrepancy, such as decreased activation levels or poor integration skills (Mohr et al., 2008). Unlike normal patients which display equal activation levels in the left hemisphere for strong and weak associations, the results from the Mohr et al. (2008) study reinforced current neuropsychological evidence that language activity in the left hemisphere in schizophrenia is impaired, and potentially attributable to deficits in semantic and working memory.

This poor working memory deficit is also displayed with regards to contextual information (Bazin et al., 2000). It was found that providing schizophrenia patients with additional contextual information does not improve cognitive performance (Kuperberg, 2010b). In a French experiment, schizophrenia patients (8 women, 22 men, $M_{age} = 32.4$), were shown incomplete sentences and asked to fill in the missing parts with the first word they deemed fit (Bazin et al., 2000). Approximately half of the words were defined as ambiguous clauses. An example of this is the French word, *serviette*, which is used to refer to a briefcase or a napkin (Bazin et al., 2000). Immediately after the presentation of an ambiguous clause, the patients were shown a context clause that primed multiple word meanings. While

it has clearly been shown in past research that schizophrenia patients display what Baddeley termed as “interactive contexts”, the findings from this study only found deficits in interactive contexts in patients with thought-disorder (Bazin et al., 2000).

The precise role of semantic memory and working memory has been assessed through research on homographs, which are words with the same spelling but have a different meaning and/or pronunciation. Homographs show the role of context in semantic associations (Salisbury et al., 2002). Sitnikova, Salisbury, Kuperberg, and Holcomb (2002) conducted an experiment where ERPs were used to look at sentence processing abnormalities that had the potential to activate context-inappropriate semantic links. Contrary to earlier studies which assessed individual word pairs or short sentences, this study looked at more natural language tasks. Sentences eliciting context-inappropriate associations were created and implanted with one or more target words; for example, *The book must have great stories because the author won an award* (Sitnikova et al., 2002). In half of the cases, the final target word matched the context of the clause in which it was embedded, *The book must have great stories because the author won an award for it*; while in the remaining half, the target word was not congruent with the context of the clause, *The skyscraper had ninety stories because the author won an award*. In both of these examples, the target word *author* was semantically-meaningful to the homographic word *stories* (Sitnikova et al., 2002). Participants with schizophrenia (1 woman, 11 men, $M_{age} = 37.7$) and subjects in the control group (1 woman, 11 men, $M_{age} = 25.5$) were asked to read the sentences normally as if they were engaging in a general reading comprehension assignment. During this process, the subjects needed to determine if the assigned target word that immediately followed the clause was relevant to the meaning of that sentence (Sitnikova et al., 2002). The findings here suggest that individuals with schizophrenia have impaired sentence processing only when the context-inappropriate homograph interfered with this process. Unlike normal individuals, those with schizophrenia cannot inhibit the context-inappropriate homograph from obstructing the meaning of the sentence as a whole (Sitnikova et al., 2002).

In sum, adult individuals with schizophrenia display numerous abnormalities and impairments in terms of cognitive processes. Most emphasis has been placed on semantic and working memory deficits in accounting for these abnormalities. In many cases, semantic deficits are attributed to poor structural and functional mechanisms. Working memory deficits are thought to be due to a failure at incorporating contextual cues, poor integration of stimuli and a decreased memory capacity. It appears that the ma-

jority of past research in this area has been studied in terms of language production and positive thought disorder. While the evidence from these studies is much clearer in establishing associations between production impairments in schizophrenia and these two theories, it is only through an understanding of language comprehension that production can be better understood as well.

Furthermore, abnormalities in semantic and working memory tend to have been researched as individual theories with little attempt to evaluate them as a combined influence to the field of language and schizophrenia. In this brief literature review, studies have been selected with the aim of highlighting the role of semantic and working memory within a single experimental task, or if not, how one or the other may be used to account for the research findings. While the studies discussed have really only focused on laboratory tasks, there is still a need to understand these mysterious abnormalities from a constrained and controlled viewpoint. Schizophrenia is a multifaceted mental disorder, and testing in laboratory settings may be the only way for researchers to attain some sort of control. Nevertheless, there is a movement towards the assessment of more natural comprehension tasks in the efforts of increasing internal and external validity. Gradually, researchers are shifting from the study of single-word recognition, to sentence completion, and now discourse analysis to show real-world cognitive functioning. Each of these efforts and advancements contributes to a more appreciative understanding of the cognitive neuroscience model of memory and of language.

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Résumé

L'objet du présent examen de la littérature était d'évaluer la compréhension linguistique chez les adultes atteints de schizophrénie. Les déficiences dans ce domaine ont été grandement attribuées aux problèmes de sémantique et de mémoire de travail. Ces derniers déficits sont liés à des réseaux de mémoire sémantique faibles, qui mènent à des désordres dans l'intégration des indices contextuels ainsi qu'à une diminution dans la capacité de mémoire. Dans cet examen, on suggère que deux théories bien connues ne sont pas indépendantes comme le supposait la recherche passée, mais interagissent mutuellement pour mieux expliquer la nature des déficits présentés.



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