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# Comparing implicit and explicit semantic access of direct and indirect word pairs in schizophrenia to evaluate models of semantic memory

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## ABSTRACT

Semantic memory deficits in schizophrenia (SZ) are profound, yet there is no research comparing implicit and explicit semantic processing in the same participant sample. In the current study, both implicit and explicit priming are investigated using direct (LION–TIGER) and indirect (LION–STRIPES; where tiger is not displayed) stimuli comparing SZ to healthy controls. Based on a substantive review (Rossell and Stefanovic, 2007) and meta-analysis (Pomarol-Clotet et al., 2008), it was predicted that SZ would be associated with increased indirect priming implicitly. Further, it was predicted that SZ would be associated with abnormal indirect priming explicitly, replicating earlier work (Assaf et al., 2006). No specific hypotheses were made for implicit direct priming due to the heterogeneity of the literature. It was hypothesised that explicit direct priming would be intact based on the structured nature of this task. The pattern of results suggests (1) intact reaction time (RT) and error performance implicitly in the face of abnormal direct priming and (2) impaired RT and error performance explicitly. This pattern confirms general findings regarding implicit/explicit memory impairments in SZ whilst highlighting the unique pattern of performance specific to semantic priming. Finally, priming performance is discussed in relation to thought disorder and length of illness.

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## 1. Introduction

### 1.1. Semantic deficits in schizophrenia

Semantic memory is described as our “general knowledge store” (Kintsch, 1980; Tulving, 1972) and theory suggests that it is organised in such a way that related ideas are stored together in a network of concepts (Minzenberg et al., 2002). The idea that a disruption to one’s understanding and memory for general knowledge contributes to schizophrenia symptomatology is appealing. Investigators have suggested a link between psychotic symptoms and impaired general knowledge for over a century (McKenna and Oh, 2005). Statements alluding to dysfunction in the semantic system have included the idea of a ‘weakness of stored regularities’ (Hemsley, 1987) or ‘deficient real world knowledge’ (Cutting and Murphy, 1988). The semantic deficits associated with schizophrenia (SZ) have been investigated using various tasks including fluency measures (Bokat and Goldberg, 2003; Henry and Crawford, 2005),

‘silly sentences’ tasks (Rossell et al., 1998) and, most commonly, semantic priming tasks (Pomarol-Clotet et al., 2008; Rossell and Stefanovic, 2007). Priming tasks require participants to respond to word pairs and the priming effect describes the speeded response to those pairs that are related (CAT–DOG) over those that are unrelated (CAT–BANANA).

### 1.2. Direct vs. indirect priming

Priming studies generally use pairs that are directly related through category (DRUM–PIANO) or association (DRUM–BEAT). The results in SZ using directly related pairs are mixed. Some research finds increased (Chenery et al., 2004; Rossell and David, 2006; Weisbrod et al., 1998), some decreased (Aloia et al., 1998; Besche et al., 1997; Ober et al., 1997; Passerieux et al., 1997; Rossell and David, 2000) and some normal (Chapin et al., 1992; Minzenberg et al., 2003; Quelen et al., 2005; Spitzer et al., 1993; Surguladze et al., 2002) priming. The variations in results have been proposed to reflect differences in task design and participant demographic and symptom profiles (Pomarol-Clotet et al., 2008; Rossell and Stefanovic, 2007). Indirectly related pairs are also used in semantic priming research. Indirect pairs describe those related by a third concept as, for example TEA–BEAN (connected

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by COFFEE). While healthy participants are typically quicker to respond to direct than indirect pairs (Sass et al., 2009), a review of those studies using indirect stimuli in SZ suggests that results are characterised by enhanced indirect priming (Rossell and Stefanovic, 2007). The spreading activation model is able to account for this effect, suggesting that it reflects a failure of inhibition in the network. As a result of this failure, distant associations which would normally be inhibited remain available, leading to enhanced indirect priming. This unusual finding, and its interpretation, have been supported by a review (Rossell and Stefanovic, 2007) and a meta-analysis, especially amongst those with thought disorder (Pomarol-Clotet et al., 2008).

### 1.3. *Implicit vs. explicit access*

There is evidence of dissociations in implicit and explicit memory function. These data come from the performance of amnesic patients (Gabrieli et al., 1995) and the elderly (Gopie et al., 2011). In addition, some studies have found differences in implicit and explicit access across episodic and semantic memory (Danion et al., 1989). Studies of Alzheimer's patients find greater impairments during explicit than implicit semantic access (Rogers and Friedman, 2008). Despite the knowledge that semantic memory is impaired in SZ (McKay et al., 1996), and that implicit and explicit semantic access can be differentially impaired in other conditions, very little research has investigated these different access routes separately and comparatively for semantic memory in SZ.

Semantic priming experiments are generally regarded as implicit in nature due to the fact that they (1) do not allude to the true nature of the experiment, and (2) provide a distractor task to further reduce awareness of the experiment's true purpose (Kreher et al., 2009a; Kuperberg et al., 2008; Neill et al., 2011; Rissman et al., 2003; Rogers and Friedman, 2008). The distractor task often includes a pseudo word as the second word in the pair (CAT-VOSH), and the participants are instructed to determine whether the second word from each pair is real or not. Explicit semantic tasks on the other hand include instructions directing attention to the semantic relatedness of stimuli. Participants are told to use semantic categories in the formulation of responses or to judge semantic category membership (Giffard et al., 2001).

### 1.4. *Implicit/explicit and direct/indirect semantic priming*

In terms of explicit semantic access, three studies have reported intact accuracy and reaction time (RT) priming in SZ using directly related stimuli (Kiang et al., 2011; Kreher et al., 2009b; Moeller et al., 2005). Kraut et al. (2002) created an indirect explicit task that required participants to determine whether two words, for example, HONEY-STINGS, evoked the idea of another concept (BEE). Assaf et al. (2007) used this task in a SZ sample and found that participants were slower than controls to categorise related pairs correctly and incorrectly categorised unrelated pairs as related more often. Thus, the literature to date in SZ has suggested normal explicit processing with direct stimuli, and abnormal function when using indirect stimuli.

In addition, one study has used the same implicit and explicit tasks as those used in the current study to examine healthy controls under the influence of ketamine (a psychomimetic drug) (Neill et al., 2011). The results found that ketamine led to increased indirect implicit priming as per SZ (Pomarol-Clotet et al., 2008; Rossell and Stefanovic, 2007), and increased errors in direct implicit priming. The explicit results were in line with SZ findings with normal direct processing and more errors when processing indirectly related pairs (Kiang et al., 2011; Kreher et al., 2009a; Lecardeur et al., 2007).

To examine the semantic processing of direct and indirect pairs both implicitly and explicitly, four tasks were employed. Two implicit tasks (direct and indirect) were created for this experiment. Both tasks included short presentation times and a distractor task. Regarding the explicit condition (Kraut et al., 2002), an indirect task (known as the 'Objects' task) was used. A direct task (named the 'Association' task) was created based on the format of Kraut's indirect task. The inclusion of the four tasks allows for a balanced design and will provide a full picture of semantic processing performance in SZ.

This is the first study to compare the same SZ group across both implicit and explicit semantic tasks using directly and indirectly related pairs. In terms of the implicit task performance, it is hypothesised that the SZ group will demonstrate increased indirect priming in comparison to controls. No specific hypothesis is made for the implicit direct task due to the mixed results in the literature. For the explicit tasks, it is hypothesised that on the indirect task, SZ participant performance will be associated with abnormalities in both RT and error data as found in Assaf's study. The direct 'Association' task has not been used in SZ, but it is predicted that performance on this task will not differ between groups because the task requires recognising more simple direct relationships with instructions and a longer response window for information processing (2.7 s). Finally, because of the findings of the meta-analysis by Pomarol-Clotet et al. (2008) that suggested greater indirect priming in those with thought disorder, it is hypothesised that there will be a positive correlation between degree of priming and level of thought disorder.

## 2. **Methods**

### 2.1. *Participants*

Eighteen SZ participants were outpatients who responded to advertising in supported accommodation and community mental health services; and four inpatients at the Alfred Hospital Melbourne who were willing to participate with their consulting psychiatrist's permission. Diagnosis and symptom profile were investigated using the Structured Clinical Interview for DSM-IV (SCID) (First et al., 1997) and current symptoms were evaluated using the Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987). All patients needed to score > 40 but < 80 on the total PANSS as well as to have a clinical diagnoses of schizophrenia to be accepted into the study (Leucht et al., 2005). This ensured all patients were mild to moderately unwell at the time of testing, but not severe, to ensure that they were able to provide consent and understand all study instructions. Thought disorder (TD) was additionally rated throughout the SCID using the Thought, Language and Communication scale (TLC) (Andreasen, 1979). Twenty-one healthy controls were recruited from advertisements around the Alfred Hospital and Monash University. They were screened for psychiatric illness using the Brief Psychiatric Rating Scale (BPRS) (Overall and Gorham, 1962) and were excluded if they had any history of psychiatric illness.

### 2.2. *Implicit priming tasks*

The stimuli for direct and indirect implicit priming tasks included 60 related word-word pairs and 30 word-pseudo-word pairs. From these stimuli, two word lists were created (A and B). In version A, 30 of the 60 word-word pairs remained related, while the other 30 pairs were re-arranged so that they now formed unrelated pairs. In version B, these relationships were counterbalanced, so that related pairs from list A were randomly re-assigned to create unrelated pairs, and the unrelated pairs were arranged back into their related word pairing. Both lists A and B also included 30 pseudo-word pairs. A short stimulus onset asynchrony (SOA) (250 ms) was used as this is the length of time commonly adopted by studies investigating 'unconscious' processing (Rossell and Stefanovic, 2007). Primes were presented for 200 ms, followed by a 50-ms inter-stimulus interval. The target was presented for 200 ms and with an additional 2000 ms response window. Participants were able to respond from the time the target appeared on screen. The lists were matched on number of letters, syllables and phonemes in each word, frequency, concreteness and imageability. Pseudo-words were pronounceable and legally spelled letter strings (e.g. pont) and were selected from the ARC pseudo-word database (Rastle et al., 2002). These tasks can be considered implicit because participants are not told that the pairs they are responding to may be related. Instead, they are given a distractor lexical decision task. They are

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