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Processing spatial–temporal information in recent-onset schizophrenia: The study of short-term memory and its susceptibility to distraction

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Abstract

Memory impairment is a core feature in schizophrenia (SZ). The aim of this study was to investigate short-term memory (STM) and its sensitivity to distraction with visual–spatial material. This study comprised 23 recent-onset SZ patients and 23 healthy controls. The degree of disruption upon recall from interleaving irrelevant items within a sequence of to-be-remembered items—the sandwich effect [Hitch, G. J. (1975). The role of attention in visual and auditory suffix effects. *Memory and Cognition, 3*, 501–505]—was examined. STM performance, whether in the presence or absence of distraction, was poorer and markedly more vulnerable to disruption in SZ. Our results suggest that processing spatial information in STM is susceptible to interference in SZ.

Keywords: Schizophrenia; Spatial information; Short-term memory; Serial memory; Distraction; Selective attention; Recent-onset

1. Introduction

Many researchers view attentional control and short-term memory (STM) processing dysfunctions in schizophrenia (SZ) as core features of the disorder. However, most, if not all, of the work on STM and its interaction with selective attention has focused on processing of verbal items. Yet, processing of spatial information seems to be particularly affected in SZ (Park & Holzman, 1992) and it is not clear whether dysfunctional attentional processes are responsible, at least in part, for the observed deficits in spatial STM (see Lee & Park, 2005, for a discussion). In the current study, we examine the capacity to remember temporal–spatial information over the short-term and its susceptibility to distraction within a paradigm well established in experimental cognitive psychology: the sandwich paradigm (Hitch, 1975; Tremblay, Nicholls, Parmentier, & Jones, 2005).

The interplay of STM and selective attention is usually investigated through the manipulation of distraction, either present or absent when a sequence of to-be-remembered (TBR) items is learned. Oltmanns and Neale (1975) developed a procedure known as the *Digit Span Distractibility Test* (DSDT), in which irrelevant items (digits said in a female voice) are interleaved with TBR items (digits read in a male voice). If, for serial recall of spoken lists, irrelevant items are interpolated between TBR items, there is a significant increase in recall errors for SZ patients as well as for healthy participants (e.g., Corrigan & Green, 1991; Harvey & Pedley, 1989; Oltmanns, 1978; Oltmanns & Neale, 1975; Rund, 1989). However, this limitation is more pronounced in SZ. Typically, SZ patients recall fewer items than controls whether the TBR list is presented with or without interleaved distractors but the presence of distractors has a much greater impact on recall for SZ patients. Indeed, for a list of six digits, the magnitude of disruption

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can reach up to 46% in the recall performance of SZ patients and up to 26% for healthy subjects (Frame & Oltmanns, 1982; see Spring, Weinstein, Freeman, & Thompson, 1991, for a meta-analysis).

In the study of normal cognition, a procedure similar to that of the DSDT is referred to the sandwich effect paradigm (e.g., Hitch, 1975). The mere interpolation of auditory irrelevant items within a sequence of TBR items produces a robust but small deleterious effect upon serial recall (e.g., Baddeley, Papagno, & Andrade, 1993; Nicholls & Jones, 2002). The so-called sandwich effect has recently been replicated with lists of visual–spatial items (Tremblay et al., 2005), using the dot task, regarded as a good analogue of the typical verbal serial recall task and a procedure that minimizes the possibility that spatial information be verbally recoded (see Jones, Farrand, Stuart, & Morris, 1995). When seeking if a verbal memory phenomenon can be reproduced in the spatial domain it is critical to ensure that the TBR information is truly spatial and nonverbal.

In SZ, there is a relative dearth of studies on spatial STM, especially for temporal–spatial information and the effect of visual–spatial distraction. From reviewing the literature, it seems consistent across studies that spatial STM is impaired (but see Salame, Danion, Peretti, & Cuervo, 1998, for a different view), though the variability in the procedures is considerable. There is ample evidence that processing of spatial information is dysfunctional as observed in variants of delayed response and delayed perceptual discrimination tasks (e.g., Park & Holzman, 1993; Tek et al., 2002). Typically, in such tasks, a target is briefly displayed, followed by a delay, and then, participants have to respond by locating or detecting the target. Those tasks are very different to serial recall procedures in terms of memory load and response requirements. With regard to serial recall or sequence reproduction of spatial material (e.g., the Corsi block task), most researchers have observed marked deficits (Fleming et al., 1997; Fraser, Park, Clark, Yohanna, & Houk, 2004; Stone, Gabrieli, Stebbins, & Sullivan, 1998), while some others failed to find a significant difference between SZ patients and controls (see Clare, McKenna, Mortimer, & Baddeley, 1993). However, the balance of evidence weighs strongly for a genuine impairment, and thus supports the claim that the deficit in STM processing is not restricted to verbal material (see, e.g., Chey, Lee, Kim, Kwon, & Shin, 2002).

According to Fischer (2001) there are two key components in spatial serial recall procedures that contribute to the memory load: serial order and spatial location. This observation also applies to verbal serial recall, which requires processing item and order information. In the case of spatial material, the location of the blocks (Corsi block task) or dots (dot task) represents item information. Using a computerized version of the Corsi block task, Dreher and his collaborators (2001) developed variants of the task that selectively tap either on spatial recall (item) or temporal recall (order). They obtained a significant difference in performance between the SZ group and the healthy subjects on the spatial but not on the temporal version of the task. The latter pattern of results observed in the spatial domain suggests that item memory is altered in SZ rather than order memory (see also Fraser et al., 2004); which parallels with the finding that order memory is preserved in verbal serial recall (Elvevag, Weinberger, & Goldberg, 2001).

To our knowledge, the impact of visual–spatial distraction on STM for visual–spatial information has never been tested in SZ. In the case of verbal serial recall, there is ample evidence that SZ patients are more sensitive to distraction than controls. One key question is whether this pattern of distraction with recall also extends to spatial STM. Based on what is probably the most influential model of STM, the so-called Working Memory (WM) model (Baddeley, 2003; see also Baddeley & Hitch, 1974), one could expect to find a different pattern of distraction for spatial STM. A key assumption of the WM model is that STM is divided into separate subsystems such as the visual–spatial sketchpad and the phonological loop (respectively responsible for processing visual images and verbal material). This view is based around the premise that the cognitive architecture is divided into separate modules, such as verbal or spatial components. However, there is accumulating evidence, that, at least for processing serial order, spatial and verbal STM are functionally equivalent. Both show similar serial position curves, with primacy and marked recency effects (e.g., Jones et al., 1995; Smyth & Scholey, 1996) and are sensitive to interference effects or distraction (e.g., Tremblay, Macken, & Jones, 2001; Tremblay et al., 2005). In order to test whether the susceptibility of STM to distraction, for spatial material, is more pronounced in SZ than in healthy controls, we propose to employ the visual–spatial version of the sandwich paradigm. This will allow us to determine whether the type of deficits reported for verbal STM (e.g., Corrigan & Green, 1991; Harvey & Pedley, 1989; Oltmanns, 1978; Oltmanns & Neale, 1975; Rund, 1989) is also found with spatial material, that is, a greater impact of distraction in patients with SZ in comparison with healthy controls. In addition, we chose to test the previously mentioned hypotheses with recent-onset participants to minimize the risk of a prevalence bias (i.e. the tendency for prevalent cases being more likely to include an overproportion of more severe cases more likely to show more severe neuropsychological impairment; Lehoux et al., 2003; Roy et al., 2003).

2. Method

2.1. Participants

The total sample included 46 participants [23 recent-onset SZ patients (19 males, 4 females) and 23 healthy controls (19 males, 4 females)] (see Table 1). All patients were outpatients suffering from SZ [paranoid ($n = 19$), undifferentiated ($n = 3$), disorganized ($n = 1$)] with a mean duration of illness of 26 months. They were all treated with