

# Neuropsychological substrates and everyday functioning implications of prospective memory impairment in schizophrenia

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## Abstract

Individuals with schizophrenia demonstrate impairment in prospective memory (ProM), which describes the multifaceted ability to execute a future intention. Despite its clear implications for everyday functioning, the neuropsychological substrates and functional correlates of ProM impairment in schizophrenia remain poorly understood. In this study, the Memory for Intentions Screening Test (MIST), a standardized measure of ProM, was administered to 72 outpatients with schizophrenia or schizoaffective disorder as part of a comprehensive neuropsychological and psychiatric research evaluation. Results showed that ProM was positively correlated with standard clinical tests of attention, working memory, processing speed, learning, and executive functioning, but not delayed recall. In the context of multiple neuropsychological predictors, learning ability was the only domain that independently contributed to ProM. Importantly, better ProM was predictive of higher functional capacity (as measured by the UCSD Performance-Based Skills Assessment-Brief Version), above and beyond the variability explained by demographic and disease factors. Analysis of component processes revealed that event-based ProM, as well as no response (i.e., omission) and task substitution errors were the strongest predictors of everyday functioning. Overall, these findings suggest that ProM impairment in schizophrenia is associated with multiple cognitive substrates, particularly episodic learning deficits, and plays an important role in everyday living skills. Studies regarding the potential effectiveness of ProM-based remediation strategies to improve functional outcomes in schizophrenia are indicated.

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## 1. Introduction

The cognitive impairments of schizophrenia are numerous and disabling (Elvevag and Goldberg, 2000; Green et al., 2004; Heaton et al., 2001; Twamley et al., 2002). Episodic learning and memory deficits are particularly common and involve higher-level encoding and retrieval difficulties in the context of intact retention of learned information (Aleman et al., 1999); functional

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neuroimaging studies implicate prefrontal systems dysfunction rather than temporal lobe dysfunction in the learning and memory deficits of schizophrenia (Seidman et al., 1994; Achim and Lepage, 2005).

Prospective memory (ProM), known colloquially as “remembering to remember,” is an aspect of episodic memory that involves the formation, maintenance, and execution of future intentions and has significant implications for daily functioning (Kvavilashvili and Ellis, 1996). However, ProM has been relatively understudied in schizophrenia, particularly in comparison to retrospective memory. ProM is a multi-step cognitive process conceptualized to function in four stages (Carey et al., 2006; Einstein and McDaniel, 1990; Knight, 1998): (1) *Intention formation* involves encoding the intention and its corresponding action, requiring both organizational and planning skills. (2) The *delay maintenance interval* requires retaining the intention during unrelated activities, and may require time monitoring to respond to time cues. (3) *Self-initiated cue recognition and intention retrieval* involves recognizing a cue (a specified time or event) and retrieving the appropriate response; this is a defining feature of ProM because the recall must be self-initiated. (4) *Intention execution* involves performing the intended task. Given the inherent complexity of this model, ProM is purported to depend upon the integrity of multiple cognitive abilities associated with frontostriatal and temporolimbic systems (Simons et al., 2006), including executive functions, working memory, episodic retrospective memory, and information processing speed (e.g., Carey et al., 2006).

The literature on ProM in schizophrenia suggests that affected individuals are slow in recognizing the content of intended actions (Kondel, 2002) and are impaired on event-based ProM tasks (Elvevag et al., 2003; Kumar et al., 2005; Shum et al., 2004). Although Shum and colleagues (2004) found disproportionate impairment on time-based versus event-based ProM tasks, our group (Woods et al., 2007b) observed no such discrepancy using a pair of psychometrically balanced tasks. We found that outpatients with schizophrenia were comparably impaired on time- and event-based ProM, performing over one standard deviation worse than healthy comparison participants, but demonstrating intact multiple-choice recognition of intentions (Woods et al., 2007b). ProM impairment was not related to diagnosis (schizophrenia vs. schizoaffective disorder), medication type or dosage, or disease duration, but was associated with older age and more severe negative symptoms. The most common types of ProM failures were omission errors (i.e., not responding to the cue at all), responding

to the cue at the wrong time, or performing the wrong intention in response to a cue. We concluded that ProM deficits in our sample were due to impaired cue detection and self-initiated intention retrieval, rather than consolidation problems; further, we suggested that the executive components of ProM, such as time monitoring and self-directed retrieval, play an important role in everyday ProM failures.

Extending our prior work, this study aimed to examine the neuropsychological substrates and day-to-day impact of ProM impairment in schizophrenia. First, we hypothesized that ProM performance would be positively correlated with performance on tasks of attention, working memory, learning, and executive functioning, and lower negative symptom severity. Our second hypothesis was that ProM performance would be significantly associated with functional skills performance. Despite the clear implications of ProM integrity for the performance of instrumental activities of daily living, no prior studies have evaluated this issue in schizophrenia. For example, ProM abilities are needed to remember event-based or time-based activities (e.g., remembering to take a medication with breakfast or at a certain time of day, respectively). Indeed, data from other clinical samples (e.g., HIV infection and traumatic brain injury) show that ProM is a robust predictor of everyday functioning (e.g., Woods et al., *in press-a*; Fortin et al., 2003). Greater understanding of the neuropsychological substrates and functional correlates of ProM impairment will advance our understanding of ProM impairment in schizophrenia and may inform rehabilitation planning to improve everyday behaviors reliant on ProM, such as taking medications, working, engaging in social activities, and managing a household.

## 2. Materials and method

### 2.1. Participants

Participants included 72 outpatients with DSM-IV (American Psychiatric Association, 1994) diagnoses of schizophrenia ( $n=33$ ), schizoaffective disorder ( $n=37$ ), or psychosis not otherwise specified ( $n=2$ ). All diagnoses were made by the treating psychiatrist and confirmed via diagnostic chart reviews by trained research staff using DSM-IV criteria. Demographic and clinical variables are presented in Table 1. The mean age of the sample was 46 years and the mean education level was 13 years. The majority of participants were male (67%) and Caucasian (58%), however, minority participants were also well represented in the sample,

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