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Prospective memory in clinical populations [post-print]

Sarah Raskin
Trinity College, sarah.raskin@trincoll.edu

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Sarah A. Raskin[1,2]

[1]Neuroscience Program, Trinity College, Hartford Connecticut
[2]Department of Psychology, Trinity College, Hartford Connecticut

address for correspondence:
Sarah Raskin
Department of Psychology and Neuroscience Program
300 Summit Street
Hartford CT, USA
Sarah.raskin@trincoll.edu

Abstract

Objective:
Prospective memory (PM) has emerged as a form of episodic memory that is frequently impaired in a variety of clinical populations. Neuropsychologists who routinely evaluate these populations are often unaware of the possibility of PM deficits or the impact these deficits may have on everyday functioning. The objective of this special issue is to provide an overview of the nature of prospective deficits in a range of clinical populations, to discuss neuropsychological assessment techniques, and to critically evaluate management strategies.
Method: We solicited papers from established researchers and issued a general call for papers for the special issue on PM in clinical populations.
Results:
We received submissions from the nine authors that we solicited. These submissions range from developmental disorders, including autism, attention deficit hyperactivity disorder, and dyslexia; to disorders of adulthood, such as schizophrenia, HIV, brain injury and multiple sclerosis; and finally disorders that tend to occur at older ages, such as Parkinson's disease and mild cognitive impairment. In addition we have included four original research articles that provide novel data on other populations. These are children and adolescents with 22q11.2 deletion syndrome, first degree relatives of people with schizophrenia, individuals with mild brain injury, and individuals with idiopathic REM sleep behavioral disorder.
Conclusions:
The issue highlights the need for clinical neuropsychologists to be aware of the possible existence of deficits in PM in a variety of clinical populations and the importance of both assessment and management strategies to reduce the impact on daily life.

Keywords: Prospective Memory, Episodic Memory, Memory for Intentions

Prospective memory (PM), i.e., the ability to remember to execute a previously formed intention (e.g., Kvavilashvili, 1992), has emerged as an important aspect of episodic memory. The cognitive functions required for successful PM performance include attention, retrospective memory recall, and planning. Prospective remembering itself involves forming the intention, monitoring time or recognizing a cue in the environment, acting upon the intention at the appropriate time, and performance evaluation once the task is completed. Two particular types of prospective remembering have been identified—time-based and event-based. Time-based intentions are those that must be completed at a particular time (e.g., please call your doctor at 2:00 pm); event-based intentions, on the other hand, require completion of the intention in response to a cue in the environment (e.g., when you see your therapist, please remind her to give you a copy of your medical records). Successful PM performance is critical in daily life tasks such as taking medications or paying bills. Deficits in PM can be mistaken for lack of initiation or poor compliance with treatment, making an accurate assessment of PM worthwhile.

With increasing recognition of the importance of PM for daily functioning, there has been an increased interest in PM research. With this growing interest, there have been special issues published on this topic in *Applied Cognitive Psychology* (2000), *The International Journal of Psychology* (2003), and the *Canadian Journal of Experimental Psychology* (2011). However, the previously published special issues have primarily focused on theoretical issues in cognitive psychology. Furthermore, seven years have passed since the publications of the most recent special issues. Thus, it has become clear that the field would benefit from an updated overview of the current state of the PM research, as well as from a review of both the theoretical

perspectives on PM construct and the practical clinical information on the assessment and treatment of individuals with PM deficits. These then are the goals of the present special issue.

The issue begins with a series of review articles that all follow a similar structure: current knowledge of PM deficits in that population, including neurological etiology if known; approaches to clinical assessment of PM for individuals with that disorder; the types of errors most often seen in that population in daily life; any published evidence-based approaches to treatment; and suggestions for management of PM deficits for individuals with the disorder. Four original research articles then follow that highlight newer research questions in populations that have not been previously studied as extensively.

The first three articles cover neurodevelopmental disorders. The article by Sheppard et al. (in this issue), provides an overview of PM in individual with autism. These authors provide an analysis of the deficits of PM within an embodied predictive-coding account. In other words, they postulate that people with autism have their attention drawn to stimuli in the environment that are not relevant to the PM cue. The reduction in the relevance and salience of the PM cue, in combination with poor prediction, lead to failures to complete PM tasks. This theoretical account leads the authors to suggest embodied interventions such as providing clear and consistent structures and expectations. The next article, by Talbot et al. (in this issue), synthesizes the small number of studies that have investigated PM in children with attention deficit/hyperactivity disorder. These children have demonstrated greater deficits in time-based, as compared to event-based, PM tasks, which the authors relate to underdeveloped executive functions. They highlight the need for a clinical measure of PM for children and recommendations are made for multicomponent psychosocial strategies, including

compensatory approaches, to mitigate any deficits. The review of PM in individuals with dyslexia by Smith-Spark (in this issue) mentions effects in children but the main focus is on adults with dyslexia. The authors report that these individuals have greater difficulty with time-based than event-based tasks; nevertheless, deficits on episodic event-based tasks and on tasks that have a longer delay have been found. The authors relate this difficulty to potential deficits in accessing episodic retrospective memories as well as executive function deficits in shifting away from the ongoing task. Specific compensatory recommendations are made, including the use of mobile reminding devices.

The special issue then turns to disorders of adulthood including schizophrenia, HIV, adults with brain injury, and multiple sclerosis. The review by Wang et al. (in this issue) focuses on individuals with schizophrenia, providing an analysis of the components of PM that have been found to be impaired in a sometimes conflicting literature. Overall, the authors find that people with schizophrenia are more likely to make errors due to a lack of awareness of the need to make a response suggesting that this is a primary deficit in prospective remembering itself. There is some evidence that time-based PM is more impaired than event-based PM, and that people with schizophrenia are more greatly affected by increases in time delays. Perhaps of greatest importance is the consistent findings that PM performance is related to negative symptoms as well as to functioning in daily life, including medication adherence. Lastly, the authors offer a number of intervention suggestions, including increasing awareness.

Individuals with HIV represent one of the more extensively studied clinical populations with respect of PM. This relatively extensive literature is reviewed by Avci et al. (in this issue). The authors suggest that PM deficits in this population are evident primarily when strategic,

rather than automatic, cognitive processes are involved. Thus, they suggest that findings of greater time-based than event-based impairments are due to failures in strategic monitoring. With this model, the authors incorporate the findings of greater deficits with longer time delays and a relationship between both executive functions and time perception with PM performance. They also review potential biomarkers for PM and common comorbidities. Importantly, they highlight the research demonstrating the interaction of age and performance within those who have HIV. The authors provide ample evidence for the effect of PM on daily life, including medication management and medication adherence, which are critical in this population. In terms of management of deficits, the authors suggest approaches that focus on improving strategic monitoring as well as behavioral techniques for daily living skills.

In the review of the relatively large number of studies of individuals with brain injury by myself and my colleagues (Raskin et al., in this issue), we also find that the current research supports the multi-process theory. That is, individuals with brain injury show greater deficits in time-based than event-based tasks and show an increased effect of longer time delays. In general, deficits are increased in conditions that require greater attention, working memory, or strategic monitoring. Within this framework, a number of other potential areas of investigation are discussed, including the effects of cue focality and the relationship between the cue and the intention. The relationships among laboratory-based tasks, clinical measures, and self-report questionnaires are discussed, with the suggestion that each of these assessment approaches may be tapping into different aspects of PM functioning. Turning to remediation suggestions, the greatest number of studies have focused on compensatory devices such as pagers, smart phones, programmable watches, and planners. However, there is some evidence for both rote

repetition and visual imagery training as rehabilitation techniques may show more promise in terms of generalizability. We suggest that the heterogeneity of brain injury lends itself to the need for individualized treatment techniques that could include compensation as well as training focused on attention, time perception, recognition of the cue, reinforcement of the memory for the intention itself, enactment, etc., depending on the deficit observed in the individual. Finally, we suggest that the literature on episodic future thinking may provide insights for training techniques that generalize to daily life.

The review of PM in individuals with multiple sclerosis by Rouleau et al. (in this issue) also highlights the relationship between PM and functioning in daily life. In a limited number of studies, individuals with multiple sclerosis were found to have greater deficits on longer time delays and on items that required a verbal response rather than an action response. A strong relationship has been demonstrated between PM performance and executive function measures. PM deficits have also been found to be related to symptoms such as pain, and to be predictive of activities in daily life such as medication adherence. The authors suggest that high cue salience improves performance, and that psychoeducation and increasing awareness represent important interventions, combined with cognitive rehabilitation techniques in individual cases.

The final two review articles turn to disorders of aging, namely Parkinson's disease and mild cognitive impairment. In reviewing the literature on PM in Parkinson's disease, Costa et al. (in this issue) do not find consistent evidence for a differential effect of time-based versus event-based cues. Like many of the other disorders reviewed, PM performance has been found to be related to executive functioning and to activities of daily living. There is some evidence to

suggest that specific deficits in PM are related to an inability to shift mental set, but that there are separate deficits in the retrospective recall of the item to be remembered. Finally, the authors present some evidence to suggest that PM is not impaired in all individuals with Parkinson's disease, but only in those who are experiencing mild cognitive impairment. Similarly, the review of PM in individuals with mild cognitive impairment by Kinsella et al. (in this issue), does not find evidence for a differential deficit in either time or event-based items. In addition, there is evidence for deficits in habitual items that are routine, such as bringing in the newspaper each morning. This suggests a primary deficit in working memory in addition to PM deficits. The authors provide a description of a novel treatment approach that embeds implementation of intentions and compensatory devices within a group treatment protocol.

The remaining articles are original research articles that provide novel data on PM in clinical populations not covered by the review articles due to the relative recency of findings of deficits. The first paper demonstrates time-based PM deficits in children and adolescents with 22q11.2 deletion syndrome. Souchay and colleagues (in this issue) tested children ages 6-14 years on a video driving game that requires the child to remember to add fuel to the car when fuel levels are low. The participants with 22q11.2DS were less likely to remember to add fuel, and also checked the fuel gage less often. The authors suggest that this could be due to a reduction in strategic monitoring, lower motivation to complete the task, or deficits in working memory.

The next original research article examines PM in first degree relatives of individuals with schizophrenia. Saleem et al. (in this issue) used a laboratory task modeled after those of Einstein and McDaniel (1990). They report that first degree relatives show impairments in

prospective remembering compared to healthy adults, but that these impairments are less severe than those seen among individuals who have been diagnosed with schizophrenia. The impairment was found to be greater for event-based tasks than for time-based tasks. This finding may be an artifact of the task, however, as all three groups performed better on the time-based task than the event-based task, a finding that is uncommon in the literature.

Next, as part of the Canadian Longitudinal Study on Aging, Bedard et al. (in this issue) administered the Miami Prospective Memory Test to a large cohort of individuals with mild traumatic brain injury (TBI). The majority reported less than one minute of loss of consciousness and all were at least one year post injury. The Miami Prospective Memory Test contains one event-based task and two time-based tasks, although only one time-based task was used in this study. The results showed a disproportionate deficit on time-based PM performance for those who experienced a mild TBI. The findings on the event-based task were somewhat more difficult to interpret, as those participants who had experienced a mild brain injury with a loss of consciousness of less than a minute performed better on this task than healthy adults. Further analyses suggested that this finding may have been due to the fact that this group was younger than controls.

The final article by Bezdicek and colleagues (in this issue) measures PM performance in individuals with REM sleep behavior disorder. These individuals demonstrated deficits in both retrospective memory on the Rey Auditory Verbal Learning Test and PM on the Memory for Intentions Test (MIST). In addition, event-based PM was impaired but time-based was not. The event-based PM deficit is suggested to be related to the retrospective memory impairment such that the cue to the intention is not successfully retrieved and recognized. Interestingly,

the time-based performance was significantly related to dopamine depletion measured by dopamine transporter imaging using SPECT.

There are several common themes that emerge across the articles in this special issues: First, studies consistently find at least some deficits of PM across a variety of disorders. This consistency highlights how important it is for clinicians to be aware of the possibility of PM deficits in individual clients. Although assessment of PM can be lengthy, clinicians should be aware that it can be a useful adjunct to their current assessment measures, especially in cases where there is a suspicion of a deficit or where there are problems in daily life that might suggest such a deficit (forgetting to take medications, go to scheduled appointments, purchase needed items, pay bills, etc.). In addition, when these deficits are detected, clinicians may want to make specific recommendations for compensatory strategies or treatment techniques to reduce the impact of these deficits. There are now two standardized clinical measures with normative data, the Cambridge Assessment of PM (CAMPROMPT) (Wilson, Emslie, Foley, Shiel, Watson, & Hawkins, et al., 2005) and the MIST (Raskin, Buckheit, & Sherrod, 2010). A number of the articles in this issue have utilized one of these two measures. There is no comprehensive clinical measure for children at this time and this need is mentioned by a few of the articles on developmental disorders (Sheppard et al. this issue, Talbot et al., this issue).

Second, many of the articles in this issue conclude that clinical populations have greater deficits in time-based than event-based tasks, and that this has been related to deficits in strategic monitoring as described by the multi-process theory (Einstein, McDaniel, Richardson, Guynn, & Cunfer, 1995). This theory suggests that some PM tasks can be completed more or less automatically, such as when a cue in the environment is sufficiently salient, while others

require more controlled processing resources. It is generally assumed that time-based tasks require greater processing resources in order to monitor time and self-initiate the intention with no external cuing. However, several articles in this special issue (Costa et al., in this issue; Kinsella et al., in this issue) have found impairments in the event-based PM, in the context of normal time-based PM performance. Interestingly, in all cases, these patterns were observed in older populations. This seems to be related to a loss of retrospective memory functioning as a part of the aging process, which differentially impacts cue encoding needed for event-based tasks.

Third, not surprisingly, past research on PM has demonstrated that PM relies on prefrontal cortical mediation, most often Brodmann's area 10 (Benoit et al., 2011). The Attention to Delayed Intention (AtoDI) model uses imaging data to explain the brain regions responsible for intention maintenance and retrieval (Cona, Scarpazza, Sartori, Moscovitch, & Bisiacchi, 2015). Specifically, the model proposes that the dorsal frontoparietal network is involved in maintenance and allocation of top-down attention that is used both to monitor for the occurrence of the PM cue and to maintain the intention in mind. The ventral frontoparietal network, on the other hand, mediates the bottom-up attention automatically captured by the occurrence of the prospective cues and used during retrieval. Consistent with past findings and with the AtoDI model, several of the articles in this issue (Avci et al., in this issue; Costa et al., in this issue; Raskin et al., in this issue; Rouleau et al., in this issue; Smith-Spark, in this issue; Talbot et al., in this issue) point out a relationship between performance on tasks of PM and tests of executive functioning, and make suggestions that it is the prefrontal dysfunction that occurs in each disorder that is mediating the PM deficits.

Fourth, rehabilitation strategies covered by the articles in this issue include compensatory strategies, such as datebooks, smartphones, and other electronic reminders. Environmental modifications are also discussed by several authors. Other strategies that may show promise include the use of visual imagery, implementation of intentions, time awareness training, and goal management training. Several authors make the point that rehabilitation is most successful when it is individually tailored and that PM training must take into consideration social and emotional factors that may impact performance (e.g., Raskin et al., in this issue).

Finally, several of the articles highlight some new areas of research that strive to build bridges between related fields of study. For example, the research on episodic future thinking, the ability to imagine specific personal episodes that may occur in the future (Szpunar, 2010), is certainly related to realization of intentions in important ways and may provide a framework for future treatment strategies (Terrett, Rose, Henry, Bailey, Altgassen, Phillips, et al., 2015). And the use of implementation of intentions (Gollwitzer & Sheeran, 2006), typically utilized in studies of weight loss or other long-term goal attainment has been suggested to facilitate PM (McDaniel, Howard, & Butler, 2008) and has been modified with mixed success as a treatment method for PM deficits in a few of the articles in this issue. These both seem to be areas of research that could be expanded in the future.

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