

Gone but not forgotten: The effects of cancelled intentions on the neural correlates of prospective memory

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Abstract

Event-related brain potentials (ERPs) were used to examine the neural correlates of the prospective interference effect and the effects of canceling an intention on the neural correlates of prospective memory. The response time data revealed a prospective interference effect that was associated with the engagement of prospective retrieval mode and item checking. The ERP data revealed that item checking was associated with sustained activity over the frontal and occipital-parietal regions of the scalp beginning at around 300 ms after stimulus onset. The ERP data also revealed that canceling an intention may have blocked the retrieval of the intention from memory when the prospective cue was encountered and led to a significant attenuation in the degree that the neural correlates of cue detection and post-retrieval processes were expressed.
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1. Introduction

Over the course of an average day we find that many of our intentions cannot be realized immediately and therefore must be postponed for some period of time. Characterizing the processes that support our ability to realize delayed intentions represents one of the primary goals of the field of prospective memory research (Ellis, 1996). The last decade has seen significant development in our understanding of the cognitive processes and neural mechanisms underlying prospective memory (Marsh et al., 2006a,b). Work in our laboratory has been particularly focused on using event-related brain potentials (ERPs) to examine the time course of neural processes associated with the realization of delayed intentions. Across a series of studies we have discovered distinct modulations of the ERPs that are differentially related to the detection of prospective memory cues when they appear in the environment (N300), the retrieval of an intention from memory (parietal old–new effect), and post-retrieval processes that may serve to coordinate the

prospective response following the retrieval of an intention (prospective positivity; for a review see West, in press-b).

In the current study we sought to extend our previous research by examining two questions: 1) what are the functional characteristics of the neural correlates of processes underlying strategic monitoring that is thought to facilitate prospective memory, and 2) what effect does canceling an intention have on the neural correlates of prospective memory. The first question was motivated by recent findings revealing that the addition of a prospective memory load to an ongoing activity is associated with sustained modulations of the ERPs over the frontal and occipital–parietal regions of the scalp beginning at around 300 ms after stimulus onset and lasting for several hundred milliseconds (West and Bowry, 2005; West et al., 2006). In the current study we sought to determine whether these modulations of the ERPs were limited to instances where individuals would be expected to be engaged in item checking (Guynn, 2003). The second question was motivated by evidence indicating that individuals may spontaneously retrieve intentions from memory when a prospective cue is encountered regardless of whether or not the intention is relevant to task performance (Einstein et al., 2005; West, in press-a), but only recruit processes supporting cue detection and post-retrieval

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processing when the cue is relevant to task performance (West, *in press-a*). In the current study we were interested in whether intentions that were formed but then cancelled might also be spontaneously retrieved when the prospective cue was encountered.

A prominent question within the literature related to event-based prospective memory is the degree to which the engagement of strategic processing is required for a prospective cue to be recognized as such when it is encountered in the environment. One school of thought proposes that relatively automatic or spontaneous processes support the detection of prospective cues (Einstein and McDaniel, 1996; McDaniel et al., 2004). A second school of thought leads to the proposal that individuals must engage in resource demanding preparatory processes (Smith, 2003; Smith and Bayen, 2004) or strategic monitoring (Guynn, 2003) in order for a prospective cue to be detected. Guynn (2003) has described two strategic processes that work in concert to facilitate the realization of delayed intentions (i.e., prospective retrieval mode and item checking). Prospective retrieval mode is thought to reflect a tonic “cognitive or neurocognitive task set to treat stimuli as cues to retrieve stored episodes” (Guynn, 2003, p. 247); in contrast, item checking is thought to represent a process that serves to evaluate whether or not a candidate stimulus is a prospective cue in contexts where a cue is anticipated.

Evidence from studies using behavioral, functional neuroimaging, and electrophysiological methodologies provides support for the idea that strategic processes facilitate event-based prospective memory in some instances. The prospective interference effect has been taken as one index of the engagement of strategic processes in event-based prospective memory (Marsh et al., 2003; Smith, 2003). This effect represents a slowing of response time for ongoing activity trials when a prospective memory component is included in the task relative to when the ongoing activity is performed in isolation (Marsh et al., 2003; Smith, 2003). The prospective interference effect is thought to result from a shift of working memory capacity away from the ongoing activity in order to meet the demands of the prospective memory component of the task (Smith, 2003). Evidence from a study using positron emission tomography reveals what may reflect a neural correlate of prospective retrieval mode (Burgess et al., 2001). In this study increased activity was observed in the lateral rostral prefrontal cortex (PFC) when individuals anticipated the occurrence of a prospective cue relative to a baseline condition. Importantly, the increased activity within the rostral PFC was not dependent on whether or not a prospective cue was presented. Other studies using ERPs have revealed what may reflect a neural correlate of item checking. In two studies we have observed a sustained frontal positivity/occipital–parietal negativity that begins around 300 ms after stimulus onset and differentiates stimuli in a prospective memory condition from a no prospective memory condition (West and Bowry, 2005; West et al., 2006).

Motivated by the debate surrounding the question of whether the recruitment of resource demanding processes is required to support prospective memory, we have recently become

interested in the degree to which modulations of the ERPs associated with the realization of intentions are dependent on the engagement of strategic monitoring. In one study a context manipulation was used to establish one task context where prospective cues were not relevant to task performance (i.e., did not require a prospective response) and one task context where prospective cues were relevant to task performance (i.e., required a prospective response; West, *in press-a*). In this study we observed that response time was slower for ongoing activity trials when the prospective cue was relevant than when it was irrelevant, presumably reflecting the engagement of strategic monitoring (Smith, 2003). The ERP data from this study revealed that the N300 and prospective positivity were elicited by prospective hits (i.e., prospective cues that were relevant to task performance and that elicited a prospective response) and were not elicited by irrelevant prospective cues. In contrast, a parietal old–new effect, that was similar to that elicited by recognition hits, was elicited by prospective cues regardless of whether or not they required a prospective response. These findings led to the conclusion that strategic monitoring may be required for cue detection and post-retrieval processes to be engaged and that monitoring may not be required for an intention to be retrieved from memory (Einstein et al., 2005; Guynn et al., 2001).

The effects of canceling an intention on the processes underlying prospective memory have not been extensively investigated. Some evidence indicates that the representation of an intention may be suppressed when it is cancelled. For instance, Marsh et al. (1999) found that the intention superiority effect (i.e., the facilitation of response time for information related to uncompleted intentions in recognition memory and lexical decision tasks, Goschke and Kuhl, 1993; Marsh et al., 1998) was reversed for intentions that were either cancelled or completed. Given evidence that monitoring may be limited to instances where an intention is relevant to task performance (West, *in press-a*) or a prospective cue is expected (Marsh et al., 2006a,b) one could expect that the N300 and prospective positivity should not be elicited by cancelled intentions; in contrast canceling an intention may have relatively little effect on the parietal old–new effect if spontaneous processes underlie the retrieval of intentions (Einstein et al., 2005).

2. Method

2.1. Subjects

Twenty-five individuals (mean age 19.6 years, range: 18–21, 7 males) were recruited from the Department of Psychology at the University of Notre Dame to participate in exchange for course credit. Three participants were excluded from the analyses due to an error during data acquisition and one was excluded from the analyses due to a failure to correctly carry out the task. This resulted in 21 individuals providing complete data for the study. Of the 21 subjects, two self reported a left hand preference and the remaining 19 self reported a right hand preference. All subjects provided informed consent before undertaking the study that was

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