



# The flexible engagement of monitoring processes in non-focal and focal prospective memory tasks with salient cues



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## ABSTRACT

Prospective memory (PM) refers to the ability to remember to perform a delayed intention. Here, we aimed to investigate the ability to *suspend* such an intention and thus to confirm previous findings (Cohen, Gordon, Jaudas, Hefer, & Dreisbach, 2016) demonstrating the ability to flexibly engage in monitoring processes. In the current study, we presented a perceptually salient PM cue (bold and red) to rule out that previous findings were limited to non-salient and, thus, easy to ignore PM cues. Moreover, we used both a non-focal (Experiment 1) and a focal PM (Experiment 2) cue. In both Experiments, three groups of participants performed an Eriksen flanker task as an ongoing task with an embedded PM task (they had to remember to press the F1 key if a pre-specified cue appeared). Participants were assigned to either a control condition (performed solely the flanker task), a standard PM condition (performed the flanker task along with the PM task), or a PM delayed condition (performed the flanker task but were instructed to postpone their PM task intention). The results of Experiment 1 with the non-focal PM cue closely replicated those of Cohen et al. (2016) and confirmed that participants were able to successfully postpone the PM cue intention without additional costs even when the PM cue was a perceptually salient one. However, when the PM cue was focal (Experiment 2), it was much more difficult for participants to ignore it as evidenced by commission errors and slower latencies on PM cue trials. In sum, results showed that the focality of the PM cue plays a more crucial role in the flexibility of the monitoring process whereas the saliency of the PM cue does not.

## 1. Introduction

In daily life, it is often not possible to carry out an activity immediately. Therefore, some intentions have to be established in memory so that they can be performed at a future time (e.g., remembering to call a friend for his birthday tomorrow). This kind of memory is defined as prospective memory (PM; Einstein & McDaniel, 1990). Prospective memory differs from retrospective memory (e.g. thinking about a past birthday party) in its time-oriented nature (future vs. past). In a typical laboratory event-based<sup>1</sup> PM experiment, participants are asked to perform an ongoing task (e.g., a lexical decision task) and are further instructed to perform an intended action at some point in the task (e.g., to press the space bar whenever the word “animal” appears; see Einstein & McDaniel, 2005). The critical difference between prospective and retrospective memory occurs at the point of

retrieval: experimenters prompt participants to recall on tests of retrospective memory but not so on tests of prospective memory (Einstein & McDaniel, 2005).

Past research on prospective memory focuses on the cognitive processes that enable participants to hold an intention in mind and to remember to carry it out when the critical (PM cue) event occurs. An everyday example of prospective memory is the intention to remember to return books to the library. One does not need to think about this intention continuously throughout the day (which would be cognitively very demanding) but only shortly before the critical time when the library book is due. Only somewhat recently, there has been growing interest in investigating the ability to cancel a completed intention or suspend a to-be-executed intention. To foreshadow, the current study deals with the ability to *postpone* a prospective memory intention. The ability to flexibly activate or deactivate cognitive processes related to

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<sup>1</sup> Besides event-based PM tasks, there exist also time-based PM tasks which refer to the ability to remember to perform an intention at a specific time (e.g., medical appointment at nine in the morning).

executing an intention is highly important – as our everyday example illustrates – because it saves precious cognitive resources that are then available for other tasks. Our objective is to make a contribution toward clarifying mixed findings, with evidence for (Cohen et al., 2016; Marsh, Hicks, & Cook, 2006; Smith, 2003) and against (Knight, Meeks, Marsh, Cook, Brewer, & Hicks, 2011; Walser, Fischer, & Goschke, 2012; Walser, Goschke, Möschl, & Fischer, 2016<sup>2</sup>) the flexible adjustment of PM cue intentions.

In the prospective memory literature, there are two theoretical perspectives that attempt to explain the possible mechanisms underlying successful execution of a PM task. The preparatory attentional processes and memory processes (PAM) theory (Smith, 2003; Smith & Bayen, 2004) as well as the Multiprocess Framework (MPV; Einstein & McDaniel, 2005; Einstein & McDaniel, 2010; Einstein, McDaniel, and Anderson, 2017). The former theory assumes that successful prospective remembering is effortful and capacity consuming and requires preparatory attentional processes. These processes are assumed to involve resources that are also required to accomplish the ongoing task. As a consequence, monitoring processes for the occurrence of a PM cue are thought to impair the ongoing task performance resulting in task interference (i.e. lower performance on ongoing task when in addition a PM task has to be performed relative to when the ongoing task is performed alone/relative to a control condition; Smith, 2003; see McDaniel & Einstein, 2007 for an overview of experiments finding significant task interference). However, some studies demonstrate successful PM task performance without further costs to the ongoing task which indicates the absence of any (costly) monitoring processes (Cohen, Dixon, & Lindsay, 2005; Cohen, Kantner, Dixon, & Lindsay, 2011; Einstein et al., 2005; see Einstein & McDaniel, 2010 for a commentary). Such a data pattern speaks for the existence of spontaneous retrieval processes at the onset of the PM cue – a phenomenon that is described by the Multiprocess Framework (Einstein & McDaniel, 2005, 2010). In line with the PAM theory, the Multiprocess Framework assumes that successful prospective remembering can be achieved by monitoring environmental events for the occurrence of a PM cue. In contrast to the PAM theory, the MPV suggests that a PM task can also be successfully accomplished by spontaneous bottom-up retrieval processes, even without engaging in costly preparatory attentional processes (Einstein et al., 2005, 2010; Einstein, McDaniel, and Anderson, 2017; McDaniel, Umanath, Einstein, & Waldum, 2015).

There is growing evidence that the extent to which participants rely on monitoring processes or spontaneous retrieval is modulated by several factors (for an overview see Einstein, McDaniel, and Anderson, 2017): for example, participants rely less heavily on monitoring processes when they receive a single PM cue as opposed to six different PM cues (Cohen, Jaudas, & Gollwitzer, 2008; Einstein & McDaniel, 2005, Experiment 3), when the PM cue target is presented with low frequency (Loft & Yeo, 2007), when the importance of the ongoing task is emphasized (Einstein et al., 2005; Loft & Yeo, 2007), and when the first PM cue target is presented with delay (Scullin, McDaniel, Shelton, & Lee, 2010a; see also Harrison, Mullet, Whiffen, Ousterhout, & Einstein, 2014; Mullet et al., 2013, for additional ways to decrease monitoring processes).

More critically for the current research, monitoring is also less important when the PM cue target is presented focally instead of non-focally (Einstein & McDaniel, 2005; Scullin, McDaniel, & Einstein, 2010b; Scullin et al., 2010a). A PM cue is considered as focal if the encoded features of the cue are processed in the service of the ongoing task. In contrast, a PM cue is considered as non-focal if it is not part of the information being processed for performing the ongoing task (Scullin et al., 2010a; Scullin et al., 2010b). For example, during a

lexical decision task participants have to decide whether the target is a word or non-word. A focal cue would be the word “animal”; a non-focal cue would be the letter “a” (see Einstein & McDaniel, 2005 for additional examples of focal vs. non-focal cues). Scullin, McDaniel, and Einstein (2010b) demonstrated that PM performance is supported by spontaneous retrieval processes when it is presented focally and by monitoring processes when it is presented non-focally. Consequently, a non-focal PM task is more likely to produce task interference than a focal PM task.

Monitoring also seems to be less important when the PM cue intention is suspended (Marsh et al., 2006; Smith, 2003). This assumption was further investigated by Cohen et al. (2016). In that study, we investigated whether participants would spontaneously notice a PM cue (as evidenced by costs in the ongoing task and/or commission errors) when it appeared outside of the appropriate task context. The appropriateness was manipulated by either telling participants that the PM cue intention would only become relevant in a later part of the experiment (PM-delayed condition, Experiment 1) or by telling the participants that the PM cue intention was no longer to be followed (PM-forget condition, Experiment 2). In two experiments, the authors demonstrated the flexibility of the monitoring process as evidenced by the absence of interference costs and commission errors (= erroneous repetition of the PM cue intention) in both, the PM-delayed and the PM-forget condition as compared to when the PM cue intention was active (standard PM condition). Critically, in that study, the ongoing task was a flanker task and the PM cue was presented amongst the surrounding flanker arrows and as such was a non-focal PM cue. Note, however, that Knight et al. (2011) *did* find evidence for the existence of spontaneous retrieval in a non-focal PM task when lures appeared outside the appropriate context. In that study, participants worked through two phases of a lexical decision task whereby only in the second phase a PM cue response was required (when an animal word starting with the letter “C” was presented). In Phase I partial-match lures (animal words starting with a letter other than “C”) or exact-match words were embedded. The exact-match lure condition resulted in more lure interference than partial-match lure or no-lure condition suggesting spontaneous noticing of intention-related items. To disentangle the opposing findings of Cohen et al. (2016) and Knight et al. (2011), one might argue that the usage of non-salient PM cues by Cohen et al. (2016) might have helped the participants to ignore their influence.<sup>3</sup> This view is in line with research by Scullin, Bugg, and McDaniel (2012) who identified PM cue salience as one factor that increases the risk for commission errors. We considered it was necessary to rule out that only non-salient PM cues outside the visual focus can be ignored by participants when instructed to do so. To this end, we conducted two experiments using a perceptually salient PM cue (bold and red) that was presented either non-focally (Experiment 1) or focally (Experiment 2). Much PM research has shown that a salient and focal PM cue that appears out of context can lead to spontaneous retrieval of an intention in the absence of monitoring (Scullin & Bugg, 2013; Scullin et al., 2012). In the present study, we aimed to further investigate how salience and focality influence monitoring processes when participants have to postpone an intention. Accordingly, we wanted to address the potential alternative interpretation that the observed flexibility in Cohen et al. (2016) was merely due to the physical features of the PM cue (no salience) or due to the non-focality of the PM cue. To sum up, the goal of the current study was twofold: First, we aimed to replicate previous research demonstrating the ability to flexibly postpone a PM intention (Cohen et al., 2016) – this time, even in the face of a perceptually

<sup>2</sup> Please see Walser et al. (2016) for the influence of similarity between completed and currently performed PM-tasks on aftereffects.

<sup>3</sup> Note that the definition of non-focal PM cues might be a bit misleading and the distinction between focal and non-focal not as dichotomy as the terms suggest. In the Cohen et al. (2016) study, the PM cue always occurred amongst distractor stimuli outside the visual focus whereas the starting letter of a word in the Knight study is, if not within the attentional focus, still within the visual focus (see also the motivation for Experiment 2).

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