Investigating the cost to ongoing tasks not associated with prospective memory task requirements

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ABSTRACT

The purpose of the current study was to investigate the relationship between prospective memory (PM) and consciousness by examining cost to ongoing activities, with cost assumed to reflect a direction of conscious resources away from the ongoing task in service of the PM task. Ongoing task blocks in which the PM task was relevant or irrelevant were alternated to achieve three aims: determine if cost would persist in irrelevant blocks when relevant and irrelevant blocks were clearly demarcated and irrelevant stimuli were incompatible with the PM task; investigate if costs would be greatest at the start of irrelevant blocks; and determine whether costs would occur when the irrelevant block preceded any relevant blocks. Costs were found in irrelevant blocks and greater cost at the start of the irrelevant blocks suggest the cost may be due in part to participants making decisions about the engagement of conscious resources at transition points.

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1. Introduction

Prospective memory (PM), or remembering to perform intentions in the future, is an important memory function in our daily lives. The goal of the current study is to build upon prior research investigating the relationship between PM and consciousness. Specifically, the current study examines the efficiency with which participants can limit the allocation of conscious resources to the PM task to times when these conscious resources can support PM performance. The allocation of conscious resources to the PM task is measured in PM paradigms by examining performance on ongoing activities. Performance of PM tasks outside of the laboratory often involves interrupting some ongoing activity in order to carry out the intended action. For instance, I may need to remember to give a message to a colleague. If this colleague walks by when I am conversing with another colleague, I have to interrupt the conversation to deliver the message. To capture this aspect of real world PM tasks, laboratory PM tasks are typically embedded in an ongoing task. For example, participants might be asked to remember to make the PM response of pressing the F1 key if they see the target word "dog" during on ongoing lexical decision task. In addition to providing a reasonable analog to real world PM tasks, the ongoing task can serve as a way to measure the extent to the PM task involves conscious resources (Smith, 2003).

A decline in ongoing task performance in a group of participants who are given PM instructions relative to a control group that does not do the PM task is often called the cost to the ongoing task. Cost to the ongoing task is generally thought to reflect the extent to which the PM task involves processing that draws on our limited span of consciousness. Although costs

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Table 1
Prior investigations of cost on irrelevant ongoing task trials using event-based PM tasks.

	Ongoing task	Block length	Designation of irrelevant trials	Notes
Cohen et al. (2012)	Lexical Decision	Baseline and PM block, each with 252 trials	PM targets were either words or non-words	
Cook et al. (2007)	Intentional study task	List of 40 words	Participants told that the PM target would not appear during the first study list, but that the PM targets could appear during the second study list	Only the first study list was presented
Lourenço and Maylor (2014)	Locate uppercase letter	Baseline block and PM block, each with 256 trials	Ongoing task stimuli appeared in yellow or in white on black background and PM task was associated with one or the other color	Trials alternated between colors either randomly or in blocks of 8 trials
Lourenço et al. (2013)	Lexical decision	Baseline and PM blocks, each with 256 trials	PM task was to respond to target syllable, which appeared only on word trials	Participants told syllable would appear in words only or in both words and non-words. Words and non-words alternated randomly
Marsh, Cook et al. (2006)	Picture and word naming	Baseline Block 1 (before PM instructions): 40 pictures and 50 words. Block 2: 50 pictures and 40 words	Participants told to make PM response only for pictures of furniture or only for furniture words. In Exp. 3, intention was associated with color of letter string (red or green)	Exp. 1A and 2: pictures and words alternated randomly. Exp. 2 only: the cue *picture* or *word* shown just before each trial. Exp. 1B: alternated in sets of ten (10 pictures, 10 words, etc.) Exp. 3: asterisk preceding each string indicated color of string
Marsh, Hicks, et al. (2006) Experiment 1	Lexical decision	Phase 1 and Phase 2 each included a block of 105 ongoing task trials	Participants were told that there would be three distinct phases and "that the animal words would appear during the third and final stage, and not during Phases 1 or 2"	Phase 2 was a questionnaire. Participants interacted with experimenter during Phase 2

to the ongoing task may not be found for all PM tasks (Einstein & McDaniel, 2010),[1] costs are consistently found when the properties of the target associated with the intention are not the focus of ongoing task processing (i.e., *non-focal targets*; Einstein et al., 2005), and the extent of the cost can be positively related to non-focal PM performance (e.g., Loft & Humphreys, 2012; Smith & Bayen, 2004), thus, in some circumstances the conscious resources that produce a cost are beneficial.

At the same time, it would not be beneficial to draw on our limited span of consciousness unnecessarily, such as during intervals when it is not possible to perform the PM task. However, prior research suggests that participants do in some cases engage these conscious resources during contexts in which the PM task is not relevant. The current study provides a replication of earlier work by Marsh, Cook, and Hicks (2006) and Lourenço and Maylor (2014), and goes beyond this prior research by examining whether participants continue to devote conscious resources to the PM task in irrelevant contexts when the irrelevant blocks of trials are clearly demarcated from blocks of trials relevant to the PM task (all three experiments), and when the stimuli in irrelevant blocks are incompatible with making a PM response (Experiments 2 and 3). Experiment 3 also investigates whether the cost in irrelevant blocks is dependent upon having previously performed the PM task, and whether the magnitude of this cost varies across trials within irrelevant blocks.

1.1. Allocation of conscious resources in irrelevant contexts

We are aware of six prior studies that have focused specifically on whether a cost is found in contexts in which the PM task is not relevant versus when the PM task is relevant. Key details of the methods used in each study can be found in Table 1. In two studies the cost has been eliminated in the irrelevant context (Cook, Marsh, Clark-Foos, & Meeks, 2007; Marsh, Hicks, & Cook, 2006). In both of these studies the relevant context was clearly demarcated and temporally rather distant from the irrelevant context. In contrast, other studies have presented less differentiated relevant and irrelevant contexts

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[1] The multiprocess view (MPV) of PM makes a distinction between focal and non-focal PM tasks. In focal PM tasks the characteristics that define the PM target event are processed as part of the ongoing task requirements. The MPV further proposes that PM tasks may sometimes be accomplished through spontaneous retrieval of the delayed intention (e.g., Einstein et al., 2005). Specifically, if the PM task is a focal task, with a simple action combined with instructions that do not emphasize the PM task, participants are less likely to engage strategic monitoring processes and will instead rely on spontaneous retrieval. This in turn should eliminate the cost to the ongoing task (Harrison & Einstein, 2010). In the case of non-focal tasks the MPV would expect that strategic monitoring would be involved and a cost to the ongoing task would be demonstrated. A non-focal task was selected for the current experiments because we were specifically interested in whether a cost, when found, can be isolated to the relevant trials only. The MPV does not make a specific prediction about factors that would influence demonstration of a cost during irrelevant blocks of the ongoing task.