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## Selective attention meets spontaneous recognition memory: Evidence for effects at retrieval

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### ABSTRACT

Previous research on the effects of Divided Attention on recognition memory have shown consistent impairments during encoding but more variable effects at retrieval. The present study explored whether effects of Selective Attention at retrieval and subsequent testing were parallel to those of Divided Attention. Participants studied a list of pictures and then had a recognition memory test that included both full attention and selective attention (the to be responded to object was overlaid atop a blue outlined object) trials. All participants then completed a second recognition memory test. The results of 2 experiments suggest that subsequent tests consistently show impacts of the status of the ignored stimulus, and that having an initial test changes performance on a later test. The results are discussed in relation to effect of attention on memory more generally as well as spontaneous recognition memory research.

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## 1. Introduction

At any moment, individuals may be asked to attend to several objects, people, or activities simultaneously, particularly with the increased prevalence of portable technology. For a student in a lecture, pulls on attention may be personal (e.g., as the blinking light on one's cell phone) or overt (e.g., surrounding students who are off task via texting or Internet surfing). Both of these types of distractions can disrupt learning and memory (Sana, Weston, & Cepeda, 2013). In order to complete tasks in these distracting circumstances, individuals must attend to one task or stimulus while simultaneously ignoring non-essential tasks or stimuli. This process of allocating attention is called selective attention.

Most of the time, selective attention is a helpful process that allows an individual to attend to the environmental stimuli of greatest concern or interest. The current research investigates the impact of selective attention on recognition test performance. Specifically, we were interested in how selective attention during a memory test affects the accuracy of memory decisions during that testing episode, as well as its effect on memorial performance on subsequent recognition tests. In this way, we hoped to assess the immediate and long term mnemonic repercussions of selective attention at test. This approach is similar to that of recent research on divided attention effects in memory (simultaneously working on two tasks), which has delineated times when memory is and is not impaired relative to a full attention condition (for a review see Mulligan, 2008). Overall, divided and selective attention research both investigate memory deficits (and benefits) associated with encountering multiple stimuli, whether that be ignoring some stimuli (selective attention) or multitasking (divided attention).

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Rock and Gutman (1981) conducted an early study on the interplay between selective attention and recognition memory. They had participants study single (full attention) or overlapped (selective attention) objects. The results of the experiment demonstrated that individuals who studied the overlapped objects (e.g., a red house overlapped with a picture of a green table) had reduced memory performance compared to individuals who studied single objects (e.g., a red house presented alone), suggesting that conditions that require selective attention at encoding impair later memory performance relative to when there are no competing stimuli presented.

Since Rock and Gutman (1981), extensive research has explored how selective attention impacts memory (Rosner, D'Angelo, MacLellan, & Milliken, 2015; Rosner & Milliken, 2014; for a review see Mulligan, 2008). One explanation for the reduction in performance for selective attention relative to full attention conditions at encoding is the increase in information that is being processed, and thus being retrieved, in the selective attention condition as compared to the full attention condition. That is, the selective attention group simply has more to remember and this decreases later performance. A question of interest to some researchers investigating effects of selective attention on memory performance has been how well participants are able to remember items that have been intentionally ignored at study (e.g., green objects in Rock & Gutman if participants are responding to the red object). Currently, there is mixed evidence in the literature regarding the influence of the ignored item on subsequent memory performance. For instance, Butler and Klein (2009) observed significant perceptual priming for previously ignored stimuli relative to novel stimuli, suggesting that the perceptual system does register ignored items. In other cases, evidence of memory for the ignored item is not readily demonstrated. For example, Ballesteros, Reales, and Garcia (2007) tested implicit memory for ignored objects and saw little evidence of priming effects when the ignored items were later presented.

The aforementioned studies focused on the role of selective attention during the encoding phase, however, selective attention may also play a role at the time of retrieval. To date, there has been less research examining how selective attention at retrieval influences subsequent memory performance. The current study is an attempt to address this neglected question. One set of studies looked at this question by testing participants on their recognition performance during a selective attention manipulation (e.g., Anderson, Jacoby, Thomas, & Balota, 2011; Ste-Marie & Jacoby, 1993). At retrieval, task relevant items were paired with task irrelevant items, and participants were told to ignore task irrelevant items while performing a recognition task. While task irrelevant items did not impact memory test accuracy for young participants, they did impact performance among older adults and for younger participants who were engaged in a divided attention task at the same time as the selective attention task (Anderson et al., 2011).

Furthermore, there has been a wealth of recent research on effects of divided attention (completion of two tasks at the same time) at retrieval primarily by Naveh-Benjamin and colleagues (e.g., Guez & Naveh-Benjamin, 2013; Naveh-Benjamin, Guez, & Marom, 2003; Naveh-Benjamin, Kilb, & Fisher, 2006). Generally, these studies suggest that divided attention is disruptive for both encoding and retrieval. For example, Guez and Naveh-Benjamin (2013) reported the results of four experiments that examined the influence of divided attention at retrieval. They found that dividing attention during an initial retrieval attempt consistently led to disrupted memory performance on subsequent tests. Naveh-Benjamin and colleagues explain these findings by suggesting that the disruption may be due to disruption at the level of working memory, specifically the Episodic Register. They argue that a reason the finding of impairment at encoding has been more prevalent is that most research designs are simply more sensitive to encoding than retrieval effects. This criticism of the divided attention literature may also be true of the selective attention literature. However, it is difficult to answer the question of how closely the effect of selective attention mirrors that of divided attention due to the lack of experiments examining selective attention at the time of retrieval.

The present experiments were aimed at addressing this gap in the literature by testing both the impact of selective attention during retrieval and the memory for ignored items presented during these trials. Generally, a disadvantage of traditional methods for studying selective attention's influence on memory retrieval is that it removes the ability to test the memory of "ignored" items because participants would not be responding to ignored stimuli during retrieval. Therefore, little is known about the mnemonic fate of the ignored items. We were able to eliminate this disadvantage by modifying a study regarding effects of divided attention (completing two tasks simultaneously) at retrieval during initial and repeated testing (Dudukovic, DuBrow, & Wagner, 2009).

Dudukovic et al. (2009) conducted a recognition memory study that manipulated both divided attention and repeated testing. In the first experiment, participants studied a list of pictures and completed both divided and full attention recognition memory tests. For the divided attention test, participants responded to images from the study phase while simultaneously completing an auditory task. The full attention test was similar, but without the auditory secondary task. After two days, the participants completed a second recognition test, under full attention. The results of the study showed a decrease in memory performance during the initial memory test for divided attention trials in Experiment 1 but not Experiment 2. Both experiments demonstrated that items responded to under a divided attention memory test had reduced recognition during the second test relative to items responded to under full attention. That is, when a test serves as an additional encoding event, memory deficits from divided attention are noted under subsequent recognition attempts.

Furthermore, Guez and Naveh-Benjamin (2013) have pointed out that the paradigm adopted by Dudukovic et al. (2009), has the further advantage of correcting a fundamental asymmetry in the manner in which attention effects on memory have traditionally been assessed. For example, in the traditional divided attention paradigm, the influence of divided attention at encoding is assessed after encoding is complete, while the influence of divided attention at retrieval is assessed continuously as the test unfolds. The current experiments adopt the Dudukovic et al. (2009) paradigm, except that we utilized a selective

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