PREDICTING PROSPECTIVE MEMORY: METACOGNITIVE SENSITIVITY AT ENCODING

Jonathan A. Susser

A dissertation submitted to the faculty of the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Psychology and Neuroscience

Chapel Hill
2016

Approved by:

Neil W. Mulligan

Kelly S. Giovanello

Peter A. Ornstein

Mark Hollins

B. Keith Payne

ABSTRACT

Jonathan A. Susser: Predicting Prospective Memory: Metacognitive Sensitivity at Encoding
(Under the direction of Neil W. Mulligan)

Prospective memory refers to our ability to remember to complete future intentions. Research on prospective memory has identified factors that influence performance; however, it is unclear how sensitive people are to these factors and how aware they are of their prospective memory abilities. In retrospective memory, or our memory for events in the past, much is known about how people assess their learning, and Koriat's (1997) cue-utilization framework outlines three types of inferential cues thought to influence memory predictions. Koriat classified cues as being intrinsic, or properties of the to-be-learned information; extrinsic, or conditions of the learning environment; and mnemonic, or subjective indices of acquisition. In the current study, I applied Koriat's framework to predictions of prospective memory. In particular, the study examined, at encoding, sensitivity to one intrinsic cue (target-response association) and one extrinsic cue (target focality) known to affect prospective memory performance. Experiment 1 examined target-response association and target focality in a between-subjects design. Experiments 2 and 3 manipulated each factor within subjects. Results indicated that judgments of prospective remembering are similar to those of retrospective remembering: they are sensitive to information intrinsic to the to-be-remembered information but less so to extrinsic cues about the learning situation. These findings nicely extend Koriat's framework to this additional metamemory domain. Important next steps will be to assess whether experience with extrinsic

cues elevates sensitivity and to study the link between prospective memory predictions and control behaviors.

ACKNOLWEDGEMENTS

First and foremost, I would like to thank my advisor, Neil W. Mulligan. Neil always supported and encouraged me, pushed me to be a better researcher and scientist, and made sure I kept the reader in mind in my writing. I truly do not think I would be here today without his guidance, and I know all of his thoughtful feedback helped me succeed. Neil was always around if I had a question, concern, or conundrum, and was excellent at putting things in perspective and ensuring everything was okay whenever I came across any major or minor (almost always minor) issues.

I would also like to thank the other members of my dissertation committee, Kelly Giovanello, Peter Ornstein, Mark Hollins, and Keith Payne, for their advice, comments, and inspiration both inside and outside of the classroom.

I owe a big thanks to the members of my lab, past and present, for all of their support over the years. Miri Besken, Milton Picklesimer, Adam Smith, and Zach Buchin all helped me develop and improve my projects and ideas. I want to strongly thank Chris Foster, the other member of my cohort. He was imperative in keeping me sane, happy, and productive throughout my entire time in graduate school. We went through everything together, and it was great to have someone to connect with along the way. And I would not have been able to collect and analyze all of my data without the help of numerous research assistants over the years.

Rebecca Stephens deserves tremendous thanks for always encouraging me, motivating me, debating me, pushing me, and navigating these last few years with me. She always strives to make me a better person, and, even though I resist at times, I know she has my best interests in mind. I am excited to see where we go from here.

Finally, my family has always been there for me, even if they barely know what I do (much of that is my fault!). I want to thank them for believing in me and loving me no matter what, and for putting up with my poor ability to keep in touch. Everything is good here.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

Our lives contain many upcoming tasks and responsibilities: we need to pick up groceries from the store, put leftovers in the fridge, relay a message to a friend, and more. Remembering to complete such tasks is referred to as prospective memory. In contrast, our memory for events and information experienced in the past is known as our retrospective memory. Although the majority of memory research has studied retrospective memory, prospective memory research has grown in recent decades because of its implications in both basic and applied domains (for reviews, see Dismukes, 2010, 2012). Crovitz and Daniel (1984) estimated that half of everyday forgetting reflects failures of prospective memory. Due to the numerous prospective demands we face, we have developed tools to help us remember. Knots on fingers, pill boxes, and basic calendars reflect some of the many aids that ease our prospective memory burdens.

Presumably, one requirement for using these tools is awareness and knowledge that they are needed. In other words, if we are confident we will remember to buy milk at the store after work, we may not set a reminder; if we worry we will forget our medication, we might put a pill box by our front door. Although some examples of prospective memory are minor, forgetting to complete certain tasks can have dire consequences. For example, McDaniel and Einstein (2007a) note the horrifying story of a father on his way to work who was supposed to take his child to school. The father forgot to drop off his child before arriving at work, and the child eventually died.

With these issues in mind, it is important to understand people's sensitivity to their prospective memory performance. We know much about how people predict their retrospective memory, but little research has examined our ability to judge whether we will complete future tasks.

Metamemory Overview

How people assess and make decisions about their memory is referred to as metamemory. In other words, metamemory reflects people's awareness of their memory processes. Researchers distinguish between two metamemorial processes: monitoring, or the assessment of memory, and control, or the decisions we make about our memory (Nelson & Narens, 1990). For example, students preparing for an exam may monitor their studying to evaluate what they know and do not know, and then use these monitoring assessments to decide whether to continue reviewing material or move on to other work.

How do researchers assess monitoring and people's judgments about their memory? In a typical study, participants learn a list of items one-by-one in preparation for a memory test. During encoding, participants make a prediction, often for each individual item, about their future memory. The most common prediction is the judgment of learning (JOL), for which participants rate their confidence in remembering an item on a scale from 0 (no confidence) to 100 (extreme confidence). Participants later take the memory test, and objective memory can be compared to predictions in a variety of ways to assess the accuracy of the metamemorial judgments (outlined in more depth below). Researchers interested in examining how people regulate or control their learning may also ask participants to select items to restudy or measure how long participants self-pace their restudying.

A primary goal of metamemory research is to understand how people make JOLs and what information goes into them (for reviews, see Bjork, Dunlosky, & Kornell, 2013; Schwartz & Efklides, 2012). If people initially make faulty predictions, their later decisions may likewise be faulty, leading to an inefficient allocation of cognitive resources (e.g., Rhodes & Castel, 2009).

Memory Monitoring

Current theorizing views monitoring as an inferential process based on cues in the learning environment (e.g., Koriat, 1997; Schwartz, 1994; Schwartz, Benjamin, & Bjork, 1997). People's predictions will be accurate to the extent that they use cues that relate to actual memory performance. If people rely on cues that are not indicative of memory, their predictions and study decisions may be impaired (e.g., Rhodes & Castel, 2009).

So what cues do people use when making judgments of future memory? Koriat (1997) proposed an influential cue-utilization framework that delineates types of cues people incorporate into their JOLs. Specifically, Koriat classified cues into three categories: intrinsic, extrinsic, and mnemonic. Intrinsic cues stem from the to-be-learned items and are perceived to reveal their ease or difficulty of learning. For example, the relation between items in word pairs would be considered an intrinsic cue, as would the concreteness of words, as this information is contained within particular items. Extrinsic cues pertain to the conditions of learning or to encoding operations applied by the learner. For example, the composition of the list in which items are presented, the delay between study and test, and any strategies that people use to aid learning (e.g., using mnemonics, generating information) would all be extrinsic cues, as these are not intrinsic characteristics of the items under study. Mnemonic cues are indicators of the degree of learning of a piece of information based on internal feelings or subjective experience. For example, feelings regarding the ease of learning or producing information would be considered mnemonic cues.

A key proposal of Koriat's (1997) framework is that intrinsic cues more strongly influence JOLs than do extrinsic cues. More specifically, participants often discount or underappreciate the effects of extrinsic factors on memory. Across multiple experiments, Koriat provided evidence for this idea by first showing that JOLs effectively tracked item difficulty of word pairs (based on the relatedness between the items), an intrinsic cue, but not the number of study trials or length of study duration, both extrinsic cues. Although all three of these variables affected actual recall performance, participants' predictions were more sensitive to, and consistent with, the effects of the intrinsic information.

Subsequent research has generally supported the discounting of extrinsic cues in forming JOLs (e.g., Carroll, Nelson, & Kirwan, 1997; Castel, 2008; Kornell & Bjork, 2009; Kornell, Rhodes, Castel, & Tauber, 2011; Susser, Mulligan, & Besken, 2013; Tauber & Rhodes, 2010; but see Begg, Vinski, Frankovich, & Holgate, 1991; Dunlosky & Matvey, 2001). For example, Koriat, Bjork, Sheffer, and Bar (2004) assessed whether participants were sensitive to the effects of differing retention intervals and item relatedness of word pairs. In one experiment, participants were told that they would be tested on word pairs either immediately or upon returning to the experiment a day or week later. Participants studied the items, made a JOL for each one, and ultimately took the memory test. As expected, predictions were sensitive to the associative relatedness of words pairs, an intrinsic cue. However, for retention interval, predictions were remarkably stable despite actual memory performance declining dramatically with increasing interval. Subsequent experiments revealed that people can display some sensitivity to retention interval when predictions are made in a within-subjects fashion; however, the effect on recall remained much greater. This pattern of results is intriguing given the salience of forgetting in everyday life. Furthermore, Susser et al. (2013) found that JOLs were influenced by perceptual characteristics of items (i.e., word font size and auditory clarity), which did not actually affect memory, but were not influenced by the composition of the list in which the items were presented (i.e., mixed vs. pure), which did.

Koriat (1997) defined the third category of cues, mnemonic cues, as subjective indices that inform the learner how well material has been learned. These mnemonic cues have been heavily researched, and the most frequently studied index has been processing fluency, or the subjective ease of processing information (Alter & Oppenheimer, 2009). Researchers have examined various instantiations of fluency, both when perceiving and producing information, and have observed a general pattern: more fluent processing is associated with greater memory confidence, even if it is not reflective of greater memory performance (e.g., Begg, Duft, LaLonde, Melnick, & Sanvito, 1989; Benjamin, Bjork, & Schwartz, 1998; Besken & Mulligan, 2013, 2014; Hertzog, Dunlosky, Robinson, & Kidder, 2003; Rhodes & Castel, 2008, 2009; Susser & Mulligan, 2015; Undorf & Erdfelder, 2011). For example, Benjamin et al. (1998) had participants mentally generate answers to trivia questions of varying difficulties. Participants pressed a key upon retrieving an answer (used as an index of retrieval fluency) and made a JOL for each. Eventually, participants took a memory test. The researchers found that JOLs increased for answers that were more quickly retrieved, but recall decreased.

Measures of JOL Accuracy

In assessing the accuracy of JOLs, researchers distinguish between absolute accuracy, sensitivity, and relative accuracy. Absolute accuracy reflects a comparison between overall levels of predictions and recall. For example, if participants predict they will remember 45% of the items (i.e., their average JOLs for a set of items is 45) and actually recall 45%, they have perfect absolute accuracy. Overconfidence and underconfidence can similarly be computed by comparing participants' predictions with their memory accuracy.

The sensitivity of JOLs refers to the extent to which patterns of JOL responses match patterns of recall, and is usually assessed in conjunction with a manipulation of memory or metamemory. For example, if a variable has similar effects on JOLs and recall, then people would seem to be sensitive to the variable. However, a manipulation may affect JOLs and not recall (referred to as a metacognitive illusion, see Rhodes & Castel, 2008), recall but not JOLs (e.g., Sungkhasettee, Friedman, & Castel, 2011), or both but in opposite directions (e.g., Besken & Mulligan, 2014). In these latter cases, people's awareness of factors influencing memory is shown to be poor. Although people can show good sensitivity (e.g., Begg et al., 1989; Koriat, 2008; Tauber & Rhodes, 2010), they also rely on cues that are not indicative of memory performance (e.g., Benjamin et al., 1998; Besken & Mulligan, 2013, 2014; Hertzog et al., 2003; Rhodes & Castel, 2008; Susser & Mulligan, 2015).

A third aspect of JOL accuracy is relative accuracy, which assesses people's ability to accurately predict performance for one item in relation to others. In other words, relative accuracy shows whether people can discriminate to-be-remembered items from those not later remembered (e.g., Dunlosky & Metcalfe, 2009). Relative accuracy is often assessed by computing an ordinal measure of association between each participant's JOLs and recall performance, and the most common measure is the Goodman-Kruskal gamma correlation (see Nelson, 1984). Gamma is positive if items that are subsequently remembered are given higher JOLs, and items subsequently forgotten receive lower JOLs. Fortunately, people generally have above-chance relative accuracy, and under certain conditions display extremely high levels (e.g., Nelson & Dunlosky, 1991), indicating that we often have awareness of which information is more likely to be remembered later.

Metamemory Conclusion

Research in metamemory has helped elucidate what people know about their memory and how they go about predicting and controlling their performance. Although people are rather accurate at deciphering what information will be remembered later (e.g., Nelson & Dunlosky, 1991), they can fall prey to illusions of memory (e.g., Benjamin et al., 1998; Rhodes & Castel, 2008, 2009) and may underappreciate the influence of certain learning conditions (e.g., Koriat et al., 2004). Koriat's (1997) cue-utilization framework represents a useful way to classify the cues people use to make predictions. Critically, though, the vast majority of research on metamemory – and all of the work discussed above – has examined retrospective memory. In other words, people are making judgments for information that they will be asked to retrieve later. Despite the importance of prospective forms of remembering, much less is known about our metamemorial abilities in this domain.

Prospective Memory Overview

Prospective memory refers to our ability to remember to carry out actions or tasks in the future. This type of memory is often viewed in contrast to retrospective memory, or the retrieval of information from the past. A main difference between the two is the type of retrieval required; when being tested on retrospective memory, participants are typically placed in a retrieval mode (by the experimenter) and asked to think about information from their past. In prospective memory, people must remember to remember; they are often engaged in ongoing activities and need to shift attention and remember to complete their intended action at the appropriate place and time (e.g., Graf & Uttl, 2001; McDaniel & Einstein, 2007b). For example, you may be walking to class when you pass a friend and realize you need to deliver a message.

Classifications of Prospective Memory

Researchers categorize prospective memory into two types: event-based and time-based. Event-based prospective memory refers to remembering to complete an action in response to an event (e.g., when you see your friend, you need to remember to give a message). Time-based prospective memory refers to remembering to complete an action at a certain time or after a certain amount of time has elapsed (e.g., taking cookies out of the oven in 15 minutes; McDaniel & Einstein, 2007a). The current study is concerned with event-based prospective memory, which has been the main focus of research in the field.

Fulfilling prospective memory intentions requires remembering two pieces of information: 1) that an intention needs to be completed (in response to the appropriate event or at the appropriate time) and 2) the contents of the intention. The former is often characterized as the prospective component of the intention, and could be said to represent prospective memory proper. The latter aspect can be considered a retrospective component akin to a cued-recall scenario, in that once the intention is initiated, the content or action (e.g., giving the message) must be remembered from the prior episode in which it was planned. The majority of prospective memory studies use a simple and easy retrospective component (e.g., pressing a single key on the keyboard) to better study the prospective component (McDaniel & Einstein, 2007a); however, other actions are also used, including saying a single word or phrase aloud to the experimenter.

Prospective Memory in the Lab

Although laboratory research on retrospective memory has been conducted for many decades, controlled experimental investigation of prospective memory began more recently.

Einstein and McDaniel (1990) pioneered such an investigation by designing a paradigm that is still widely used today. In a typical experiment, participants are engaged in an ongoing task; for example, they may rate the pleasantness of words. This aspect of the paradigm is supposed to represent being occupied by everyday activities. Participants are also instructed to perform an action at a point later in the experiment. This is the prospective memory intention. For example, participants may be asked to press a key when they encounter a particular word (i.e., the target word). Prior to the start of the ongoing task, researchers include a delay so the prospective intention does not stay in working memory, which would make the task a vigilance one (Uttl, 2008). Then, the ongoing task begins, and the target word(s) is presented a certain number of times. Prospective memory performance is generally calculated as the number of times participants complete the action out of the total number of target presentations.

Factors Influencing Prospective Memory

Using Einstein and McDaniel’s (1990) laboratory paradigm, researchers have investigated factors that affect prospective memory success (e.g., Brandimonte & Passolunghi, 1994; Einstein et al., 2005; Hicks, Marsh, & Cook, 2005; Loft & Yeo, 2007). Three factors that have received considerable attention are the focality of the target, the distinctiveness of the target, and the relation between the target and action or response.

Target focality refers to the type of processing fostered by the target in the context of the ongoing task in relation to its initial encoding (McDaniel & Einstein, 2000). A target is considered focal if its features emphasized in the ongoing task are consistent with the features that are emphasized at encoding. In other words, the nature of target processing during the ongoing task and at initial encoding overlap. A target is considered non-focal when the processing of the target during the ongoing task and at encoding differs. For example, if the prospective memory intention requires participants to respond to a particular syllable found in words and the ongoing task is to determine whether one word is an exemplar of a category word, the target would be non-focal; processing the syllable is not necessary for completing the word-categorization task. On the other hand, if the intention requires participants to respond to a particular exemplar, the processing is consistent, and the target would be focal (see Einstein & McDaniel, 2005).

Focal targets, due to their overlap in processing, typically lead to better prospective memory than do non-focal targets (e.g., Einstein et al., 2005; McBride & Abney, 2012; McBride, Beckner, & Abney, 2011; Scullin, McDaniel, & Einstein, 2010). For example, Einstein et al. (2005, Experiment 2) had participants perform a word-categorization task while holding the intention of pressing a key upon encountering a target. For half of the participants, the target was a focal, single word; for the other half, the target was the syllable *tor*. In both conditions the target occurred four times throughout the categorization task. Einstein et al. found enhanced prospective memory performance for the focal as compared with the non-focal target.

McBride and Abney (2012) examined focality in a different manner. Rather than manipulating the nature of the target, they kept the target constant and manipulated the ongoing task in which it occurred. The prospective memory intention was to press a key whenever a word with repeated, consecutive vowels was seen (e.g., *moose*; there were six targets total). For the ongoing tasks, participants had to indicate whether a word contained three or more vowels (the focal condition), whether a word contained three or more syllables (a non-focal condition), or whether a word represented something living or non-living (a second non-focal condition). Similar to the results of Einstein et al. (2005), prospective memory performance was better for participants in the focal condition than the two non-focal conditions, who displayed similar accuracy.

The distinctiveness of the target in its surrounding context can also influence prospective memory (e.g., Brandimonte & Passolunghi, 1994; Cohen, Dixon, Lindsay, & Masson, 2003; McDaniel & Einstein, 1993). For example, Brandimonte and Passolunghi (1994) assessed both target distinctiveness and familiarity in the context of a short-term memory ongoing task. To manipulate distinctiveness, targets were presented either in all capital letters or in lowercase (consistent with the rest of the words). To manipulate familiarity, participants either received a high-frequency target (house) or a low-frequency target (chrism). Targets were presented eight times total. Results showed enhanced prospective remembering for both distinctive and unfamiliar targets.

Most studies on prospective memory focus on people's memory for the prospective component of the intention; these studies are interested in how people know when to carry out an action. To answer this question, the retrospective component of the intention is kept consistent across conditions and made very simple, such as the press of a single key on the keyboard. Other studies, however, are interested in how the association between the target and action affects performance (e.g., Loft & Yeo, 2007; Marsh, Hicks, Cook, Hansen, & Pallos, 2003; Pereira, Ellis, & Freeman, 2012).

Cohen, West, and Craik (2001) had participants study picture-word pairs for a later test. Embedded in this study phase were prospective memory intentions consisting of a picture and accompanying phrase. Participants were told that if they encountered a target picture in the later test phase, they should say the phrase aloud to the experimenter. There were 24 intentions in total, one-third being highly related (e.g., target = patient in doctor's room, phrase = *I must go to* *the doctor*); one-third being somewhat related (e.g., target = ambulance, phrase = *I must go to the doctor*); and one-third being unrelated (e.g., target = hot air balloon, phrase = *I must go to the doctor*). If participants could not remember a particular phrase but did recognize a target, they notified the experimenter.

Cohen et al. (2001) scored prospective memory performance in three ways. To measure overall performance, Cohen et al. assessed the number of correct phrases retrieved from each of the three conditions (8 targets in each). To measure the prospective component specifically, Cohen et al. examined the number of times participants identified a target, regardless of whether the phrase was remembered correctly. To measure the retrospective component specifically, Cohen et al. examined the number of correct phrases reported as a proportion of the identified targets. Results indicated that overall prospective memory performance decreased as the relation between the target and action weakened. Relatedness had this same effect on the individual prospective and retrospective components, but had a larger effect size for the latter.

Subsequent research on the effects of relatedness has not parsed out the prospective and retrospective components; however, to minimize the role of the former, the targets are kept the same for all intentions. For example, Marsh et al. (2003, Experiment 4) had participants learn eight target-response word pairs.[1] Some participants received pairs that were related (e.g., dog-food), while other participants received pairs that were unrelated (e.g., dog-album). All participants saw the same targets, but those in the unrelated condition had the response words re-paired (see also Pereira et al., 2012). Participants' task was to say the response word aloud upon

[1]For simplicity, I will refer to these intentions as target-response intentions throughout the rest of this paper. The target is the prospective memory target, and the response is the content of the action.

encountering the target during a lexical decision task. Marsh et al. found better performance for the related pairs.

Retrieving Intentions

In addition to understanding the factors that affect prospective memory, another important question is how people retrieve intentions upon the appearance of a target. In particular, researchers debate whether prospective memory retrieval occurs spontaneously when the target is presented or if a form of monitoring is necessary (e.g., Einstein & McDaniel, 2005; Loft & Yeo, 2007; McDaniel & Einstein, 2000, 2007a, 2007b; Smith, 2003; Smith, Hunt, McVay, & McConnell, 2007).[2] Although not the focus of the current study, I will describe the different perspectives briefly here.

Monitoring. Monitoring in prospective memory is thought to be a capacity-demanding process driven by the need to retrieve an intention, and is often assessed by examining costs to the ongoing task. The preparatory attentional and memory processes (PAM) theory, outlined by Smith and colleagues (e.g., Smith, 2003, 2015; Smith et al., 2007), has received the most support. The theory proposes that successful prospective remembering relies on preparatory monitoring processes that scan the environment for potential targets and that are always engaged when targets are expected to occur. However, the monitoring does not need to be in the focus of attention at all times; it can occur peripherally outside of focal awareness, though still consuming cognitive resources. Furthermore, this preparatory monitoring is flexible and will be most active in the "performance interval" or "the particular spatial-temporal constraint defining the

---

[2] Monitoring in metamemory refers to how people judge, assess, or predict their memory. However, monitoring in prospective memory refers to the use of resource-demanding attentional allocation to prepare to carry out intentions. I will try to make the appropriate meaning of the word evident through the surrounding context.

circumstance under which carrying out ... the intention will complete the original intent" (Smith et al., 2007, p. 742; see also Marsh, Hicks, & Cook, 2006).

To examine this form of preparatory monitoring, Smith (2003) had participants respond to six different prospective memory targets in the context of a lexical decision task in which reaction times (RTs) were assessed. One group of participants was told to respond to the targets immediately by pressing a key, while another group delayed its response until after the lexical decision task. According to the PAM theory, lexical decision times should be slower, throughout the entire task, in the immediate than delayed prospective memory group, as only the former needs to prepare to respond. This is what Smith found. Furthermore, participants who were more accurate on the prospective task exhibited slower RTs, suggesting a resource-demanding monitoring process that is related to prospective memory success.

Spontaneous retrieval. In their early prospective memory study, Einstein and McDaniel (1990) had participants rate how often they thought about the intention throughout the experiment. Participants reported rather low levels of monitoring, yet still performed accurately on the prospective memory task. Although such a questionnaire is not foolproof, it does denote the possibility that other routes can lead to successful prospective memory. In contrast to the idea that a capacity-consuming process is required, McDaniel and Einstein (2007b) have argued that more spontaneous target-driven processes can also support performance. They go on to say that people may be biased to use this route because it would be costly for a monitoring process – even one on the periphery of attention (Smith et al., 2007) – to be constantly engaged (e.g., Einstein & McDaniel, 2005; McDaniel & Einstein, 2007a). With spontaneous retrieval, the prospective memory target, upon appearance, would trigger retrieval of the intended action.

In one demonstration of this mechanism, Einstein et al. (2005, Experiment 3) had participants proceed through a sentence completion task in which they had to judge whether a word fit into a sentence. Participants completed two blocks of the task: a baseline block (with no prospective memory intention) and a prospective memory block that asked participants to press a key in response to a target word in the sentences. Participants either responded to four out of six potential prospective memory targets (consistent with Smith, 2003) or a single target, four times. Response times were gathered in both blocks. The researchers found that prospective memory performance was equivalent (and high) in both conditions. However, ongoing-task costs (comparing the baseline to prospective blocks) were only found in the six-target condition. The results indicate that people can demonstrate good prospective memory without costs to ongoing activities, providing evidence for spontaneous processes.

Multiprocess framework. To accommodate both monitoring and spontaneous retrieval processes supporting prospective memory, McDaniel and Einstein (2000; see also Einstein & McDaniel, 2005, 2010; Einstein et al., 2005) proposed a multiprocess framework that outlines circumstances under which each process ought to be engaged. These researchers argued that conditions of the task (e.g., the importance of the intention, the expected delay between encoding and retrieval, the number and nature of targets) and of the individual (e.g., cognitive or personality differences) may encourage one route over the other (but see Smith, 2010).[3]

Researchers include target focality as one factor that can alter the type of retrieval used; non-focal targets are thought to need more monitoring to be retrieved, while focal ones can be retrieved through spontaneous mechanisms. The multiprocess framework's proposed relation

[3]Though not the focus of the current study, this proposal implies an element of metacognition in prospective memory. In other words, participants may be sensitive to variations in prospective memory conditions and allocate attention accordingly (e.g., Einstein & McDaniel, 2008; Hicks et al., 2005; McDaniel & Einstein, 2000).

between the focality of the target and the type of processing implies that factors that impact the amount of attentional resources available (e.g., divided attention, task importance, aging) ought to have larger effects when targets are non-focal than focal (e.g., McDaniel & Einstein, 2007a). This assumption has generally been borne out (e.g., Einstein et al., 2005; Kliegel, Jäger, & Phillips, 2008; Kliegel, Martin, McDaniel, & Einstein, 2004; McDaniel & Einstein, 2000; cf. Loft & Yeo, 2007).

Prospective Memory Conclusion

Laboratory research on prospective memory has thoroughly investigated how we remember to carry out our intentions and the variables that influence performance. Multiple routes can lead to successful retrieval, and a variety of factors determine how we approach our intentions (McDaniel & Einstein, 2000; McDaniel, Guynn, Einstein, & Breneiser, 2004; Smith, 2003). This finding – that intentions can be completed in different ways – suggests a role for metacognition in the allocation of attention (Hicks et al., 2005; Smith, 2015), but direct investigations of how people monitor their prospective memory are limited.

Metamemory Monitoring in Prospective Memory

People appear to be aware of the nature of prospective memory targets and can allocate attention accordingly to achieve adequate performance (e.g., Einstein et al., 2005; Marsh et al., 2006; see also Einstein & McDaniel, 2008). Surprisingly, little research has explored the more basic capacity of how people predict – at encoding – their future prospective memory, a line of work that can shed light on people's use of tools to facilitate remembering (see Smith, 2015, for a recent overarching framework). As Meeks, Hicks, and Marsh (2007) note, "... at the time people form an intention they must decide concomitantly just how much environmental support they are going to need to actually accomplish the task" (p. 998; see also Gilbert, 2015). These aids can be thought of as the control components of prospective memory, and being able to accurately predict our performance would allow us to more efficiently use them (see, for example, Marsh, Hicks, & Landau, 1998). Furthermore, Hicks et al. (2005) proposed that people decide how to allocate their attentional resources based on their predictions of prospective memory success (see also Marsh, Hicks, & Cook, 2005).

The few studies that have directly examined predictions of prospective memory have uncovered intriguing results; however, they have used a variety of methods – both to assess prospective memory and metamemory – that makes it difficult to draw clear conclusions. For example, some studies have used item-by-item JOLs, while others have used aggregate judgments. Item-by-item predictions allow researchers to get fine-grained examinations of specific target influences on predictions (e.g., Schnitzspahn, Zeintl, Jäger, & Kliegel, 2011); a potential limitation of aggregate judgments is they are typically made without participants knowing the actual targets (e.g., Meeks et al., 2007). In general, the research has been concerned with the absolute accuracy of people's predictions, and typically finds that people are underconfident (e.g., Knight, Harnett, & Titov, 2005; Meeks et al., 2007; Schnitzspahn et al., 2011). Certain studies have also examined sensitivity to prospective memory manipulations (e.g., Meeks et al., 2007).

Meeks et al. (2007) provided the first controlled laboratory investigation of prospective memory and metamemory. In the context of a lexical decision task, participants were asked to respond to various targets. For some participants, the targets were animal words, and for others, they were words containing the syllable *tor*. During encoding, participants predicted the percentage of targets (out of eight total) they expected to find. Participants also completed the Prospective and Retrospective Memory Questionnaire (PRMQ; Smith, Della Sala, Logie, &

Maylor, 2000), a self-report questionnaire that assesses particular everyday retrospective and prospective memory performance and failures, such as "Do you fail to mention or give something to a visitor that you were asked to pass on?"

Although prospective memory performance was better for the animal than syllable targets, predictions were similar for the two and exhibited underconfidence. In the animal condition, predictions significantly correlated with performance, suggesting that participants had some sensitivity to their performance, at least for certain intentions. Additionally, negative correlations between PRMQ scores and predictions suggested that participants may have used their knowledge of their own everyday memory failures to judge their current performance. The researchers also found that participants in the syllable condition performed the ongoing task more slowly, a result partially consistent with the proposal of Hicks et al. (2005) in that participants may had recognized this task to be more difficult (however, predictions were not associated with ongoing task latencies).

In a similar fashion to Meeks et al. (2007), Meier, von Wartburg, Matter, Rothen, and Reber (2011) examined people's sensitivity to a cue-specificity manipulation; some participants were given a specific target word to respond to (the word trumpet) and others were a given a general category (a word that is a musical instrument). The ongoing task had participants view short lists of word-object pairs, in which they read the word and remembered the object. Predictions were made using a 6-item questionnaire that assessed both the prospective and retrospective components of prospective remembering, and one average score was then computed. Results showed no difference in predictions or prospective memory performance for the two types of targets.

Schnitzspahn et al. (2011) directly tied phenomena from the retrospective JOL literature to the study of prospective metamemory: they examined whether JOLs (both based on the prospective and retrospective components) would display the delayed-JOL effect (see Rhodes & Tauber, 2011) and the underconfidence-with-practice effect (see Koriat, Sheffer, & Ma'ayan, 2002).[4] The former effect is the finding that JOLs made immediately after studying items are less accurate than JOLs made at a delay. The latter effect is the finding that JOLs tend to initially be overconfident, but with repeated study trials, become underconfident.

For the ongoing task, Schnitzspahn et al. (2011) had participants read a story in preparation for a later test. Within the story were prospective memory target words (10 total); participants were asked to click on these targets (e.g., *Cappuccino*) and then type in an associated phrase (e.g., *Clean glasses*). To examine the JOL phenomena, participants were presented with either one or three encoding trials of the prospective memory intentions, making JOLs for half of the intentions immediately and the other half after a delay. The JOLs for the prospective component (i.e., prospective JOLs) assessed the likelihood of recognizing a target as a target. The JOLs for the retrospective component (i.e., retrospective JOLs) assessed the likelihood of recalling the actual content of a particular target. For example, for the prospective memory intention *Cappuccino-Clean glasses*, participants, effectively, rated the probability that they would become aware that an action needed to be taken when they encountered *Cappuccino*

[4]Einstein and McDaniel (2008) note that assessing predictions of prospective memory is complex due to the dual prospective and retrospective components of intentions. Although people may have high confidence in the particular action to-be-carried-out (e.g., buying milk), they may not be as confident in remembering when to perform the action (e.g., on the way home from work). Therefore, obtaining separate predictions for the two components or making people aware of this distinction may be beneficial.

during the ongoing task (the prospective component).[5] They also rated the probability that they would become aware of the phrase *Clean glasses* when encountering *Cappuccino* (the retrospective component).

Regarding the delayed-JOL effect, delayed JOLs – for both components of the intention – had better relative accuracy than immediate JOLs. Regarding the underconfidence-with-practice effect, all participants were underconfident in their prospective JOLs. The retrospective JOLs, though, revealed a different pattern: participants in the one-encoding condition were overconfident, but those in the three-encoding condition were underconfident – the typical underconfidence-with-practice effect. Importantly, these results demonstrate that processes involved in making predictions of prospective memory resemble those from the retrospective metamemory literature.

The Current Study

Given the abundance of research on metacognitive monitoring in the retrospective domain (e.g., Bjork et al., 2013; Dunlosky & Metcalfe, 2009; Koriat, 1997) and the lack of such research in the prospective domain (cf. Meeks et al., 2007; Meier et al., 2011), the current study explores people's insight into their own prospective memory by assessing their sensitivity to factors known to affect performance. This study also examines whether people can distinguish between the two components of prospective memory intentions: prospective and retrospective. To guide this study, I used Koriat's (1997) cue-utilization framework. As noted earlier, Koriat outlined three types of inferential cues that people use to make their JOLs: intrinsic, or cues that pertain to the particular items being judged; extrinsic, or characteristics of the study

---

[5]Schnitzspahn et al. (2011) did not name the specific prospective memory elements when obtaining their JOLs, instead using generic superordinate categories. For example, for the intention *Cappuccino*-*Clean glasses*, the prospective JOL read, "How probable is it that you will become aware that something has to be done upon encountering a beverage" (p. 22).

environment; and mnemonic, or subjective indices of learning. Koriat proposed that intrinsic cues are often attended to while extrinsic cues are less so, and it is unclear whether this idea holds in prospective memory.

For the current experiments, I chose to examine one intrinsic cue and one extrinsic cue. For the intrinsic cue, I selected target-response association strength. The relatedness of targets to responses has been found to influence the fulfillment of intentions (e.g., Marsh et al., 2003; McDaniel et al., 2004; Pereira et al., 2012; cf. Loft & Yeo, 2007), such that related targets and responses typically lead to better performance. Similarly, in retrospective metamemory, the relation between items in word pairs is a strong intrinsic cue that people use, giving higher predictions to related than unrelated pairs (e.g., Dunlosky & Matvey, 2001; Mueller, Tauber, & Dunlosky, 2013; Soderstrom & McCabe, 2011; Undorf & Erdfelder, 2015).

For the extrinsic cue, I chose target focality. As explained above, focality refers to the way the prospective memory target is processed at encoding in relation to how it is processed during the ongoing task (see McDaniel & Einstein, 2000). A target is considered focal when processing is matched (e.g., the target is the word *horse* and the ongoing task is lexical decision, which requires the processing of letters as words or not). A target is considered non-focal when processing is mismatched (e.g., the target is the word *horse* and the ongoing task is counting vowels). Prospective memory performance is typically enhanced for focal as compared with non-focal targets (e.g., Einstein et al., 2005; McBride & Abney, 2012). Focality is a condition of the learning context and therefore would be considered an extrinsic cue in Koriat's (1997) classification.

The present study extends the prior literature by using an influential metamemory framework to examine people's sensitivity to factors known to affect prospective memory performance. Furthermore, this study addresses some of the limitations of the prior research (e.g., Meeks et al., 2007) by having participants make predictions (in typical JOL fashion) for both prospective and retrospective components on specific target items.

CHAPTER 2: EXPERIMENT 1

Experiment 1 examined whether participants are sensitive to the effects of target-response association and target focality, intrinsic and extrinsic cues respectively according to Koriat's (1997) classification. Both factors have been found to affect prospective memory performance (better accuracy for related intentions and focal targets; e.g., Einstein et al., 2005; Marsh et al., 2003; Pereira et al., 2012). To remain consistent with the prospective memory literature, both factors were manipulated between subjects.

Regarding focality, I manipulated the ongoing task participants engaged in, similar to McBride and Abney (2012). This format allowed me to keep the prospective memory targets consistent across conditions and allowed all participants to make JOLs on individual words (rather than syllables or word categories, which have been used as non-focal targets in previous research). As will be detailed below, the focal and non-focal ongoing tasks were made as comparable as possible.

Based on the prospective memory literature (e.g., Marsh et al., 2003; McBride & Abney, 2012), actual memory performance should be better for the focal than non-focal targets (on the prospective component) and for related than unrelated intentions (on the retrospective component). Based on the cue-utilization framework of JOLs (Koriat, 1997), JOLs should show sensitivity to target-response association but should discount the effect of focality. An open question is whether participants will be able to distinguish between the two components when making their JOLs.

Method

Participants

One hundred and seven undergraduate students from the University of North Carolina at Chapel Hill participated in exchange for course credit. Two participants failed to follow instructions for the ongoing task (and their performance on the ongoing task was ~60%), and their data were not used. The data from one additional participant were lost due to a computer malfunction. Therefore, the final data set consisted of results from 104 participants, 26 in each of the four conditions

Materials and Design

The design was a 2 (target-response association: related vs. unrelated) x 2 (focality: focal vs. non-focal) between-subjects design. Stimuli for the ongoing tasks were obtained from the English Lexicon Project (Balota et al., 2007) and consisted of 90 words and 82 pronounceable non-words (172 items total), all ranging from 4-6 letters in length. Half of the words and non-words contained more than two vowels. Sixteen of the words were critical items and used as targets for the prospective memory task. These were randomly halved and counterbalanced to act as old/new items on the recognition test at the end of the experiment. Because the targets were words and therefore all received the same [word] response in the lexical decision task, they also all contained two or fewer vowels so that they likewise all received the same response in the vowel counting task. In all, there were 164 ongoing task trials per participant.

The "study list" of prospective memory target-response intentions consisted of eight targets paired with either a related or unrelated response word. Related target-response pairs were formed by choosing the most frequent associate of each target word based on the

University of South Florida word association norms (Nelson, McEvoy, & Schreiber, 1998). Unrelated target-response pairs were formed by randomly re-pairing the related pairs.

The “test list” used for the lexical decision and vowel counting ongoing tasks consisted of the 164 words and non-words. The items in this list were randomly ordered anew for each participant with the constraint that a random prospective memory target appeared every 20 trials.

The recognition test consisted of all 16 critical items, the eight targets seen previously and the eight new items.

Procedure

The study consisted of five main phases: instruction for the ongoing task; instruction, encoding, and prediction for the prospective memory intentions; a delay; the ongoing task; and the recognition and cued-recall tests. First, participants were told about the ongoing task, which was referred to as the “letter strings task.” Participants in the focal condition were informed that a little later in the experiment they would see individual letter strings on the computer screen and that their goal would be to classify them as either words or non-words as quickly and accurately as possible. Responses were made by pressing the D (*word*) and K (*non-word*) keys. Each trial consisted of three parts. The first was a “waiting” screen, and participants pressed the Space Bar to begin the trial. The second was a brief (250 ms) delay. The third was the letter string, which remained visible until the participant made a response.

In a similar fashion, participants in the non-focal condition were informed that a little later in the experiment they would see individual letter strings on the computer screen and that their goal would be to determine the number of vowels each string contained as quickly and accurately as possible. Responses were made by pressing the D (*two or fewer vowels*) and K (*more than two vowels*) keys. Each trial consisted of three parts. The first was a “waiting” screen, and participants pressed the Space Bar to begin the trial. The second was a brief (250 ms) delay. The third was the letter string, which remained visible until the participant made a response.

After the researcher was confident that participants understood the instructions, the researcher explained that a second goal of the experiment was to see how people remember to complete intentions in the future. Participants were told that they would be shown pairs of words, with the first word of a pair being the “target” and the second word being the “response.” They were also given an example. Participants were then instructed that if they encounter a target word later, during the letter-strings task, they should notify the researcher and try to say the associated response word aloud. If this response word was forgotten, the participant was told to still identify the target and let the researcher know. This type of responding allowed measurement of both the prospective and retrospective components of the intention (detailed below).

To encode the prospective memory intentions, participants were shown, in a random order, the eight target-response pairs for 8 seconds each. They were asked to say each pair aloud, and after the 8 s rated their confidence (i.e., made their JOL) in remembering the intention. Participants made two confidence ratings for each intention. The first rating (the prospective JOL) assessed participants’ ability to remember that they had to do something upon seeing the target word later. The second rating (the retrospective JOL) assessed participants’ ability to recall the particular response word, given they noticed the target. Both ratings were made on a scale from 0 (*not confident at all*) to 100 (*extremely confident*), and participants were encouraged to use the entire scale.

Next, participants were given a word-stem cued-recall memory test on the target-response intentions to ensure they were learned. Participants first saw the first two letters of a target and were asked to complete it and say it out loud. After retrieving (or attempting to retrieve) the target, participants pressed the *Spacebar* and were given feedback (i.e., were shown the target). Participants pressed the *Spacebar* again and proceeded to a blank screen at which they attempted to retrieve the associated response word. After attempting to retrieve the response, participants pressed the *Spacebar* and were given feedback (i.e., were shown the response). This was repeated for all eight intentions. Then, participants provided the same two JOLs as above. This design enabled participants to report their confidence upon initial learning and once intentions had been studied and tested.

After the encoding and predicting of intentions, participants completed a three-minute math distractor task to remove the intentions from working memory. Next, participants were reminded of the ongoing task (either lexical decision or vowel counting) and performed the task. No reference was made to the prospective memory intentions. At the end of the experiment, participants completed an old/new recognition test of the targets, followed by a cued-recall test of the target-response pairs. In the recognition test, participants saw a focus point (+) for 500 ms, a blank delay for 200 ms, and then a critical test word. Participants responded using the O (*old*) and N (*new*) keys. In the cued-recall test, participants were given a sheet of paper listing the prospective memory targets and wrote the associated response for each one. At this point, participants who had failed to identify any target words during the ongoing task were asked whether they remembered the prospective memory aspect of the experiment at all. Participants were then debriefed and thanked for their participation.

Results

To start, the recognition data revealed that participants effectively learned the prospective memory targets, making the rest of the data easier to interpret. Recognition memory performance (corrected hit rate: hits - false alarms) was overall very high (M = .96, SD = .08). A 2 (target-response association: related vs. unrelated) x 2 (focality: focal vs. non-focal) between-subjects analysis of variance (ANOVA) revealed a marginally significant main effect of target-response association, *F*(1, 100) = 3.68, *p* = .058, which showed better recognition for related (*M* = .98, *SD* = .05) than unrelated (*M* = .95, *SD* = .10) targets. There was no main effect of focality, *F*<1, and no interaction, *F*<1. Turning to the cued-recall results, I found a significant main effect of target-response association, *F*(1, 100) = 27.54, *p* < .001, *MSE* = 0.03, η^2_p = 0.22, with better cued recall for related (*M* = .95, *SD* = .16) than unrelated (*M* = .76, *SD* = .20) responses. There was no main effect of focality, *F*<1, and no interaction, *F*(1, 100) = 1.18, *p* = .181. These latter results demonstrate that the expected relatedness effect on memory remained despite the extensive encoding of the intentions.

Judgments of Learning

JOLs were made twice, first after initial exposure to each pair and again after all the pairs had been studied and tested. Figures 1 and 2 show the mean JOLs for the different experimental conditions and time points. Because I did not anticipate any differences across the two rounds of JOLs, I submitted the data to two 2 (target-response association) x 2 (focality) x 2 (time) mixed ANOVAs (one on prospective JOLs and the other on retrospective JOLs).

For prospective JOLs (Figure 1), the analysis revealed a significant main effect of target-response association, *F*(1, 100) = 10.18, *p* = .002, *MSE* = 474.70, η^2_p = 0.09, with greater JOLs for related than unrelated intentions, and a significant main effect of time, *F*(1, 100) = 6.18, *p* = .015, *MSE* = 93.82, η^2_p = 0.06, with an increase in JOLs from initial to second-round predictions. There was no main effect of focality, *F*<1, no interaction between target-response association and focality, *F*(1, 100) = 1.86, *p* = .176, and no interactions between time and target-response association, *F*(1, 100) = 1.43, *p* = .235, or between time and focality, *F*<1. There was, however, a marginally significant three-way interaction between time, target-response association, and focality, $F(1, 100) = 3.20$, $p = .077$. To decompose this interaction, I analyzed the data at each JOL time point separately using 2 (target-response association) x 2 (focality) between-subjects ANOVAs.

For initial prospective JOLs, the analysis revealed a significant main effect of target-response association, $F(1, 100) = 11.36$, $p = .001$, $MSE = 289.43$, $\eta^2_p = 0.10$, no main effect of focality, $F<1$, and no interaction, $F<1$. For the second-round prospective JOLs, the analysis again revealed a significant main effect of target-response association, $F(1, 100) = 6.02$, $p = .016$, $MSE = 279.09$, $\eta^2_p = 0.06$, and no main effect of focality, $F<1$, but a significant interaction, $F(1, 100) = 3.96$, $p = .049$. Decomposing this interaction revealed a significant relatedness effect in the focal condition, $t(50) = 3.33$, $p = .002$, but not in the non-focal condition, $t(50) = 0.31$, $p = .757$. The simple effect of focality was also assessed separately for the related and unrelated conditions. Neither of these analyses were significant, related: $t(50) = 1.69$, $p = .098$; unrelated: $t(50) = 1.11$, $p = .275$.

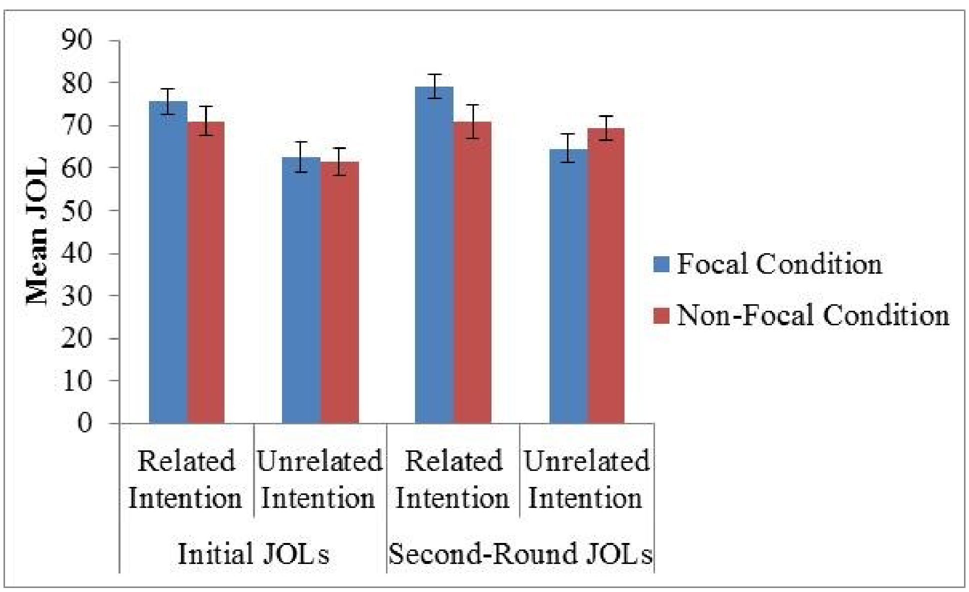

Figure 1. Mean initial and second-round prospective JOLs by focality and target-response association in Experiment 1. Error bars are ± 1 SE.

Turning to retrospective JOLs (Figure 2), the same 2 x 2 x 2 ANOVA revealed a significant main effect of target-response association, $F(1, 100) = 32.00$, $p < .001$, $MSE = 500.12$, $\eta^2_p = 0.24$, and of time, $F(1, 100) = 75.16$, $p < .001$, $MSE = 91.59$, $\eta^2_p = 0.43$. There was no main effect of focality, $F<1$, no interaction between target-response association and focality, $F(1, 100) = 2.86$, $p = .094$, and no interaction between time and target-response association, $F<1$, or between time, target-response association, and focality, $F<1$. However, there was a trending interaction between time and focality, $F(1, 100) = 3.35$, $p = .070$. This result seems to be driven by the finding that initial retrospective JOLs non-significantly favored focal over non-focal intentions, $F<1$, while the reverse was true for second-round JOLs (but again non-significantly), $F<1$.

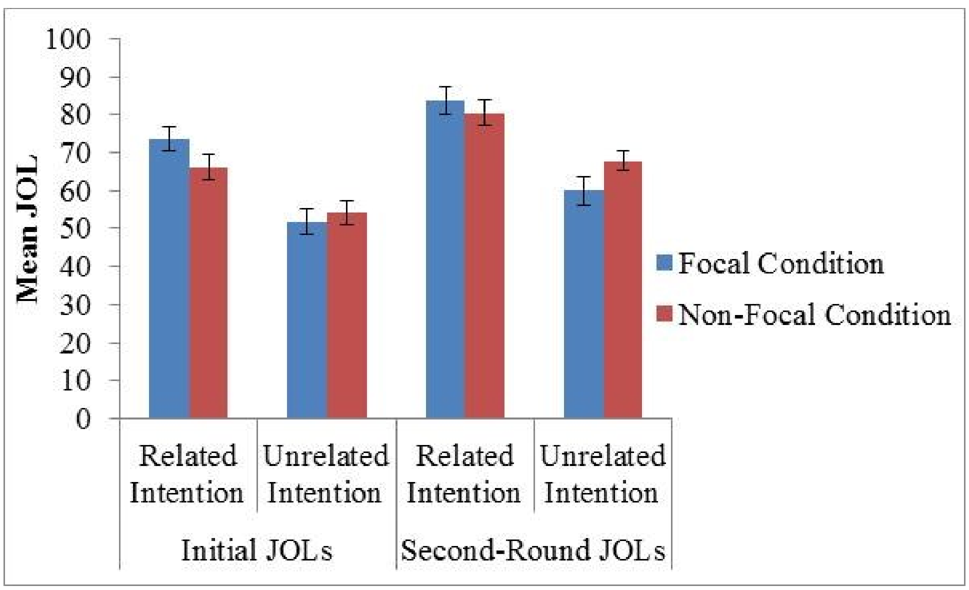

Figure 2. Mean initial and second-round retrospective JOLs by focality and target-response association in Experiment 1. Error bars are ± 1 SE.

For completeness, the relative accuracy of JOLs is reported using within-subject gamma correlations computed between JOLs and prospective memory performance. This analysis was performed separately for the prospective JOLs (with prospective component memory) and the retrospective JOLs (with retrospective component memory). However, these data may be of limited reliability given the small number of target items upon which they are based. Additional caution is warranted because of the amount of missing data. In the computation of gamma, ties on a variable are excluded (Gonzalez & Nelson, 1996). So, if a participant gave the same JOL for every item or recalled (or failed to recall) every item, gamma could not be calculated. This aspect of the gamma calculation produced the variable degrees of freedom below and in the subsequent experiments.

Interestingly, all gamma correlations were significantly or marginally greater than 0. The correlation between initial prospective JOLs and memory for the target was positive and significant ($G = .28$, $SE = .12$), $t(27) = 2.24$, $p = .033$. The correlation between second-round prospective JOLs and target memory approached significance ($G = .24$, $SE = .12$), $t(29) = 2.01$, $p = .054$, and did not differ from the initial round, $t(27) = 0.62$, $p = .543$.[6] The gamma correlation between initial retrospective JOLs and memory for the response was significantly greater than 0 ($G = .20$, $SE = .09$), $t(43) = 2.18$, $p = .035$. Finally, the correlation between the second round of retrospective JOLs and response memory was significant ($G = .57$, $SE = .07$), $t(45) = 8.07$, $p < .001$, and also significantly greater than initial JOLs, $t(43) = 3.85$, $p < .001$.

Prospective Memory Performance

As described earlier, prospective memory performance was assessed in two ways. The prospective component was measured as the proportion of times out of eight (the total number of targets) that the participant noted the presence of a target. This value was also conducted conditionalized on participants' recognition of the targets at the end of the experiment. The patterns of the unconditionalized and conditionalized data are the almost identical (except where

[6]For some participants in the current analysis and throughout the gamma correlation results, only a single gamma could be computed (either for the initial or second-round predictions). Therefore, the average values used in the paired-samples comparisons (and degrees of freedom) slightly differed.

noted); therefore, only the unconditionalized data are reported. The retrospective component was measured as the number of times participants retrieved the correct response word given they recognized the target.

See Table 1 for mean proportion prospective memory performance for both the prospective and retrospective components. A 2 (target-response association: related vs. unrelated) x 2 (focality: focal vs. non-focal) ANOVA was conducted on memory for the prospective component. This analysis revealed no main effect of target-response association, $F(1, 100) = 2.18$, $p = .143$, no main effect of focality, $F(1, 100) = 1.13$, $p = .290$, and no interaction, $F<1$.

The same 2 x 2 analysis conducted on memory for the retrospective component showed a significant main effect of target-response association, $F(1, 75) = 29.94$, $p < .001$, $MSE = 0.03$, $\eta^2_p = 0.29$, with better memory for related responses ($M = .96$, $SD = .09$) than unrelated responses ($M = .74$, $SD = .25$). There was no main effect of focality, $F<1$, and no interaction, $F<1$.

Table 1. Mean (SE) Proportion Prospective Memory Performance for the Prospective and Retrospective Components in Experiment 1

	Prospective Component		Retrospective Component	
	Focal	Non-Focal	Focal	Non-Focal
Related Intention	.79 (.07)	.68 (.09)	.96 (.02)	.97 (.01)
Unrelated Intention	.64 (.08)	.59 (.08)	.73 (.05)	.74 (.05)

Ongoing Task Performance

Although not the focus of the present study, performance on the ongoing task was also assessed. For these computations, I assessed the accuracy and speed with which participants classified the letter strings as words or non-words or as having more than two vs. two-or-fewer vowels. For response times, incorrect trials and trials that contained prospective memory targets were removed because they could skew performance (see Marsh et al., 2003; McBride & Abney, 2012). In total, 9% of trials were removed.

Table 2 displays mean accuracy and response times (in milliseconds) for the ongoing tasks. A 2 (target-response association: related vs. unrelated) x 2 (focality: focal vs. non-focal) ANOVA was conducted on the proportion of correct trials. Overall, accuracy was high, at ~96%. The analysis revealed no main effect of target-response association, $F<1$, no main effect of focality, $F<1$, and no interaction, $F(1, 100) = 1.06$, $p = .307$.

The same 2 x 2 analysis was conducted on ongoing task response times using the mean of each participant's mean response times. There was a marginally significant main effect of target-response association, $F(1, 100) = 3.18$, $p = .077$, with faster responding in the unrelated than related intentions condition; a significant main effect of focality, $F(1, 100) = 41.93$, $p < .001$, $MSE = 1.91 \times 10^5$, $\eta^2_p = 0.30$, with slower response times for the non-focal (vowel counting) than focal (lexical decision) task; and no interaction, $F<1$.

Table 2. Mean (SE) Proportion Accuracy and Mean (SE) of the Mean Response Times (in Milliseconds) for the Ongoing Tasks in Experiment 1

	Accuracy		Response Times	
	Focal	Non-Focal	Focal	Non-Focal
Related Intention	.96 (.01)	.96 (.01)	1321.83 (73.68)	1898.05 (91.60)
Unrelated Intention	.96 (.01)	.95 (.01)	1189.48 (62.21)	1724.34 (108.41)

Discussion

Consistent with Koriat's (1997) cue-utilization framework, the extrinsic cue of focality did not affect participants' retrospective JOLs. Critically, the variable also failed to influence prospective JOLs. Further in line with cue-utilization was that the intrinsic cue of relatedness (target-response association) did affect retrospective JOLs. Not only that, relatedness also affected prospective JOLs. Therefore, this experiment provides preliminary evidence that predictions about prospective memory behave similarly to those about retrospective memory.

Participants' predictions were generally reflective of their actual performance. Target-response association influenced prospective memory for the retrospective component, consistent with prior research (e.g., Cohen et al., 2001; Marsh et al., 2003). However, the use of relatedness as a cue for the prospective JOLs acted as a metacognitive illusion because this variable did not affect memory for the target. It is unlikely that participants' prospective JOLs were driven by a generalization from the retrospective JOLs because prospective JOLs were always provided first. However, a form of generalization cannot be completely ruled out: participants' consistently high retrospective JOLs in the related condition may have carried over into their predictions of the targets (the prospective JOLs). Experiment 2, which will use a within-subjects manipulation of relatedness, will shed light on this idea because participants will (presumably) be intermixing high and low retrospective JOLs, reducing any overall biasing effect. I will also return to this broader issue in the *General Discussion*.

Furthermore, participants predicted no effect of focality and, likewise, I did not find a focality effect on prospective memory performance. This lack of a focality effect is inconsistent with the majority of prior research, which tends to show better memory for focal than non-focal targets. It should be noted that the results of Experiment 1 (Table 1) exhibit a numerical trend in the direction of a focality effect, but it was not significant. To further probe a potential effect, I returned to the data and noticed that 15 (14%) of the participants completely forgot the prospective memory aspect of the experiment. In other words, at the end of the experiment, these participants indicated that they noticed certain target words but failed to remember to act on them. Prior prospective memory research has similarly encountered this issue and occasionally excludes these participants from analyses (e.g., Abney, McBride, Conte, & Vinson, 2015; McDaniel et al., 2004). Therefore, I reran the analyses on only those participants who had knowledge of the prospective memory task. The results remained largely intact but now revealed a significant effect of focality.[7] Specifically, a 2 (target-response association) x 2 (focality) ANOVA conducted on memory for the prospective component showed better identification of focal targets (*M* = .87, *SD* = .25) than non-focal targets (*M* = .71, *SD* = .38), $F(1, 85) = 4.81$, $p = .031$, $MSE = 0.10$, $\eta^2_p = 0.05$.

---

[7]Removing these forgetters additionally produced a main effect of target-response association on memory for the prospective component, with better target memory for related (*M* = .87, *SD* = .27) than unrelated (*M* = .71, *SD* = .37) targets, $F(1, 85) = 5.04$, $p = .027$, $MSE = 0.10$, η2p = 0.06. However, this effect became non-significant when the conditionalized data were used ($p = .053$). Additionally, the marginally significant main effect of target-response association on ongoing task response times became significant, $F(1, 85) = 5.28$, $p = .024$, $MSE = 1.89 \times 10^5$, η2p = 0.06, with faster responding in the unrelated intentions condition. No other changes across the three experiments were found when examining the data this way.

CHAPTER 3: EXPERIMENT 2

Experiment 1 used a between-subjects design of relatedness and found an effect on both retrospective JOLs and prospective JOLs. Experiment 2 moved to a within-subjects manipulation of relatedness. This exploration is important for a number of reasons: 1) although the effect of relatedness on retrospective JOLs was predicted, it should be replicated given that this is the first analysis of intrinsic cues in the prospective metamemory domain; 2) the effect of relatedness on prospective JOLs was intriguing and not predicted, and therefore should also be replicated and further verified; and 3) the effect on prospective JOLs could be based on a biasing effect from making many high retrospective JOLs in the between-subjects related condition (or many low JOLs in the unrelated condition), so moving to a within-subjects manipulation should be less biasing because the retrospective JOLs should vary between high and low confidence. Consistent with the previous experiment, I predict prospective memory performance and JOLs to be higher for the related than unrelated intentions.

Method

Participants

Thirty-three undergraduate students from the University of North Carolina at Chapel Hill participated in exchange for course credit. One participant failed to follow instructions for the ongoing task (and performance on this task was ~60%) and was not used. The final data set consisted of results from 32 participants.

Materials, Design, and Procedure

The experiment was similar to Experiment 1 except that target-response association was manipulated within subjects and the focality manipulation was removed (the ongoing task for all participants was lexical decision, consistent with prior research; Marsh et al., 2003). Of the eight prospective memory intentions, four consisted of related targets and responses and four consisted of unrelated targets and responses. Relatedness was counterbalanced across participants. Otherwise, the task instructions and structure of the experiment were the same as in Experiment 1.

Results

Post-experiment corrected recognition accuracy was high (M = .96, SD = .05), but was significantly higher for the targets from related (M = .98, SD = .00) than unrelated (M = .94, SD = .10) intentions, $t(31) = 2.68$, $p = .012$. Final cued-recall performance, unsurprisingly, was better for responses from related (M = .96, SD = .09) than unrelated (M = .82, SD = .22) intentions, $t(31) = 3.79$, $p = .001$.

Judgments of Learning

See Figures 3 and 4 for the relevant JOL data. To assess whether target-response association affected JOLs, separate 2 (target-response association) x 2 (time) repeated-measures ANOVAs were conducted. The first analysis, run on the prospective JOLs (Figure 3), revealed a significant main effect of target-response association, $F(1, 31) = 21.34$, $p < .001$, $MSE = 150.52$, $\eta^2_p = 0.41$, no main effect of time, $F<1$, and no interaction, $F(1, 31) = 1.49$, $p = .232$.

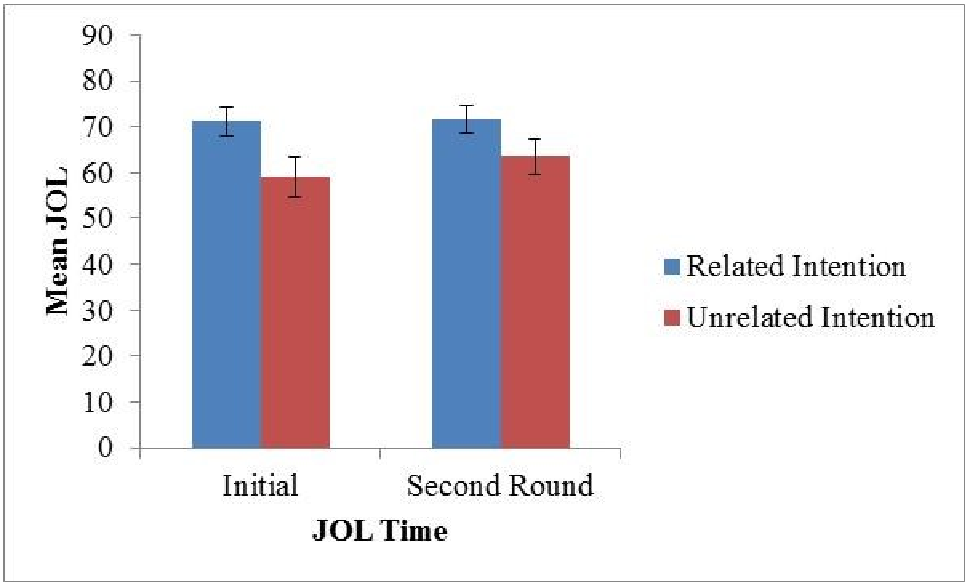

Figure 3. Mean initial and second-round prospective JOLs in Experiment 2.
Error bars are ± 1 SE.

The second analysis, on retrospective JOLs (Figure 4), revealed a significant main effect of target-response association, $F(1, 31) = 65.47$, $p < .001$, $MSE = 174.14$, $\eta^2_p = 0.68$, a significant main effect of time, $F(1, 31) = 31.50$, $p < .001$, $MSE = 197.81$, $\eta^2_p = 0.50$, and a significant interaction, $F(1, 31) = 8.71$, $p = .006$, $MSE = 94.49$, $\eta^2_p = 0.22$. Although the effect of target-response association was significant at both time points, the interaction suggests that the effect was larger at initial JOLs ($d = 1.28$) than second-round JOLs ($d = 1.01$).

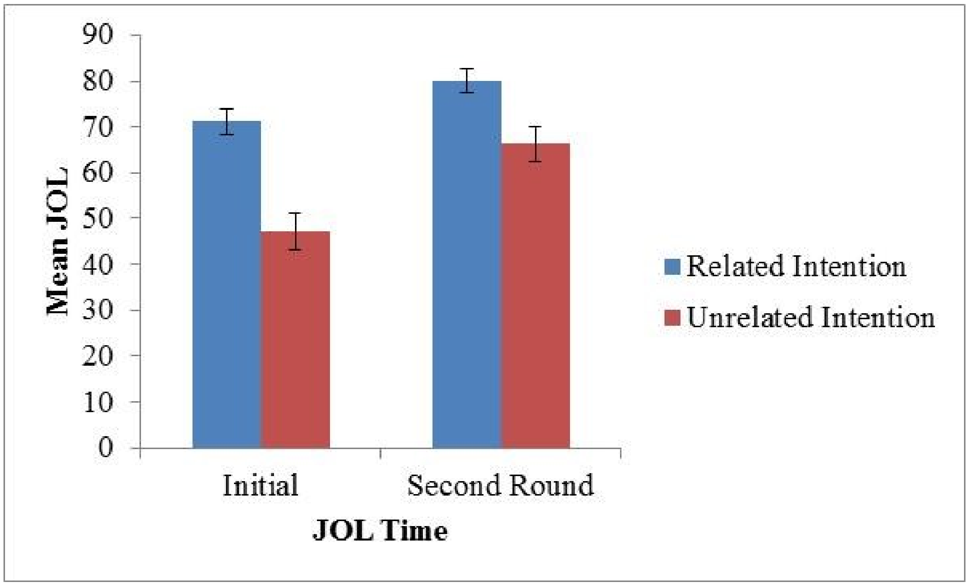

Figure 4. Mean initial and second-round retrospective JOLs in Experiment 2.
Error bars are ± 1 SE.

As with Experiment 1, the results from relative accuracy should be taken lightly given the limited data being used. The gamma correlation between initial prospective JOLs and memory of the target did not differ from 0 ($G = -.05$, $SE = .18$), $t(9) = 0.25$, $p = .808$. Likewise, the gamma correlation between the second-round prospective JOLs and memory for the target did not differ from 0 ($G = .17$, $SE = .20$), $t(9) = 0.85$, $p = .416$, and was not different from the initial gamma, $t(9) = 1.64$, $p = .135$. The gamma correlation between initial retrospective JOLs and memory for the response was marginally greater than 0 ($G = .31$, $SE = .15$), $t(14) = 2.07$, $p = .058$. Finally, the gamma correlation between second-round retrospective JOLs and memory for the response was significantly greater than 0 ($G = .71$, $SE = .11$), $t(13) = 6.24$, $p < .001$, and significantly greater than the initial correlation, $t(13) = 2.70$, $p = .018$.

Prospective Memory Performance

Table 3 shows memory performance for the prospective and retrospective components. A paired-samples *t*-test on memory for the prospective component revealed that participants did not differ in their ability to identify targets of related intentions and unrelated intentions, $t(31) =$

1.72, p = .096. Although this effect is trending, conducting the analysis on the conditionalized data reduces the effect (related: M = .66, SD = .44; unrelated: M = .65, SD = .44), $t(31)$ = 0.66, p = .514. The same analysis on memory for the retrospective component showed that participants remembered significantly more related responses than unrelated responses, $t(21)$ = 2.95, p = .008.

Table 3. Mean (SE) Proportion Prospective Memory Performance for the Prospective and Retrospective Components in Experiment 2

	Prospective Component	Retrospective Component
Related Intention	.66 (.08)	.97 (.02)
Unrelated Intention	.62 (.08)	.80 (.07)

Ongoing Task Performance

Overall, ongoing task accuracy was high, at ~94%. For task response times, a total of 10% of trials were removed due to errors and target trials. The average response latency (mean of the mean response times) was 1144.55 ms (SE = 44.80).

Discussion

The results of Experiment 2 generally replicated Experiment 1 and coincided with Koriat's (1997) cue-utilization framework. Specifically, using a within-subjects design of relatedness, Experiment 2 found that participants were more confident in their ability to remember related responses than unrelated responses, consistent with much prior research in the traditional JOL domain (for a review, see Mueller et al., 2013). Critically, and also consistent with Experiment 1, this effect carried over to confidence for identifying targets as well, with greater prospective JOLs in related than unrelated intentions. This latter result rules out potential explanations for the finding in Experiment 1. Specifically, given the between-subjects design of Experiment 1, it was possible that participants' prospective JOLs were driven by an overall bias to provide either high (in the related condition) or low (in the unrelated condition) JOLs. Because Experiment 2 mixed related and unrelated intentions, participants varied their JOLs and therefore would be less influenced by any general tendency to provide high or low predictions.

Although participants were accurately sensitive to the effect of relatedness on the memory for the retrospective component, their use of this variable as a cue for the prospective component JOLs acted as a metacognitive illusion once again: memory for identifying targets did not differ across relatedness.

The relative accuracy results were less clear than those of Experiment 1. Participants were again able to effectively discriminate which responses they would be able to recall, particularly after practicing with the intentions. However, they were less able to identify which targets they would be able to recognize. This difference in relative accuracy will be returned to in the *General Discussion*.

CHAPTER 4: EXPERIMENT 3

Using a between-subjects design, Experiment 1 revealed that JOLs were insensitive to target focality. This finding provides initial evidence that an extrinsic cue does not influence metamemory in prospective memory. However, from the traditional JOL literature we know that although extrinsic cues tend to be discounted in JOLs, increasing their salience using a within-subjects manipulation can enhance people's sensitivity to them. For example, Koriat et al. (2004) assessed the effect of retention interval on JOLs, first using a between-subjects design: before making JOLs during encoding, participants were told they would take a test either immediately after studying the items, a day later, or a week later. In this design, participants' JOLs did not show any sensitivity to retention interval, though retention interval did substantially affect actual memory performance. In a subsequent experiment, Koriat et al. used a within-subjects design in which, while studying each item, participants were informed when they would be tested on that item (either immediately after study, a day later, or a week later). Here, participants still grossly underestimated the effect of retention interval on memory, but their predictions did at least decrease with increasing retention intervals.

The results of Koriat et al. (2004) suggest that being made aware of the contrasting levels of an extrinsic variable can enhance its effect on metamemory. Therefore, in contrast to Experiment 1's between-subjects assessment of focality, Experiment 3 tested whether having participants make JOLs for both focal and non-focal targets – a within-subjects manipulation –

would improve sensitivity to the cue. Focality should influence actual prospective memory performance, and the question is whether it will now affect JOLs.

Method

Participants

Thirty-two undergraduate students from the University of North Carolina at Chapel Hill participated in exchange for course credit.

Materials, Design, and Procedure

The experiment was similar to Experiment 1 except the target-response association manipulation was removed and focality was assessed within subjects. All prospective memory intentions were unrelated target-response pairs. Unrelated intentions were selected to try to increase the variability in prospective memory performance so as to reduce the amount of missing data in the computation of relative accuracy (see above discussion). Because only four prospective memory targets occurred per ongoing task, the tasks were halved to maintain the overall percentage of target trials from the prior experiments.

The study consisted of six main phases: instruction for the ongoing tasks; instruction, encoding, and prediction for the prospective memory intentions; a delay; the first ongoing task; the second ongoing task; and the recognition and cued-recall tests. Participants were first told about both ongoing tasks (using identical instructions to Experiment 1); they were informed that later in the experiment they would perform two tasks involving letter strings. For the focal task, participants would classify the letter strings as either words or non-words. This task was termed the "word – non-word task." For the non-focal task, participants would determine the number of vowels contained in the letter strings. This task was termed the "vowel counting task."

The encoding of the prospective memory intentions was identical to the prior experiments; however, when making their JOLs for each word pair, participants were informed whether that target item would occur during the lexical decision task or the vowel counting task (in total four targets occurred in each task). The assignment of the targets to each task was counterbalanced across participants. Participants were then tested on their memory for the pairs and rated their confidence a second time, consistent with Experiment 1.

After encoding and predicting the intentions, participants completed a three-minute math distractor task. Next, participants were reminded of the first ongoing task (either lexical decision or vowel counting) and completed it. They then proceeded to the second ongoing task, with the order of the tasks and letter strings contained in each task counterbalanced across participants. No reference was made to the prospective memory intentions. The recognition and cued-recall tests were identical to above.

Results

Post-experiment recognition accuracy was again very high ($M = .95$, $SD = .07$), and did not differ between the focal ($M = .93$, $SD = .11$) and non-focal targets ($M = .96$, $SD = .06$), $t(31) = 1.14$, $p = .263$. Similarly, cued-recall performance did not differ across the focal ($M = .66$, $SD = .30$) and non-focal ($M = .77$, $SD = .21$) conditions, $t(31) = 1.60$, $p = .119$.

Judgments of Learning

See Figures 5 and 6 for the relevant JOL data. Separate 2 (focality) x 2 (time) repeated-measures ANOVAs were conducted to assess the effect of focality on prospective and retrospective JOLs. For prospective JOLs (Figure 5), there was no main effect of focality, $F<1$, no main effect of time, $F<1$, and no interaction, $F<1$. For retrospective JOLs (Figure 6), there was likewise no main effect of focality, *F*(1, 31) = 1.39, *p* = .248, no main effect of time, *F*<1, and no interaction, *F*(1, 31) = 2.69, *p* = .111.

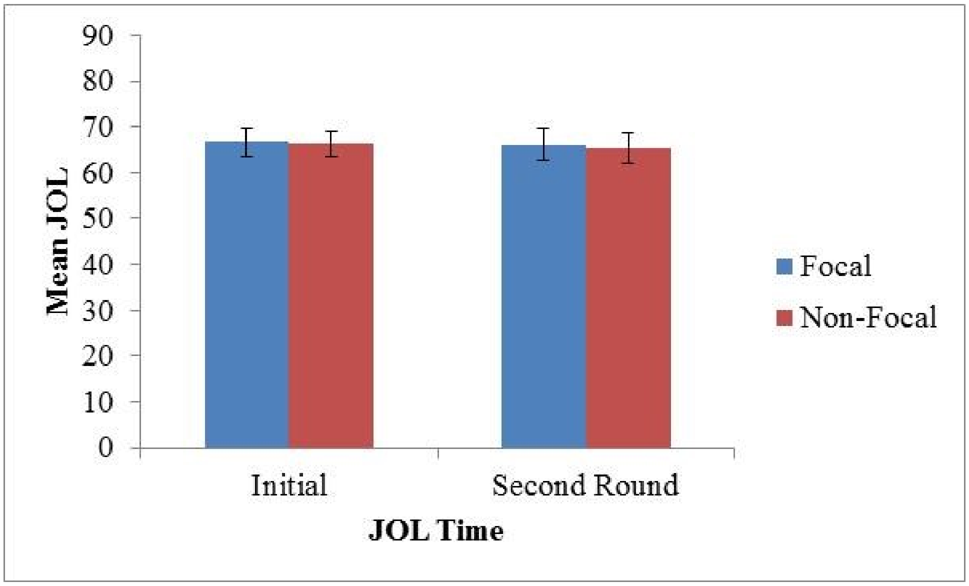

Figure 5. Mean initial and second-round prospective JOLs in Experiment 3.
Error bars are ± 1 SE.

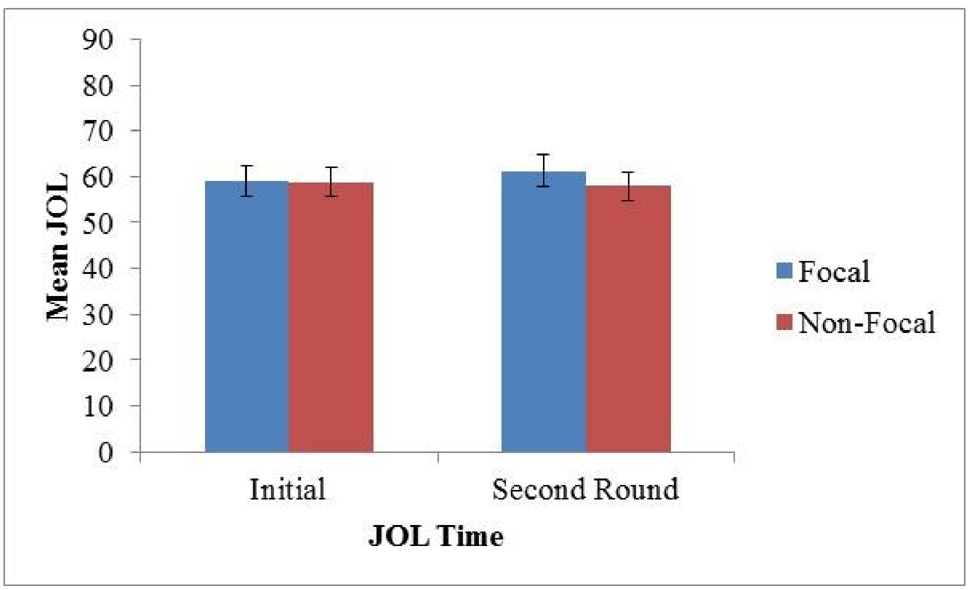

Figure 6. Mean initial and second-round retrospective JOLs in Experiment 3.
Error bars are ± 1 SE.

The relative accuracy of the initial prospective JOLs was poor (*G* = -.18, *SE* = .22) and did not differ from 0, *t*(9) = 0.82, *p* = .434. Later prospective JOLs continued to show no discriminability of items (*G* = .07, *SE* = .21), *t*(9) = 0.35, *p* = .738, and accuracy did not differ from the initial gamma correlation, $t(9) = 0.85$, $p = .416$. The gamma correlation between initial retrospective JOLs and memory for the response likewise did not differ from 0 ($G = .00$, $SE =$ 14), $t(21) = 0.02$, $p = .988$. However, the relative accuracy of the second-round retrospective JOLs was significantly greater than 0 ($G = .54$, $SE = .12$), $t(21) = 4.71$, $p < .001$, and significantly greater than the original correlation, $t(21) = 2.57$, $p = .018$.

Prospective Memory Performance

See Table 4 for prospective memory performance for the prospective and retrospective components. Starting with memory for the target (the prospective component), a paired-samples *t*-test found that performance did not differ between the focal and non-focal conditions, $t(31) =$ 1.14, $p = .264$. Unsurprisingly, performance also did not differ on the retrospective component, $t(19) = 1.31$, $p = .206$.

Table 4. Mean (SE) Proportion Prospective Memory Performance for the Prospective and Retrospective Components in Experiment 3

	Prospective Component	Retrospective Component
Focal Target	.64 (.08)	.71 (.07)
Non-Focal Target	.58 (.08)	.70 (.05)

As an additional approach to assessing prospective memory performance across focality, I conducted a between-subjects comparison of performance only on the first ongoing task. Consistent with the prior results, however, memory for the prospective component was statistically equivalent for those who completed the focal lexical decision task first ($M = .56$, $SD = .30$) and the non-focal vowel counting task first ($M = .63$, $SD = .46$), $t(30) = 0.38$, $p = .705$.

Ongoing Task Performance

See Table 5 for ongoing task accuracy and response times. Performance on both the lexical decision and vowel counting ongoing tasks was high and did not differ, $t(31) = 0.13$, $p =$

.900. For response times, 9% of trials were removed due to errors and target trials. Participants performed the lexical decision task faster than the vowel counting task, $t(31) = 5.71$, $p < .001$.

Table 5. Mean (SE) Proportion Accuracy and Mean (SE) of the Mean Response Times (in Milliseconds) for the Ongoing Tasks in Experiment 3

	Accuracy	Response Times
Focal Task (Lexical Decision)	.95 (.01)	1268.26 (65.41)
Non-Focal (Vowel Counting)	.95 (.01)	1773.56 (113.15)

Discussion

Consistent with Experiment 1, Experiment 3 found that JOLs were not sensitive to the extrinsic cue of target focality. Critically, Experiment 3 used a within-subjects manipulation, and participants made predictions both for targets that would appear in the focal lexical decision task and the non-focal vowel counting task. This result is consistent with Koriat's (1997) cue-utilization framework and other studies that show poor awareness of extrinsic cues (e.g., Castel, 2008; Kornell & Bjork, 2009). Prior research has found that using within-subjects manipulations of extrinsic cues can increase people's sensitivity to them (e.g., Koriat et al., 2004). However, this does not appear to be the case for target focality in prospective memory.

The current experiment (and Experiment 1) assessed awareness of extrinsic cues using a design that is typical of metamemory studies: participants are described the condition of learning (whether it be the context in which the target item will appear, the number of study opportunities, the retention interval, etc.) and then make their JOLs for the varying levels of that condition. Based on this usual methodology, I did not find evidence for an effect of the extrinsic cue of focality. However, it may be that participants' lack of direct experience with the tasks reduced an influence even when the comparison was made salient (especially given that participants may not have been able to appreciate these types of learning situations solely through a description). This issue will be returned to in the *General Discussion*.

In this experiment JOLs also did not increase from the initial to the second-round JOLs, after practice with the intention pairs. This is somewhat surprising, but given that all of the word pairs were unrelated and somewhat difficult to learn, participants may have used their recall success during the word-stem cued-recall testing phase to guide their later predictions. Specifically, if a participant gave a JOL of 60 to an item but then was unable to recall it during the test, that participant might use the failure-to-recall when making their next JOL for that item, and subsequently either provide a similar or lower prediction. In retrospective metamemory, this idea is known as the memory for past test heuristic (Finn & Metcalfe, 2007). Because the first two experiments integrated both related and unrelated word pairs (either between participants in Experiment 1 or within participants in Experiment 2), performance during the testing phase would presumably be better overall, and therefore participants would have more successful recall attempts on which to base (and potentially increase) their JOLs.

Although numerically in the expected direction, focality failed to influence objective prospective memory (the lack of an effect on the retrospective component is not surprising given that once a target is noticed, the nature of the task should not influence participants' ability to remember the response). It is unclear why no focality effect was found, as it has been observed in both between- (e.g., McBride & Abney, 2012) and within-subjects (e.g., Altgassen, Kliegel, & Martin, 2009) designs. One plausible explanation is that the inclusion of JOLs increased the perceived importance of the prospective memory component of the experiment and made participants more likely to monitor during both ongoing tasks, which would favor non-focal targets. Alternatively, JOLs could have diverted participants' attention away from the prospective aspect of the experiment. Another possibility is that the inclusion of unrelated target-response intentions sufficiently taxed participants' memory. Typical studies of focality use a very simple retrospective component, such as pressing a key (e.g., Einstein et al., 2005), which minimizes what participants need to remember. In the current experiment, unrelated intentions were chosen to increase the variability in the data to get a more reliable estimate of relative accuracy. It is also important to note that recognition of the targets at the end of the experiment was still very high, suggesting that despite needing to learn eight unrelated word pairs, participants effectively encoded all targets.

CHAPTER 5: GENERAL DISCUSSION

Being able to accurately assess our memories is important for how we use and allocate our cognitive resources. Although a wealth of research has examined our ability to judge retrospective memory – when we know we will be asked to retrieve information later (see Bjork et al., 2013) – limited research has examined how we judge our prospective memory (e.g., Meier et al., 2011; Smith, 2015) – our ability to remember something in the future at the correct place and time. Critically, prospective remembering plays a big role in our daily lives (Crovitz & Daniel, 1984). A main goal of the current study, therefore, was to understand how people make predictions of their prospective memory and to determine whether the information used to guide these predictions resembles that used in predictions of retrospective memory.

According to Koriat's (1997) cue-utilization framework, people tend to use specific item-level characteristics (intrinsic cues) when making their JOLs but fail to consider features of the general learning environment (extrinsic cues). Three experiments examined whether JOLs of prospective remembering behave similarly. Experiment 1 included target-response association (an intrinsic cue) and target focality (an extrinsic cue) in a between-subjects design, and Experiments 2 and 3 replicated and extended Experiment 1 to further dissect each individual cue in within-subjects designs. JOLs tapped both the prospective component of prospective remembering (i.e., remembering *that* something has to be done in response to a particular event) and the retrospective component (i.e., remembering the content of the intention), the latter of which is nearly identical to traditional JOLs. Furthermore, all experiments produced very high recognition memory of the target items, supporting the notion that any prospective memory errors were indeed due to failures of prospective memory and not due to poor encoding of the items. This outcome gives confidence in interpreting the prospective memory data.

Across the three experiments, a consistent pattern emerged: participants' JOLs – both the ones assessing retrospective remembering and true prospective remembering – were sensitive to the intrinsic cue of target-response association but not the extrinsic cue of focality. The null focality effect on JOLs remained even when focality was manipulated within subjects and participants were able to compare the two conditions (though not actually experience them, which will be discussed more below). Importantly, the results of the retrospective JOLs are consistent with the predictions of the cue-utilization framework (Koriat, 1997). The novel findings from the prospective JOLs, though, provide preliminary evidence that the types of cues that influence (or fail to influence) judgments of retrospective memory also influence judgments of prospective memory. Further, these results suggest that Koriat's (1997) cue-utilization framework generalizes to this alternative JOL measure, and they set the stage for future comparisons between the domains of metamemory.

The finding that prospective JOLs were influenced by target-response association is particularly intriguing given that this variable did not consistently influence objective prospective remembering (though it did affect memory for the response, consistent with prior research; e.g., Marsh et al., 2003). This result is known as a metacognitive illusion and resembles many studies in the traditional JOL domain when a variable influences JOLs but not memory performance (e.g., Rhodes & Castel, 2008, 2009; Susser & Mulligan, 2015). Given that item-relatedness strongly affects JOLs in the retrospective domain (see Mueller et al., 2013), it is plausible that in the current study participants' retrospective JOLs carried over to their prospective JOLs. Two points argue against this idea. First, the order of the JOLs was such that participants always made prospective JOLs before retrospective JOLs. Had retrospective JOLs been made first, it would be intuitive to think that providing a high (related) or low (unrelated) JOL for the response of a word pair could then be simply generalized to the target. Having participants always provide prospective JOLs first, though, eliminated this possibility. Second, it could be the case that participants were generally biased to provide high or low JOLs throughout the task. In other words, when participants got in the routine of making high JOLs for related responses, they continued with this tendency throughout, in a sort of anchoring and adjusting manner. This idea could account for the results of Experiment 1 that came from a between-subjects design and had participants only respond to one type of word pair. However, in Experiment 2's within-subjects manipulation, participants' JOLs would vary from high to low across word pairs, making an overall bias unlikely to play a role.

Research from the traditional metamemory field suggests that people may guide their JOLs using a belief that related information (particularly response words from related pairs) will be better remembered than unrelated information (Mueller et al., 2013). The present result implies that this belief extends beyond memory for the response and to memory for identifying the target as well. One way to more concretely explore this idea would be to use some of the methods used in retrospective metamemory research. For example, research could implement a questionnaire that describes a study involving related and unrelated word pairs, but in which only memory for the first word of each pair was tested. Participants could then predict how many of each type of word would be remembered. If the pattern remained the same (i.e., greater JOLs for targets from related pairs than unrelated pairs), it would suggest that people do have this sort of belief.

Another possibility stems from the method used to elicit JOLs in the present experiments. Specifically, participants were presented with the entire word pair when making both the prospective and retrospective JOLs. So, even when participants were predicting memory for the target, seeing the relation between the target and response may have biased their JOLs. To untangle this idea, a follow-up study could show the relevant words individually: when asking for prospective JOLs, only the target word of the pair would be shown, and when asking for retrospective JOLs, only the response would be shown.

Target focality, on the other hand, generally failed to influence prospective memory, making participants' JOLs accurately sensitive. The lack of a focality effect on prospective memory, however, is generally inconsistent with the prior literature (e.g., Altgassen et al., 2009; Einstein et al., 2005; McBride & Abney, 2012). Although both Experiments 1 and 3 found a numeric trend in the expected direction favoring focal targets, the pattern was not significant. (Experiment 1 did find a significant benefit of focal targets, though, when those data of only participants who remembered the prospective memory task were analyzed).

Research in retrospective metamemory has found that item-by-item JOLs can have reactive effects on performance, reducing or eliminating typical memory phenomena (e.g., Besken & Mulligan, 2013, 2014). For example, Besken and Mulligan (2013) examined metamemory in the perceptual interference effect, which is the finding that words that are presented briefly (e.g., 100 ms) and then backward-masked are better recalled than words presented visually intact for the entire study duration (e.g., 2.5 s; Mulligan & Lozito, 2004). In two experiments, Besken and Mulligan presented a mix of masked and intact words and had participants make JOLs for the two types of items. In one experiment, participants made JOLs immediately following each item. In the other experiment, aggregate JOLs were made at the end of the entire study list and participants predicted how many of the items of each type they would remember. Both experiments found that participants were more confident in remembering the intact items. More importantly, though, the memory advantage for the masked items (i.e., the perceptual interference effect) only emerged when aggregate JOLs were used; item-by-item JOLs eliminated the effect. One potential explanation for this reactivity is that JOLs induced deeper processing of the study items, and this deeper processing selectively benefited the intact items. Alternatively, making JOLs may have directed attention away from the study items and, in particular, reduced the deep processing typically afforded to the masked items (see also Besken & Mulligan, 2014).

Similarly, recent findings in prospective metamemory have suggested that making predictions can alter performance and how people engage with the ongoing tasks (Meier et al., 2011; Rummel, Kuhlmann, & Touron, 2012). For example, Meier et al. had participants complete a prospective memory task in which half of the participants responded to a specific prospective memory target (respond whenever the word “trumpet” appears in the context of a short-term memory task) and the other half to a general category of targets (respond whenever a word for a musical instrument appears). Furthermore, half of the participants responded to a 6-item prediction questionnaire after learning about the prospective memory intention. The other half did not. Meier et al. found that making performance predictions boosted performance of the categorical intention condition but did not influence the specific intention condition. Additionally, making predictions was associated with increased self-reported searching for the target, and the researchers reasoned that the predictions may have elevated the perceived importance of the prospective memory task. Relating these findings to the present study, it is possible that having participants make item-by-item JOLs enhanced participants’ later monitoring of the targets, and this monitoring more strongly benefited the non-focal condition. On the other hand, it also seems reasonable to think that making the JOLs may have distracted participants from the prospective memory aspect of the study and impaired performance more for the usually well-remembered focal condition. Therefore, a potential follow-up study could substitute aggregate JOLs in place of item-by-item measurements to assess whether reactivity is playing a role in the current design.

Although not a primary focus of the study, examining relative accuracy produced interesting (and somewhat mixed) results. As noted above, though, these data should be taken with caution given that they are based on a limited number of items (unlike typical retrospective memory studies, which include many study items) and because of the amount of missing data brought about by the computation of gamma correlations. Relative accuracy was calculated separately for the prospective and retrospective aspects of the intentions, and for the prospective component, Experiment 1 found that participants displayed rather accurate predictions. However, Experiments 2 and 3 painted a different picture: participants had poor insight into their future memory for which targets they would identify.

One potential explanation for the generally weak prospective relative accuracy is that participants made JOLs without having direct experience with the ongoing task or experience with recognizing targets embedded in the task. That is, the memory context was unfamiliar. In retrospective metamemory studies, in contrast, participants have more familiarity with basic recall and recognition tests, which are at least somewhat similar to the memory tests and challenges they have experienced in the past. The structure of prospective memory studies is much different. And indeed, in the current study relative accuracy for the retrospective component was generally better, especially for the second-round JOLs. The high accuracy of these JOLs made after practice is consistent with the finding that relative accuracy increases across study-test cycles (e.g., Koriat et al. 2002) as people can better discriminate among items.

The mixed relative accuracy in the current study is somewhat inconsistent with prior research (Knight et al., 2005; Schnitzspahn et al., 2011) that has found, using gamma correlations, that people can show metacognitive insight at the item level. These discrepancies in findings could stem from the more basic calculation issues regarding gamma discussed above. For example, Knight et al. (2005) and Schnitzspahn et al. (2011) both included more prospective memory intentions (20 and 10), which would make their assessments more reliable. However, Knight et al. requested just a single prediction for each intention (i.e., did not distinguish between the prospective and retrospective components), so it is difficult to fully interpret their results in comparison with the current findings. Schnitzspahn et al. did tease apart the two components in their predictions and generally found better accuracy, particularly for the prospective component. It is possible that their ongoing task was easier for participants to evaluate (participants needed to click on prospective memory targets embedded in a story they were reading) and provided them with more insight into which items they would remember. Additionally, although this design seemed to produce less variability in the data (particularly on prospective component memory), it is possible their outcomes resulted in fewer ties and less missing data (unfortunately, the researchers did not report this information). Overall, it is evident that research needs to be conducted to further assess relative accuracy in prospective memory.

Limitations

The current study integrated the typical designs of both prospective memory and metamemory. Although it effectively enabled me to broadly assess both topics, it limited some of particular questions I could answer within each domain. For example, the assessment of relative accuracy was rather limited. Because this measurement is calculated within participants at the item level, to obtain a reliable estimate, many items per participant are needed (Spellman, Bloomfield, & Bjork, 2008). However, at the same time, prospective memory research typically uses a limited number target items, and increasing the number of targets can alter performance and the emphasis of the task (e.g., Einstein et al., 2005). I attempted to find a balance in the current study, but a goal of future research will to be continue to identify ways of assessing item-level accuracy.

Likewise, the focality of a prospective memory target has been a focus of research on prospective memory, primarily because of its theoretical importance (McDaniel & Einstein, 2000, 2007a). A large body of research is dedicated to understanding how people engage with the ongoing task. With focality, one particular way of assessing ongoing task processing is to compare how long people take to respond to the task across focal and non-focal conditions (or a comparison can be made with a baseline block of trials when no prospective memory intentions are to be responded to). Research generally finds that people perform the ongoing task more slowly when non-focal targets are used, an indication that people are monitoring more and devoting more resources to finding the targets (e.g., Altgassen et al., 2009; Einstein et al., 2005). However, to make this assessment, the same ongoing task needs to be performed across the focal and non-focal conditions. Indeed, focality is traditionally assessed by holding the ongoing task constant while altering the prospective memory target (e.g., using lexical decision with word targets [producing a focal condition] or with syllable targets [producing a non-focal condition]). I wanted all of the target items to be words so participants would be predicting memory for typical word stimuli; therefore, I manipulated the type of ongoing task (consistent with McBride & Abney, 2012). Because the tasks themselves differed, any differences in response times could be due to task difficulty and not the focality of the targets. An ongoing follow-up study incorporates a baseline practice block to better be able to draw conclusions regarding attention allocation in the ongoing tasks.

Future Directions

The results of Experiments 1 and 3 suggested that participants did not have any sensitivity to the extrinsic cue of focality. This finding is generally consistent with the traditional JOL literature, which has found that people often fail to appreciate cues that are part of the broader learning environment but not inherent in the items themselves (e.g., Castel, 2008; Koriat et al., 2004). Furthermore, the design used in the current experiments reflects that of typical metamemory studies assessing sensitivity to extrinsic cues (e.g., Koriat et al., 2004; Kornell & Bjork, 2009). Specifically, these cues, because they represent conditions of the learning context, are often merely described to participants (such as by telling participants how many study opportunities they will have or when the memory test will occur) and are not directly experienced. Likewise, in our experiments, participants did not have any experience with the focal and non-focal tasks before making their predictions, and without any prior exposure to these tasks (presumably), participants would have had to base their JOLs purely on beliefs devoid of any concrete experience.

It is plausible, however, that for participants to demonstrate any sensitivity to extrinsic cues, some prior experience needs to be drawn upon. As an example, participants in Koriat et al.'s (2004) study surely had experience with forgetting before taking part in the experiment and could have used this experience to inform their JOLs (especially when a within-subjects design was used). Consequently, an important follow-up study (which is ongoing) to the current experiments is to have participants practice the ongoing task prior to providing their JOLs. The direct interaction with the tasks may increase people's awareness of their potential effects.

In addition to examining what cues influence JOLs, a current emphasis in metamemory research is to understand how these cues exert their influence (e.g., Koriat et al., 2004; Mueller et al., 2013; Susser, Jin, & Mulligan, 2016). Specifically, a cue can affect JOLs through direct fluency-based processing of the relevant stimuli, through an a priori belief that people have about a cue, or through a belief that develops over the course of an experiment. For example, when encoding to-be-learned material, certain stimuli may be easier to process, perceive, or produce than other stimuli (e.g., Koriat & Ma'ayan, 2005; Susser & Mulligan, 2015). This difference in fluency processing may then translate into differences in JOLs, with greater fluency typically being associated with greater confidence (e.g., Besken & Mulligan, 2014; Undorf & Erdfelder, 2015).

Alternatively, people may come into an experiment with a belief about how some variable affects memory. Kornell et al. (2011) used a questionnaire to assess people's beliefs about the effect of font size on memory. Participants read a description about a prior experiment examining font size and they then predicted how many words of each type (large font or small font) they would be able to recall. Solely through reading this description, and without experiencing any words themselves, participants reported more confidence in remembering the large- than small-font items, suggesting that a belief about font size guided predictions (see also, Mueller, Dunlosky, Tauber, & Rhodes, 2014).

It is also possible that participants do not have an a priori belief about a cue, but that as they interact with the study materials and engage with the experiment, they develop one over time. This type of belief is often assessed with a measure known as a pre-study JOL, which is a

JOL made before a particular item but that informs the participant what type of item is upcoming (whether it be a related pair vs. an unrelated pair, a large-font item vs. a small-font item, etc.). This design minimizes any potential effect of fluency processing because JOLs are made prior to interaction with a specific stimulus. Although much more research needs to be done to assess the more basic question of what cues affect prospective metamemory, a logical next step would be to examine how these different influences play a role. This pursuit would be an additional way to integrate the two bodies of metamemory research.

Finally, understanding how people make JOLs and monitor their memory performance is particularly important because of its proposed link to control behaviors, or ways people decide to use their cognitive resources (Nelson & Narens, 1990, 1994; Rhodes & Castel, 2009). For example, if you think you are unlikely to remember to carry out an action later on, do you then do something about it in hopes of preventing a memory failure? That is, if memory monitoring predicts that you are unlikely to remember something later, do you decide to engage in control processes to try to change that predicted outcome? Within prospective memory, control behaviors range from spending more time encoding intentions, to setting reminders, to allocating more attention to the ongoing task surroundings. Therefore, a critical endeavor in research on prospective metamemory will be to investigate how predictions made at encoding relate to these various control behaviors.

In ongoing task performance, the basic prospective memory laboratory paradigm already has a built-in control measure: if participants judge an intention to be difficult to carry out, they may allocate more attention to it in the interim, during the “performance phase” of the ongoing task. Indeed, Hicks et al. (2005) proposed that, upon learning about the ongoing and prospective memory tasks, people decide how to allocate their attention in the ongoing task. In particular, Hicks et al. stated that people use their predictions about how easy it will be to fulfill a prospective memory intention to determine how to allocate resources later. Further testing this idea would be an ideal place to start investigating control processes in prospective metamemory.

Conclusions

The current study takes an important step in helping us understand how people judge their prospective memory. Consistent with predictions of retrospective remembering, predictions of prospective memory seem to be based primarily on information stemming from the to-be-remembered information and not on external, situational factors. Not only do these findings nicely bridge the retrospective and prospective metamemory domains, but they also open the door for many follow-up investigations to further connect the two. With continuing interest in metamemory processes more generally (see Dunlosky & Tauber, 2015) and the applied relevance of prospective remembering, pursuits of metamemory in prospective memory should be fruitful for years to come.

REFERENCES

Abney, D. H., McBride, D. M., Conte, A. M., & Vinson, D. W. (2015). Response dynamics in prospective memory. *Psychonomic Bulletin & Review, 22*(4), 1020-1028. doi:10.3758/s13423-014-0771-6

Alter, A. L., & Oppenheimer, D. M. (2009). Uniting the tribes of fluency to form a metacognitive nation. *Personality and Social Psychology Review, 13*, 219-235. doi:10.1177/1088868309341564

Altgassen, M., Kliegel, M., & Martin, M. (2009). Event-based prospective memory in depression: The impact of cue focality. *Cognition and Emotion, 23*(6), 1041-1055. doi: 10.1080/02699930802284158

Balota, D. A., Yap, M. J., Cortese, M. J., Hutchinson, K. A., Kessler, B., Loftis, B., ... Treiman, R. (2007). The English Lexicon Project. *Behavior Research Methods, 39*, 445-459. doi:10.3758/BF03193014

Begg, I., Duft, S., LaLonde, P., Melnick, R., & Sanvito, J. (1989). Memory predictions are based on ease of processing. *Journal of Memory and Language, 28*, 610-632. doi:10.1016/0749-596X(89)90016-8

Begg, I., Vinski, E., Frankovich, L., & Holgate, B. (1991). Generating makes words memorable, but so does effective reading. *Memory and Cognition, 19*, 487-497. doi:10.3758/BF03199571

Benjamin, A. S., Bjork, R. A., & Schwartz, B. L. (1998). The mismeasure of memory: When retrieval fluency is misleading as a metamnemonic index. *Journal of Experimental Psychology: General, 127*, 55-68. doi:10.1037/0096-3445.127.1.55

Besken, M., & Mulligan, N. W. (2013). Easily perceived, easily remembered? Perceptual interference produces a double dissociation between metamemory and memory performance. *Memory & Cognition, 41*, 897-903. doi:10.3758/s13421-013-0307-8

Besken, M., & Mulligan, N. W. (2014). Perceptual fluency, auditory generation, and metamemory: Analyzing the perceptual fluency hypothesis in the auditory modality. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 40*, 429-440. doi:10.1037/a0034407

Bjork, R. A., Dunlosky, J., & Kornell, N. (2013). Self-regulated learning: Beliefs, techniques, and illusions. *Annual Review of Psychology, 64*, 417-444. doi:10.1146/annurev-psych-113011-143823

Brandimonte, M. A., & Passolunghi, M. C. (1994). The effect of cue-familiarity, cue-distinctiveness, and retention interval on prospective remembering. *The Quarterly Journal of Experimental Psychology Section A: Human Experimental Psychology, 47*, 565-587. doi:10.1080/14640749408401128

Carroll, M., Nelson, T. O., & Kirwan, A. (1997). Tradeoff of semantic relatedness and degree of overlearning: Differential effects on metamemory and on long-term retention. *Acta Psychologica, 95*, 239-253. doi:10.1016/S0001-6918(96)00040-6

Castel, A. D. (2008). Metacognition and learning about primacy and recency effects in free recall: The utilization of intrinsic and extrinsic cues when making judgments of learning. *Memory & Cognition, 36*, 429-437. doi:10.3758/MC.36.2.429

Cohen, A-L., Dixon, R. A., Lindsay, D. S., & Masson, M. E. J. (2003). The effect of perceptual distinctiveness on the prospective and retrospective components of prospective memory in young and old adults. *Canadian Journal of Experimental Psychology, 57*, 274-289. doi:10.1037/h0087431

Cohen, A-L., West, R., & Craik, F. I. M. (2001). Modulation of the prospective and retrospective components of memory for intentions in younger and older adults. *Aging, Neuropsychology, and Cognition, 8*, 1-13. doi:10.1076/anec.8.1.1.845

Crovitz, H. F., & Daniel, W. F. (1984). Measurements of everyday memory: Toward the prevention of forgetting. *Bulletin of the Psychonomic Society, 22*, 413-414. doi:10.3758/BF03333861

Dismukes, R. K. (2010). Remembrance of things future: Prospective memory in laboratory, workplace, and everyday settings. *Reviews of Human Factors and Ergonomics, 6*, 79-122. doi:10.1518/155723410X12849346788705

Dismukes, R. K. (2012). Prospective memory in workplace and everyday situations. *Current Directions in Psychological Science, 21*, 215-220. doi:10.1177/0963721412447621

Dunlosky, J., & Matvey, G. (2001). Empirical analysis of the intrinsic-extrinsic distinction of judgments of learning (JOLs): Effects of relatedness and serial position on JOLs. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 27*, 1180-1191. doi:10.1037//0278-7393.27.5.1180

Dunlosky, J., & Metcalfe, J. (2009). *Metacognition*. Los Angeles, CA: SAGE Publications.

Dunlosky, J., & Tauber, S. K. (Eds.) (2015). *The Oxford handbook of metamemory*. Retrieved from http://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780199336746.001.0001/oxfordhb-9780199336746. doi:10.1093/oxfordhb/9780199336746.001.0001

Einstein, G. O., & McDaniel, M. A. (1990). Normal aging and prospective memory. *Journal of*

Experimental Psychology: Human Learning and Memory, 16, 717-726. doi:10.1037/0278-7393.16.4.717

Einstein, G. O., & McDaniel, M. A. (2005). Prospective memory: Multiple retrieval processes. *Current Directions in Psychological Science, 14*, 286-290. doi:10.1111/j.0963-7214.2005.00382.x

Einstein, G. O., & McDaniel, M. A. (2008). Prospective memory and metamemory: The skilled use of basic attentional and memory processes. In A. S. Benjamin and B. H. Ross (Eds.), *The psychology of learning and motivation: Skill and strategy in memory use* (pp. 145-173). San Diego, CA: Elsevier.

Einstein, G. O., & McDaniel, M. A. (2010). Prospective memory and what costs do not reveal about retrieval processes: A commentary on Smith, Hunt, McVay, and McConnell (2007). *Journal of Experimental Psychology: Learning, Memory, and Cognition, 36*, 1082-1088. doi:10.1037/a0019184

Einstein, G. O., McDaniel, M. A., Thomas, R., Mayfield, S., Shank, H., & Morrisette, N. (2005). Multiple processes in prospective memory retrieval: Factors determining monitoring versus spontaneous retrieval. *Journal of Experimental Psychology: General, 134*, 327-342. doi:10.1037/0096-3445.134.3.327

Finn, B., & Metcalfe, J. (2007). The role of memory for past test in the underconfidence with practice effect. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33*(1), 238-244. doi:10.1037/0278-7393.33.1.238

Gilbert, S. J. (2015). Strategic use of reminders: Influence of both domain-general and task-specific metacognitive confidence, independent of objective memory ability. *Consciousness and Cognition, 33*, 245-260. doi:10.1016/j.concog.2015.01.006

Gonzalez, R., & Nelson, T. O. (1996). Measuring ordinal association in situations that contain tied scores. *Psychological Bulletin, 119*(1), 159-165. doi:10.1037/0033-2909.119.1.159

Graf, P., & Uttl, B. (2001). Prospective memory: A new focus for research. *Consciousness and Cognition, 10*, 437-450. doi:10.1006/ccog.2001.0504

Hertzog, C., Dunlosky, J., Robinson, A. E., & Kidder, D. P. (2003). Encoding fluency is a cue used for judgments about learning. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 29*, 22-34. doi:10.1037/0278-7393.29.1.22

Hicks, J. L., Marsh, R. L., & Cook, G. I. (2005). Task interference in time-based, event-based, and dual intention prospective memory conditions. *Journal of Memory and Language, 53*, 430-444. doi:10.1016/j.jml.2005.04.001

Kliegel, M., Jäger, T., & Phillips, L. H. (2008). Adult age differences in event-based prospective memory: A meta-analysis on the role of focal versus nonfocal cues. *Psychology and Aging, 23*, 203-208. doi:10.1037/0882-7974.23.1.203

Kliegel, M., Martin, M., McDaniel, M. A., & Einstein, G. O. (2004). Importance effects on performance in event-based prospective memory tasks. *Memory, 12*, 553-561. doi:10.1080/09658210344000099

Knight, R. G., Harnett, M., & Titov, N. (2005). The effects of traumatic brain injury on the predicted and actual performance of a test of prospective remembering. *Brain Injury, 19*, 19-27. doi:10.1080/02699050410001720022

Koriat, A. (1997). Monitoring one's own knowledge during study: A cue-utilization approach to judgments of learning. *Journal of Experimental Psychology: General, 126*, 349-370. doi:10.1037/0096-3445.126.4.349

Koriat, A. (2008). Easy comes, easy goes? The link between learning and remembering and its exploitation in metacognition. *Memory & Cognition, 36*, 416-428. doi:10.3758/MC.36.2.416

Koriat, A., Bjork, R. A., Sheffer, L., & Bar, S. K. (2004). Predicting one's own forgetting: The role of experience-based and theory-based processes. *Journal of Experimental Psychology: General, 133*, 643-656. doi:10.1037/0096-3445.133.4.643

Koriat, A., & Ma'ayan, H. (2005). The effects of encoding fluency and retrieval fluency on judgments of learning. Journal of Memory and Language, 52, 478-492. doi:10.1016/j.jml.2005.01.001

Koriat, A., Sheffer, L., & Ma'ayan, H. (2002). Comparing objective and subjective learning curves: Judgments of learning exhibit increased underconfidence with practice. *Journal of Experimental Psychology: General, 131*, 147-162. doi:10.1037/0096-3445.131.2.147

Kornell, N., & Bjork, R. A. (2009). A stability bias in human memory: Overestimating remembering and underestimating learning. *Journal of Experimental Psychology: General, 138*, 449-468. doi:10.1037/a0017350

Kornell, N., Rhodes, M. G., Castel, A. D., & Tauber, S. K. (2011). The ease-of-processing heuristic and the stability bias: Dissociating memory, memory beliefs, and memory judgments. *Psychological Science, 22*, 787-794. doi:10.1177/0956797611407929

Loft, S., & Yeo, G. (2007). An investigation into the resource requirements of event-based prospective memory. *Memory & Cognition, 35*, 263-274. doi:10.3758/BF03193447

Marsh, R. L., Hicks, J. L., & Cook, G. I. (2005). On the relationship between effort toward an ongoing task and cue detection in event-based prospective memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 31*, 68-75. doi:10.1037/0278-7393.31.1.68

Marsh, R. L., Hicks, J. L., & Cook, G. I. (2006). Task interference from prospective memories covaries with contextual associations of fulfilling them. *Memory & Cognition, 34*, 1037-1045. doi:10.3758/BF03193250

Marsh, R. L., Hicks, J. L., Cook, G. I., Hansen, J. S., & Pallos, A. L. (2003). Interference to ongoing activities covaries with the characteristics of an event-based intention. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 29*, 861-870. doi:10.1037/0278-7393.29.5.861

Marsh, R. L., Hicks, J. L., & Landau, J. D. (1998). An investigation of everyday prospective memory. *Memory & Cognition, 26*, 633-643. doi:10.3758/BF03211383

McBride, D. M., & Abney, D. H. (2012). A comparison of transfer-appropriate processing and multi-process frameworks for prospective memory performance. *Experimental Psychology, 59*, 190-198. doi: 10.1027/1618-3169/a000143

McBride, D. M., Beckner, J. K., & Abney, D. H. (2011). Effects of delay of prospective memory cues in an ongoing task on prospective memory task performance. *Memory & Cognition, 39*, 1222-1231. doi:10.3758/s13421-011-0105-0

McDaniel, M. A., & Einstein, G. O. (1993). The importance of cue familiarity and cue distinctiveness in prospective memory. *Memory, 1*, 23-41. doi:10.1080/09658219308258223

McDaniel, M. A., & Einstein, G. O. (2000). Strategic and automatic processes in prospective memory retrieval: A multiprocess framework. *Applied Cognitive Psychology, 14*, S127-S144. doi:10.1002/acp.775

McDaniel, M. A., & Einstein, G. O. (2007a). Prospective memory: An overview and synthesis of an emerging field. Los Angeles, CA: SAGE Publications.

McDaniel, M. A., & Einstein, G. O. (2007b). Spontaneous retrieval in prospective memory. In J. S. Nairne (Ed.), *The foundations of remembering: Essays in honor of Henry L. Roediger, III* (pp. 225-240). New York, NY: Psychology Press.

McDaniel, M. A., Guynn, M. J., Einstein, G. O., & Breneiser, J. (2004). Cue-focused and reflexive associative processes in prospective memory retrieval. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 30*, 605-614. doi:10.1037/0278-7393.30.3.605

Meeks, J. T., Hicks, J. L., & Marsh, R. L. (2007). Metacognitive awareness of event-based prospective memory. *Consciousness and Cognition, 16*, 997-1004. doi:10.1016/j.concog.2006.09.005

Meier, B., von Wartburg, P., Matter, S., Rothen, N., & Reber, R. (2011). Performance predictions improve prospective memory and influence retrieval experience. *Canadian Journal of Experimental Psychology, 65*, 12-18. doi:10.1037/a0022784

Mueller, M. L., Dunlosky, J., Tauber, S. K., & Rhodes, M. G. (2014). The font-size effect on judgments of learning: Does it exemplify fluency effects or reflect people's beliefs about memory? *Journal of Memory and Language, 70*, 1-12. doi:10.1016/j.jml.2013.09.007

Mueller, M. L., Tauber, S. K., & Dunlosky, J. (2013). Contributions of beliefs and processing fluency to the effect of relatedness on judgments of learning. *Psychonomic Bulletin & Review, 20*, 378-384. doi:10.3758/s13423-012-0343-6

Mulligan, N. W., & Lozito, J. P. (2004). Self-generation and memory. In B. H. Ross (Ed.), *Psychology of learning and motivation* (pp. 175-214). San Diego, CA: Elsevier Academic Press.

Nelson, D. L., McEvoy, C. L., & Schreiber, T. A. (1998). *The University of South Florida word association, rhyme, and word fragment norms*. Retrieved from http://web.usf.edu/FreeAssociation/

Nelson, T. O. (1984). A comparison of current measures of the accuracy of feeling-of-knowing predictions. *Psychological Bulletin, 95*, 109-133. doi:10.1037/0033-2909.95.1.109

Nelson, T. O., & Dunlosky, J. (1991). When people's judgments of learning (JOLs) are extremely accurate at predicting subsequent recall: The "delayed-JOL effect." *Psychological Science, 2*, 267-270. doi:10.1111/j.1467-9280.1991.tb00147.x

Nelson, T. O., & Narens, L. (1990). Metamemory: A theoretical framework and new findings. In G. H. Bower (Ed.), *The psychology of learning and motivation* (pp. 125-173). New York, NY: Academic Press.

Nelson, T. O., & Narens, L. (1994). Why investigate metacognition? In J. Metcalfe and A. P. Shimamura (Eds.), *Metacognition: Knowing about knowing* (pp. 1-25). Cambridge, MA: MIT Press.

Pereira, A., Ellis, J., & Freeman, J. (2012). Is prospective memory enhanced by cue-action semantic relatedness and enactment at encoding? *Consciousness and Cognition, 21*, 1257-1266. doi:10.1016/j.concog.2012.04.012

Rhodes, M. G., & Castel, A. D. (2008). Memory predictions are influenced by perceptual information: Evidence for metacognitive illusions. *Journal of Experimental Psychology: General, 137*, 615-625. doi:10.1037/a0013684

Rhodes, M. G., & Castel, A. D. (2009). Metacognitive illusions for auditory information: Effects on monitoring and control. *Psychonomic Bulletin & Review, 16*, 550-554. doi:10.3758/PBR.16.3.550

Rhodes, M. G., & Tauber, S. K. (2011). The influence of delaying judgments of learning on metacognitive accuracy: A meta-analytic review. *Psychological Bulletin, 137*, 131-148. doi:10.1037/a0021705

Rummel, J., Kuhlmann, B. G., & Touron, D. R. (2013). Performance predictions affect attentional processes of event-based prospective memory. *Consciousness and Cognition, 22*, 729-741. doi:10.1016/j.concog.2013.04.012

Schnitzspahn, K. M., Zeintl, M., Jäger, T., & Kliegel, M. (2011). Metacognition in prospective memory: Are performance predictions accurate? *Canadian Journal of Experimental Psychology, 65*, 19-26. doi:10.1037/a0022842

Schwartz, B. L. (1994). Sources of information in metamemory: Judgments of learning and feelings of knowing. *Psychonomic Bulletin & Review, 1*, 357-375. doi:10.3758/BF03213977

Schwartz, B. L., Benjamin, A. S., & Bjork, R. A. (1997). The inferential and experiential bases of metamemory. *Current Directions in Psychological Science, 6*, 132-137. Retrieved from http://www.jstor.org/stable/20182470

Schwartz, B. L., & Efklides, A. (2012). Metamemory and memory efficiency: Implications for student learning. *Journal of Applied Research in Memory and Cognition, 1*, 145-151. doi:10.1016/j.jarmac.2012.06.002

Scullin, M. K., McDaniel, M. A., & Einstein, G. O. (2010). Control of cost in prospective memory: Evidence for spontaneous retrieval processes. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 36*, 190-203. doi:10.1037/a0017732

Smith, G., Della Sala, S., Logie, R. H., & Maylor, E. A. (2000). Prospective and retrospective memory in normal ageing and dementia: A questionnaire study. *Memory, 8*, 311-321. doi:10.1080/09658210050117735

Smith, R. E. (2003). The cost of remembering to remember in event-based prospective memory: Investigating the capacity demands of delayed intention performance. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 29*, 347-361. doi:10.1037/0278-7393.29.3.347

Smith, R. E. (2010). What costs do reveal and moving beyond the cost debate: Reply to Einstein and McDaniel (2010). *Journal of Experimental Psychology: Learning, Memory, and Cognition, 36*, 1089-1095. doi:10.1037/a0019183

Smith, R. E. (2015). Prospective memory: A framework for research on metaintentions. In J. Dunlosky and S. K. Tauber (Eds.), *The Oxford handbook of metamemory*. Retrieved from http://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780199336746.001.0001/oxfordhb-9780199336746-e-9. doi:10.1093/oxfordhb/9780199336746.013.9

Smith, R. E., Hunt, R. R., McVay, J. C., & McConnell, M. D. (2007). The cost of event-based prospective memory: Salient target events. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33*, 734-746. doi:10.1037/0278-7393.33.4.734

Soderstrom, N. C., & McCabe, D. P. (2011). The interplay between value and relatedness as bases for metacognitive monitoring and control: Evidence for agenda-based monitoring. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 37*, 1236-1242. doi:10.1037/a0023548

Spellman, B. A., Bloomfield, A., & Bjork, R. A. (2008). Measuring memory and metamemory: Theoretical and statistical problems with assessing learning (in general) and using gamma (in particular) to do so. In J. Dunlosky & R. A. Bjork (Eds.), *Handbook of memory and metamemory* (pp. 95-116). New York, NY: Psychology Press.

Sungkhasettee, V. W., Friedman, M. C., & Castel, A. D. (2011). Memory and metamemory for inverted words: Illusions of competency and desirable difficulties. *Psychonomic Bulletin & Review, 18*, 973-978. doi:10.3758/s13423-011-0114-9

Susser, J. A., Jin, A., & Mulligan, N. W. (2016). Identity priming consistently affects perceptual fluency but only affects metamemory when primes are obvious. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 42*(4), 657-662. doi:10.1037/xlm0000189

Susser, J. A., & Mulligan, N. W. (2015). The effect of motoric fluency on metamemory. *Psychonomic Bulletin & Review, 22*, 1014-1019. doi:10.3758/s13423-014-0768-1

Susser, J. A., Mulligan, N. W., & Besken, M. (2013). The effects of perceptual fluency and list composition on judgments of learning (JOLs). *Memory & Cognition, 41*, 1000-1011. doi:10.3758/s13421-013-0323-8

Tauber, S. K., & Rhodes, M. G. (2010). Does the amount of material to be remembered influence judgments of learning (JOLs)? *Memory, 18*, 351-362. doi:10.1080/09658211003662755

Undorf, M., & Erdfelder, E. (2011). Judgments of learning reflect encoding fluency: Conclusive evidence for the ease-of-processing hypothesis. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 37*, 1264-1269. doi:10.1037/a0023719

Undorf, M., & Erdfelder, E. (2015). The relatedness effect on judgments of learning: A closer look at the contribution of processing fluency. *Memory & Cognition, 43*, 647-658. doi:10.3758/s13421-014-0479-x

Uttl, B. (2008). Transparent meta-analysis of prospective memory and aging. *PLoS ONE, 3*(2). doi:10.1371/journal.pone.0001568