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ORIGINAL ARTICLE

Implementation intentions about nonfocal event-based prospective memory tasks

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Abstract Implementation intentions are detailed and systematic plans that are developed during intention formation. We compared two different implementation intentions to standard event-based prospective memory instructions using three different kinds of intentions. Two of these intentions involved nonfocal cues whereas the remaining intention was about specific, focal cues. Implementation intentions dramatically increased detection performance for the nonfocal intentions. Because the exact cues could not be specified during intention formation, we argue that cue salience and that strengthening the cue to target action association are not very viable mechanisms to explain all instances of the beneficial consequences of forming implementation intentions.

Introduction

Consulting memory for planned activities and then eventually fulfilling them is an important aspect of our daily lives, and this endeavor is one that pervades our personal and social standing in the world around us. People who know that they often forget to accomplish intended activities generally take compensatory steps to reduce such failures (Marsh, Hicks, & Landau, 1998). We also tend to label other people as unreliable when they frequently forget their social intentions and obligations, and many times we interpret such failures as indicating that such people are also untrustworthy or irresponsible (Winograd, 1988). Consequently, understanding why people forget to complete their intentions, or why they succeed, is an important endeavor in the scientific study of human memory. Only in the last decade or two has rigorous laboratory inquiry into prospective memory been seriously undertaken. In the present study, we explored one technique that has been proposed to increase the probability that people will succeed in fulfilling the activities that they intend to perform. More specifically, we investigated a class of intentions called *implementation intentions* that potentially modify the way that prospective memory tasks are planned (Gollwitzer, 1999; Gollwitzer & Schaal, 1998).

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In standard laboratory studies of event-based tasks, participants are engaged in an activity that is designed to simulate the busy demands of everyday life (e.g., Einstein, McDaniel, Williford, Pagan, & Dismukes, 2003; Ellis, Kvavilashvili, & Milne, 1999; McDaniel, Guynn, Einstein, & Breneiser, 2004). People are asked prior to commencing this activity to perform some action if they ever encounter a particular cue or set of cues during this ongoing activity. For example, they might be asked to make an overt response when a particular word appears, or when a particular face appears (Maylor, 1996, 1998). The proportion of cues that are detected is considered to be one standard metric of prospective memory performance. Salient cues, that are highly related to the target action that is to be performed, and processing in the ongoing activity that focuses attention on the correct features of the cues are all factors that tend to improve prospective memory (Einstein & McDaniel, 2005; McDaniel & Einstein, 2000). Likewise, implementation instructions are also hypothesized to improve performance, but mainly as a consequence of the manner in which an intention is encoded. Essentially, implementation intentions involve specifying the exact situation(s) that one will be in when the intended activity is to be performed in the future. By specifying in detailed fashion the specific contextual cues that should be encountered (e.g., when and where), these cues can be associatively linked more strongly to the intended action (c.f., Marsh, Hicks, & Cook, 2008). If one wants to increase compliance with a nonroutine pill taking activity (say, taking antibiotics), then one could plan to take the pill right after pouring ones' first cup of morning coffee. Because coffee makers tend not to change locations, then binding of the extra situational cue to the target action should increase performance.

There are many good examples of implementation intentions improving real-world performance. For example, the formation of implementation intentions has increased vitamin-taking behavior and exercising (Sheeran & Orbell, 1999), frequency of breast self-examination (Orbell, Hodgkins, & Sheeran, 1997), and monitoring blood glucose levels (Liu & Park, 2004). Implementation intentions have also been studied in the context of social phenomenon such as counteracting ego depletion (Webb & Sheeran, 2003), aiding in habit replacement (Holland, Aarts, & Langendam, 2006) as well as attaining prosocial goals (Trötschel & Gollwitzer, 2007). Related to aging research, Chasteen, Park, and Schwarz (2001) asked older adults to imagine themselves performing an event-based prospective task like that described in the previous paragraph. Chasteen et al. argued that a 30 s imagination period was an implementation instruction and they found that it improved prospective memory performance. Because older adults presumably have less cognitive resources than younger adults, implementation intentions have been argued to make prospective memory relatively automatic or reflexive (Gollwitzer, 1999). To support this claim, Cohen and Gollwitzer (2008) found an improvement with implementation instructions as compared with standard instructions in a laboratory event-based task (with younger adults). One issue with such findings is that Ellis (2008) claims that the standard laboratory-based instructions may be so similar to implementation intentions that demonstrating their added benefit in the laboratory may be difficult to do. According to this criticism, many standard studies use specific cues (e.g., the words *spaghetti* or *church*) and they have instructed participants to press a key on the keyboard to indicate intention fulfillment.

Even if implementation intentions do make retrieval of the intention automatic, that supposition does not necessarily specify the theoretical mechanism(s) that would cause such automaticity. Two such mechanisms might be increasing the salience of the cue and also increasing the strength of the association between the cue and target action to be performed (McDaniel, Howard, & Butler, 2008). By the former account, specification of the exact cues and their situational context should make them be more discrepant in their familiarity values as compared with other background material when they are encountered (Einstein et al., 2005; Guynn & McDaniel, 2007). The increased discrepancy may then cause a search for their significance; accordingly the resulting effect would be that the intention is drawn to mind and then fulfilled. By the latter account, a strong association between the cue and target action will increase the reflexive retrieval of the entire associative structure when either is encountered (Moscovitch, 1994). As previously stated, there is no direct experimental evidence that implementation intentions cause automatic retrieval. They also could act to change people's attentional allocation strategies to search more consciously for the occurrence of event-based cues. If that happened, then there should be more task interference (i.e., slowing to the ongoing task) when implementation instructions are given as compared with when they are not (for more about task interference, see Hicks, Marsh, & Cook, 2005; Marsh, Cook, & Hicks, 2006).

We took the opportunity in this study to measure task interference using a variety of intentions in order to explore the notion of whether implementation intentions really do cause automatic retrieval or if they increase the attention devoted to the intention. If they do cause automatic retrieval, then there should be no differential slowing on the ongoing activity when people form implementation intentions, but there should be better event-based cue detection as compared with standard event-based instructions. In addition, if the effect of forming an implementation intention causes automatic retrieval of the intention, then there could even be a *reduction* to task interference (Cohen & Gollwitzer, 2008). Perhaps an even more important endeavor in this study was to ascertain whether implementation intentions improve prospective memory in cases where the cues are arguably *nonfocal*. Focal cues are specified in advance insofar as they are very specific concepts and the cognitive processing of the ongoing task would not interfere or may even aid one in processing the correct features of the cue (Einstein & McDaniel, 2005). By contrast, nonfocal cues are neither salient nor does the cognitive processing of the ongoing task necessarily aid in detecting them.

One kind of intention that is arguably nonfocal is a categorical intention such as having an intention to respond when one sees a word denoting an animal or responding to a word that has the syllable *tor* in it (Einstein et al., 2005). We believe that it might be difficult, if not impossible, for a cue salience account of implementation intentions to increase prospective memory to an animal-based or a syllable-based intention. If the ultimate cues are *deer* and *cow* with an animal-based intention, then one cannot easily increase their salience during encoding of an implementation intention because the exact cues will not be known during intention formation. The same would be true of cues such as *tornado* and *history* with a nonfocal syllable intention. Therefore, if implementation instructions increase prospective memory with nonfocal intentions then a cue salience mechanism is highly unlikely to explain the benefit of forming that kind of intention and therefore another theoretical mechanism must be sought. Whether an explanation based on increasing the strength of the cue to target action association would be viable is unclear with nonfocal intentions, as well. If it could, then the only association to be strengthened is between the semantic representation of a category such as animals in general and the target action that is to be performed. We will return to this issue later.

Overview of the experiments

We conducted three experiments that we report together for brevity; however, the reader is also encouraged to view these as conditions because they can be considered one large-scale experiment. We have chosen to call them experiments because it distinguishes the methods, but we acknowledge that the whole set of results can be considered a unified package of results. We have chosen the terms experiment and condition as a means of trying to segregate our results so that other researchers can pursue or refute our claims. Each experiment differed in the particular intention that participants were asked to fulfill. In Experiments 1 and 2 nonfocal cues were used (the intention to respond to words denoting animals and the words containing syllable *tor*, respectively) whereas in Experiment 3 two specific animal cue words were used.

Within each of the three experiments, there were three separate between-subjects conditions. The first condition provided what we consider to be standard event-based, verbal instructions; and we consider this a baseline condition within each experiment. The two other conditions tested within each experiment were what we consider to be implementation intentions. Following Chasteen et al. (2001) and Liu and Park (2004), the first of these conditions asked participants to imagine themselves performing the target activity when they detected a cue. Although several studies suggest that imagination is not necessarily a central feature of implementation intentions (e.g., Cohen & Gollwitzer, 2008; McDaniel et al., 2008), this type of instruction has never been studied in the context of nonfocal intentions. Cohen and Gollwitzer's approach was to have the participants say aloud to the experimenter "When I see X, then I will do Y!" which they did three times at encoding. In the second of our implementation conditions we asked participants to imagine for 30 s as in the other implementation intention condition, but in addition a screen appeared asking them to utter the when-then phrase to the experimenter. To summarize, there were nine independent groups across the three experiments which differed on the level of cue specificity (i.e., respond to animals, words with the syllable *tor* in it, or *deer* and *cow*) and on the type of intention instruction (i.e., standard, imagery, and imagery + when/then). Our two main dependent variables were the speed with which participants performed the ongoing lexical decision task and the proportion of cues that they detected.

Method

Participants

Undergraduate students from the University of Georgia volunteered in exchange for partial credit toward a research appreciation requirement. Each participant was tested individually in sessions that lasted approximately 25 min. Target cell sizes were $N = 35$ in the nine independent groups across the three experiments. These were not met when an experimenter had to be rotated on to a different project. Three conditions fell shy of this goal, two conditions had 34 and one had 33 participants. Thus, a total of 311 people were tested.

Materials and procedure

The ongoing activity was a lexical decision task that we have used on many previous occasions (e.g., Marsh, Hicks, & Watson, 2002). This task was comprised of 210 trials with equal numbers of valid English words and pronounceable nonwords. The 105 valid words were chosen from the Kučera and Francis (1967) norms. The nonwords were created by changing one or two letters from other words taken from the same source; but, the nonwords were still pronounceable. Every condition had 8 prospective memory cues that occurred on trials 25, 50, 75, etc. through trial 200. In Experiment 1, these were 8 different animal names, in Experiment 2 the cues were 8 different words containing the syllable *tor*, and in Experiment 3, these were the words *deer* and *cow* each repeated four times each. Assignment of cues to trials was random for any given participant. Participants were asked to discriminate between words and nonwords by pressing one of two labeled keys on which they rested their two index fingers; and they were asked to respond rapidly without sacrificing accuracy on this ongoing task. The instructions for the ongoing task were always delivered first, followed by the instructions for the prospective memory task. After reading all instructions, the prospective memory instructions were repeated verbatim by the experimenter and the ongoing task instructions were repeated in the experimenter's own words. Each trial was self-initiated in response to the participant pressing the space bar with one of their thumbs during a message that read "*waiting*." If a cue was detected, we asked them to press the/-key during the waiting message following their word response on that trial (c.f., Marsh et al., 2003).

The critical manipulations across the experiments and their conditions were the prospective memory instructions, and therefore, we take some care in explaining them. When a standard, verbal prospective memory instruction was delivered it was given as nonchalantly as possible. In Experiment 1, participants read the following instruction:

> Oh, by the way, if you ever encounter *an animal word* during the judgment task (e.g., MONKEY), press the WORD key as you normally would, and then press the "/" key during the 'waiting' message.

For the syllable intention in Experiment 2, the phrase *an animal word* was replaced with the phrase *a word that has the syllable TOR in it;* and for the specific cue condition of Experiment 3, the phrase *an animal word* was replaced by the phrase *the words DEER or COW*. The instructions for Experiment 2 had an appropriate nontested *tor*-word given as an example but no parenthetical example was given in Experiment 3.

In the first implementation intention condition of Experiment 1, participants read the following:

Now, please take a few moments to imagine yourself responding to an animal word. Please visualize yourself making a word judgment when encountering an animal word. Then, imagine yourself pressing the slash ('/') key during the 'waiting' message in response to seeing this word. Take a few moments to close your eyes and imagine seeing an animal word, after which you will press the word key followed by the slash key.

The experimenter watched participants and when they had finished reading the instructions, the experimenter reiterated them and then timed the visualization period for 30 s with a hand-held stop watch. We label this the imagery instruction, and in Experiments 2 and 3 the quoted text was updated in very minor ways to be consistent with the syllable and specific cues intentions, respectively. Finally, in each of the three experiments there was a second implementation intention condition that we have labeled the imagery + when-then condition. The instructions and procedures were identical to the imagery condition, but after the 30 s imagery session the experimenter advanced the computer monitor to a special screen and directed the participant to do what was printed on the monitor. The directive on the monitor in Experiment 1 was to turn to the experimenter and say the following statement out loud: "When I see an animal word, then I will press the slash key!" Unlike Cohen and Gollwitzer (2008) we did not have them repeat it three times, but rather, only once. For Experiments 2 and 3, the when-then statement was updated appropriately for the intentions used in those experiments (syllable and specific cues, respectively). Following the instructions, the experimenter ensured that the computer screen was blank and then administered an unrelated distractor task for 4 min as timed by a hand-held stop watch. The ongoing task was then commenced with no further mention of the respective prospective memory task.

Results and discussion

Unless otherwise specified with a p value, the statistical results are significant with only the conventional 5% probability of a Type I error. Across all experiments and all conditions late cue detection responses occurred an insignificant 0.76% of the time, and consequently, they were not counted as instances of successful performance. The data are presented in Fig. 1 with the top panel containing cue detection proportions and the bottom panel containing the average reaction time to words in the lexical decision task

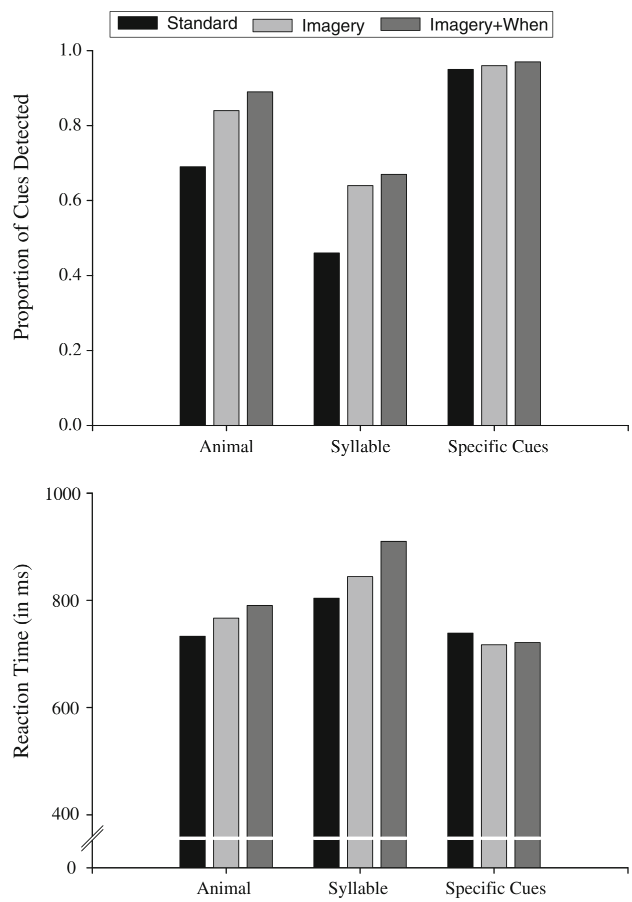

Fig. 1 Proportion of cues detected and reaction times (in milliseconds) to the word trials of the lexical decision task as a function of both cue focality and the type of intention instruction given

after removing errors and reaction times longer than 2.5 standard deviations from a given participant's grand mean. In Experiment 1 the two implementation intentions improved cue detection of animal items, $F(2, 102) = 8.49$, $\eta_p^2 = 0.14$. The identical outcome occurred in Experiment 2 with the other nonfocal intention of finding words containing a particular syllable (*tor*), $F(2, 99) = 3.13$, $\eta_p^2 = 0.06$. Unfortunately, the specific cues (*deer* and *cow)* led to ceiling performance in all three conditions in Experiment 3, so there was no room for implementation intentions to show their benefit, $F(2, 101) < 1$, ns. This outcome probably occurred because of the well-specified nature of the intention and because the cues were each repeated four times each during the performance interval. As the reader can see, both implementation intentions employing imagery lead to much better cue detection in Experiment 1, $t(68) = 2.59$, and in Experiment 2, $t(67) = 1.98$. However, there was no added benefit of having participants explicitly utter the when-then statement to the experimenter in either experiment.

We define task interference from intentions as the slowing to the ongoing task that is caused by having a prospective memory (Marsh, Hicks, Cook, Hansen, & Pallos, 2003). In these experiments, the amount of slowing caused by implementation intentions is relative to the standard event-based instruction conditions. As the reader can see in the bottom panel of Fig. 1, the two nonfocal intentions (Experiments 1 and 2) produced a step-like function across the three conditions within each experiment, but this was not true with specific cues where reaction times were essentially equivalent in all conditions. With an intention to respond to animals in Experiment 1, the imagery + when-then intention caused much slower response latencies as compared with the standard instructions, $t(68) = 2.12$, but technically we should not be reporting this as significant because the omnibus ANOVA failed to reach conventional significance, $F(2, 102) = 2.20$, $\eta_p^2 = 0.04$, $p = 0.11$. By contrast, with the syllable intention of Experiment 2, the same difference was present between the standard and imagery + when-then conditions, $t(65) = 3.00$, and the omnibus ANOVA was significant by conventional standards, $F(2, 99) = 5.20$, $\eta_p^2 = 0.10$. In the two contrasts just reported the magnitude of the differences in reaction times was 90 ms in Experiment 1 and 110 ms in Experiment 2. Consequently, we are inclined to believe that the implementation instruction effect is essentially the same in both experiments, viz., imagery alone produces small and insignificant slowing whereas the imagery + when-then statement produces much more task interference for nonfocal intentions. As mentioned earlier, the latencies across the three conditions in Experiment 3 were equivalent, $F(2, 101) < 1$, ns. There was a small, nominal *reduction* in latencies when implementation instructions were given for specific cues in Experiment 3, a difference that has been previously reported as significant (i.e., Cohen & Gollwitzer, 2008). The small effect we found, then, might actually represent a real phenomenon that should be investigated further.

Across the three experiments it is clear that ceiling performance on cue detection was obtained with the specific (focal) cues and that implementation instructions would be ineffective in changing performance under these instructions. To verify this, we conducted a 3 (cue type or experiment) × 3 (intention or instruction) ANOVA.

Consistent with the foregoing discussion, providing specific cues resulted in better cue detection performance which is consistent with Einstein and McDaniel's (2005) assertions concerning focal versus nofocal cues, $F(2, 302) = 60.89$, $\eta_p^2 = 0.29$. In this overall analysis, providing implementation instructions also improved performance, $F(2, 302) = 9.55$, $\eta_p^2 = 0.06$. Consequently, we conclude that either type of implementation intention increases cue detection for *nonfocal* cues. Unfortunately, the interaction failed to reach significance because of generally low power to detect interactions despite our substantial sample sizes (Cohen, 1988), $F(4, 302) = 1.80$. In a similar 3 × 3 analysis on task interference (i.e., reaction times), there was a main effect of cue type suggesting that less specific intentions (i.e., nonfocal) created more slowing on the ongoing activity, $F(2, 302), = 33.06$, $\eta_p^2 = 0.19$. The main effect of instruction was also present, $F(2, 302) = 4.74$, $\eta_p^2 = 0.03$. However, this effect was qualified by a significant interaction, $F(4, 302) = 2.61$, $\eta_p^2 = 0.03$. This result confirms that implementation instructions increase task interference for the nonfocal intentions but these same instructions do not do so for the focal intention. The foregoing analysis on task interferences is consistent with the idea that implementation intentions change attentional allocation policies for nonfocal intentions, but they do not change such policies that may already be in place for focal intentions[1].

Conclusions

We found significant benefits to implementation intentions with nonfocal cues that could not have been anticipated during intention formation. Therefore, the general benefit

[1] We also analyzed task interference for the word trials in the temporal vicinity of successful cue detection (i.e., within ten total lexical decision trials before cue detection). The reaction times for these trials were statistically equivalent to the overall latencies across all nine conditions in the three experiments that we have reported here. This outcome of latencies in the vicinity of cue detection replicates our previously published work that also found no such differences (i.e., Hicks et al. 2005). However, we acknowledge that there is one report that may differ in this conclusion (see West, Krompinger, & Bowry, 2005).

of implementation intentions cannot be solely due to any increased the salience of the cue. Although Ellis and Milne (1996) argue that participants could be sampling memory for animal items during intention encoding in Experiment 1, that effect should be constant across all three instructional conditions unless they engage in extended sampling time during the 30 s of imagery. Even so, people would be unlikely to guess (or anticipate) which animals would eventually occur. In addition, the results in Experiment 2 were identical to Experiment 1; and it is very unlikely that participants could guess which words with a particular syllable (*tor*) would occur because this is a very poor retrieval cue for words (e.g., Tversky & Kahneman, 1983). The current results also do not support strengthening of the cue-to-target action explanation of the benefit of forming implementation intentions across all circumstances. To detect an animal cue, one must categorize it as animal before one can realize that one has an intention about it. The intention to press the slash key to animals can be strengthened as a whole unit (i.e., intention qua planned activity) but this is not the spirit in which cue-to-target action strengthening is depicted in the literature (e.g., McDaniel et al., 2004). Rather, a strong association occurs between a specific cue (see *spaghetti*) and the target action (say *sauce*) whereas a weak association does not (see spaghetti, say steeple). We are saying that implementation intentions probably do not increase such a relation when the cues are nonfocal in nature (e.g., animals and syllables).

By saying that implementation intentions can strengthen the whole planned unit, we are essentially saying that they can increase the retrieval sensitivity of the intention (Mäntylä, 1993). Heightened sensitivity comes from planning and elaborating an intention according to Mäntylä. However, that is tautologically related to the implementation instruction itself, and consequently does not explain the underlying mechanism providing the benefit to cue detection. Perhaps increased retrieval sensitivity is actually the increased perceived importance of the prospective memory task. Not surprisingly, more important intentions tend to be completed at a higher rate (e.g., Kliegel, Martin, McDaniel, & Einstein, 2001). Importance can be defined as the amount of effort one expends at succeeding at the task. We define this variable as reflecting two separate attentional allocation policies adopted at the outset of the experiment (e.g., Hicks et al., 2005; Marsh, Hicks, & Cook, 2005). One policy is associated with attention to the entire task set (i.e., the ongoing and prospective memory tasks) and the other policy specifies the preferred division of attention between the ongoing and prospective memory tasks. Concerning the latter attentional policy, the greater the relative weighting given to the prospective memory task, the less resources that will be available to perform the ongoing task and therefore latencies become slower.

Imagery alone did not result in latencies that were statistically slower than the standard instructions, but they were nominally slower in the two experiments with nonfocal intentions. Nevertheless, prospective memory was significantly better than in the standard condition. By contrast, imagery + when-then statement resulted in latencies that *were* statistically slower with a concomitant *benefit* to prospective memory. This complex pattern of behavior suggests that implementation instructions do cause a change in people's attentional allocation policies, but it is not at all clear that these changes are functionally related to cue detection performance. In the two nonfocal experiments, the difference in average latencies between the standard and imagery conditions is on the order of 30–40 ms with a resulting increase in prospective memory on the order of 15–20%. The additional slowing caused by adding the when-then statement as compared to imagery alone is on the order of 60–70 ms with the net change to cue detection being only 2–3% greater. As we have claimed on several other occasions (e.g., Marsh et al., 2003), the amount of task interference does not appear to be functionally related to cue detection performance, because if it were, the imagery + when-then conditions should have exhibited much better performance than the imagery alone conditions.

The drawback to Experiment 3 is that cue detection was on ceiling performance. However, the benefit of conducting that experiment lies in the latency data. That experiment clearly shows that not all implementation intentions will change people's attention allocation policies. Perhaps with only a few specific cues, implementation intentions reinforce that the intention will be easy to perform and participants decide not to weight the prospective memory task any differently than they do under standard instructions. By contrast, with the nonfocal intentions perhaps the implementation instructions reinforce that cues may go easily undetected and people adjust their attentional allocation policy accordingly. We believe that the reason why task interference is not perfectly correlated with the detection of nonfocal cues is that speed in the ongoing task is only one determinant of cue detection. Other relevant factors probably determine this that do not directly affect latency such as the number of times one is reminded of the intention or how many trials after successful cue detection does the intention enjoy a state of heightened activation. These are influences on cue detection that are not measured in the current paradigm, and they can be difficult to measure without making the prospective memory a vigilance task. It is also possible that the complex pattern of latency and cue detection data with nonfocal cues is due to an increased amount of attention being devoted to *both* the lexical decision and prospective memory tasks. Implementation instructions could result in an increase in the overall allocation of attention to both tasks and therefore may result in lower task interference than would be expected if attention was increased only towards the prospective memory task.

If implementation intentions with focal and nonfocal cues have the same theoretical mechanism underlying their benefit then it is clear that neither cue salience nor strengthening of the cue to target action are strong contenders. Rather, implementation instructions seem to be affecting the attentional allocation policy that people adopt in some cases, but not in others. Even so, our hope is that the current study in showing benefits with a nonfocal intention will prod others to search for potentially common mechanisms across focal and nonfocal intentions such the microstructure of an event-based response. For example Marsh et al. (2003) have argued that four stages occur in successfully detecting an event-based cue: cue recognition, verification that the cue meets the conditions for responding, retrieval of the target action, and coordination of the prospective with the ongoing task response. Implementation intentions could facilitate any one of these processes (with some being more obvious candidates than others) and thereby act to increase successful responding. Our point is that alternative mechanisms need to be developed for how implementation intentions actually increase performance in everyday prospective memory tasks. Once they have been identified they can be scrutinized more closely in the laboratory and developed into viable strategies for improving prospective memory, particularly in populations with documented deficits in completing planned activities. Of course, the processes involved in this study might not perfectly reflect those processes involved in implementation intentions outside of the laboratory (e.g., medication adherence). Hence, the theoretical issues raised in the current study (and with any other laboratory study on implementation intentions) should be examined with more applied types of prospective memory designs as well.

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