The valence of event-based prospective memory cues or the context in which they occur affects their detection

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Event-based prospective memory tasks entail detecting cues or reminders in our environment related to previously established intentions. If they are detected at an opportune time, then the intention can be fulfilled. In Experiments 1a–1c, we gave people 3 different nonfocal intentions (e.g., respond to words denoting animals) and discovered that negatively valenced cues delivered the intention to mind less frequently than positively valenced cues. In Experiment 2, this effect was extended to valenced and neutral sentential contexts with convergent results that cues embedded in negatively valenced sentences evoked remembering the intention less often than in positive contexts. In addition, both classes of valence caused the intention to be forgotten more often than a more neutral context. We propose that valence has the ability to usurp attentional resources that otherwise would have supported successful prospective memory performance.

One of the most important human abilities is our capacity to plan and to shape our future. We do so by anticipating the activities that we want or need to undertake in the not-so-distant future (e.g., ensuing days and weeks). In doing so, we store those intentions in memory until the circumstances warrant and allow their completion. Memories of intentions that we want to complete are unlike memories of past experiences insofar as they are mainly a product of thought, imagination, and anticipation rather than composed of the spatiotemporal detail that comes from actually performing an activity (Marsh, Cook, & Hicks, 2006). For this reason, scholars of memory have drawn a distinction between retrospective memory for experiences already undertaken and prospective memory for activities that we plan to initiate in the future. Some researchers believe that intentions reside in memory with an above-baseline level of activation or are able to be revived faster than retrospective memories (Goschke & Kuhl, 1993; Marsh, Hicks, & Bink, 1998). If true, this characteristic may contribute to people having a higher probability of noticing intention-related material in their environment, thereby supporting the successful detection of event-based prospective memory cues. For example, the intention to replenish a gallon of milk may cause one to notice grocery or convenience stores more readily than if one did not have the same

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intention (also see Marsh, Cook, Meeks, Clark-Foos, & Hicks, 2007).

Aside from this potential general readiness to process intention-related material, characteristics of the cues themselves also determine the probability that they will be detected and bring the intention to mind (Einstein et al., 2005; McDaniel, Guynn, Einstein, & Breneiser, 2004). Einstein and McDaniel (2005) drew a distinction between focal cues and nonfocal cues, with the former being more salient either because they stand out from their background or because the ongoing cognitive activity focuses people on the relevant aspect of the cue, thereby causing awareness of the intention more automatically. For example, an uppercase word denoting an intention to respond would be noticed easily against a background of lowercase words (Einstein, McDaniel, Manzi, Cochran, & Baker, 2000), or a high-frequency word against a background of low-frequency words (or vice versa) would be a distinctive cue (McDaniel & Einstein, 1993), as would a green word against words that are all black, as compared with a background of constantly changing colored words (West, Wymbs, Jakubek, & Herndon, 2003). More generally, McDaniel et al. (2004) argued for a discrepancy plus search model of event-based cue detection in which a cue that is discrepant in its familiarity value against its background context receives extra processing, thereby causing an intention about it to be retrieved relatively automatically (also see Breneiser & McDaniel, 2006). However, not all manipulations of relative salience necessarily affect event-based performance. Hicks, Cook, and Marsh (2005) manipulated the size of cues that occurred in the focus and in the periphery of attention. Only size changes that were in the background changed cue detection, whereas already focal processing mitigated against changes in salience affecting cue detection.

At a more general level, these studies demonstrate that successful event-based prospective memory often (but not always) competes with the ongoing task for resources, and when the ongoing task is challenging, fewer event-based cues will be detected (Marsh, Hancock, & Hicks, 2002; McNerney & West, 2007). For example, West, Krompinger, and Bowry (2005) found that when people were more engrossed in the ongoing task as indexed by shorter reaction time latencies, they detected fewer event-based cues than when they were less engrossed in the task and were going more slowly. West and Craik (1999) reported a related finding in which they argued that older adults more often have momentary lapses of intention than younger adults, which lead to overall prospective memory deficits, also indexed by reaction times in the vicinity of event-based cues. Together these results suggest that event-based cue detection often requires some optimum level of central executive resources (Marsh & Hicks, 1998; McDaniel, Einstein, Stout, & Morgan, 2003; McDaniel, Glisky, Rubin, Guynn, & Routhieaux, 1999), and tasks and conditions that draw resources away from the prospective memory task or the experimental task set as a whole can result in worse event-based cue detection.

The purpose of this study was to assess whether the affective valence of a cue might also affect cue detection. Although it is debated, valenced information has been said to receive extra processing when it is encountered, which often confers a memory advantage as compared with otherwise comparable neutral material (Buchanan & Adolphs, 2004; Cahill & McGaugh, 1995; Hamann, 2001). Whether this advantage is wholly modulated by arousal has also been debated. A full consideration of these issues is beyond the scope of this article, and it is probably the case that both valence and arousal make separable and unique contributions to subsequent memory performance (Kensinger & Corkin, 2004; Lang, Greenwald, Bradley, & Hamm, 1993). In terms of the present study, the question was whether material varying in its valence affects an event-based prospective memory task. All of us have formed an intention about a valenced cue at one time. For example, imagine the scenario of having two coworkers, one of whom you like immensely and the other of whom creates an immediate feeling of antipathy. Assuming that you must remember to deliver a message to each of them, which cue will evoke the intention more frequently? In the memory literature, negative items tend to be remembered better than neutral items, but the emotional enhancement effect is less consistent for positive items. Given this, whatever cognitive and emotional reactions are evoked by valenced stimuli are likely to be stronger for negative than positive items.

Our thesis was that valenced event-based cues would indeed affect remembering to fulfill the inten-

tion in one of two alternative ways. First, if the cue attracts attention it may be processed more fully, and the intention to respond may have a higher probability of coming to mind. In this case, we would predict that negative cues (e.g., *rat, maggot*) would elicit better event-based prospective memory because they are processed more deeply than positive cue items (e.g., *kitten, puppy*). Second, the reaction one has to a valenced item may obligatorily bring related thoughts to mind and serve as a temporary distraction (i.e., a drain on attentional resources), thereby lowering cue detection in general. If this outcome was obtained, then we would predict that negative cues would be detected less frequently than positive cues. Regardless of which of the two outcomes is obtained, from a theoretical standpoint the manipulation of the valence of cues may represent another way in which to investigate the sensitivity of event-based prospective memory to variations in attentional loads. Rather than impose a general load, as has been done with standard divided attention studies, we may be able to induce the load through the valenced characteristic of the cue or its surrounding context. Under the first alternative, attention is being drawn to the cue itself; and under the second alternative, that additional attention brings with it other thoughts and reactions that may further displace the intention momentarily or otherwise prevent it from being brought to conscious awareness.

EXPERIMENTS 1A–1C

We conducted three highly related experiments that are reported together for brevity. In all three experiments four positive and four negative cues were embedded randomly in a lexical decision task. Participants were asked to respond to these cues as categorical intentions that differed across the three experiments. In Experiment 1a, the intention was to respond to animals and insects. In Experiment 1b, we asked participants to form the intention to respond to words denoting moods and emotions. Finally, in Experiment 1c we asked them to respond to words denoting weather-related phenomena. In all three cases we held constant the arousal value of the cues in the positive and negative categories of cues; all that differed was their rated valence. Consequently, any difference in cue detection will be a function of valence and not arousal.

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. Each of the three experiments had a sample size of 30. The experiments were conducted in different semesters (within the same academic year), but our experience is that the general population being sampled does not change appreciably over time.

Materials and procedure

The parameters of the ongoing lexical decision task were identical to those used by Marsh, Hicks, and Watson (2002). There were 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 made in house by changing one or two letters of 105 valid English words to make them pronounceable nonwords. The eight prospective cues occurred every 25 trials at trials numbered 25, 50, and so on, through trial number 200. Cues were assigned to these eight positions randomly anew for each participant without regard to whether the cue had a positive or negative valence. The cues themselves were taken from the Affective Norms for English Words (ANEW; Bradley & Lang, 1999) that contains both valence and arousal ratings. On a 1 (*negative*) to 9 (*positive*) scale the positive cues for the three experiments averaged 7.21, 7.58, and 8.45 in their valence, respectively. By contrast, the average valence rating of the negative cues was 2.69, 3.06, and 1.73 across the three experiments, respectively. Thus, there were large differences in the valence ratings between positive and negative cues. By contrast, the average arousal ratings for the six classes of cues was kept in the 4–6 (*neutral*) range. The words and nonwords (more accurately, their parent word form) that made up the majority of trials were kept fairly neutral by our judgment, but we did not strictly prove this because many were not contained in the ANEW corpus.

All three experiments were conducted identically, with the exception of the intention given to participants. The experiment began with participants reading instructions off the computer monitor. When the participants indicated that they understood them, the

experimenter cleared the monitor and delivered the instructions again in her own words. For the intention itself, it was delivered rather matter-of-factly as "Oh, by the way, if you ever happen to see a word denoting animals or insects, press the word key as you normally would and then press the slash key." Each trial was self-paced insofar as the participant had to initiate the trial with a spacebar press in response to seeing a message that said "waiting." Therefore, participants were functionally issuing their prospective memory responses in between trials. Of course, the software recorded slash key responses whenever they occurred. When the participants indicated that they understood what was being requested of them, they were given a puzzle as a distractor task for 4 min, as timed by a handheld stopwatch. When the time arrived to commence the ongoing task, the experimenter initiated the software without making any reference to the prospective memory task. In Experiment 1b, the intention was to respond to moods and emotions, whereas in Experiment 1c participants were given an intention about weather-related phenomena. In each case an example was given that they would not encounter during the lexical decision task. The ongoing task responses were made with the right (*word*) and left (*nonword*) index fingers poised over the "J" and "F" keys, respectively.

RESULTS AND DISCUSSION

Unless otherwise reported with a p value, all statistical tests are significant at the conventional 5% error rate in all experiments in this report. In keeping with our prior practice, late prospective responses to cues were not counted as correct, although including them does not change the interpretation of the data. The data for all three experiments are summarized in Figure 1, with each pair of bars denoting a different intention that was used across the three experiments. As can be seen in that figure, positive cues consistently elicited more responses than did negative cues. We analyzed the data from all three experiments together in a 3 (intention: animals, emotions, and weather) × 2 (valence of the cue: positive or negative) mixed-model analysis of variance (ANOVA) with repeated measures on the second factor. Positively valenced event-based cues were detected more often than negative ones, $F(1, 87) = 11.34$, $MSE = .48$, $\eta^2_p = .12$. Valence did not interact with the type of intention, and there was no

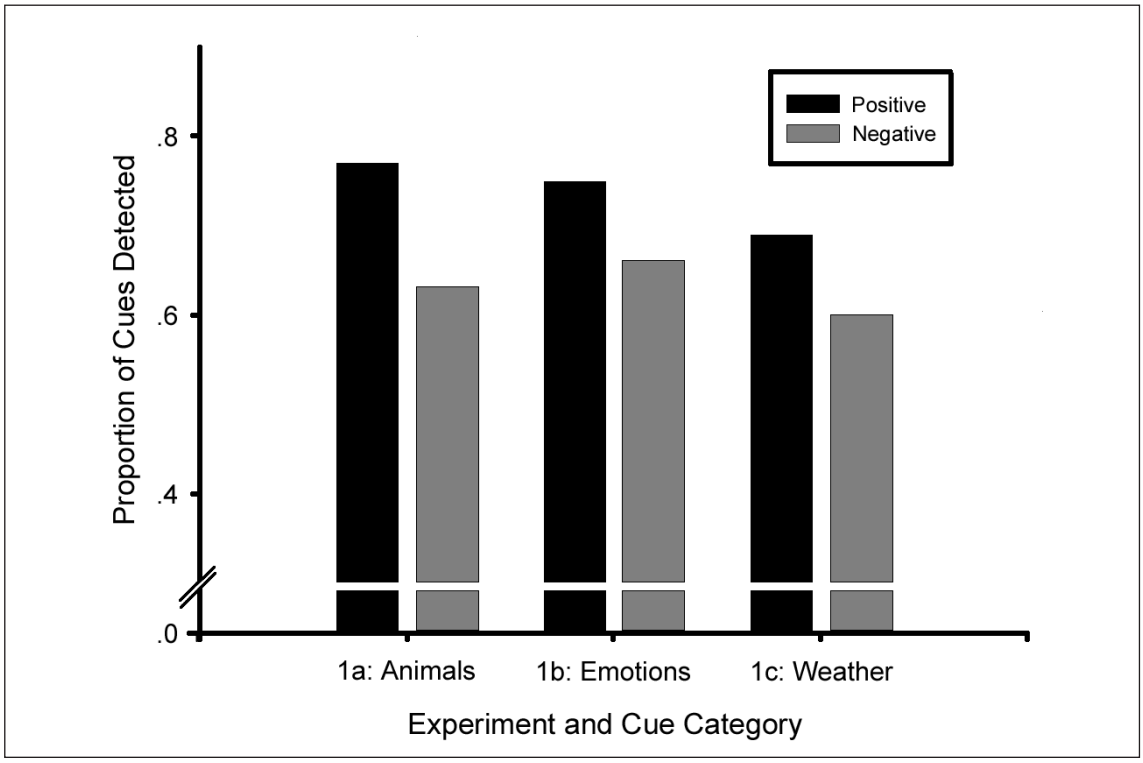

FIGURE 1. Proportion of positively and negatively valenced event-based prospective memory cues detected, Experiments 1a–1c

overall main effect of the type of intention across the three experiments.

On the assumption that negative valence attracts attention, we believe that other thoughts and feelings were evoked when participants processed negatively valenced items. For example, the concepts of *maggot, spider, tornado, grief,* and *terrified* may be associated with negative situational thoughts that more automatically come to mind than with concepts such as *puppy, snow, happy,* and *delighted*. We are not claiming that, all other things being equal, people have more associations to negative concepts than positive concepts. Rather, we are saying that these associations may be generated more automatically for negatively valenced material and interfere with event-based prospective memory processes. As mentioned earlier, processing negative cues acts functionally like a divided attention task to reduce performance. Much like filling working memory with another task, we believe, the thoughts and associations displace or prevent the intention from being brought into awareness. These effects are unlikely to be stimulus driven insofar as we found the same effect in each experiment. So if there were some confound in the stimuli for a given experiment, its reemergence would be unlikely again in two different sets of eight additional event-based cues. Consequently, with the tasks and conditions used here the effect of negative valence seems to be rather general. Nevertheless, Experiment 2 was conducted to further assess the generality of the phenomenon and to correct any shortcomings of Experiments 1a–1c.

EXPERIMENT 2

To demonstrate that the negative valence effect is not an artifact of the use of a lexical decision task, in this experiment the ongoing task was a sentence rating task (cf. Einstein et al., 2005). Participants were asked to rate the valence of positive, negative, and neutral sentences. One infelicity of Experiments 1a–1c is that we did not include a neutral baseline from which to observe whether there was an overall effect of valence as compared to neutral cues. Experiment 2 corrects this problem. If this experiment replicates the findings from the previous experiments, then cues embedded in negative sentences should be detected less frequently than those embedded in positive sentences. The critical question was whether there would be any difference between positive and neutral sentences. If valence in general affects event-based prospective memory processes, then a deficit to cue detection should be observed for cues embedded in both negative and positive sentences relative to neutral ones. On the other hand, perhaps positive valence exerts little influence on performance and is equivalent to processing more neutral material. We used the categories of foods and vehicles as a counterbalancing variable to ensure once again that the valence effects we observed were not stimulus bound. The reader should note that this experiment represents a true conceptual replication of the effect of valence on prospective memory because rather than the cue words themselves being valenced, as they were in Experiments 1a–1c, now the entire sentential context delivered the valence.

METHOD

Participants

Undergraduates 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 40 min. Forty volunteers were tested.

Materials and procedure

The valenced and neutral sentences were taken from Maratos and Rugg (2001). We used 75 each of the positive, negative, and neutral versions of the sentences. If a sentence was used for one level of valence, then it was not repeated at another level of valence. In addition to these 225 sentences, 9 additional sentences were also included that contained an event-based cue. For participants assigned the food intention, three food items were embedded in positive sentences (e.g., "They quenched their thirst with the cool succulent fruit"), three were included in negative sentences (e.g., "Those who got diarrhea had eaten oysters"), and a final three were included in neutral sentences (e.g., "After leaving, they went out to get some milk"). Thus, participants rated a total of 234 sentences. The same parameters applied to participants assigned an intention to respond to vehicles insofar as they received three cues embedded in sentences of each level of valence. Obviously, the semantics of the sentences containing cues were different for the two counterbalancing conditions that received the different intentions.

The software controlling the experiment randomly assigned sentences to trials anew for each participant. The sentences containing cues were also randomly assigned to trials 25, 50, etc., through trial 225 without regard to their level of valence. The remaining procedural details followed Experiments 1a–1c very closely. Participants read instructions for the sentence rating task from the computer monitor. These were cleared, and the experimenter reiterated the instructions to rate the sentences on a 7-point scale with 1 being *negative,* 4 being *neutral,* and 7 being *positive.* The experimenter explained the intention to respond either to food items or to vehicles. Once the participant indicated that he or she understood the task, a 3-min distractor task (i.e., a puzzle) ensued before the sentence rating task was commenced without any reminder of the prospective memory task. The prospective memory task was to push the slash key before making a valence rating, but as before such a response would have been recorded whenever it was issued.

RESULTS AND DISCUSSION

As a manipulation check, we analyzed the average valence rating of the positive, negative, and neutral sentences. These means were 5.68, 1.57, and 4.23, respectively, and they significantly differed from one another in the expected fashion, $F(2, 78) = 746.39$, $MSE = 17.22$, $\eta^2_p = .95$. Thus, participants perceived the valence differences as we expected that they would. The resulting effect on event-based prospective memory is summarized in Figure 2, pooling over the counterbalancing intentions (which did not appreciably affect performance). The omnibus ANOVA found that the valence of the sentence affected cue detection, $F(2, 78) = 7.89$, $MSE = .07$, $\eta^2_p = .17$. Of the three possible pairwise comparisons, all were statistically significant, with the smallest being $t(39) = 2.08$. As can be seen in Figure 2, cues delivered in negative sentences were detected less frequently than those detected in positive sentential contexts. That outcome replicated the findings reported in Experiments 1a–1c, and it bolsters our confidence that these valence effects are genuine influences on event-based prospective memory performance. In addition, cues embedded in both positive and negative sentences were detected less frequently than cues presented in a neutral context. That outcome suggests that valence in general can detract from cue detection. Consequently, had we used neutral items in Experiments 1a–1c, cue detection would have been better than for the positive items.

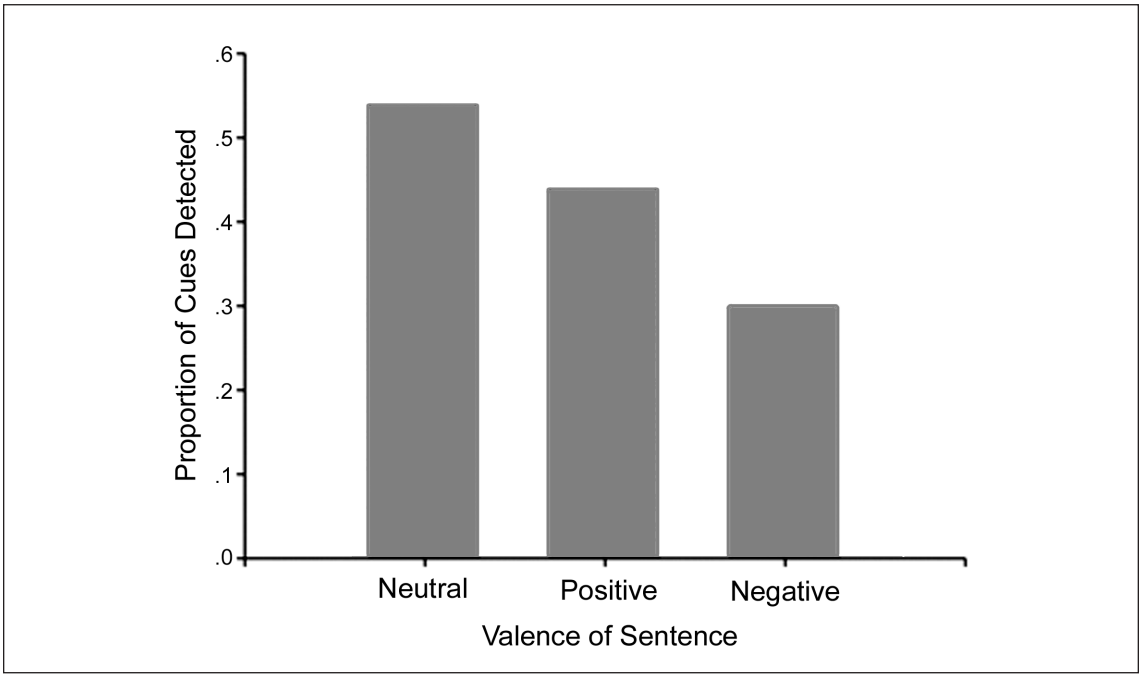

Figure 2. Proportion of event-based cues detected in neutral, positively, and negatively valenced sentences, Experiment 2

Overall cue detection was lower in this experiment than in the previous ones. That outcome could be a result of several factors. First, much more information was being processed in this experiment than single words in the lexical decision task. Second, making valence ratings may be more engaging and interesting than making word–nonword judgments. Third, two thirds of the stimuli were valenced in this experiment, so encountering a negative or positive concept was a very common event, whereas the lexical decision stimuli were neutral with the exception of the event-based cues. According to McDaniel et al.'s (2004) discrepancy plus search model, the cues may have been more salient in the lexical decision task for all three of these reasons. The important point is that a valenced cue or cue encountered in a valenced context is less likely to be categorized as relevant to a previously established intention, and therefore the opportunity to fulfill the intention is missed more often.

GENERAL DISCUSSION

We have argued throughout that processing emotional information captures attention. The literature is replete with good examples of this fact. Memory for items that precede and follow an emotional stimulus is often depressed much as it is in the standard isolation effect (Strange, Hurlemann, & Dolan, 2003). Moreover, attention to the emotional information does not even have to be processed more deeply to have this effect. For example, Mackay et al. (2004) found no evidence of slowing for emotional stimuli in an emotional lexical decision task but nevertheless found depressed subsequent memory for items in the vicinity of the emotional item. In this sense, attention is "sticky" to valenced items and prevents full attentional processing to other material contemporaneously residing in working memory. Of course, the event-based cues used in Experiments 1a–1c are not as valenced in an absolute sense as the materials that lead to anterograde and retrograde amnesic-like effects (e.g., taboo words). However, the important point is that something akin to this happens when cues are valenced or when they occur in a valenced context. Processing a word such as *puppy* may direct attention toward a memory such as the last time one saw a family in front of the grocery trying to give away a box of puppies rather than the memory that one has an intention to respond to animals and insects. Even the thought "That is disgusting" upon encountering the word *roach* could be sufficient to momentarily disrupt access to the intention. Recently, we placed an episodic fan on event-based cues. The larger the fan, the worse the cue detection (Cook, Marsh, Hicks, & Martin, 2006). In much the same manner, valenced cues may more readily evoke information that is unrelated to intention, thereby reducing the probability that the intention comes to mind.

We are aware that the effects being reported here are not large, but they do have consistency in their favor. Consequently, we are not saying that all valenced cues and all valenced contexts will always have deleterious consequences for event-based prospective memory. The use of more focal cues or overlearning of the intention could trump the valence effect. For example, Chasteen, Park, and Schwarz (2001) have shown that forming an implementation intention about an event-based cue dramatically improves older adults' performance. Therefore, if we had asked participants to mentally form an image of themselves pressing a key when they encountered an insect or animal, the valence effect might have been attenuated or perhaps not occurred at all. The exact boundary conditions of when valence will and will not affect prospective memory definitely must be explored further. As we have argued here, those boundary conditions are likely to be intimately linked with when attention is and is not needed to reactivate the memory that one has an intention in the first place.

Recently, the argument has been made that valence exerts its influence through prefrontal cortical processing, whereas arousal exerts its influence through psychophysiological processing such as the involvement of the amygdala (Kensinger & Corkin, 2004). Because we held arousal constant, the effects we are investigating must exert their influence on prefrontal cortical structures and processes. This argument is consistent with Marsh and Hicks's (1998) original argument that many prospective memory tasks entail some optimum level of central executive resources. When divided attention tasks tap peripheral systems such as the phonological loop or pure visuospatial abilities, event-based prospective memory is generally left intact. Consistent with our argument that valence may bring extra unrelated information to the fore, this

information appears to disrupt event-based prospective memory processes, at least on some proportion of the trials tested here.

Event-based prospective memory tasks are not the only kind of intention that people form. In time-based tasks people form the intention to perform an activity at a particular time or after a certain amount of time has elapsed. In activity-based tasks a plan is formulated to perform the activity after the completion of some other activity. Obviously, because there are few event-based cues to those tasks, the prevailing local spatiotemporal and emotional contexts are the only means for valence to affect such intentions. Imagine that one decides to do laundry after watching a movie. If the movie has a particularly sad ending, the current experiments might suggest that the laundry gets started later or perhaps even another day. In more extreme examples, do intentions get displaced by happy news of an engagement or winning a contest and by sad news of an unexpected death or serious illness? Such situations may impede all kinds of prospective memory processes. Because people tend to attribute prospective memory failures to others' bad character, perhaps a better attribution might be to wonder whether the person has a prevailing set of valenced issues that could have disrupted otherwise normal prospective memory processes. Obviously, we are just beginning to understand how valence and emotion affect prospective memory. Rather than enhancing it, the tentative answer is that valence interferes with completing one's intentions. The next challenge is finding the variables that insulate prospective memory from the potentially harmful effects of valence.

NOTES

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