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BRIEF REPORT

Context cue focality influences strategic prospective memory monitoring

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Abstract

Monitoring the environment for the occurrence of prospective memory (PM) targets is a resource-demanding process that produces cost (e.g., slower responding) to ongoing activities. However, research suggests that individuals are able to monitor strategically by using contextual cues to reduce monitoring in contexts in which PM targets are not expected to occur. In the current study, we investigated the processes supporting context identification (i.e., determining whether or not the context is appropriate for monitoring) by testing the *context cue focality hypothesis*. This hypothesis predicts that the ability to monitor strategically depends on whether the ongoing task orients attention to the contextual cues that are available to guide monitoring. In Experiment 1, participants performed an ongoing lexical decision task and were told that PM targets (TOR syllable) would only occur in word trials (focal context cue condition) or in items starting with consonants (nonfocal context cue condition). In Experiment 2, participants performed an ongoing first letter judgment (consonant/vowel) task and were told that PM targets would only occur in items starting with consonants (focal context cue condition) or in word trials (nonfocal context cue condition). Consistent with the context cue focality hypothesis, strategic monitoring was only observed during focal context cue conditions in which the type of ongoing task processing automatically oriented attention to the relevant features of the contextual cue. These findings suggest that strategic monitoring is dependent on limited-capacity processing resources and may be relatively limited when the attentional demands of context identification are sufficiently high.

Keywords Prospective memory · Attention · Strategic monitoring · Context · Focality

Event-based prospective memory (PM) refers to the ability to remember to execute future intentions (e.g., deliver message) in response to external cues (e.g., professor) often while individuals are busily engaged in ongoing activities. When ongoing task processing (e.g., making lexical decisions in the lab) does not automatically orient attention to the relevant features of the PM target (e.g., detecting the syllable "TOR"), intention fulfillment occurs via resource-demanding *monitoring* processes. Monitoring involves actively maintaining the PM intention in awareness and searching the environment for the occurrence of targets that exacts a *cost* to ongoing task performance (i.e., slower responding; Smith, Hunt, & McVay, 2007). Recent studies have demonstrated that people strategically monitor by making use of contextual cues that signal the likelihood of encountering PM targets (e.g., professor), thereby conserving limited-capacity resources in contexts in which targets are not expected (e.g., student recreation center; see Smith, 2017, for a review). In the current study, we investigate the processes supporting context identification (i.e., determining whether one is in an expected context or not), a necessary prerequisite for strategic monitoring, by testing the *context cue focality hypothesis*. This hypothesis predicts that the ability to monitor strategically depends on whether the ongoing task orients attention to the contextual cues that are available to guide monitoring.

Strategic monitoring involves the heightening of monitoring in contexts in which targets are expected (i.e., high likelihood of occurrence) and the conservation of limited-capacity resources by relaxing monitoring in unexpected contexts (i.e., low likelihood of occurrence). Strategic monitoring is typically examined by varying ongoing task stimuli on some dimension (e.g., word type) and specifying that PM targets will only occur in one of the dimensions (e.g., within words but not

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nonwords; Bugg & Ball, 2017). For example, Lourenço, White, and Maylor (2013) had participants perform an ongoing lexical decision task in which words and nonwords were presented randomly. Participants in the *specific* condition were (validly) instructed that PM targets (the syllable "TOR") would occur only in word trials (*expected context*) but not nonword trials (*unexpected context*). In contrast, those in the *nonspecific* condition were told that targets could occur in both trial types. It was found that monitoring was equivalent across conditions for word trials, but significantly reduced on nonword trials in the specific condition compared to the nonspecific condition. Applying Guynn's (2003) theory of strategic monitoring, this suggests that the specific condition used context to engage (words) or disengage (nonwords) PM target checks (i.e., "is there a 'TOR' syllable?") on a trial-by-trial basis (see also Cohen, Jaudas, Hirschhorn, Sobin, & Gollwitzer, 2012; Kuhlmann & Rummel, 2014).

Although such findings indicate that participants *can* utilize context to strategically target check on a trial-by-trial basis, they do not necessarily speak to the processes underlying strategic monitoring. These processes include (but are not limited to) the *encoding* and *maintenance* of PM-context associations, *identification of context* (as expected or unexpected) while performing the ongoing task, and the *engagement* and *disengagement* of PM-specific target checks (monitoring) following context identification (see Fig. 1). The current study investigated the processes underlying identification of context during the ongoing task, with the goal of understanding how attention influences this process.

Several lines of evidence suggest that attention influences strategic monitoring processes and may affect the process of context identification. The ability to engage/disengage monitoring is easier (as evidenced by more robust differences in monitoring across expected and unexpected contexts) when contextual cues are blocked (i.e., eight consecutive trials of one context followed by eight of the other, and so on) than when they are random (i.e., vary unpredictably trial by trial). This difference has been attributed to the reduced demands on attention afforded by the blocked procedure (e.g., Lourenço & Maylor, 2014). However, it is also possible that the blocked procedure facilitates context identification because context only needs to be identified on the first trial of the block. In addition, it has been shown that when context varies randomly, participants strategically monitor in response to simple (word type) but not complex contextual cues (word type and location), the latter of which requiring additional attentional resources to identify feature conjunctions. However, when the blocked procedure is used, strategic monitoring is evidenced in response to the complex contextual cue (Ball & Bugg, 2018; Bugg & Ball, 2017).

Another reason for anticipating that strategic monitoring may depend on the attentional demands associated with context identification relates to the suggestion by Kuhlmann and Rummel (2014) that context identification may essentially serve as a second PM intention. Participants must remember to first identify whether the *context* is appropriate for target checking (e.g., word trials) and then decide whether the stimulus contains intention relevant details (e.g., "TOR" syllable). In this regard, strategic monitoring requires utilization of costly resources to maintain contextual information and make trial-by-trial decisions on whether or not the context is appropriate for monitoring while performing a demanding ongoing task.[1] It is the outcome of this context identification decision that determines whether additional resources need to be devoted to the PM task (e.g., if "yes," engage target check). Consequently, strategic monitoring may depend on the attentional demands associated with context identification while performing the ongoing task.

To test the above claim more directly, the current study extends a highly influential distinction (the *target focality* distinction) in the PM literature that significantly impacts the cognitive processes underlying PM target detection. *Target focality* is determined by the processing overlap between the ongoing task and PM targets (a notion first introduced by Maylor, 1996). Targets are considered focal/nonfocal when the type of ongoing task processing (e.g., making lexical decisions) does/does not automatically orient attention to the relevant features of the PM targets (Einstein & McDaniel, 2005). Focal target (e.g., the specific word "doctor") detection is thought to occur without engagement of costly preparatory attention via relatively automatic, reactive processes following target processing (i.e., spontaneous retrieval of the intention; Bugg, McDaniel, & Einstein, 2013; Einstein & McDaniel, 2005). In contrast, nonfocal target (e.g., the syllable "TOR") detection requires engagement of costly monitoring resources (e.g., as investigated in strategic monitoring paradigms).

Based on Kuhlmann and Rummel's (2014) assertion that context identification essentially serves as a second PM intention, a similar distinction may apply to the ability to monitor strategically—context identification, and consequently strategic monitoring, may depend on the overlap between the ongoing task and *contextual cues*. We suggest that contextual cues may be considered focal/nonfocal when the type of ongoing task processing does/does not automatically orient attention to the relevant features of the *context* cue. For example, during an ongoing lexical decision task, the specific instruction that targets ("TOR" syllable) will only occur in *words* would yield focal contextual cues (Lourenço et al., 2013), whereas the instruction that targets will only occur in

[1] Interestingly, a similar identification (or verification) process has been thought to occur specifically on PM target trials. A common finding is that ongoing task decisions on PM target trials are slower than on nontarget trials, which is suggested to reflect the orchestration of a microstructure of different cognitive processes: recognition of the PM target, *verification* that the context is appropriate for responding, retrieval of the target action, and coordination of the PM response with ongoing task demands (Knight, Ethridge, Marsh, & Clementz, 2010; Marsh, Hicks, & Watson, 2002).

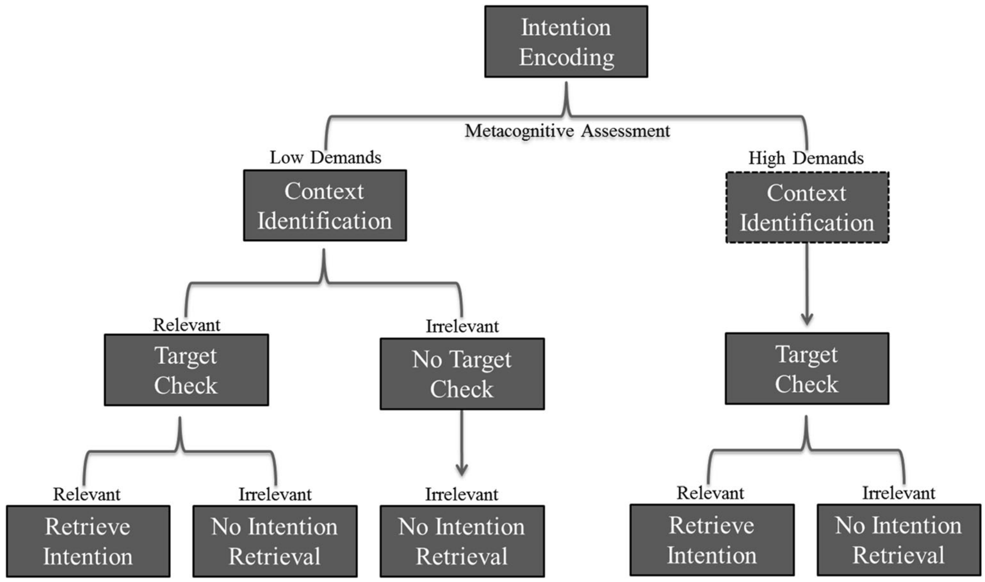

Fig. 1 Hierarchical representation of the processes involved in strategic monitoring, including *encoding* and *maintenance* of the PM-context associations, *identification of context* (as expected or unexpected) while performing the ongoing task, and the *engagement* and *disengagement* of PM-specific target checks following context identification. During intention encoding, participants make metacognitive assessments on the difficulty of coordinating ongoing task demands with context identification. If the perceived task demands are relatively low (left portion of figure), participants may be willing to engage context identification to determine whether the context is relevant for target checking. If the perceived demands are relatively high (right portion of figure), participants may opt to ignore context identification (dashed box) and instead engage target checking on each trial. Context identification and/or PM target detection could occur via top-down preparatory control processes or transient reactivation of task goals following stimulus onset

items starting with consonants would yield nonfocal contextual cues. While both contextual features (lexicality or initial letter) could be utilized to conserve processing resources in unexpected contexts, presumably the identification of nonfocal context cues is more attentionally demanding than focal context cues. Thus, if participants are sensitive to the attentional demands needed to identify focal versus nonfocal *contexts,* this may influence the ability to monitor strategically, consistent with the *context cue focality hypothesis*.

To provide a more concrete example, imagine that a graduate student is instructed by her advisor to meet with a professor at a conference. Other than his name (which will appear on his nametag), the only information the student knows about the professor is that he either "always wears a tie" *or* "always wears penny loafers." To fulfill the intention of speaking with the professor while busily engaged in the poster session, she could check every nametag, or selectively check the nametag for individuals in ties or loafers. If told that the professor wears a tie (focal context condition), it may be optimal to selectively check nametags of individuals in ties, given the relative overlap between the ongoing task (checking nametags) and context (tie) in terms of visual scanning distance. In contrast, if told that the professor wears loafers (nonfocal context condition) it may actually be more costly (in terms of visual scanning) to first check if the individual is wearing loafers and then selectively check the nametag of those that are wearing loafers than it is to simply check each nametag. That is, the benefit of conserving attentional resources by *not* target checking for individuals in tennis shoes may not outweigh the cost of having to identify context (i.e., loafers) on a person-by-person basis.

Experiment 1

The purpose of Experiment 1 was to provide an initial test of the context cue focality hypothesis. Participants performed an ongoing lexical decision task across three blocks (control, specific, and nonspecific). The control block served as a baseline measure of ongoing task performance without a PM intention. In the specific block, participants were instructed that PM targets ("TOR" syllable) would only occur in word trials (focal context condition) or, alternatively, in items starting with consonants (nonfocal context condition). In the nonspecific block, the focal context condition was instructed that targets could occur in word *or* nonword trials whereas the nonfocal context condition was instructed that targets could start with consonants *or* vowels. We refer to "expected" trials as those in which participants were told targets would appear during the specific block (e.g., word trials in the focal context condition), whereas "unexpected" trials refer to those in which participants were told targets would *not* appear in the specific block (e.g., nonword trials in the focal context condition). For consistency we use the expected/unexpected terminology to denote the same trial types in the nonspecific block even though participants actually expected targets to occur in both trial types (e.g., in the focal context condition, the expected and unexpected trials were word and nonword trials, respectively, although technically participants expected targets to occur in nonword trials).

The predictions were relatively straightforward. First, because the PM *target* ("TOR") was considered nonfocal, we anticipated RT slowing (i.e., monitoring cost) across all trials in the PM blocks relative to the control. The novel prediction of the context cue focality hypothesis was that costs would be similar between the specific and nonspecific blocks on expected trials regardless of condition (e.g., word/consonant trials in the focal/nonfocal conditions) but there would be a greater reduction in cost across blocks on unexpected trials in the focal context condition (e.g., nonword trials) than the nonfocal context condition (e.g., vowel trials). Such a pattern would demonstrate that strategic monitoring is dependent on the attentional demands associated with identifying contextual information. However, the alternative possibility was that both focal and nonfocal context conditions would similarly be able to reduce monitoring on unexpected trials in the specific block. This finding would be consistent with the majority of extant theories of strategic monitoring that do not explicitly address how different contextual features may influence engagement of strategic monitoring (e.g., Einstein & McDaniel, 2005; Guynn, 2003; Smith et al., 2007).

Method

Participants

Sixty-six undergraduates (ages 18–25 years) from Washington University received course credit for participation. Participants were randomly assigned to the focal (n = 33) or nonfocal (n = 33) conditions and tested individually in ~45-minute sessions.

Materials

The ongoing lexical decision task (LDT) consisted of 856 stimuli (half words) from the ELP database (Balota et al., 2007) that were four to eight letters and two to three syllables in length. Half of the words/nonwords started with consonants (letters C, D, M, R, and S), and the other half started with vowels (letters A, E, I, O, and U). There were 16 PM targets containing the syllable TOR, all of which were words starting with consonants (e.g., *stored, monitor*). All items were presented in uppercase, 30-point font and appeared in the center of the screen.

Procedure

The general procedure was loosely modeled after Lourenço et al. (2013) and is depicted in Fig. 2. For the ongoing LDT, participants were instructed to make word (F key) and nonword (J key) decisions as quickly and accurately as possible, after which a "spacebar" message would appear to indicate that they should press the spacebar to continue to the next trial. Following a brief (16 trials) practice LDT phase, participants performed a baseline block (no intention), a specific PM block, and a nonspecific PM block, the order of which was fully counterbalanced across participants (resulting in a total of six possible orders). Prior to beginning the PM blocks, participants were additionally instructed that whenever they saw the syllable "TOR" they should press the 7 key after making their lexical decision. Prior to the specific PM block, participants in the focal context condition were instructed that the syllable "TOR" would only occur in words, whereas those in the nonfocal context condition were told that "TOR" would only occur in items starting with consonants. Prior to the nonspecific PM block, participants in the focal context condition were instructed that the syllable "TOR" could occur in words or nonwords, whereas those in the nonfocal context condition were told that "TOR" could occur in items starting with consonants or vowels. Following PM instructions, there was a ~2.5-min delay in which participants completed half of the Shipley Vocabulary Test (Shipley, 1940) prior to beginning the PM block. Following the baseline block instructions participants filled out a demographics questionnaire. At the end of the experiment all participants filled out a postexperimental questionnaire to check their memory for the PM task instructions. All participants correctly recalled the instructions in both experiments.

The baseline and PM blocks each consisted of 280 LDT items (140 words and 140 nonwords), with half of each starting with a consonant or vowel. Presentation of stimuli was randomized for each participant. Eight targets were presented in each PM block (every 34 trials), the order of which was randomly selected for each participant.

Results and discussion

The following data analytic procedure was used for both experiments. For accuracy and response time (RT) analyses, the first five trials of the baseline and PM blocks, the PM target trial, and the three trials following the PM target were excluded. RT analyses were conducted on correct trials only and were trimmed at 2.5 standard deviations from each participant's mean separately for each trial type (i.e., word-consonant, word-vowel, nonword-consonant, nonword-vowel) and each block (i.e., control, specific, and nonspecific; Lourenço et al., 2013), resulting in the removal of 3% of the data in each block for both experiments. Because ongoing task accuracy was high, relatively unaffected by PM demands, and did not contradict the RT data, we only report full analyses for the standard RT measures for all experiments (Bugg & Ball, 2017). The primary dependent variable for all RT analyses was the cost measure (PM RT − baseline RT) across the

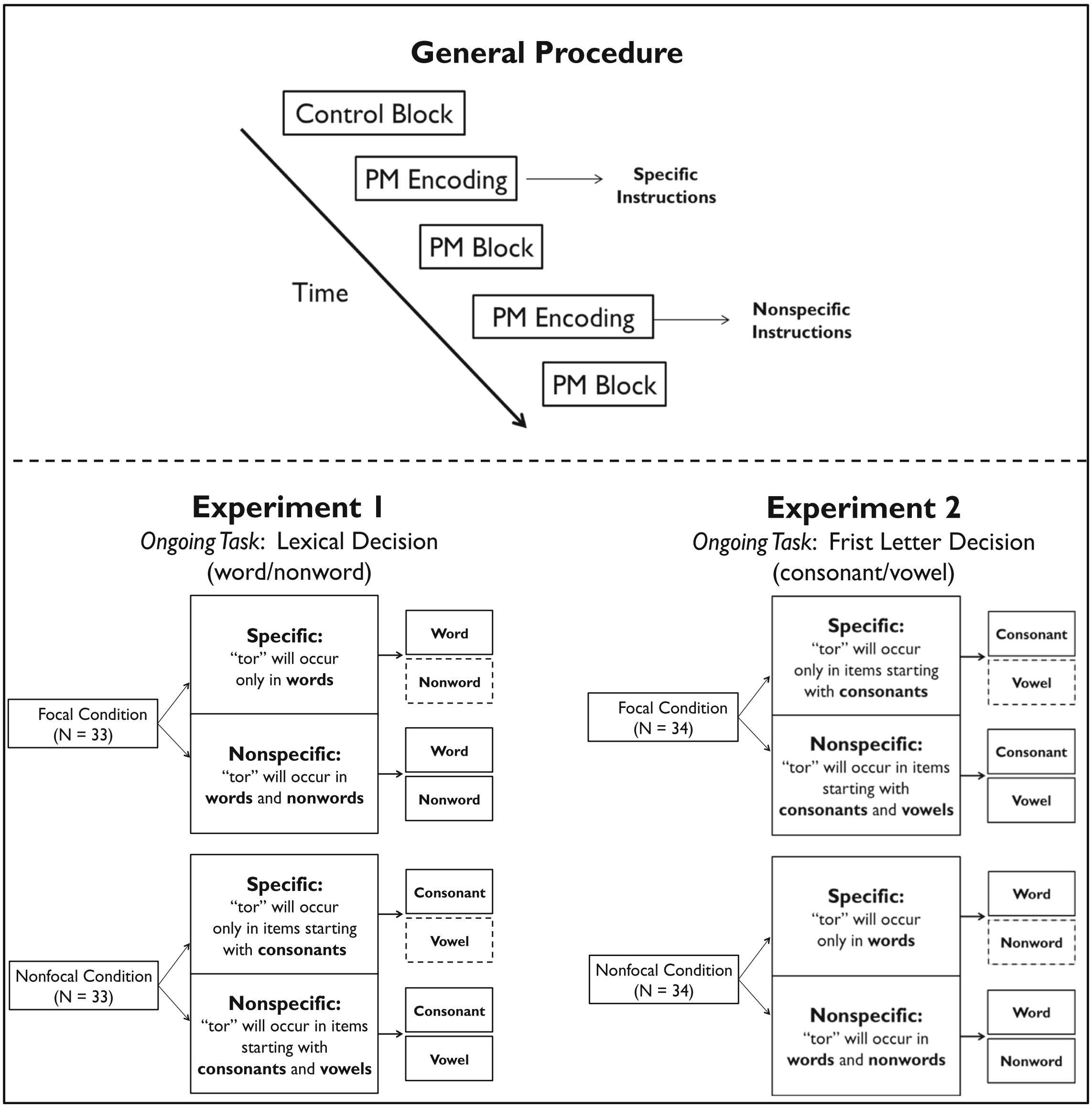

Fig. 2 Upper portion shows the general procedure used in Experiments 1 and 2. Lower portion shows the instructions given to the different context cue conditions (focal, nonfocal) in each block (specific, nonspecific) for Experiments 1 and 2. Dashed boxes reflect the trial types (i.e., unexpected contexts) in which participants should hypothetically reduce monitoring if appropriately using contextual information to guide strategic monitor

different contexts because preliminary analyses indicated that there was significant slowing in the PM block due to possessing an intention (relative to the baseline block) for all experiments. For all analyses, RTs were collapsed across the consonant/vowel dimension in the focal condition, and across the word/nonword dimension in the nonfocal condition. The alpha level was set at .05.

Response times

Descriptive statistics for RT measures can be found in Table 1. Mean RT cost (PM RT − control RT) was submitted to a 2 (block: specific vs. nonspecific) × 2 (trial type: expected vs. unexpected) × 2 (context cue focality: focal vs. nonfocal) mixed-factorial analysis of variance (ANOVA), with context cue focality as the between-subjects factor. For brevity, we will only discuss the relevant findings. However, the results from the full model can be found in Table 2. Importantly, the three-way interaction was significant, $F(1, 64) = 7.26$, $p = .009$, $\eta_p^2 = .102$, indicating different patterns of strategic monitoring as a function of context focality.

As can be seen in Fig. 3, the three-way interaction reflects that there was evidence for strategic monitoring adjustments in the focal context condition but not in the nonfocal context condition. Replicating Lourenço et al. (2013), in the focal context condition there was no cost difference across blocks on expected (word) trials, $F(1, 32) = 3.85$, $p = .059$, $\eta_p^2 = .107$, but cost was significantly reduced during the specific

Table 1 Mean reaction times in milliseconds (standard errors) for each block (control, nonspecific, specific) and trial type (expected, unexpected) for the focal and nonfocal context cue conditions of Experiments 1 and 2

		Control		Specific		Nonspecific	
Experiment	Focality	Expected	Unexpected	Expected	Unexpected	Expected	Unexpected
1	Focal	617 (13)	662 (14)	688 (19)	726 (20)	712 (20)	791 (26)
	Nonfocal	662 (15)	669 (17)	808 (33)	817 (34)	785 (22)	796 (24)
2	Focal	566 (15)	546 (14)	726 (23)	665 (15)	748 (18)	757 (19)
	Nonfocal	565 (12)	571 (12)	684 (21)	707 (22)	712 (29)	743 (33)

block on unexpected (nonword) trials relative to the nonspecific block, $F(1, 32) = 10.16$, $p = .003$, $\eta_p^2 = .241$. In contrast, for the nonfocal context condition there was no cost difference across blocks on expected (consonant) or unexpected (vowel) trials (*F*s < 1). These findings suggest that the attentional demands associated with context identification influenced the ability to monitor strategically. Strategic monitoring was selectively observed when the context cue was focal to the ongoing task.

Target detection

To examine PM performance, the proportion of successfully detected PM targets was submitted to a 2 (block: specific vs. nonspecific) × 2 (context cue focality: focal vs. nonfocal) mixed-factorial ANOVA (left portion of Fig. 4). However, there was no effect of block or focality, and no interaction between the two (*F*s < 1.39, *p*s > .243). The null effect of context on target detection is consistent with prior research (Bugg & Ball, 2017; Lourenço et al., 2013; Lourenço & Maylor, 2014) and makes sense given that targets were in the same "expected" context across specific and nonspecific blocks (e.g., word trials in the focal condition) for which monitoring was equivalent.

Experiment 2

Experiment 1 provided preliminary support for the context cue focality hypothesis. Experiment 2 was designed as a conceptual replication and extension of Experiment 1 to ensure that lack of strategic monitoring in the nonfocal context condition was not simply due to participants being unable to utilize first letter information to adjust attention on a trial-by-trial basis. The procedure of Experiment 2 was identical to Experiment 1, except that the ongoing task was to determine whether each stimulus started with a consonant or a vowel. In this case, ongoing task processing (i.e., determining first letter) automatically orients attention to consonant/vowel (*focal*), but not word/nonword (*nonfocal*), information. We expected to replicate the findings of Experiment 1 in which strategic monitoring was observed only for the focal context condition.

Table 2 Results from the omnibus ANOVA for each experiment

Experiment	Factor	*df*	*F*	*MSE*	η_p^2	Significance	
1	Focality	1,64	5.41	25273	.078	.023	*
	Trial type	1,64	3.03	1555	.045	.086	*ns*
	Block	1,64	0.63	13525	.010	.431	*ns*
	Focality × Trial Type	1,64	1.34	1555	.020	.252	ns
	Focality × Block	1,64	5.35	13525	.077	.024	*
	Trial Type * Block	1,64	8.28	887	.115	.005	**
	Focality × Trial Type × Block	1,64	7.26	887	.102	.009	**
2	Focality	1, 66	1.13	35085	.017	.293	*ns*
	Trial type	1, 66	2.25	1575	.033	.138	*ns*
	Block	1, 66	12.39	10822	.158	.001	**
	Focality × Trial Type	1, 66	8.71	1575	.117	.004	**
	Focality × Block	1, 66	1.01	10820	.015	.318	*ns*
	Trial Type × Block	1, 66	20.40	1273	.236	<.001	***
	Focality × Trial Type × Block	1, 66	12.59	1273	.160	.001	**

Note. Mean RT cost was submitted to a 2 (block) × 2 (trial type) × 2 (context cue focality) mixed-factorial ANOVA. The significance column refers to the *p* value from the omnibus ANOVA for each factor. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$. *ns* = not significant

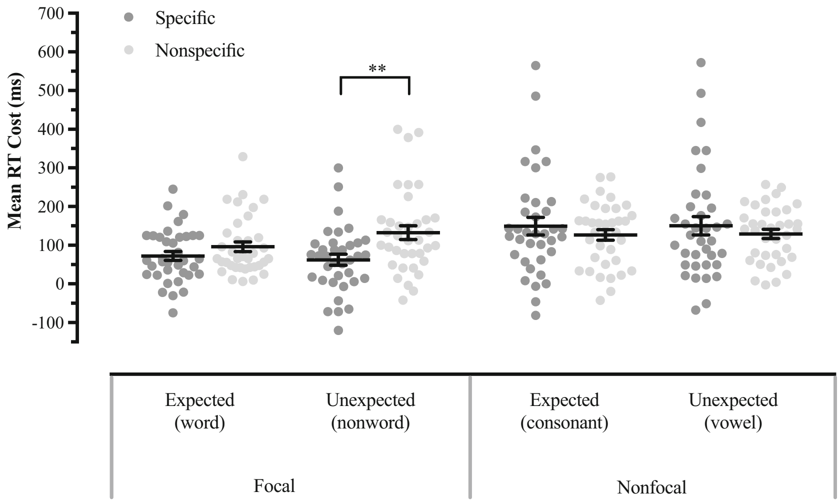

Fig. 3 Cost estimates plotted separately block (specific, nonspecific) and trial type (expected, unexpected) for the focal and nonfocal context cue conditions of Experiment 1. Black lines reflect mean performance and error bars reflect standard errors. Circles reflect individual cost estimates for each participant. These results demonstrate that only participants in the focal condition were able to reduce monitoring on unexpected trials in the specific condition. $^{**}p < .01$

Method

Participants

Sixty-eight undergraduates (ages 18–25) from Washington University received course credit for participation. Participants were randomly assigned to the focal (n = 34) or nonfocal (n = 34) conditions and tested individually in ~45-minute sessions.

Materials and procedure

The materials and procedure were identical to Experiment 1, except that the ongoing task was to decide whether the first letter was a consonant (F key) or a vowel (J key). Consequently, during the specific block, participants in the focal condition were told that "TOR" would only occur in items starting with consonants, whereas those in the nonfocal condition were told that targets would only occur in words.

Results and discussion

Response times

Mean RT cost (PM RT − control RT) was submitted to a 2 (block: specific vs. nonspecific) × 2 (trial type: expected vs. unexpected) × 2 (context cue focality: focal vs. nonfocal) mixed-factorial ANOVA, with context cue focality as the between-subjects factor (see Tables 1 and 2 for descriptive statistics and the full ANOVA model). Importantly, the

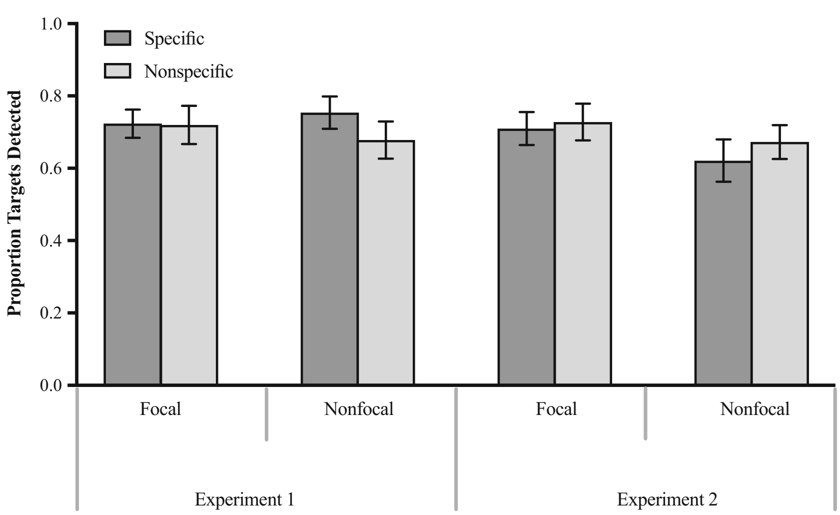

Fig. 4 Proportion of targets detected across PM blocks (specific, nonspecific) for the focal and nonfocal context cue conditions of Experiments 1 and 2. Error bars reflect standard errors

three-way interaction was significant, $F(1, 66) = 12.59$, $p = .001$, $\eta_p^2 = .160$.

As can be seen in Fig. 5, the three-way interaction reflects that there was evidence for strategic monitoring adjustments in the focal context condition but not in the nonfocal context condition. Replicating Experiment 1, in the focal context condition there was no cost difference across blocks on expected (consonant) trials, $F(1, 34) = 1.53$, $p = .225$, $\eta_p^2 = .044$, but cost was significantly reduced during the specific block on unexpected (vowel) trials relative to the nonspecific block, $F(1, 34) = 31.21$, $p < .001$, $\eta_p^2 = .486$. In contrast, for the nonfocal context condition there was no cost difference across blocks on expected (word) trials, $F(1, 34) = 2.19$, $p = .148$, $\eta_p^2 = .062$, or unexpected (nonword) trials, $F(1, 34) = 2.67$, $p = .112$, $\eta_p^2 = .075$. These results replicate Experiment 1, demonstrating that strategic monitoring was selectively observed when the context was focal to the ongoing task and suggest that the lack of strategic monitoring in Experiment 1 was not due to the inability to use first letter information to guide monitoring.

Target detection

The proportion of successfully detected PM targets was submitted to a 2 (block: specific vs. nonspecific) × 2 (context focality: focal vs. nonfocal) mixed-factorial ANOVA (right portion of Fig. 4). As with Experiment 1, there was no effect of block or focality, and no interaction between the two (Fs < 1.43, ps > .236).

General discussion

The current study examined the novel hypothesis that context cue focality influences strategic PM monitoring. Consistent with this hypothesis, there was a striking contrast between the findings in the focal and nonfocal context cue conditions in both Experiments 1 and 2—only in the focal context condition was a strategic monitoring adjustment observed. As anticipated, monitoring was similar across specific and nonspecific blocks on expected trials, regardless of condition. However, only focal context conditions were successfully able to reduce monitoring on unexpected trials during the specific block. These findings suggest that strategic monitoring is dependent on limited-capacity processing resources and may be relatively limited when the attentional demands of context identification are sufficiently high.

It has been suggested that during intention formation or while performing the ongoing task participants make metacognitive assessments about the difficulty of the ongoing and PM tasks and adopt an attention allocation policy that optimizes performance across the two (Marsh, Cook, & Hicks, 2006). The results from the current study suggest that similar metacognitive assessments about the relative difficulty of context identification may be made that influence the decision to monitor strategically. Assuming both context identification and target checking require limited-capacity processing (Bugg & Ball, 2017), the decision[2] to utilize costly resources to identify context on a trial-by-trial basis may be based on assessments of the required effort and expected reward in doing so (i.e., expected value of control; Shenhav, Botvinick, & Cohen, 2013). In the current study, focal context processing could be outsourced to the ongoing task such that context identification could occur relatively automatically following the ongoing task decision. In contrast, nonfocal context information needed to be continuously maintained, and context identification required an additional processing step (i.e., effort) either prior to or following the ongoing task decision. Thus, the expected cost of identifying focal, but not nonfocal, contextual cues may have been sufficiently low to justify doing so to conserve resources on unexpected trials. Importantly, the context cue focality hypothesis suggests that when the attentional demands associated with target checking are perceived to be greater than for context identification, participants should presumably show evidence for strategic monitoring (even with nonfocal contexts; see Scullin, McDaniel, Shelton, & Lee, 2010, for evidence that different nonfocal PM *targets* can influence monitoring difficulty).

More broadly speaking, these results align well with predictions from the Dual Mechanisms of Control framework that posits attention control operates via two distinct processing modes: *proactive control* involves top-down, sustained use of goal representations to bias attention prior to stimulus onset, whereas *reactive control* involves transient reactivation of goals to bias attention following stimulus onset (Braver, 2012). We argue that when sufficiently strong context–task associations are formed at encoding (i.e., focal context condition), reactive control processes following stimulus onset may serve to activate task goals (e.g., disengage monitoring on nonword trials; cf. Bugg et al., 2013). In contrast, with weaker context–task associations (i.e., nonfocal context condition), proactive control processes are needed to maintain task goals and bias attention toward identifying contextually relevant information. These results are also generally consistent with the Dynamic Multiprocess Framework view of PM that posits that bottom-up and top-down processes interact to facilitate *intention* retrieval (Scullin, McDaniel, & Shelton, 2013; Shelton & Scullin, 2017). Specifically, this framework suggests that bottom-up contextual features may trigger spontaneous retrieval of the PM intention, which may in turn signal that top-down monitoring processes should be engaged. This

[2] Although "decision" suggests conscious intent, it is possible that such decisions occur rather implicitly (i.e., outside of conscious awareness) during the ongoing task (see Smith et al., 2007, for a similar view in regard to monitoring).

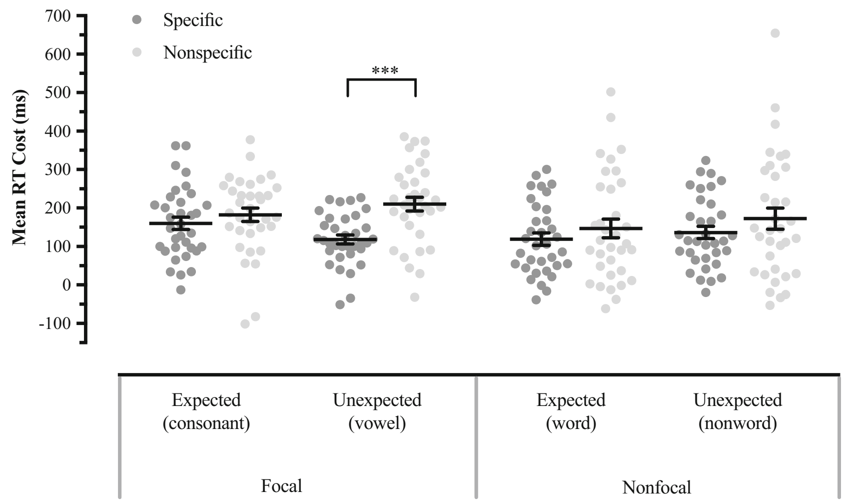

Fig. 5 Cost estimates plotted separately block (specific, nonspecific) and trial type (expected, unexpected) for the focal and nonfocal context cue conditions of Experiment 2. Black lines reflect mean performance and error bars reflect standard errors. Circles reflect individual cost estimates for each participant. These results demonstrate that only participants in the focal condition were able to reduce monitoring on unexpected trials in the specific condition. $^{***}p < .001$

interaction is particularly important when PM targets are nonfocal (as in the current study), as engagement of costly resources can be minimized until the appropriate context for monitoring is encountered and the intention is spontaneously retrieved. While we do not wish to suggest that spontaneous retrieval underlies context identification, we do believe that a similar reactive control mechanism may contribute to both context identification and spontaneous retrieval in the context of prospective remembering. This reactivation of task goals may occur via transient activation of frontally mediated attention networks or hippocampally mediated episodic retrieval processes (Braver, 2012). Future research in this domain will be integral in understanding how bottom-up and top-down control processes interact to support different facets of prospective remembering (e.g., context identification, target checking, intention retrieval) and whether these processes recruit common neural circuitry.

One alternative explanation of the current findings is provided by the delay theory (Heathcote, Loft, & Remington, 2015), which posits that costs arise because the PM task races and competes for response selection with the more routine ongoing task. To ensure that an ongoing task response is not made prior to the PM response, participants therefore selectively delay responding in contexts in which targets are expected to occur (e.g., words) to allow more time for PM evidence to accumulate. Consistent with this idea, Heathcote et al. (2015) reanalyzed the data by Lourenco et al. (2013) using mathematical modeling techniques and found that participants selectively delayed responding on word trials (see also Strickland, Heathcote, Remington, & Loft, 2017). The results of the current study could therefore reflect that participants set a bias to respond more cautiously in contexts in which targets were expected to occur (at least in focal conditions) rather than strategically adjusting attentionally demanding monitoring processes on a trial-by-trial basis.

Two caveats deserve consideration. First, it should be noted that if focal context identification was truly automatic, ongoing task cost should have been near zero on unexpected trials during the specific block because target checking was of no utility on these trials (e.g., nonwords in Experiment 1). One possibility is that context identification was indeed automatic (i.e., produced no slowing), and this residual cost reflects maintenance of a prospective retrieval mode across all ongoing task trials (Guynn, 2003; Lourenço et al., 2013). Alternatively, it may be that even focal context identification requires some degree of limited-capacity processing that reduces attentional resources necessary for ongoing task responding, especially given the demands of coordinating context identification with both the ongoing and PM task. For instance, there may be residual slowing following focal context identification due to engagement of task-switching processes (i.e., switching from context identification to target checking). Unfortunately, there is no obvious way to disentangle these views in the current study (but see Reynolds, West, & Braver, 2008, for evidence that sustained/transient processes may be dissociable with neuroimaging techniques). Nevertheless, these results suggest that theories of strategic monitoring should consider that multiple processes may contribute to ongoing task costs (see Kuhlmann & Rummel, 2014).

Second, we are not suggesting that individuals *cannot* monitor strategically in response to nonfocal contextual cues. In fact, Lourenço and Maylor (2014) showed that participants used a nonfocal contextual cue (color) to reduce monitoring in unexpected contexts while determining the letter case of letter pairs (see also Kulhmann & Rummel, 2014). However, as suggested by the authors, context identification may have occurred relatively automatically via bottom-up attentional capture given that color information is typically processed fairly automatically. Similarly, there is evidence to suggest that nonfocal *target detection* can also occur relatively easily when targets are defined by perceptually salient features (Smith et al., 2007). It is therefore likely that perceptual (and conceptual) contextual features interact with focality to influence the relative ease with which context identification can occur.

Lastly, it is worth noting that contextual cues had little influence on target detection (see also Bugg & Ball, 2017; Lourenço et al., 2013; Lourenço & Maylor, 2014; but see Kuhlmann & Rummel, 2014). This was anticipated given that targets occurred in the same "expected" context across specific and nonspecific blocks (e.g., word trials in Experiment 1), and monitoring was equivalent across the two. However, the null effect of context expectations on cue detection at the trial level stands in contrast to prior research showing that context expectations at the block level (e.g., "TOR" syllable will occur in second LDT block but not in first LDT block) often do show a benefit to target detection (e.g., Ball et al., 2015; Meier, Zimmermann, & Perrig, 2006). Future research is therefore needed to understand how different contextual associations may ultimately influence target detection.

Conclusions

Strategic monitoring is typically thought to reflect optimal behavior from a resource-conservation perspective. However, strategic monitoring requires the orchestration of a variety of processes that each require some degree of limited-capacity processing, including context identification. The context cue focality hypothesis suggests that the decision to engage costly strategic monitoring processes depends on the overlap in processing needed for performing ongoing activities and identifying contextual cues relevant to the PM intention. The results from the current study suggest that when the attentional demands associated with context identification are sufficiently high, reliance on context to guide monitoring may not always be optimal in terms of processing efficiency. These results support the context cue focality hypothesis, suggesting that strategic monitoring may be limited to more focally processed contextual features.

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