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Forgetting No-Longer-Relevant Prospective Memory Intentions Is (Sometimes) Harder With Age but Easier With Forgetting Practice

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In young adults, it has been shown that prospective memory (PM) commission errors, the erroneous performance of a previously relevant intention, are less likely for repeatedly performed intentions (than never performed intentions). We examined whether this pattern holds for older adults, for whom impaired response inhibition processes might heighten risk of commission errors for repeatedly performed PM intentions. Older adults encoded a PM intention to press a key when a target word appeared during an ongoing lexical decision task. Target words were presented 4 (repeatedly) or 0 times before participants were instructed the PM task was finished and should not be performed again. Target words were then (re)presented and commission errors were recorded. Experiment 1 demonstrated it was easier for older adults to forget (deactivate) a PM intention that was performed repeatedly (4-target condition) than one that was never performed (0-target condition). However, older adults were more likely to make commission errors than young adults in the 4- but not the 0-target condition. Experiments 2 and 3 examined whether distinct strategies reduce commission errors. Whereas a preparatory instructional strategy produced inconsistent effects, forgetting practice was highly effective in producing floor levels of commission errors for older and young adults in the 4-target condition. Findings are interpreted within the dual-mechanisms account of PM commission errors, which highlights the interplay of spontaneous retrieval and cognitive control in the forgetting of previously relevant intentions. Practically, the findings provide first evidence of a translational strategy that older adults may use to minimize commission errors.

Keywords: aging, commission errors, cognitive control, prospective memory, strategies

On any given day, we are faced with the challenge of remembering to fulfill prospective memory (PM) intentions at the appropriate time in the future. We try to remember to perform tasks such as taking medication, telling a colleague that this afternoon's talk was cancelled, and stopping by a store to purchase detergent. Day to day, some PM intentions remain relevant, whereas other intentions may become irrelevant. An intriguing question concerns the "crossing off" of intentions from one's mental to-do list and the process by which PM intentions transition from an active state to a deactivated state. Failing to forget (i.e., deactivate)[1] PM intentions can lead to commission errors, the erroneous performance of a previously relevant PM intention, which may have serious consequences (e.g., double-dosing of a medication; Kimmel et al., 2007). Older adults may be at a higher risk of making commission errors than young adults (Scullin, Bugg, & McDaniel, 2012), although the sparse evidence to date is mixed. Understanding the conditions under which PM commission errors may be more pronounced in older adults and strategies for reducing such errors is of both theoretical and practical importance.

The Commission Error Paradigm: Prior Findings and Theory

A paradigm that has been useful for examining the deactivation of PM intentions in young and older adults is the commission error paradigm (see Figure 1; Scullin et al., 2012; for related paradigms, see Goschke & Kuhl, 1993; Marsh, Hicks, & Bink, 1998; Pink &

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[1] Throughout this article, we use the terms "forgetting" and "deactivation" of PM intentions interchangeably. When using the term "forget," we do not mean to imply that an intention is permanently inaccessible. The activation of the intention may be temporarily decreased or only accessible under particular conditions (e.g., in particular contexts or in response to particular cues; Scullin, Bugg, & McDaniel, 2012; Scullin, Bugg, McDaniel, & Einstein, 2011).

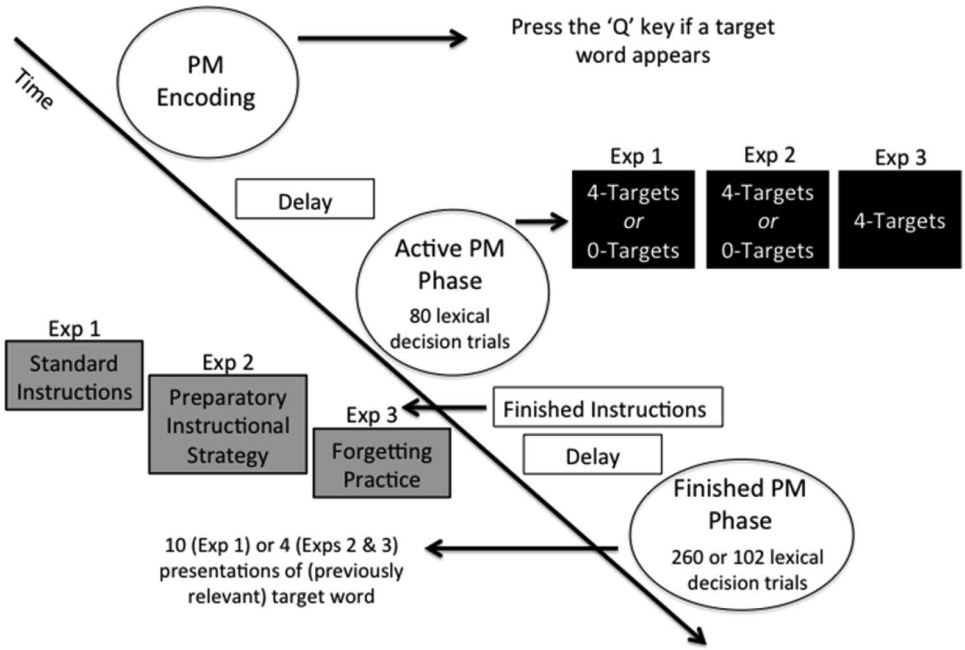

Figure 1. The procedures used for the commission error paradigm in Experiments 1, 2, and 3. PM = prospective memory.

Dodson, 2013; Walser, Fischer, & Goschke, 2012). In this paradigm, participants are engaged in an ongoing task (e.g., lexical decision) and are tasked with remembering to press a given key (e.g., "Q") upon presentation of a target word (e.g., "corn"). After this initial "active PM" phase, participants are instructed that the PM task is finished and the intention should not be performed again. In the "finished PM" phase that follows, participants continue to perform the lexical decision task and target words are occasionally represented. A commission error occurs when a participant presses "Q" during the finished PM phase despite being instructed that the PM task was finished. Commission errors represent a failure to (fully) deactivate the PM intention (i.e., residual activation of the intention; Walser et al., 2012).

From a theoretical standpoint, the dual-mechanisms account of PM commission errors posits that such errors reflect two distinct processes: spontaneous retrieval and cognitive control (Scullin & Bugg, 2013). Spontaneous retrieval brings to mind the previously relevant PM intention upon encountering the target word in the finished PM phase. Retrieval is described as spontaneous because participants are not actively monitoring for target words in an effort to fulfill an intention during the finished PM phase (Scullin & Bugg, 2013). The role of cognitive control is to deactivate the PM intention, for instance, when it is retrieved during the finished PM phase. Depending on the retrieval-control dynamics, commission errors are expected to be more or less likely (e.g., spontaneous retrieval in presence of weak vs. strong cognitive control, respectively).

Aging may be associated with a particularly problematic retrieval-control dynamic. Consider that older adults generally exhibit spared spontaneous retrieval of PM intentions (Henry, MacLeod, Phillips, & Crawford, 2004; Ihle, Hering, Mahy, Bisiacchi, & Kliegel, 2013; Kvavilashvili & Fisher, 2007; Mullet et al., 2013; Scullin, Bugg, McDaniel, & Einstein, 2011) and impaired cognitive control (e.g., Braver, Satpute, Rush, Racine, & Barch, 2005; Braver & West, 2008; Zacks & Hasher, 1994; but see Bugg, 2014a; Verhaeghen, 2011), conditions that are ripe for producing commission errors. Indeed, Scullin et al. (2012) found an age-related increase in commission errors (for evidence of an age-related increase in commission errors of *active* intentions, see Boywitt, Rummel, & Meiser, 2015; Einstein, McDaniel, Smith, & Shaw, 1998; Marsh, Hicks, Cook, & Mayhorn, 2007; McDaniel, Bugg, Ramuschkat, Kliegel, & Einstein, 2009), and this pattern was especially prominent when salient contextual cues and task processing demands served as reminders of the PM intention during the finished PM phase. In particular, a colored background screen accompanied target words in the active PM phase and again in the finished PM phase in which the target words were no longer relevant. Scullin et al. also found that commission errors occurred most often for older adults with diminished inhibition-executive control abilities (see also Scullin et al., 2011). Under similar conditions, however, Bugg, Scullin, and McDaniel (2013) found a nonsignificant increase in commission errors for older compared with young adults (cf. Cohen, Dixon, & Lindsay, 2005, who examined intention interference rather than commission errors as a measure of intention deactivation). These patterns underscore the need for further exploration of age-related changes in the deactivation of PM intentions.

In Experiment 1, we adopted the approach of examining rates of commission errors for older adults under conditions presumed to differentially tax cognitive control (see Bugg & Scullin, 2013). In the four-target condition, participants had the opportunity to respond repeatedly (on four occasions) during the active PM phase, and thereby build an association between the PM target and the PM response that would need to be overridden in the finished PM

phase (cf. Roberts, Hager, & Heron, 1994). In the zero-target condition, participants encoded the PM intention *but* they never encountered PM targets during the active PM phase. As such, this condition placed less demand on cognitive control to override an associated response when the target occurred in the finished PM phase.

We reasoned that older adults might make more commission errors in the four-target condition compared with the zero-target condition if older adults' difficulty in forgetting previously relevant intentions is closely related to response inhibition processes. This prediction converges with prominent theoretical accounts such as the inhibitory deficit theory (Lustig, Hasher, & Zacks, 2007; Zacks & Hasher, 1994) and prefrontal cortex function theory (West, 1996). These accounts posit that aging is associated with greater difficulty controlling prepotent but incorrect response tendencies, which may be related to the deterioration of brain regions supporting such control (i.e., prefrontal cortex; Aron, Robbins, & Poldrack, 2004; Raz, Gunning-Dixon, Head, Dupuis, & Acker, 1998).

This prediction might be considered somewhat tentative, however, in light of prior findings with young adults. Despite the reduced demands on control of a prepotent response in the zero-target condition, Bugg and Scullin (2013) found that young adults were *more* likely to make a commission error if they never performed the PM intention (zero-target condition) than if they performed it repeatedly (four-target condition; cf. Marsh et al., 1998, for evidence of a similar pattern for young adults in an active intention paradigm). One interpretation of this difference is that the act of performing a PM intention facilitated (rather than hindered) forgetting of the PM intention. For instance, Bugg and Scullin proposed that the four-target condition may have selectively yielded the formation of episodic traces (during PM response execution in the active phase) to which a "stop tag" (i.e., creation of a no-go memory) could be bound upon receipt of the finished instruction (cf. Hommel, Müsseler, Aschersleben, & Prinz, 2001), thereby facilitating young adults' ability to withhold the PM response thereafter. An alternative interpretation of this difference is that unperformed intentions are harder to forget than performed intentions (see Marsh et al., 1998; i.e., in the terms of Goschke & Kuhl, 1993, intentions in the zero-target condition may reside at a higher baseline level of activation, similar to the to-be-performed intentions in their paradigm). Along these lines, Bugg and Scullin considered that a Zeigarnik-like mechanism (Zeigarnik, 1938) might have led participants to perseverate on the "interrupted" (unfulfilled) intention in the zero-target condition (cf. Rothermund, 2003). Such mechanisms could similarly affect older adults. Therefore, an alternative prediction for Experiment 1 was that older adults would show better PM intention deactivation (lower rate of commission errors) in the four-target condition compared with the zero-target condition. Such a pattern would suggest that the effects of performing versus not performing an intention on the forgetting of no-longer-relevant intentions extend to older adults.

Experiment 1

Method

Participants and design. Thirty-six community dwelling older adults aged 60 to 83 years ($M = 73.03$, $SD = 6.33$) were recruited from Washington University's Older Adult Subject Pool and participated for monetary compensation. On average, they reported 15.61 ($SD = 2.92$) years of education, had a mean Shipley vocabulary score of 29.29 ($SD = 5.02$), and were in good health ($M = 4.00$, $SD = .83$ on 5-point scale ranging from 1 [*poor*] to 5 [*excellent*]). All participants had normal or corrected vision and normal color vision. Participants were randomly assigned to zero-target ($n = 19$) and four-target ($n = 17$) conditions.[2] Participants in these conditions were statistically similar in age, education, vocabulary scores, and self-reported health ($ts < 1$).

Materials and procedure. The procedure was identical to that employed by Bugg and Scullin (2013, Experiment 1; see Figure 1). Participants first completed a lexical decision task in which they were instructed to make word/nonword judgments as quickly and accurately as possible by pressing keys marked with a "Y" sticker and "N" sticker (5 and 6 on a number pad, respectively) with their dominant hand. The word stimuli were presented one at a time in white typeface against a black background screen. After practice with this task, participants were given their PM instruction: to respond with a Q key press with their dominant hand when presented with a target word. Participants were told they could press the Q key before or after they made the word/nonword judgment. Participants were randomly assigned the target words *corn* and *dancer* or the target words *fish* and *writer*, and were told the target words would be presented on a colored (red or blue) background (this was counterbalanced across participants, e.g., a given participant might see the target words *corn* and *dancer* on the red background, and that same participant would see the control words *fish* and *writer* on a blue background). Participants were then asked to write down their two target words on a form. A brief delay followed (Einstein & McDaniel, 1990) during which participants completed a vocabulary task and demographics form. Following the delay, participants completed 80 trials of the lexical decision task while attending to their PM intention (i.e., the active PM phase). On each lexical decision trial, a fixation cross appeared for 500 ms, followed by the stimulus, which was presented until the participant responded by pressing the 5 (Y), 6 (N), or Q key. A 500-ms blank screen followed. Nontarget words were presented in the same white typeface and black background format as before, while target words were presented in white typeface against the colored background. For those participants in the four-target condition, a target word appeared four times (e.g., two presentations of *corn* and two of *dancer*) during the active PM phase. For those in the zero-target condition, however, the target words were never presented during the active PM phase.

After completing the active PM phase, participants received the following instruction (in all capital letters, for emphasis): "Please note that you no longer need to press Q in the presence of target words. That task is finished and should not be performed again." Participants were then instructed that their only remaining goal was to continue performing the lexical decision task with Y and N key presses. After a brief delay comprising a second vocabulary task and 24 lexical decision trials, participants began the finished PM phase. The previously relevant target words were presented in

[2] The unbalanced groups reflect that one participant who was randomly assigned to the four-target condition was inadvertently administered the version with zero targets.

10 of 260 lexical decision trials on the colored background for participants in both the four-target and zero-target conditions.

Results

Data for one older adult in the zero-target condition were excluded because he or she pressed the Q key 56 times during the active PM phase, indicating a failure to understand the instructions. For the analysis of reaction times (RTs) on the lexical decision task, we included only correct trials in this and subsequent experiments.

Active PM phase. RTs on nontarget trials were similar for older adults in the zero-target (M = 1,114, SD = 249) and four-target (M = 1,191, SD = 306) conditions, $t(33) < 1$. The proportion of correct PM responses on target trials (PM hits), which was defined as a Q press within two trials following the target[3] was 82% for older adults in the four-target condition. PM hits cannot be calculated for the zero-target condition.

Finished PM phase. A commission error was defined as a Q press during the finished PM block.[4] Significantly fewer older adults made a commission error in the four-target condition (24%) compared with the zero-target condition (67%), $\chi^2(1) = 6.56$, $p = .010$ (see Figure 2). Moreover, the mean number of commission errors (out of 10 possible) was significantly lower in the four-target condition (M = 1.53, SD = 3.26) than the zero-target condition (M = 4.39, SD = 4.65), $t(33) = 2.09$, $p = .044$.

Secondary analysis. For purposes of gaining further insight into potential age-related differences, we next conducted a secondary analysis comparing older adults' performance in the current study with that of 53 Washington University undergraduates (n = 27 and 26, respectively, in zero- and four-target conditions) that completed the same task and for whom data were reported previously (Bugg & Scullin, 2013, Experiment 1). In the active PM phase, young adults (97%) in the four-target condition made significantly more PM responses to targets than did the older adults (82%), $t(41) = 2.28$, $p = .028$. In the finished PM phase, a significantly greater number of older adults (24%) made commission errors in the four-target condition than did young adults (0%), $\chi^2(1) = 6.75$, $p = .009$. This age-related difference was also evident when examining the mean number of commission errors made by older adults (M = 1.53, SD = 3.26) relative to young adults (M = 0.00, SD = 0.00), $t(41) = 2.41$, $p = .021$. Notably, these age differences in the number of participants who made a commission error (older = 33% vs. young = 0%) and the average number of commission errors (M_{older} = 2.17 and M_{young} = 0.00) were still present after excluding older adults who did not respond to all four targets, thereby closely matching young (M = .97) and older adults' (M = 1.0) PM hit rates in the active PM phase. By contrast, in the zero-target condition, wherein over half of the young (56%) and older adults (67%) made a commission error, the age difference was not significant for number of participants to make a commission error, $\chi^2(1) < 1$, or mean number of commission errors (M_{young} = 3.00, SD = 4.16; M_{older} = 4.39, SD = 4.65), $t(43) = 1.05$, $p = .301$.

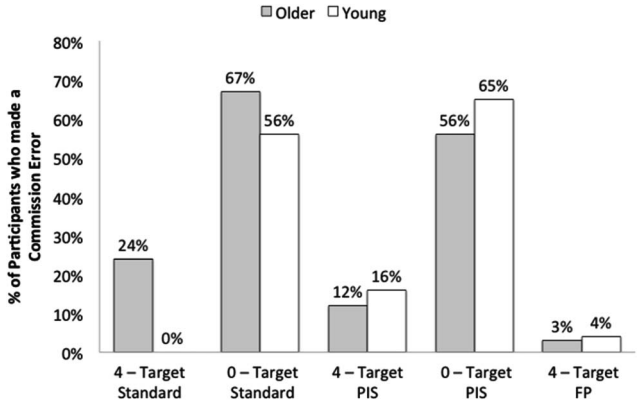

Figure 2. The percentage of older and young adult participants who made a commission error in the standard four- and zero-target conditions in Experiment 1, the preparatory instructional strategy (PIS) conditions in Experiment 2, and the forgetting practice (FP) condition in Experiment 3 (four-target only). Young adult data from the four-target standard condition are from Bugg and Scullin (2013, Experiment 1).

Discussion

Experiment 1 revealed two novel findings. First, consistent with Bugg and Scullin's (2013) findings with young adults, fewer older adults in the four-target condition were susceptible to making a commission error than in the zero-target condition. Corroborating this pattern, the average number of commission errors made by older adults in the four-target condition was lower than in the zero-target condition. These patterns indicate it was easier for older adults to forget about (deactivate) a no-longer-relevant PM intention that they performed previously (fulfilled) than an intention that remained completely unfulfilled.

The second novel finding was that older adults were more likely than young adults to make a commission error in the four-target condition, and the average number of commission errors was greater for older than young adults in the four-target condition. Neither of these differences emerged in the zero-target condition. The age-related increase in susceptibility to commission errors in the four-target condition is consistent with the view that spontaneous retrieval is generally intact (e.g., McDaniel & Einstein, 2007) but cognitive control is generally impaired (e.g., Lustig et

[3] There is not a standardized procedure for defining PM hits as occurring on the target trial, the next trial, or within two or more trials after the target event. Most researchers allow PM responses on (at least) the next trial unless they specify that the PM response must be given *prior to* the ongoing task response (which we do not do to avoid inadvertently biasing participants' strategies). In this article, we defined PM hits as we have in our previous PM and commission error experiments (Scullin & Bugg, 2013; Scullin et al., 2012, 2011). However, we retrospectively checked whether restricting the definition of a PM hit to the trial on which the target word occurs or the immediately following trial changed overall hit rates or the pattern of results reported. It did not. All but five hits across all experiments occurred within one trial of encountering the PM target.

[4] This criterion has been used in past studies on commission errors (Bugg & Scullin, 2013; Bugg, Scullin, & McDaniel, 2013; Scullin et al., 2012), because the primary goal of commission error research is to identify whether a participant will *ever* repeat a PM response after they have been instructed that the PM task is finished. Using a more conservative criterion of defining a commission error as a Q press within one trial following the previously relevant PM target does not appreciably change the commission error results in Experiment 1 or the subsequent experiments. This is because all but five commission errors across all experiments occurred within one trial of encountering the previously relevant PM target.

al., 2007; Zacks & Hasher, 1994; see also West, 1996) in older adults. This spontaneous retrieval–control dynamic in older adults may be associated with an exacerbated risk of making a commission error, especially in conditions that place a demand on control to override a prepotent association between the PM target and response (including the presence of the salient screen color and overlap in ongoing task contexts; cf. Scullin et al., 2012). To the extent that aging might be viewed as a naturally occurring condition of divided attention (e.g., Jennings & Jacoby, 1993), and the four-target condition yields somewhat habitual responding, this pattern also converges with Pink and Dodson's (2013) finding that habitual (but not nonhabitual) PM intentions are harder to control (inhibit) under conditions of divided attention.

One might question whether the age-related increase in susceptibility to commission errors in the four-target condition was attributable to an alternative source, namely, the age-related decrease in PM hits during the active PM phase. Recall that PM performance in the active PM phase was significantly lower for older adults. Assuming that the degree to which an intention is fulfilled is negatively related to risk of making a commission error (see Bugg & Scullin, 2013, Experiment 3, for evidence of such a relationship in young adults), the age-related increase in commission errors in the four-target condition could be caused by older adults performing the PM intention *less* frequently than young adults during the active PM phase. Note that this contrasts with a control account, which posits that the age-related increase is attributable to the *more* frequent performance of the intention (and build-up of target–response associations that must be overridden) in the four-target condition. Consistent with the control account, in a group of young and older adults for whom PM hit rate was matched, 33% more older adults made commission errors (and older adults made more errors on average) in the four-target condition.

To summarize, *within* the older adult sample, fewer participants made commission errors in the four-target condition compared with the zero-target condition. This pattern indicates it was easier for older adults to forget about a no-longer-relevant intention that was previously performed than one that they never had the opportunity to perform. This suggests that the force(s) that produce a heightened rate of commission errors in the zero-target condition—be it the lack of episodic traces to which a stop tag can be applied or Zeigarnik-like tension (or another mechanism)—also compromise older adults' ability to forget no-longer-relevant PM intentions. When comparing *between* the older and young samples, however, an age-related increase in commission errors was found only in the four-target condition that required control of a no-longer-relevant but prepotent response tendency. This finding is consistent with the view that age-related differences in commission errors may be more pronounced under conditions that expose the relatively weaker response inhibition processes of older compared with young adults (Scullin et al., 2012).

Experiment 2

It is of practical importance to identify strategies that lower older adults' risk of making a commission error, and doing so may provide further theoretical insights into the processes that underlie commission errors. To date, however, no such strategies have been identified (but see May, Manning, Einstein, Becker, & Owens, 2015, for evidence that emotional cues decrease older adults' commission errors for active [i.e., not finished] intentions in a habitual PM paradigm). Experiment 2 aimed to fill this critical gap by examining the effects of a preparatory instructional strategy in reducing commission errors.

From a translational perspective, it may be especially important to identify strategies that reduce rates of commission errors *in the four-target condition*, because this condition is analogous to the types of real-world PM intention deactivation challenges that motivated development of the commission error paradigm, namely, those with potentially serious health consequences (e.g., double dosing, Kimmel et al., 2007). A potent example is the need for an older adult to withhold the urge to take a habitually taken medication upon encountering a salient cue (e.g., medicine bottle placed on a pillow) after being instructed not to take another dose. Nonetheless, we also included the zero-target condition in the present experiment. This allowed us to systematically replicate the primary finding from Experiment 1 (i.e., lower rate of commission errors for older adults in the four- than the zero-target condition), and examine whether we could strategically intervene in lowering rates of commission errors in the condition that produced very high rates in Experiment 1.

As in the preceding experiment, participants were told that the PM task was finished following the active PM phase. However, participants were additionally instructed to *prepare* for the occurrence of the previously relevant PM targets and avoid the urge to press Q when they were encountered (referred to hereafter as the *preparatory instructional strategy*). In the standard commission error paradigm (Experiment 1), participants are not privy to the fact that targets will (re)appear or that targets may produce an impulsive response. We reasoned that the preparatory instructions might enable participants to mentally remap the targets to a new response (i.e., not pressing Q), similar to a "prepared reflex" (e.g., Hommel, 2000) or "instructed mapping" (Cohen-Kdoshay & Meiran, 2007). These concepts refer to the intentional formation of a stimulus–response (S-R) association simply via instructions (preparation), that is, without practice. Instructed mappings can affect performance by activating responses in a fashion resembling the automatic activation accompanying actual practice (e.g., Cohen-Kdoshay & Meiran, 2007; Wenke, De Houwer, De Winne, & Liefooghe, 2015). In the commission error paradigm, the instructed mapping may enable automatic activation of a no-go response to targets in the finished PM phase.

Although to our knowledge there is no evidence for instructed mappings in older adults, the findings of Paxton, Barch, Storandt, and Braver (2006) provided optimism that older adults could benefit from the preparatory instructional strategy. They found that older adults prepared upcoming responses based on an instructional strategy in the AX-CPT (continuous performance task) such that their performance approximated that of young adults. Errors were reduced on occasional trials that required inhibition of a primed but incorrect response. In the finished PM phase of the commission error paradigm, participants in the four-target condition must similarly react by inhibiting a prepotent but (now) incorrect response on occasional trials. Thus, it was predicted that commission errors might decrease with older adults' use of the preparatory instructional strategy in the four-target condition. Although there was no room for improvement for young adults in the

four-target condition, a young adult group was included to examine age-related differences.

An exploratory question was whether the preparatory instructional strategy would potentially reduce older *or* young adults' susceptibility to commission errors in the zero-target condition. On the one hand, the success of the preparatory instructional strategy should not depend on the existence of episodic traces (of prior responding), because instructed mappings have been demonstrated for novel S-R associations with which participants do not have prior practice (e.g., Cohen-Kdoshay & Meiran, 2007). Accordingly, to the extent that the preparatory instructional strategy formulates a strong mapping between the PM target and the no-go response, this new association may effectively minimize accessibility of the original PM intention in the zero-target condition. On the other hand, if commission errors in the zero-target condition primarily stem from perseverating on the unfulfilled intention (Zeigarnik, 1938; cf. Rothermund, 2003), it is not clear that instructing participants to (further) prevent themselves from pressing the Q key in response to targets would minimize commission errors.

Method

Participants and design. Fifty community-dwelling older adults aged 60 to 90 ($M = 72.98$, $SD = 7.87$) were recruited from Washington University's Older Adult Subject Pool and participated for monetary compensation. Forty-two Washington University undergraduates aged 18 to 24 years ($M = 19.58$, $SD = 1.41$) participated for course credit. All subjects had normal or corrected vision and normal color vision. Older adults ($M = 15.11$, $SD = 2.72$) reported significantly more years of education than young adults ($M = 13.80$, $SD = 1.61$), $t(85) = 2.63$, $p = .010$.[5] Average vocabulary scores favored the older adults, $t(89) = 1.89$, $p = .062$ ($M_{older} = 28.67$, $SD_{older} = 4.32$; $M_{young} = 27.12$, $SD_{young} = 3.38$). Health ratings were comparable for older adults ($M = 3.95$, $SD = 1.00$ on 5-point scale ranging from 1 [*poor*] to 5 [*excellent*]) and young adults ($M = 4.13$, $SD = .70$), $t < 1$. Within the older adult age group, participants were randomly assigned to zero-target ($n = 25$) and four-target ($n = 25$) conditions. These conditions were statistically similar in age, education, vocabulary scores, and self-reported health ($ts \leq 1.12$). Within the young adult age group, the four-target condition ($n = 25$) was collected independently of the zero-target condition ($n = 17$). Young adults in these conditions were statistically similar in vocabulary scores and self-reported health ($ts < 1$), but young adults in the zero-target condition were, on average, 1.3 years older and 1.3 years more educated than those in the four-target condition ($ps \leq .014$).

Materials and procedure. The materials and procedure were identical to Experiment 1, with three exceptions (see Figure 1). First, the finished instructions read as follows (in all capital letters, for emphasis):

> Please note that the target words will appear in the next phase and you may feel the urge to press the 'Q' key in the presence of the target words. That task is finished, however, so we would like you to prepare to avoid pressing 'Q' during the next phase.

Participants pressed the spacebar when they were ready to proceed. As in Experiment 1, they were reminded that their only remaining goal was to continue performing the lexical decision task, and a brief delay followed during which a second vocabulary task and 24 lexical decision trials were administered. Participants then began the finished PM phase. Second, we shortened the finished PM phase such that there were 102 lexical decision trials and the previously relevant target words were presented in four of the lexical decision trials (twice each). In Experiment 1, we found that all participants who made a commission error did so within the first four presentations of target words. Third, at the end of the experiment, participants were asked about the approaches they used after reading the preparatory instructions. Specifically, they rated the extent to which they used eight strategies on a scale of 1 (*did not use at all*) to 4 (*used fully*; see Table 1 for list of strategies).

Results

Active PM phase. RTs on nontarget trials during the lexical decision task were similar for older adults in the four-target ($M = 1241$, $SD = 312$) and zero-target ($M = 1246$, $SD = 539$) conditions, $t < 1$. The same was true for young adults in the four-target ($M = 777$, $SD = 166$) and zero-target ($M = 719$, $SD = 147$) conditions, $t(40) = 1.16$, $p = .252$. With respect to age, older adults were slower than young adults on nontarget trials in the four-target condition, $t(48) = 6.55$, $p < .001$, and the zero-target condition, $t(40) = 3.92$, $p < .001$.

The proportion of correct PM responses on target trials (PM hits) did not differ for the young adults (89%) and the older adults (76%) in the four-target condition, $t(48) = 1.47$, $p = .148$. PM hit rate could not be calculated for the zero-target condition.

Finished PM phase. Providing a conceptual replication of Experiment 1 under conditions in which a preparatory instructional strategy was employed, significantly fewer older adults in the four-target condition (16%) made a commission error than in the zero-target condition (56%), $\chi^2(1) = 8.68$, $p = .003$, and the average number of commission errors (out of four possible) was lower in the four-target condition ($M = 0.44$, $SD = 1.12$) than in the zero-target condition ($M = 1.56$, $SD = 1.73$), $t(48) = 2.71$, $p = .009$. The same held true for young adults, with 12% making a commission error in the four-target condition compared with 65% in the zero-target condition, $\chi^2(1) = 12.65$, $p < .001$, replicating Bugg and Scullin (2013). Moreover, the average number of commission errors was lower for young adults in the four-target ($M = 0.32$, $SD = 0.99$) than the zero-target ($M = 2.06$, $SD = 1.85$) condition.

Examining age differences, a commission error was made by an equivalent number of young and older adults in the four-target condition, $\chi^2(1) < 1$, and the average number of commission errors was equivalent across age groups ($t < 1$). In the zero-target condition, an equally high number of young and older adults made a commission error, $\chi^2(1) < 1$, and the average number of commission errors was equivalent across age groups ($t < 1$; see Figure 2).

Postexperimental ratings of strategy use. Four participants were partially or fully missing data, and were excluded from the analysis. Descriptively, the strategy rated as most frequently used

[5] Four young adults did not complete the questionnaire assessing years of education and health ratings. One young adult did not specify their years of education, and another did not complete the vocabulary task.

was compartmentalizing, and this was true for young ($M = 3.07$, $SD = 1.00$) and older ($M = 3.00$, $SD = 1.14$) adults (see Table 1; cf. Sahakyan & Kelly, 2002, for benefits of mental context change to forgetting). We submitted the ratings of the eight items to a multivariate ANOVA with condition (four vs. zero target) and age (young vs. older) as factors. Age was the only significant factor, $F(8, 77) = 3.69$, $p = .001$, and only one age difference survived correction for multiple comparisons: Older adults ($M = 2.46$, $SD = 1.26$) rated doing absolutely nothing but reading the instructions significantly higher than young adults ($M = 1.83$, $SD = 0.82$), $p = .006$.

Cross-experiment analysis. To determine whether the preparatory instructional strategy decreased commission errors relative to the standard condition, in which no strategy was assigned, we compared the preparatory instructional strategy condition in Experiment 2 with the standard condition in Experiment 1. Because the finished PM phase was shortened in Experiment 2, for comparative purposes, we restricted this analysis to the first four target trials in the finished PM phase.[6] Table 2 reports commission error rates during the first four trials for each experiment.

Although there was nominally an improvement for older adults in the four-target preparatory instructional strategy condition, there were as many older adults who made a commission error as in the four-target standard condition, $\chi^2(1) < 1$, and the average number of commission errors did not differ for older adults across conditions ($t < 1$). Young adults in the four-target preparatory instructional strategy condition were *more* likely to make a commission error than in the standard condition, and this difference approached significance, $\chi^2(1) = 3.32$, $p = .069$. The average number of commission errors was also nominally higher in the preparatory instructional strategy condition than the standard condition for young adults, $t(49) = 1.65$, $p = .105$.

The results for the zero-target condition mirrored those of the four-target condition. Compared with the standard condition, there were nominally fewer older adults ($\chi^2 < 1$) and nominally more young adults ($\chi^2 < 1$) who made a commission error in the preparatory instructional strategy condition. Similarly, the average number of commission errors did not differ between the preparatory instructional strategy condition and the standard condition for either older or young adults ($ts \leq 1.30$).

Table 1
Mean (SD) Subjective Ratings of Strategy Use for Older and Young Adults in Experiment 2

Strategy	Older	Young
I mentally suppressed the finished task.	2.43 (1.31)	2.55 (1.11)
I thought of something new to try to forget the finished task.	1.59 (1.05)	1.38 (.76)
I tried to clear my mind.	2.48 (1.28)	2.14 (1.09)
My mind simply wandered to other thoughts.	1.59 (1.05)	1.98 (.92)
I compartmentalized by considering the computer task that followed a new phase or context.	3.00 (1.14)	3.07 (1.00)
I formed a new memory that I did not have to do the finished task.	2.61 (1.27)	2.05 (1.13)
I tried to prepare myself not to press the wrong key.	2.83 (1.16)	2.43 (1.23)
I did absolutely nothing but read the instructions.	2.46 (1.26)	1.83 (.82)

Note. For all items, the options were 1 = *did not use at all*, 2 = *used barely*, 3 = *used somewhat*, 4 = *used fully*.

Table 2
Cross-Experimental Comparisons of Performance on the First Four Target Trials in the Finished PM Phase

Experiment	Age group	Condition	Percent who made a CE	Average (*SD*) number of CEs
1	Older	4-target	24	.59 (1.23)
	Older	0-target	67	1.83 (1.72)
	Young	4-target	0	.00 (.00)
	Young	0-target	56	1.37 (1.62)
2	Older	4-target PIS	16	.44 (1.12)
	Older	0-target PIS	56	1.56 (1.73)
	Young	4-target PIS	12	.32 (.99)
	Young	0-target PIS	65	2.06 (1.85)
3	Older	4-target FP	3	.13 (.73)
	Young	4-target FP	4	.15 (.78)

Note. Cross-experimental comparisons were restricted to the first four target trials within the finished PM phase because Experiments 2 and 3 comprised just four target trials (whereas Experiment 1 had ten target trials). PM = prospective memory; CE = commission error; PIS = preparatory instructional strategy; FP = forgetting practice.

Discussion

The purpose of Experiment 2 was threefold. First, we aimed to systematically replicate the primary finding from Experiment 1, and did so—older adults in a preparatory instructional strategy condition were far less susceptible to making commission errors in the four-target than the zero-target condition. Second, we investigated whether a preparatory instructional strategy would reduce the rate of commission errors, especially for older adults in the four-target condition, given its translational significance. This strategy provided participants with advance information about the upcoming occurrence of targets in the finished PM phase, warned them they may feel an urge to respond, and instructed them to prepare not to press Q when encountering targets. However, the strategy did not significantly decrease risk of commission errors for older adults relative to the standard condition in Experiment 1. Moreover, for young adults, there was a statistical trend for the rate of commission errors to *increase* with use of the preparatory instructional strategy. The combination of these patterns resulted in a nonsignificant age difference in the four-target condition, which differs from the pattern observed in the standard, four-target standard condition in Experiment 1. The inconsistent effects of the preparatory instructional strategy cast doubt on the viability of this approach for reducing commission errors in the four-target condition.

[6] This approach seemed preferable to comparing experiments by converting the average number of commission errors to the average proportion of commission errors, because some evidence suggests that the aftereffects of PM intentions decrease with repeated exposure to previously relevant PM targets (Walser, Plessow, Goschke, & Fischer, 2014). Note that the difference between the length of the finished PM phases in Experiment 1 versus Experiment 2 (and 3) was irrelevant to the analysis of the number of participants who made a commission error, because all participants who made an error in Experiment 1 did so within the first four trials.

For older adults, the preparatory instructional strategy might have depended too heavily on self-initiated processes, which are known to be impaired in older adulthood (e.g., Craik, 1986; Craik & Bialystok, 2006; see also Bugg, 2014b, for evidence that older adults are less effective at sustaining an attentional bias). For instance, upon receiving the preparatory instructions, only those participants that intentionally prepared to perform the instructed task may have been successful in creating a strong association between the PM targets and a no-go response (Liefooghe, De Houwer, & Wenke, 2013). This may have required participants to mentally rehearse the association between PM targets and the instructed response by imagining not responding to targets. It is also possible that older adults' use of the preparatory instructional strategy was constrained by cognitive limitations. Instructed S-R mappings need to be actively maintained in working memory (for the mappings to automatically influence performance; Liefooghe et al., 2013), and are effective when there are no competing working memory demands (e.g., a concurrent task; Cohen-Kdoshay & Meiran, 2007). Active maintenance of the mappings in the face of the ongoing lexical decision task may have challenged older adults. In line with these possibilities, the postexperimental strategy ratings indicated that older adults rated doing "nothing more than reading the preparatory instructions" more highly than young adults, possibly reflecting older adults' difficulty instantiating a concrete approach to deactivating the intention.

The trend for an increased rate of commission errors for young adults with use of the preparatory instructional strategy in the four-target condition may reflect the ironic effects of young adults' attempts to mentally suppress thoughts about the PM intention (see Wegner, Schneider, Carter, & White, 1987, for evidence that thought suppression leads to preoccupation with such thoughts). Use of a mental suppression strategy was also rated highly by young adults (see Table 1). Regardless of the source, the increased rate suggests that when given no strategy (standard condition), young adults spontaneously use approaches that may be more effective than the preparatory instructional strategy.

Finally, a third purpose of Experiment 2 was to explore the effects of the preparatory instructional strategy in the zero-target condition. Here, too, the strategy yielded similarly inconsistent results. Nominally, there was improvement in the older adult group but worse performance in the young adult group.

Experiment 3

Considering that the preparatory instructional strategy may have relied too heavily on self-initiated processes, Experiment 3 examined whether a novel strategy rooted in actual experience would effectively reduce the number of older adults who made a commission error to floor levels (and keep the level of commission errors low for young adults). We termed this novel strategy "forgetting practice" because the goal was to assist participants in *forgetting* (deactivating) the previously relevant PM intention, and the new target–response mappings were *practiced* and not simply instructed as in Experiment 2. In particular, participants encountered targets and were given practice withholding the Q-press response following the finished instructions. This strategy is more analogous to what is termed an "applied" or "practiced" S-R mapping. Importantly, practiced mappings can produce stronger S-R associations than simply instructed mappings (e.g., Wenke et al., 2015), while eliminating the need for active preparation (e.g., mental rehearsal) or maintenance within working memory. We predicted that forgetting practice might facilitate older adults' forgetting (deactivation) of the no-longer-relevant PM intention. As in Experiment 2, a young adult group was included for purposes of examining age-related differences in commission errors. However, in this experiment, we selectively examined the effects of forgetting practice in the four-target condition, given its translational significance, as noted earlier.

Method

Participants and design. Thirty community-dwelling older adults aged 66 to 94 years ($M = 74.46$, $SD = 8.18$) were recruited from Washington University's Older Adult Subject Pool and participated for monetary compensation. Twenty-six Washington University undergraduates aged 18 to 22 years ($M = 19.46$, $SD = 1.10$) participated for course credit. All subjects reported normal or corrected vision and normal color vision. Older adults ($M = 15.04$, $SD = 2.34$) reported more years of education than young adults ($M = 13.46$, $SD = 1.13$), $t(49) = 3.00$, $p = .004$,[7] but had similar vocabulary scores, $t(54) = 1.08$, $p = .286$ ($M_{older} = 28.03$, $SD_{older} = 4.94$; $M_{young} = 26.81$, $SD_{young} = 3.25$). The older adults rated their health as "good" ($M = 3.84$, $SD = 0.78$ on 5-point scale ranging from 1 [*poor*] to 5 [*excellent*]), as did the young adults ($M = 3.96$, $SD = .81$), $t < 1$.

Materials and procedure. The materials and procedure replicated those of Experiment 1, with two exceptions (see Figure 1). First, following the finished instructions participants received "forgetting practice." They were told they would receive practice not pressing the Q key in response to target words on the colored background. They were instructed that the purpose was to help them achieve the goal of only performing the lexical decision task and not pressing "Q" when they encountered target words later on. Then they were presented with 10 lexical decision trials, four of which were target words (two presentations of each word) presented on the same colored background used during the active PM phase. Feedback was provided in the form of "Correct" or "Incorrect – Remember you must still categorize the letter strings correctly as words or nonwords, BUT you should no longer press Q when you see a target word on a colored background." Following forgetting practice, there was a brief delay during which the second vocabulary task was administered in addition to more lexical decision trials. Because participants performed 10 lexical decision trials during forgetting practice, we presented 14 additional trials at this point to equate the total number of lexical decision trials that were presented prior to the beginning of the finished PM phase (24 trials) across experiments. Second, we again used the abbreviated version of the finished PM phase, as in Experiment 2.

Results

Active PM phase. Older adults ($M = 1343$, $SD = 412$) were slower to respond to nontarget trials during the lexical decision task than young adults ($M = 729$, $SD = 106$), $t(54) = 7.39$, $p < .001$. The proportion of correct PM responses (PM hits) was

[7] Three older adults and two young adults did not complete the questionnaire assessing years of education and health ratings.

significantly higher for the young adults (88%) than the older adults (53%), $t(54) = 3.49$, $p = .001$. Older adults' PM performance was much lower than in the preceding experiments, which will be factored into the analysis of commission errors (see Finished PM phase subsection).

Forgetting practice phase. One older adult and no young adults pressed the Q key in response to a target during the forgetting practice phase.

Finished PM phase. Commission errors were made by one older adult (3%) and one young adult (4%), $\chi^2(1) < 1$ (see Figure 2). The mean number of commission errors was equally low for older ($M = 0.13$, $SD = 0.73$) and young ($M = 0.15$, $SD = 0.78$) adults ($t < 1$). When examining only participants whom responded to all targets in the active PM phase, thereby equating young ($n = 21$) and older adults' ($n = 11$) PM hit rates, the pattern was very similar (0% of older and young adults made a commission error).

Cross-experiment analysis. To determine whether forgetting practice decreased commission errors relative to the standard condition, in which no strategy was assigned, we contrasted the forgetting practice condition in Experiment 3 to the standard condition in Experiment 1, restricting analysis to the first four target trials (see Table 2). For older adults, significantly fewer participants made a commission error with use of forgetting practice, $\chi^2(1) = 4.66$, $p = .031$. The mean number of errors declined nominally with use of forgetting practice, $t(45) = 1.60$, $p = .117$. For young adults, commission errors in the standard and forgetting practice conditions were equally low (0 to 4% of participants), $\chi^2(1) = 1.02$, $p = .313$, as was the mean number of commission errors across conditions ($t = 1$).

Discussion

The primary finding of Experiment 3 was that forgetting practice, which entailed the experience of encountering the PM targets and attempting to withhold the previously relevant response (i.e., pressing Q) prior to the finished PM phase, was highly and consistently effective in reducing commission errors in the four-target condition. Floor levels of commission errors were observed for older adults, such that their performance was significantly better than older adults who were not given a strategy (in the standard condition of Experiment 1) and equivalent to that of young adults, who were also at floor. The elimination of the age-related difference, and especially the decrease in commission errors within the older adult sample, is of practical importance, as it reveals that the risk of making a PM commission error for older adults following repeated performance of a PM intention (e.g., medication taking; Kimmel et al., 2007) is not immutable.

Interestingly, examining participants' performance during the forgetting practice trials indicated that only one participant (an older adult, and this was not the older adult who later made a commission error) pressed the Q key. This may seem surprising given the age-related difference in commission errors observed in Experiment 1 (cf. Vallesi, Hasher, & Stuss, 2010). However, it is important to remember that forgetting practice occurred immediately after the finished instructions were presented, at a point at which the intention to not press Q was likely active (i.e., within working memory) and had not been eroded by many trials of performing the ongoing task. In contrast, commission errors during the finished PM phase occur in response to targets that are presented after a filled delay (see also Bugg & Scullin, 2013; Bugg et al., 2013; Scullin & Bugg, 2013; Scullin et al., 2012), which is more analogous to real world situations in which one must overcome the urge to perform the PM intention following a period of distraction or delay (but see Walser, Plessow, Goschke, & Fischer, 2014, for evidence that it is not the delay per se that reduces susceptibility to commission errors but rather it is the repeated exposure to previously irrelevant targets).

During forgetting practice, the incorrect feedback message included a reminder not to press the Q key in response to target words. The finding that so few errors were made on target trials during forgetting practice appears to suggest that the effectiveness of forgetting practice does not reflect simply repeated exposure to the instruction not to press the Q key. However, the incorrect feedback message was also displayed on any nontarget trials on which participants made a lexical decision error, leaving open the possibility that repeated exposure might explain the benefits of forgetting practice. Examining the nontarget trials indicated that neither older nor young adults made many errors (less than one trial of the six was responded to incorrectly by each group). Most importantly, countering the repeated exposure account, examining only the 25 older and 13 young adults who made zero errors during the forgetting practice phase (i.e., did not receive any additional reminders of the finished instructions) did not change the results of the commission error analysis.

General Discussion

There were four novel findings in the present study. First, older adults had an easier time forgetting no-longer-relevant PM intentions that had been performed (repeatedly) than PM intentions that were never performed. This pattern was observed both when the standard instructions were employed (Experiment 1) and when the preparatory instructional strategy (Experiment 2) was employed. Second, relative to young adults, older adults were more likely to make a commission error and make more commission errors in the standard, four-target condition. An age difference was not observed in the zero-target condition. We proposed that the four-target standard condition placed more demand on cognitive control, namely, response inhibition processes, during the finished PM phase than the zero-target condition. In line with prior findings and theory (e.g., Lustig et al., 2007; West, 1996; Zacks & Hasher, 1994), this appeared to disproportionately impair older adults. Performance in the zero-target condition, in contrast, may not have differed because young and older adults may be equally likely to be disadvantaged by the lack of episodic traces or experience a Zeigarnik-like tension that keeps unfulfilled intentions accessible. Yet another way to interpret the age equivalency of commission errors in the zero-target condition is from an evolutionary perspective. A mechanism that enables individuals to *not* forget items left undone on their mental to-do lists may have evolved to support various PM-related goals (e.g., biological—"I need to remember to ask my doctor to check my lipid levels"; social—"I need to remember to pick up my neighbor's mail while she is on vacation"). Viewed from this perspective, it is notable that as we age, it appears just as easy to remember intentions we intended to do but never did even when we are told we can forget them. Possibly, it is functionally better to be biased to repeat intentions so as to

avoid errors of omission (failures to remember to perform an intention).

A third novel finding in the present study was that providing older adults with forgetting practice prior to the finished PM phase significantly reduced commission errors, such that forgetting practice mitigated the age-related difference in PM commission errors in the four-target condition. Forgetting practice involved directly linking a new response—in this case, a "no-go" response—to the PM target via actual experience. In Experiment 3, the number of forgetting practice opportunities (four) was proportionate to the number of retrieval practice (performance) opportunities (four) in the active PM Phase. Possibly, this enabled a thorough overwriting of the preexisting target–response association. An interesting question, both theoretically and practically, is whether fewer trials of forgetting practice would be similarly effective. In a compatibility task, Dreisbach and Bäuml (2014) found that directing young participants (once) to forget what they just did effectively reduced accessibility of previously learned S-R rules, providing evidence for retroactive control of a habit. Forgetting practice may also serve to improve retroactive control and work as effectively with just one attempt at forgetting practice.

Theoretically, the reduction in commission errors with forgetting practice may have occurred via one of two routes (or a combination), highlighted by the dual-mechanisms account of PM commission errors (Scullin & Bugg, 2013). One possibility is that forgetting practice directly facilitated cognitive control such that when the intention was spontaneously retrieved in response to targets in the finished PM phase, the no-go response was automatically primed and reactively applied. A second possibility is that forgetting practice prevented or significantly minimized spontaneous retrieval of the PM intention. In this case, the age-related difference in commission errors may have been mitigated because the demand on control of a prepotent response tendency was no longer high. One approach to informing this theoretical question would be to examine response times to the previously relevant PM targets in the finished PM phase. If participants exhibit significantly less intention interference (i.e., slowed responding on ongoing task) to PM targets in the forgetting practice condition relative to the standard condition, then this supports the second possibility. Unfortunately, the present paradigm is not well suited for examining this question because, for instance, there were only four PM target trials in the finished PM phase in Experiment 3. However, future studies may advance theoretical understanding of the benefits of forgetting practice by utilizing commission error paradigms that are better suited for this purpose (i.e., they include a larger number of PM target trials to get reliable estimates of response times and tend to not produce commission errors that can muddy interpretation of this measure; Scullin et al., 2011; Walser et al., 2012).

Our fourth finding was that a preparatory instructional strategy was less consistently effective in reducing commission errors. It yielded a nominal reduction in the number of older adults who made a commission error, but a nearly significant increase in the number of young adults (relative to the standard, no-assigned-strategy condition). As noted previously, older adults may have struggled in self-initiating a mental version of forgetting practice in response to the preparatory instructions (Craik, 1986; Craik & Bialystok, 2006), such that a weak (instructed) S-R mapping resulted. The finding that forgetting practice significantly reduced commission errors for older adults, whereas the preparatory instructional strategy did not, is consistent with evidence that older adults may not spontaneously adopt beneficial strategies (see also the strategy rating data from Experiment 2), but are able to use them when environmental support is provided (Naveh-Benjamin, Craik, & Ben-Shaul, 2002). This raises the question of whether explicitly guiding older adults on how to mentally practice (i.e., create an instructed mapping) may reduce commission errors to floor levels in the preparatory instructional strategy condition.

Alternatively, the preparatory instructional strategy might yield stronger benefits if it directed older adults' attention to the *only* task that remains relevant following the finished instructions (i.e., lexical decision task).[8] Mayr, Spieler, and Hutcheon (2015) found that this approach was effective in reducing "fade out costs" in a task-switching paradigm. A fade-out cost is routinely observed for older, but not young, adults and refers to the tendency to perform single task blocks less fluently following a task-switching block; the idea is that although consultation of external cues is not necessary in a single task block, older adults continue to inspect the cues, which slows their performance. Older adults who were given an instruction reminding them of the one task that would remain relevant did not show the fade-out cost. Given the similarities between the fade-out paradigm and commission error paradigm, namely, the transition from a dual-task to a single-task situation and a need to no longer attend to external cues (i.e., PM cues in the commission error paradigm), such an approach may also be effective for reducing older adults' commission errors.

Although we have suggested that the greatest translational value may be gained from intervening in the four-target condition, given its approximation of real-world challenges with significant health consequences (see Kimmel et al., 2007), future research might further consider approaches to reducing commission errors in the zero-target condition. We explored the preparatory instructional strategy as one such approach in Experiment 2, but as in the four-target condition, it yielded inconsistent effects. Given the benefits of forgetting practice in the four-target condition, a natural next step may be to evaluate its effectiveness in the zero-target condition, and doing so may provide further theoretical insights into the mechanisms that underlie the benefits of forgetting practice.

Conclusion

To conclude, the present study demonstrated that various factors influence older adults' susceptibility to making PM commission errors. As is the case for young adults (Bugg & Scullin, 2013), PM intentions that are not "crossed off" of older adults' mental to-do lists tend to remain active and make older adults more vulnerable to commission errors than those that have been crossed off. Relative to young adults, when no strategy is instructed, older adults

[8] Indeed, a similar approach could also be employed as an alternative to the forgetting practice strategy used in Experiment 3. That is, participants might engage in what might be conceived of as a more traditional form of practice following the finished instructions (given the goal is to perform only the lexical decision task at that point forward), in which they practice emitting only the "Y" or "N" responses to stimuli including targets. Note that the focus switches from learning of a stimulus-no-go response association with use of forgetting practice to a stimulus-"Y/N" response association with this type of practice.

appear to be more vulnerable to making commission errors particularly when prior, repeated responding to PM targets formulates a S-R association that must later be inhibited. Finally, instructing older adults to mentally prepare prior to the finished PM phase did not significantly reduce their vulnerability to commission errors following repeated responding; however, providing older adults with forgetting practice achieved this goal, possibly because it forged a stronger association between the PM targets and the no-go response.

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