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Controlling Intentions: The Surprising Ease of Stopping After Going Relative to Stopping After Never Having Gone

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Abstract

Decades of cognitive-control research have highlighted the difficulty of controlling a prepotent response. We examined whether having prepotent prospective-memory intentions similarly heightens the difficulty associated with stopping an intention once a prospective-memory task is finished. In three experiments, participants encoded a prospective-memory intention (e.g., press *Q* in response to the targets *corn* and *dancer*) and subsequently encountered either four targets or zero targets. Instructions then indicated that the prospective-memory task was finished. In a follow-up task, the targets appeared, and commission errors were recorded. Surprisingly, it was easier for participants to stop the intention when it had been fulfilled (four-target condition) than when it had gone unfulfilled (zero-target condition; Experiments 1 and 2). This was true even after intention cancellation (Experiment 2). Although repeatedly performing an intention strengthens target-action links, it appears to enable deactivation of the intention, a process that is largely target specific (Experiment 3). We relate these findings to the Zeigarnik effect, target-action deactivation, and reconsolidation theories.

Keywords

cognitive processes, response inhibition, prospective memory

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Stop reading the words on this page! Unless you looked away, you probably found it difficult to follow this instruction. Reading, after all, seems relatively automatic (Logan, 1980). The difficulty of not reading is an example of the more general challenge of attempting to control a habitual response. This challenge has launched hundreds of studies, including some that feature the Stroop task, in which participants control the urge to read while naming the color of a word's typeface (e.g., MacLeod, 1991). The go/no-go task also requires participants to withhold a habitual response; however, the response is one that becomes prepotent via practice in an initial go phase (Garavan, Ross, & Stein, 1999) and not via extended practice in real life (e.g., reading). In the go phase, participants press a response key each time any stimulus is shown. In the subsequent no-go phase, participants continue to press a key in response to all stimuli from the go phase except one particular stimulus that appears infrequently. Commission errors—responses on no-go trials—are thought to reflect inhibitory control failures, which have been linked theoretically to the strength of the prepotent go response (Roberts, Hager, & Heron, 1994).

A seemingly analogous paradigm was recently developed to investigate commission errors in prospective memory (PM; Scullin, Bugg, & McDaniel, 2012; cf. Pink & Dodson, 2013; Walser, Fischer, & Goschke, 2012). PM refers to the ability to remember to execute an intention at the appropriate time in the future. In the first phase of the PM-commission-error paradigm, participants perform an ongoing task (e.g., lexical decision) and are given a PM intention to press a distinct key (e.g., *Q*) whenever they encounter target words (e.g., *corn* or *dancer*). The targets appear rarely, and PM performance is usually near perfect. Participants are then told that the PM task is

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finished and does not need to be performed again. In the subsequent commission-error phase (i.e., Phase 2), participants continue the lexical decision task and occasionally encounter the previously relevant targets. Young adults often erroneously press *Q* again in response to these targets. The frequency of commission errors increases when targets are salient, when there is contextual overlap between Phases 1 and 2 (Scullin et al., 2012), or when a verbal encoding strategy (i.e., an implementation intention) is used to strengthen the PM intention (Bugg, Scullin, & McDaniel, 2013). Another cause of such errors is participant fatigue when the targets are encountered (Scullin & Bugg, 2013). The convergence of these and other findings (Walser et al., 2012) suggests that commission errors reflect the combined consequences of spontaneous retrieval of the PM intention and insufficient control of the PM response (i.e., pressing *Q*) in Phase 2.

Given the apparent similarity between the PM-commission-error paradigm and the go/no-go task, one might predict that the frequency of commission errors should be related to the prepotency of the PM intention (Roberts et al., 1994). Pink and Dodson (2013) manipulated target presentation in Phase 1 to promote habitual (10 times) or nonhabitual (1 time) responses. They hypothesized that repeated performance of the PM intention would induce a heightened state of response activation, such that full attention would be needed to oppose the tendency to perform the action in Phase 2. Dividing the participant's attention was therefore expected to increase commission errors in the habitual condition but not in the nonhabitual condition, and this is precisely the pattern that was found. The authors concluded that commission errors occur when a target is associated with a PM intention, the intention has been acted on many times, and the participant is distracted in Phase 2; therefore, commission errors reflect failures of control (i.e., failures of inhibition).

The current experiments addressed whether prior performance of a PM intention is necessary for commission errors to occur. Could merely encoding the PM intention and expecting to perform it produce similar errors? In Experiment 1, there were either four presentations (Bugg et al., 2013) or zero presentations of a PM target in Phase 1. If repetition of the PM intention is a critical condition for commission errors (Pink & Dodson, 2013), commission errors should be observed for the four-target but not the zero-target condition. If the commission-error paradigm is analogous to the go/no-go paradigm, stopping in response to targets in Phase 2 (i.e., withholding the PM intention) should be more difficult after having performed the intended action (four-target condition) than after never having performed the action (zero-target condition; Roberts et al., 1994; cf. Hommel, Musseler, Aschersleben, & Prinz, 2001).

This is not a foregone conclusion, however, because some prior findings support the opposite prediction. For example, Zeigarnik (1938) found that recall of interrupted tasks was higher than recall of completed tasks. More recently, Marsh, Hicks, and Bink (1998) showed that the intention-superiority effect (i.e., the heightened accessibility of words related to scripts participants intended to perform versus neutral scripts; Goschke & Kuhl, 1993) was evident before the opportunity to perform a PM intention (including interruption of the PM task) but was not apparent after completion of a PM intention. To the extent that the zero- and four-target conditions of the current study approximated the interrupted and completed conditions, respectively, more commission errors would be expected in the zero-target condition than in the four-target condition.

Experiment 1

Method

Participants and design. Fifty-three Washington University undergraduate students participated in Experiment 1. We manipulated the number of targets in the active-PM block (Phase 1) between subjects. Participants were randomly assigned to the zero-target (n = 27) and four-target (n = 26) conditions.

Materials and procedure. The procedure is depicted in Figure 1. Following the procedure of Scullin et al. (2012), we first had participants practice a lexical decision task, in which they were asked to quickly and accurately make word/nonword judgments by pressing number-pad keys labeled *Y* (5) or *N* (6), respectively, in response to stimuli presented one at a time on a computer screen. Then they encoded the PM intention (i.e., pressing the *Q* key if they saw a target word) and were informed that target words would appear on a red (or blue) background. They were given two target words (*corn* and *dancer* for some participants and *fish* and *writer* for the remainder) and then told to write down the target words and the key to be pressed (*Q*). A brief delay followed encoding of the PM intention (Einstein & McDaniel, 1990), during which a vocabulary task and a demographics form were administered. After the delay, the active-PM block began. Participants performed the lexical decision task on 80 trials with the intention to press the *Q* key if a target word was shown. All words appeared in a white typeface. Control words (i.e., the two words not used as target words) appeared against the background color not used for target words (background colors were counterbalanced across participants). For the four-target condition, a target word (e.g., two were *corn* and two were *dancer*) appeared on 4 of the

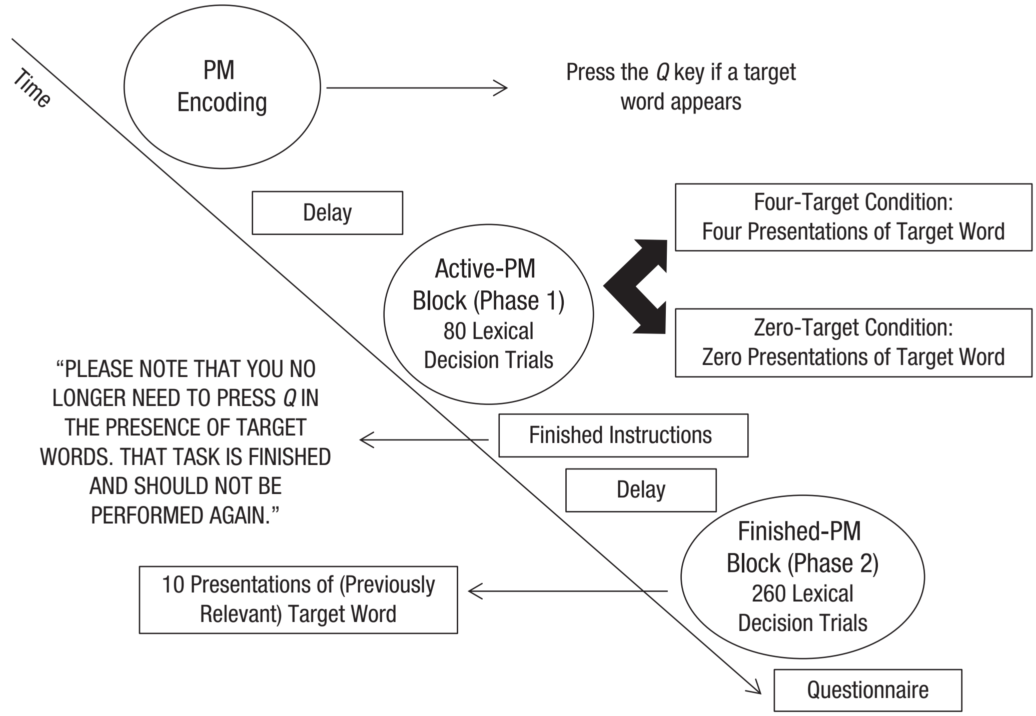

Fig. 1. Procedure for the zero-target and four-target conditions of Experiments 1 and 2. In both conditions, participants first encoded a prospective-memory (PM) intention to press a response key (*Q*) if they encountered a target word. PM encoding was followed by a delay containing a filler task and a questionnaire. Then the active-PM phase began, in which participants performed 80 lexical decision trials, making word/nonword judgments. Some of the participants saw four presentations of the target word in these trials, and the remainder saw none. After this phase ended, and participants were instructed that they should no longer respond to target words, there was a second delay. This delay was followed by a longer block of lexical decision trials, but this time there were 10 presentations of a target word, and commission errors were recorded. Finally, participants answered a questionnaire.

80 trials. For the zero-target condition, the target words appeared on none of the 80 trials.

When participants had completed the active-PM block, they 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." This is a stronger version of the instruction used in our prior studies (e.g., Bugg et al., 2013; Scullin & Bugg, 2013). Participants were then instructed that their only goal was to continue to make the word/nonword judgments by pressing the *Y* and *N* keys. After a brief delay, during which another vocabulary task and 24 lexical decision trials were administered, the finished-PM block (Phase 2) began. Participants in both conditions completed 260 lexical decision trials. For both the four-target and zero-target conditions, 10 of the trials contained a target word. The background colors matched those used with targets (if presented) during the active-PM block.

Results

Active-PM block. In Phase 1, response times on nontarget trials in the lexical decision task were similar for participants in the four-target (M = 723 ms) and zero-target (M = 703 ms) conditions, $t < 1$. Successful fulfillment of the PM intention was defined as a *Q* press on a target trial or the following trial. In the four-target condition, the percentage of correct responses was high (97%).

Finished-PM block. In Phase 2, a commission error was defined as a *Q* press. As shown in Figure 2, no participant made a commission error in the four-target condition, which was in stark contrast to the results in the zero-target condition, in which 56% of participants made a commission error, $\chi^2(1, N = 53) = 20.15$, $p < .001$.

Discussion

PM commission errors occurred only in the zero-target condition. This finding suggests that stopping oneself

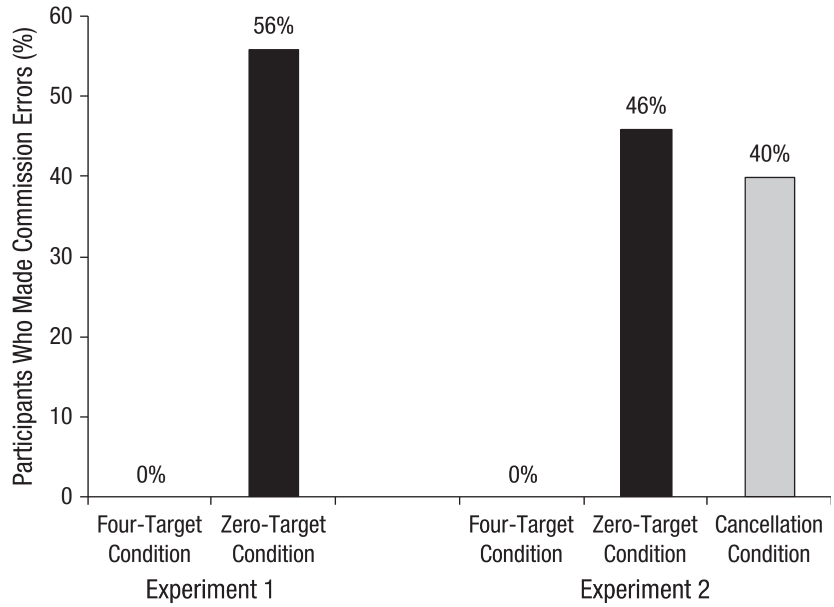

Fig. 2. Percentage of participants who made commission errors in the finished-PM (prospective memory) block (Phase 2) as a function of condition in Experiments 1 and 2.

from performing a PM intention is more difficult after never having performed it than after having performed it. This is a surprising finding in the context of research on the go/no-go task and other cognitive-control tasks (e.g., the Stroop task), which highlights the difficulty associated with controlling a prepotent response (e.g., Klein, 1964; Roberts et al., 1994), as well as in the context of prior PM research that found an increase in commission errors after repeated performance of the PM intention (Pink & Dodson, 2013). According to these studies, participants who performed the PM intention on multiple occasions would have made more errors when they encountered a target word in the finished-PM block than participants who did not perform the PM intention, but this was not so. Before we considered possible explanations for this surprising finding, we first aimed to replicate and extend it in Experiment 2.

Experiment 2

In addition to the four-target and zero-target conditions from Experiment 1, Experiment 2 included a cancellation condition, in which the PM intention was encoded but shortly thereafter canceled (Marsh, Hicks, & Bryan, 1999; West, McNerney, & Travers, 2007). This condition served as a theoretically important comparison with the zero-target condition because, as in that condition, participants encoded the PM intention as if they were going to perform it, but no targets were actually presented during the active-PM block. However, unlike participants in the zero-target condition, participants in the cancellation condition did not expect to perform the PM intention during the active-PM block because the intention was canceled immediately before that block began. Consequently, in the cancellation condition, we predicted less anticipatory monitoring (i.e., maintaining the intention in working memory while expecting and searching for targets; Marsh, Hicks, & Cook, 2006; Smith, 2003) than in the zero-target condition. We hypothesized that if the high frequency of commission errors in the zero-target condition in Experiment 1 were related to anticipatory monitoring (Walser et al., 2012), then commission errors should be significantly reduced in the cancellation condition of the current experiment. By contrast, if the absence of intention fulfillment were responsible, then commission errors should not differ in the cancellation and zero-target conditions.

Method

Participants and design. Seventy Washington University undergraduate students participated in three conditions: zero targets (n = 24), four targets (n = 24), or cancellation (n = 22). We excluded data from 2 participants in the cancellation condition because of experimenter deviations from the established protocol.

Materials and procedure. To ensure that participants in the cancellation condition robustly encoded the intention before it was canceled, we asked them to write down the intention three times rather than reading it only once as they had in Experiment 1. This procedure was also used for the zero-target and four-target conditions, but all other procedures were identical to those in Experiment 1. The cancellation condition was identical to the zero-target condition, except that (a) we presented cancellation instructions immediately before the active-PM block (in capital letters for emphasis: "Please note that you have been assigned to a condition in which you no longer need to press *Q* in the presence of target words. That task is canceled and should not be performed," and (b) we replaced the finished instructions with a reminder that participants' only goal was to make word/nonword judgments by pressing *Y* or *N*.

Results

Active-PM block. In Phase 1, the percentage of correct PM responses was high (92%) in the four-target condition. As in Experiment 1, mean response times on nontarget trials in the lexical decision task were similar in the four-target (M = 778 ms) and zero-target (M = 725 ms) conditions, $t(46) = 1.29$, $p = .21$. It is noteworthy that participants in the cancellation condition responded significantly faster on nontarget trials (M = 663 ms) than did participants in the zero-target condition (M = 725 ms), $t(42) = 2.02$, $p < .05$, which suggests a disengagement of anticipatory monitoring in the cancellation condition (Smith, 2003).

Finished-PM block. In Phase 2, we replicated the central finding of Experiment 1, namely that far more participants made commission errors in the zero-target condition (46%) than in the four-target condition (0%), $\chi^2(1, N = 48) = 14.27$, $p < .001$. In the cancellation condition, 40% of participants made a commission error; this percentage was statistically greater than the percentage in the four-target condition, $\chi^2(1, N = 44) = 11.73$, $p = .001$, but statistically equivalent to the percentage in the zero-target condition, $\chi^2(1, N = 44) < 1$ (see Fig. 2).

Discussion

Experiment 2 replicated the primary finding of Experiment 1 by showing that the rate of commission errors was much higher in the zero-target condition than in the four-target condition. This finding shows that completed intentions are less accessible than unfulfilled intentions, echoing prior studies (Marsh et al., 1998; Zeigarnik, 1938; for a related finding, see Mayr & Keele, 2000). In those experiments, however, it was not possible to examine stopping (i.e., commission errors) because of the nature of the intention (e.g., participants intended to perform a scripted action, such as "insert the filter"), and the task used to assess the accessibility of the intention (e.g., response times to script-related words, such as "insert," on the lexical decision task). The current commission-error findings advance the literature by showing that an unfulfilled intention is not only more accessible but also more likely to be inappropriately executed, even when the person has been instructed that the PM task is finished. This is in part what makes the heightened rate of commission errors in the zero-target condition surprising—in the study by Marsh et al. (1998), intention accessibility (i.e., lexical decision response times) for the unfulfilled intention was assessed before an anticipated performance of the intention. In other words, there was good reason for participants to keep the intention accessible. In the current experiments, participants were explicitly informed that the intention should not be performed before we assessed intention accessibility (i.e., by measuring commission errors).

Experiment 2 also served as a theoretically important extension of Experiment 1 by ruling out anticipatory monitoring as the cause of the heightened rate of commission errors in the zero-target condition. Anticipatory monitoring during the active-PM block was significantly less pronounced in the cancellation condition than in the zero-target condition, but commission errors were equally frequent. Contrary to the findings of Marsh et al. (1999), who found that both cancellation and performance of an intention resulted in intention deactivation, our findings revealed significantly more commission errors in the cancellation condition than in the four-target condition. Marsh et al. measured intention deactivation using lexical decision response times to words that were related to a canceled or performed intention (i.e., scripts that described actions to be performed), whereas in the current experiments, we measured intention deactivation by commission errors, which reflect the accessibility of the target-action link itself (Bugg et al., 2013; Scullin & Bugg, 2013). Cancellation may have different effects on these measures, or procedural differences may account for the discrepancy. For example, in the Marsh et al. study, participants encoded two sets of intentions (scripts); then they were told that they would be performing one intention and that the other was canceled. This procedure may facilitate deactivation of the canceled intention because it allows participants to direct attention to the to-be-performed intention when the cancellation instruction is given.

Experiment 3

The findings of Experiments 1 and 2 supported the view that performing an intention, though it presumably strengthens target-action links (McDaniel & Scullin, 2010), enables intention deactivation. In Experiment 3, we investigated whether the deactivation process associated with intention fulfillment is specific to a target for which the intention was performed or generalizes to other targets relevant to the intention. A four-target, single-cue condition was implemented in which two targets were encoded (e.g., *corn* and *dancer*), but only one target was presented (e.g., *corn*) during the active-PM block. During the finished-PM block, we manipulated whether the first target was the presented (*corn*) or nonpresented (*dancer*) target. We focused the commission-error analysis on the first target (see Scullin & Bugg, 2013) to avoid the possible confounding influences of later seeing the other (e.g., nonpresented) type and potentially making a commission error in response to it. On the basis of the results of Experiments 1 and 2, we predicted greater commission errors for the nonpresented target than for the presented target. To determine whether the degree of intention fulfillment (partial, complete, or none) affected the deactivation process, we contrasted commission-error frequency in the four-target, single-cue condition in this experiment with that in the four-target, both-cues condition and zero-target condition of the preceding experiments.

Method

Participants and design. Forty Washington University undergraduate students participated in a four-target, single-cue condition, in which only one of the two members of an encoded target pair (e.g., *corn*) was presented four times during the active-PM block and the other member (e.g., *dancer*) was not presented. Designation of targets as presented versus nonpresented was counterbalanced across participants.

Materials and procedure. The procedure was identical to that in the four-target condition of Experiments 1 and 2, except that only one member of a target pair was presented during the active-PM phase, and control words were not included. In the finished-PM block, both targets were presented five times each, but for half of the participants, the presented target appeared first, and for the other half, the nonpresented target appeared first.

Results

Active-PM block. In Phase 1, the mean response time for lexical decisions was 725 ms, and the percentage of correct PM responses was 93%.

Finished-PM block. In Phase 2, 9 of 40 participants (23%) made a commission error in response to the first target during this block, and commission errors were 3.5 times more likely when the first target was the nonpresented target rather than the presented target, $\chi^2(1, N = 40) = 3.58$, $p = .06$ (see Fig. 3).

Comparison of first-target commission errors with Experiments 1 and 2. To maximize power, we collapsed the data separately for the four-target conditions in Experiments 1 and 2, in which both targets had been presented, and for the zero-target conditions in Experiments 1 and 2, in which neither target had been

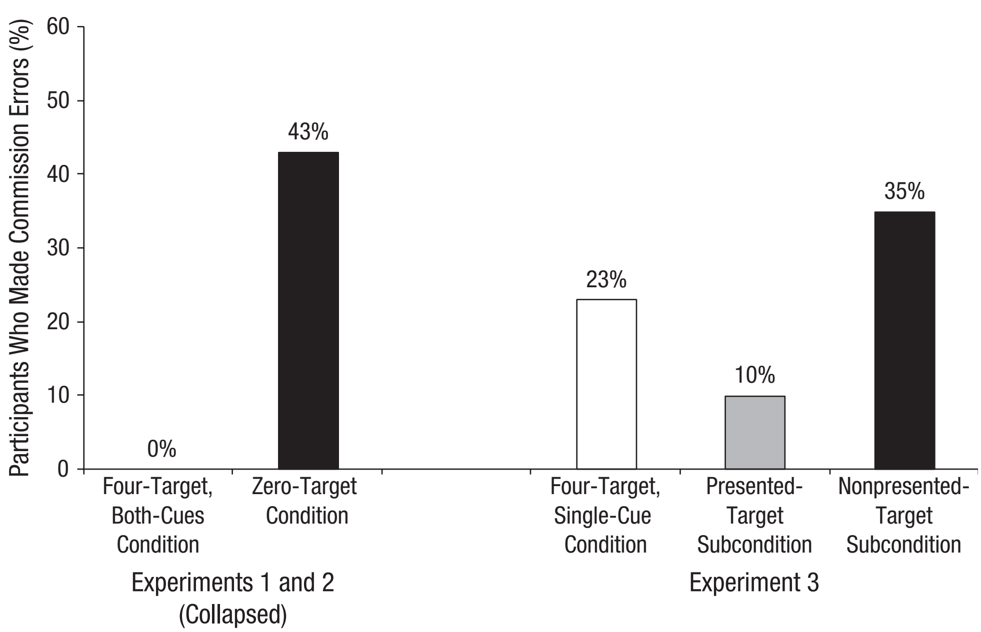

Fig. 3. Percentage of participants who made commission errors in response to the first target in the finished-PM (prospective memory) block (Phase 2) as a function of condition in Experiments 1 and 2 (collapsed) and Experiment 3.

presented. Figure 3 illustrates that commission errors in the four-target, single-cue condition of Experiment 3 (23%) were more frequent than in the four-target, both-cues conditions of Experiments 1 and 2 combined, $\chi^2(1, N = 90) = 12.50$, $p < .001$, and less frequent than in the zero-target conditions of Experiments 1 and 2 combined, $\chi^2(1, N = 91) = 4.25$, $p = .04$. When we restricted the analysis to the presented target from the four-target, single-cue condition (10%), there were slightly more commission errors than in the four-target, both-cues conditions of Experiments 1 and 2, $\chi^2(1, N = 70) = 5.15$, $p = .02$, and significantly fewer commission errors than in the zero-target conditions of Experiments 1 and 2, $\chi^2(1, N = 71) = 7.05$, $p = .008$. By contrast, for the nonpresented target (35%), commission-error frequency was similar to that for the zero-target conditions, $\chi^2(1, N = 71) < 1$, and greater than that for the four-target, both-cues condition, $\chi^2(1, N = 70) = 19.44$, $p < .001$ (see Fig. 3).

Discussion

The findings from Experiment 3 converged with those of the preceding experiments: Performing an intention facilitated its deactivation. We identified a graded effect of commission errors, in which frequency was lowest after full intention fulfillment, elevated after partial intention fulfillment, and highest in the absence of intention fulfillment.

Experiment 3 extended our prior findings by demonstrating that the benefits of intention fulfillment were largely specific to the target for which the intention was performed. Commission errors were 3.5 times as frequent for the nonpresented target relative to the presented target, although this difference was marginally significant. An equally high rate of commission errors was found for the nonpresented target in Experiment 3 and the zero-target conditions in Experiments 1 and 2. Because both of these conditions involved a target for which the intention remained wholly unfulfilled, this pattern indicates that performing the intention in response to the presented target did not facilitate deactivation of the intention for the nonpresented target in the four-target, single-cue condition. By contrast, the higher rate of commission errors for the presented target in the four-target, single-cue condition than in the four-target, both-cues condition suggests that the residual activation of the (unfulfilled) intention for the nonpresented target increased the risk of making a commission error in response to the presented target. These findings indicate that normal intention deactivation primarily involves the disassembly of specific target-action links (Scullin, Einstein, & McDaniel, 2009) and, to a lesser extent, the entire goal representation (which would include all targets associated with the goal of performing the intention), at least with distinct and unrelated cues (Walser et al., 2012).

General Discussion

The current findings clearly and consistently demonstrated that it is easier to stop after going than it is to stop after never having gone (i.e., to deactivate an intention after having performed it than after never having performed it). Unlike such classic control paradigms as the Stroop and go/no-go tasks, PM-intention prepotency in the current paradigm did not heighten the difficulty associated with stopping an intention once the PM task was finished. Quite the reverse was true. When participants had never responded to a PM target (in the active-PM block), approximately 50% of participants made a commission error, which is definitively higher than the 0% of participants who made an error in the conditions of Experiments 1 and 2 in which intentions were completely fulfilled.

What might be the source of the increased rate of commission errors for unfulfilled intentions? In Experiment 2, we ruled out the possibility that anticipatory monitoring caused a buildup of intention strength or response priming (Walser et al., 2012). Our findings might be explained by the Zeigarnik (1938) effect, which refers to the higher recall of unfinished tasks than of finished tasks. Zeigarnik attributed the effect to the tension and perseveration of memory created by a task interruption. According to the Zeigarnik account, the heightened frequency of commission errors in the zero-target and cancellation conditions occurred because the task was functionally interrupted, which caused unresolved tension and perseveration of that PM intention.

A more contemporary explanation concerns the formation of episodic traces during the active-PM block; such traces should involve an integration of the target and action (i.e., stimulus-response link) selectively for those conditions in which participants encountered (and responded to) targets (e.g., Hommel, 1998). According to the view that automatic retrieval of the episodic trace may occur when the target appears in the finished-PM block, thereby priming the associated action, it is surprising that commission errors were absent (or significantly reduced) in the four-target conditions compared with the zero-target conditions (e.g., Waszak & Hommel, 2007). One possibility is that when the intention was completed, participants who repeatedly performed the PM task (i.e., pressed *Q*) had a greater number of episodic traces or a richer representation of intention completion than participants who did not perform the PM task (but see Walser et al., 2012, Experiment 4).[1] Consequently, it may have been easier for the former group to associate a stop tag with these traces when the finished instructions were shown (Hommel et al., 2001); that is, it may have been easier to build a more effective no-go memory.

Alternatively, the instructions may have primed the specific target-action association for deactivation (Scullin et al., 2009). According to this deactivation view, seeing the PM cue in the finished-PM phase no longer (or to a lesser extent) triggered memory of the intention. Consider, for example, the real-world intention of remembering to deliver a message to a friend. After delivering the message, people probably do not consciously think "I no longer need to give Josh this message," and when they see Josh later, people probably will not again think of the message to deliver (nor do people think "stop—do not give Josh the message"). This deactivation view seems to be consistent with reconsolidation theory (Nader & Hardt, 2009), which argues that when memories are reactivated, they become transiently destabilized. During this labile state, memories will either be strengthened or primed to be discarded (Diekelmann, Büchel, Born, & Rasch, 2011; Nader, Schafe, & Le Doux, 2000). Considering the present results, the reconsolidation perspective would be that performing an intention in response to a specific target cue reactivated that target-action link, which left it transiently destabilized and primed for deactivation (on further receipt of the finished instructions).

The current findings help adjudicate between the Zeigarnik (1938) account and more modern accounts (e.g., specific target-action deactivation). The Zeigarnik account predicts that the interruption of a task produces tension and perseveration. In Experiment 3, all participants had the opportunity to execute the intention (task); therefore, according to Zeigarnik, commission errors should have been minimal. However, commission errors were minimal only in the condition in which the first target presented during the finished-PM block was the target previously presented (and responded to) during the active-PM block. When the nonpresented target was encountered first during the finished-PM block, commission errors were as frequent as in the zero-target conditions of Experiments 1 and 2. These results advance theory on intention deactivation beyond the consideration of a general process associated with task completion that involves the relief of "tension" (i.e., the Zeigarnik account). Collectively, our findings consistently suggested that it is easier to deactivate an intention after having performed it than after never having performed it, and they implicated specific target-action deactivation processes that enable the forgetting of completed intentions after they have been performed.

Author Contributions

J. M. Bugg and M. K. Scullin developed the study concept, designed the study, tested participants, and collected, analyzed, and interpreted the data. J. M. Bugg drafted the manuscript, and M. K. Scullin provided critical revisions. All authors approved the final version of the manuscript for submission.

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Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

Note

1. We thank an anonymous reviewer for suggesting this explanation.

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