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The Cost of Remembering to Remember
Cognitive Load and Implementation Intentions Influence Ongoing Task Performance

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Imagine the following scenario: You need to remember to execute an important intention, such as turning off your cell phone before an important meeting. In the past, you may have been embarrassed by the failure to complete such an intention, thereby disturbing an entire room of colleagues, not to mention the invited speaker. Therefore, you are especially determined to successfully complete this goal. However, at the same time, you may need to keep your phone activated until the last possible minute because of an impending vital phone call from a family member. How do you successfully fulfill these conflicting objectives? Cognitively speaking, are there differential attentional requirements (more or less resources) depending on the quality or complexity of the intention? Are there strategies one can employ to ensure a higher likelihood of fulfilling an intention while reducing the resources required to execute it? In this chapter, we describe research that attempts to answer such questions.

Reasons for prospective memory failure are often attributed to the person becoming absorbed in some other ongoing thoughts or activity such that the opportunity for execution of the intention passes. For example, the need to turn off the cell phone may be temporarily forgotten if the individual becomes engrossed in a conversation with the department chair prior to the meeting. This example underscores the key feature of prospective memory: the idea that prospective memory is inherently effortful because an intention must be retrieved when one is in the midst of some other competing activity (Maylor, 1996). For example, successful realization of the intention requires that the person disengage and interrupt the ongoing flow of thought and activity for it to be properly executed. Therefore, prospective memory is thought to require a higher degree of self-initiated processing (Craik, 1986). The more engrossing the ongoing task, the more prospective memory may suffer due to increased competition (d'Ydewalle, 1995). Thus, prospective memory involves striking a balance between executing an intention and maintaining ongoing task activities.

Based on some recent research on a phenomenon known as the *intention superiority effect*, intentions are thought to have some built-in qualities that make it more likely that they will be completed. For example, a number of researchers (e.g., Cohen, Dixon, & Lindsay, 2005; Freeman & Ellis, 2003; Goschke & Kuhl, 1993; Marsh, Hicks, & Bink, 1998; Marsh, Hicks, & Bryan, 1999) have shown that information related to intentions was highly accessible compared to information that was not future oriented. For example, results revealed that undergraduate participants showed better access to material that was intended for some future activity compared to material that was not future oriented. This phenomenon was termed the intention superiority effect (Goschke & Kuhl, 1993). In the typical paradigm, participants are asked to memorize written descriptions of two activities. Next, participants in an "execute" condition are informed that they will have to execute one of these activities (e.g., setting a table) later, whereas those in an "observe" condition only observe the experimenter carrying out the task. Then participants from both conditions receive a recognition memory test or lexical decision task that includes words from both scripts. Experimenters assume that the time it takes to match a probe item with its match in long-term memory is inversely related to the accessibility of that representation (Anderson, 1983).

Results from a number of studies showed faster reaction times for the items related to the to-be-executed task (e.g., Goschke & Kuhl, 1993; Marsh et al., 1998; Marsh et al. 1999). These results were thought to demonstrate that material related to intentions may experience some type of increased accessibility or superiority relative to information that is not future oriented. These findings lead to a question: If representations of intentions have increased activation or can be accessed more easily, do they compete or interfere with other ongoing activities? That is, does holding an intention in mind consume attentional resources?

THE COST OF HOLDING AN INTENTION IN MIND

Increasingly, there is growing interest in examining this issue of whether ongoing task performance is affected by the presence of an embedded intention. More simply, the question is whether there are costs to holding an intention in mind.

Some researchers (e.g., Smith, 2003, chap. 2, this volume; Smith & Bayen, 2004) argue that prospective memory is capacity dependent because at some level one is always monitoring the environment for a cue. Others (e.g., Einstein & McDaniel, 1996; Einstein et al., 2005; Guynn, McDaniel, & Einstein, 2001) argue that prospective memory can be automatic in the sense that the intention sometimes seems to pop into mind with little or no effort. The logic is as follows: When the intention is encoded, a representation is established that involves the target event and the response that is to be performed. Automatic retrieval of the response is assumed to occur once the target is identified because the representation has either a reduced threshold or a heightened level of activation. Therefore, conscious processes were involved at the time that the intention was formed but were not needed before the occurrence of the target event.

In contrast to this idea of automatic retrieval, Smith (2003) examined the issue of costs to ongoing task performance and showed that reaction time performance on an ongoing task was significantly increased by the presence of an embedded intention. More interestingly, these increased reaction times occurred even on neutral trials when no prospective memory target was present. Smith (2003) interpreted her findings as support for the preparatory attentional and memory processes (PAM) theory, which suggests that capacity-demanding attentional resources are needed for successful prospective memory performance (see also Smith & Bayen, 2004). In Smith's (2003) paradigm, both groups learned a list of six prospective memory target words. One group (embedded condition) was told to make a certain response when any of these words appeared during the lexical decision task, whereas the other group (delayed condition) was told that they should make their response at the end of the experiment, after the lexical decision task was finished. Thus, in one condition, the prospective memory task was embedded within a lexical decision task, and in the second condition the participants performed only the lexical decision task. In the embedded case, participants were instructed to try to remember to press the F1 key when they saw any of the six target words during the lexical decision task. In the delayed case, participants were told that they did not have to remember to press the key until after the lexical decision task had been completed. The two groups learned the same prospective memory target words and received the same prospective memory instructions, except for the delay.

According to PAM theory, preparatory attentional processes are engaged before the occurrence of the target event, and it is these processes that draw on limited resources. Therefore, Smith (2003) hypothesized that reallocation of resources would be necessary in an embedded prospective memory group, but that a delayed prospective memory group would not have to engage in the preparatory processing during the lexical decision task. She predicted that lexical decision reaction times to nontarget control words would be longer in the prospective memory embedded case than in the prospective memory delayed situation.

Not only did participants have longer reaction times on prospective memory trials, but latencies were longer on the nonprospective memory trials as well. The author interpreted these findings as evidence for PAM theory as they showed that capacity-consuming resources are needed to discriminate between target and nontarget events, as well as to recollect the intention even on trials where there is no target present. Smith (2003) made the fairly strong claim that the results are inconsistent with a view of prospective memory that proposes that intentions can be retrieved automatically (e.g., Einstein & McDaniel, 1996; Guynn et al., 2001) and are more consistent with the suggestion that successful event-based prospective memory tasks require attentional resources. (See Einstein et al. [2005], for an alternative view providing empirical support for spontaneous retrieval in a prospective memory task.)

Marsh, Hicks, Cook, Hansen, and Pallos (2003) conducted a study in which they examined slowing to the ongoing task more specifically by exploring whether it is due to several subcomponents of prospective memory. For example, they reasoned that cue detection may be achieved through four processes, including (a) recognition of a cue that was previously associated with an intention, (b) verification of whether that cue meets the requirements that were specified during encoding, (c) retrieval of the correct action, and (d) coordination of executing the action and maintaining ongoing task performance. In four experiments, they manipulated performance to examine whether slowing occurs due to verification processes (Experiments 1 and 2), or whether it was due to retrieval processes of the response action (Experiments 3 and 4). These experiments were undertaken to explore which cognitive processes of prospective memory are resource demanding and therefore cause slowing to ongoing task performance. Results showed that both of these processes contributed to ongoing task slowing. For example, Experiment 2 demonstrated that cues that were unrelated to each other showed more task interference than cues that were related to each other (e.g., animal words). This result was seen as evidence that the process of verifying the cue does require processing resources that interfere with prospective memory performance. Furthermore, target–response pairings that were highly associated (e.g., photo–album) showed much less interference than cue–target pairings that were not associated (e.g., dog–album). This indicated that processes devoted to retrieval of the response do interfere with ongoing task performance. In general, results showed that attention allocated to ongoing task performance resulted in more resources being available for cue detection.

NEW EXPERIMENTS

In a line of experiments that we recently carried out (e.g., Cohen, Jaudas, & Gollwitzer, in preparation), we attempted to replicate results by Smith (2003).[1] In contrast to Smith's paradigm, our paradigm required participants to make their lexical decision on each trial first, before they made their prospective memory response (if appropriate). This change to the protocol (also used by Marsh, Hicks, Cook, Hansen, & Pallos 2003) ensured that any observed cost was not due to participants withholding their lexical decision response because they were trying to decide whether it was a prospective memory target. Therefore, increased costs would have to be due to a process other than item checking. For example, observed

[1] We would like to thank Rebekah Smith for her generosity in sharing her materials with us and for her helpful comments when we were deciding on the experimental design.

costs may be a result of the need to periodically bring the intended action to mind, thereby maintaining the association between the prospective memory target and the intended action, similar to suggestions made by Guynn (2003). Alternatively, increased costs could be due to increased working memory load. For example, the need to hold an intention in mind, depending on the complexity of it, may result in increased memory load. This latter possibility was specifically examined in Experiment 3 of the current line of experiments.

In Experiment 1, participants were randomly assigned to either a control condition or an intention condition. Participants performed a first block of a lexical decision task that consisted of 126 word trials and 126 nonword trials (252 in total). After the first block of trials, participants received instructions for the prospective memory task. They were asked to take 2 minutes to memorize six target words (e.g., *blue, girls, decided, member, maybe, husband*). Participants in the control condition were told that they would have to recall the six words at the end of the experiment. Those in the intention condition were told that they would have to make an additional response to these words if they encountered them in the second half of the lexical decision task (see Figure 17.1 for a schematic of the experimental design). Participants were told to press the F1 key on the computer keypad (after first making their lexical decision) if they saw any one of these words during the experiment. We emphasized the lexical decision task and told them that they should be sure to respond as quickly and accurately as possible in the word–nonword decisions. However, we told them to also keep in mind that they must perform an additional response to the six target items.

Our results replicated those of Smith (2003). In Block 1, response latencies did not differ between conditions; therefore, we computed difference scores in which

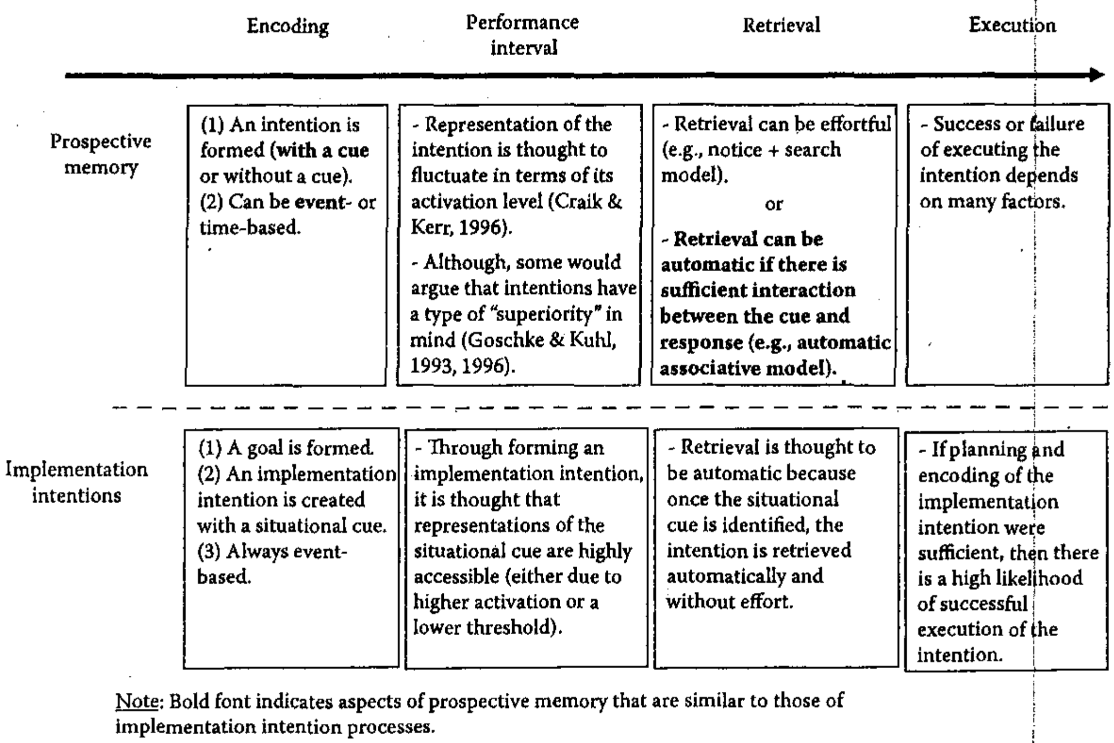

FIGURE 17.1 Schematic of the experimental design in Experiment 1.

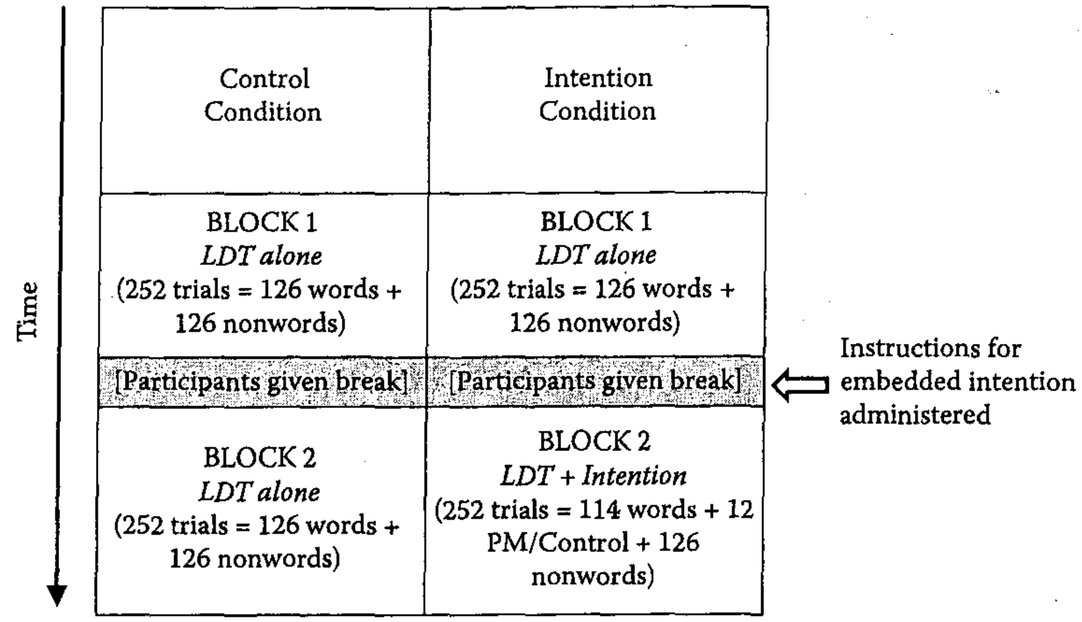

FIGURE 17.2 Reaction time latencies on ongoing lexical decision task trials in Experiment 1 as a function of condition. Bars represent standard error.

we subtracted Block 1 latencies from Block 2. Results showed that participants in the control condition exhibited a large practice effect, but that those in the intention condition did not benefit from practice due to the embedded intention (see Figure 17.2). It is worth mentioning that the latencies in our analyses of ongoing task costs in all our experiments did not include prospective memory trials. In fact, to reduce the likelihood that any "switch costs" would inflate our measure of ongoing task costs, we did not include the first three trials following a prospective response.

In our next experiment, we were interested in investigating whether the costs associated with executing the intention could be due to the coordination of two manual key presses. Some researchers might argue that participants were required to hold in mind two sets of instructions, both of which involved a manual key press. The fact that these two responses involved similar output channels (manual) could have created a type of response confusion, or conflict, leading to increased response times. That is, participants in the intention condition had to coordinate the act of pressing a computer key (yes or no) in response to the lexical decision task, while they also had to press another key (F1) for the prospective memory task. It is plausible that coordinating two manual responses led to the observed costs in the previous experiment. Therefore, the method was exactly the same in this experiment as in the previous experiment, except that participants were required to say "word" aloud when they saw one of the six target prospective memory cues instead of pressing the F1 key. Furthermore, we were interested in examining whether changing the retrospective memory component of the prospective memory intention to a verbal response would decrease observed costs.

Results for Experiment 2 were similar to those of the previous experiment in that participants in the control condition exhibited a large practice effect from Block 1 to Block 2 but participants in the intention condition did not benefit from practice

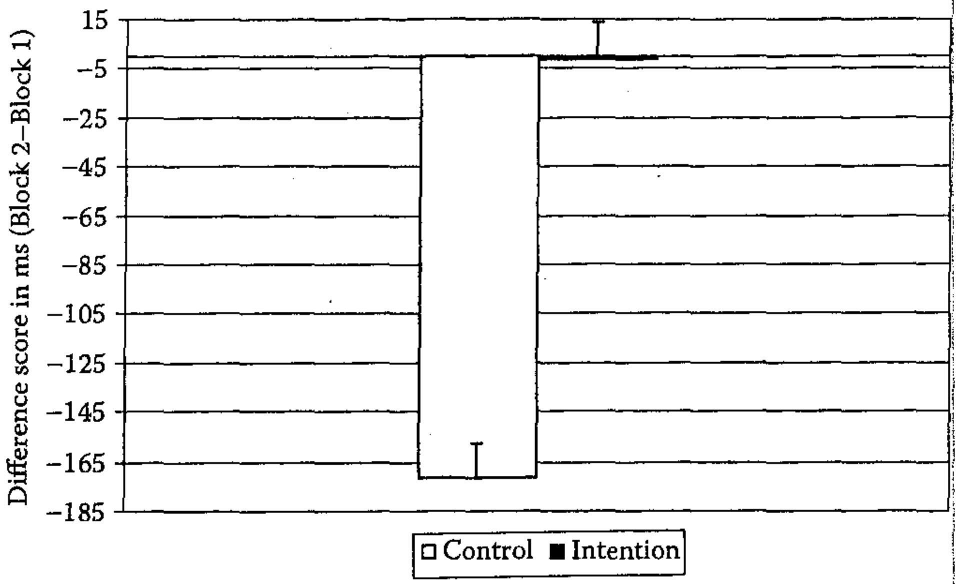

FIGURE 17.3 Reaction time latencies on ongoing lexical decision task trials in Experiment 2 as a function of condition. Bars represent standard error.

(see Figure 17.3). Our results are in line with those found by Marsh, Hicks, Cook, Hansen & Pallos (2003), who also showed that there is cue interference when participants perform a vocal prospective memory response. Prospective memory performance was considerably lower in Experiment 2 (53%) compared to Experiment 1 (82%). It may be that making a vocal response to a prospective memory cue was more difficult and led to more forgetting than making a manual key press response. Possibly the manual prospective memory response served as a type of reminder in the first experiment, whereas this was not the case in Experiment 2 with the verbal mode of responding.[2] However, we are reluctant to make any strong claims about this discrepancy based on a cross-experiment comparison. It may be interesting to deliberately manipulate response modality in subsequent experiments to examine how prospective memory and ongoing task performance are affected.

In the previous two experiments, participants were required to memorize six target words. It is possible that holding six targets in mind taxed working memory, causing excessive cognitive load, and that it was this aspect of the task that led to increased costs. Therefore, ongoing task costs may not be due to item checking but rather to periodic retrieval of the target + action association with ongoing task latencies increasing with the numbers of targets held in mind. Marsh, Hicks, Cook, Hansen & Pallos (2003)varied cue set size because they were interested in the effect that this manipulation could have on verification processes. The logic was that a larger cue set size would take longer to verify and this load on verification processing would increase ongoing task costs. The authors asked participants to memorize either four or eight target cues. Indeed, results showed that costs were increased for those in the eight versus four cue set size condition. Furthermore, a more recent study by Einstein et al. (2005) supported the multiprocess view by demonstrating that

[2] We thank Mark McDaniel for suggesting this interpretation.

participants rely on different processes for different task demands. That is, results of Experiment 3 of their line of studies showed significantly more ongoing task costs with six-target events compared to a condition involving one target.

We conducted a study to examine more specifically when cue set size begins to interfere with ongoing task performance. It may be that there is a point at which working memory load becomes taxed and ongoing task performance begins to suffer. That is, we wanted to explore at what exact point working memory load begins to interfere with ongoing task performance. In our study, we varied cognitive load across seven conditions in which participants received no intention (control condition) or one, two, three, four, five, and six target cue words. Each target occurred 12 times; therefore, those in the two-word condition had each target appear six times and those in the three-word condition had each target appear four times each, and so on. Therefore, the only aspect of the design that varied was the number of targets that participants had to hold in mind. Surprisingly, there were no significant differences for prospective memory performance as a function of condition (proportion correct ranged between .70 and .80). Thus, prospective memory was not significantly affected by our manipulation of working memory load. However, there were significant differences for ongoing task costs. Similar to findings by Einstein et al. (2005), our results showed that there were no costs to ongoing task performance in the one-word condition and only marginal costs in the two-word condition. Significant costs emerged in the three-word condition and increased in magnitude to the six-word condition (see Figure 17.4). Our results suggest that working memory load may influence the way that attention is allocated over the course of the task as a function of cognitive load. In a recent paper by Unsworth and Engle (2006), the authors suggested that primary memory is thought to have an upper bound of approximately four items. They provided evidence that when

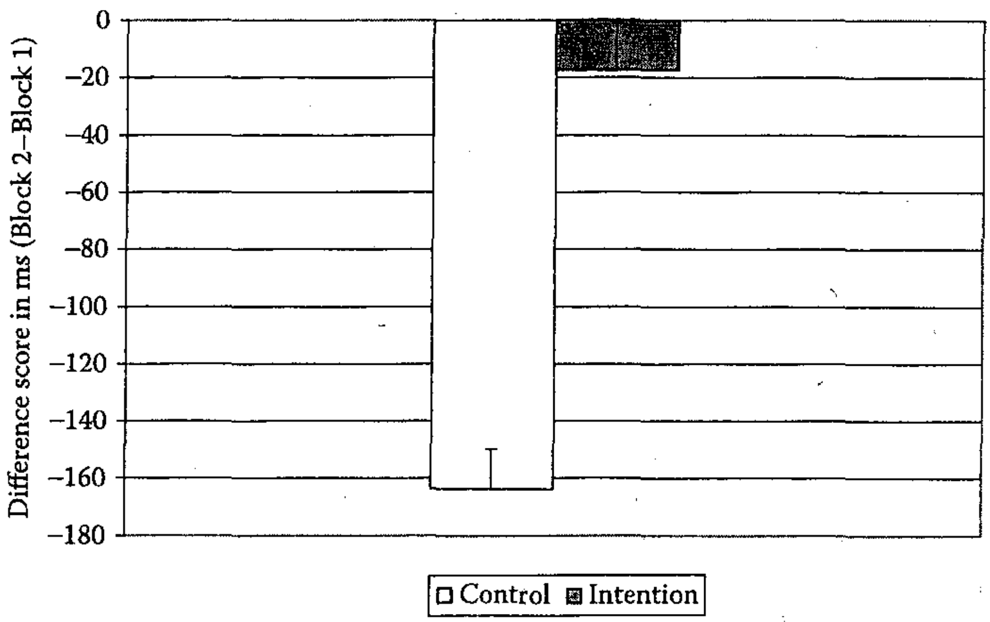

FIGURE 17.4 Reaction time latencies on ongoing lexical decision task trials in Experiment 3 as a function of condition. Bars represent standard error.

more than four items are present, items within primary memory are probabilistically displaced and must be recalled from secondary memory. Therefore, items are displaced from primary memory and must be retrieved from secondary memory, which may require additional resources leading to increased ongoing task costs.

These results provide support for the multiprocess framework (Einstein et al., 2005), which suggests that prospective memory may be mediated by spontaneous processing such that there are little or no costs to ongoing task performance under conditions of low working memory load. To further examine our findings, we conducted a regression model analysis in which we modeled ongoing task performance (difference scores) as a function of condition. In Fit 1, we entered a model to test the linear function, which was significant ($p < .05$) with a slope of 27. Thus, the slope could be interpreted to mean that difference score latencies decreased by 27 ms (signifying costs to ongoing task performance) with each unit increase of condition. Inspection of Figure 17.5 shows that the linear fit is generalizing across performance in the one-word condition. In a sense, the significant linear function implies that there is an increase in cognitive load from the control condition to the one-word condition when that is obviously not the case. Therefore, in Fit 2, we entered a model that takes into account performance in the one-word condition. The trend approached significance ($p = .09$) and the slope was 24. Although this second model was only marginally significant, it is suggestive that performance in the one-word condition is best explained by a model with a J-type function.

Results from this regression analysis are important in helping to quantify the increased costs to ongoing task performance as a function of each unit increase in cognitive load. Our results show that there was little or no cost when participants had to hold one target in mind. Smith (2003) stated that successful event-based

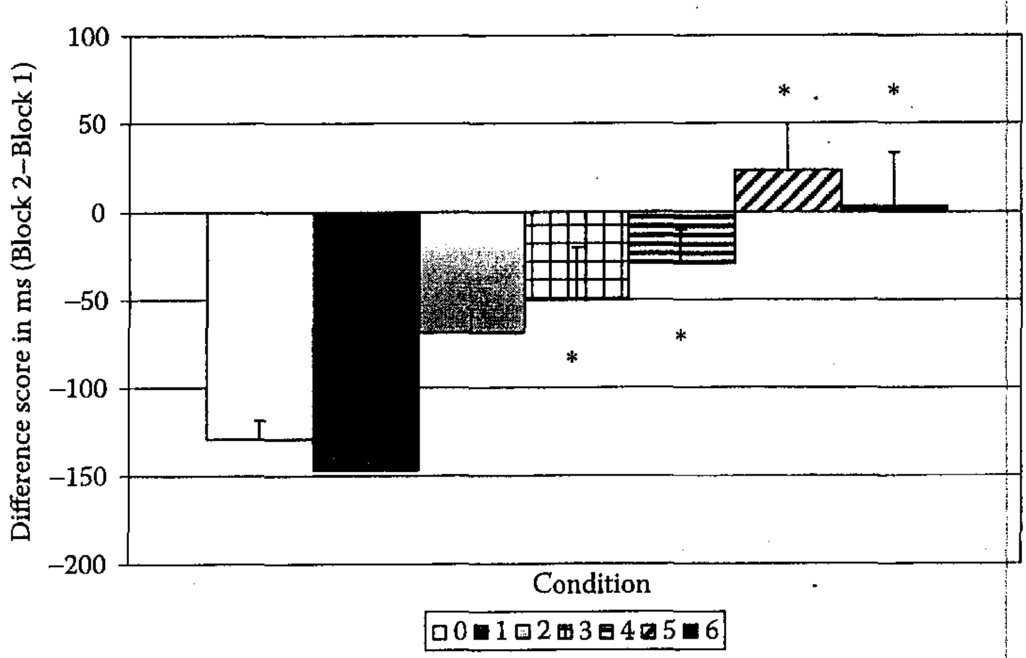

FIGURE 17.5 Regression model of ongoing task performance (difference scores) in Experiment 3 as a function of condition. Fit 1 was significant and Fit 2 showed a trend toward significance.

prospective memory responding always requires attentional resources. However, our results suggest that participants are able to juggle multiple demands (ongoing task + prospective memory task) when cognitive load is minimal, providing support for the multiprocess view (McDaniel & Einstein, 2000).

SELF-REGULATORY STRATEGIES AND PROSPECTIVE MEMORY

In the previous section, we described the tension between holding an intention in mind and the potential effect it can have on other ongoing activity. An interesting question to examine is whether these costs are amenable to self-regulatory strategies. More specifically, can one influence prospective memory and ongoing task performance by adopting a particular mind state or strategy? Marsh, Hicks, and Cook (2005) proposed that cue detection may be negatively affected when the intention and ongoing task are similar in nature (both semantic or both orthographic) because they compete for the same resources. The experimenters also used an effort manipulation wherein participants were instructed to allocate low, medium, or high effort toward the ongoing task. Results showed that there was a general interference effect when participants had to execute an intention versus a condition with no intention. Furthermore, increased effort toward semantic analysis of a letter string reduced the detection of semantic cues but not orthographic cues, and high effort in analyzing orthography of words resulted in reduced detection of orthographic cues. Marsh et al. (2005) made a distinction between overall general costs to ongoing task performance because of an embedded intention and the changing allocation of attention over the course of the task. Thus, the authors concluded that the relationship between ongoing task performance and cue detection is more complicated in that slower ongoing task performance may indicate sloppy inattentive processing in which cues may go unattended. By contrast, faster ongoing task latencies may reflect increased attention to the ongoing task; if the cue detection is competing for the same resources, it will be negatively affected (Marsh et al., 2005). Therefore, consequences of an adopted strategy depend on the degree to which a participant allocates attention to either the prospective memory task and the ongoing task and the degree to which he or she focuses on particular aspects of that task (e.g., semantic or orthographic).

Implementation Intentions

In Experiment 4 of our line of experiments, we had two related objectives: (a) to examine whether using a self-regulatory strategy known to enhance controlled processing would benefit prospective memory accuracy, and, more interestingly, (b) to examine whether enhancing prospective memory performance through the use of a self-regulatory strategy would come at a cost to ongoing task performance. Similar to questions posed in Marsh et al. (2005), we were interested in the relationship between cue detection and ongoing task performance. If we enhance performance on one component (prospective memory), does it necessarily come at a cost to the other component (ongoing task)? Therefore, in Experiment 4, we employed a self-regulatory strategy that is thought to enhance prospective memory performance known as implementation intentions.

Implementation intentions have been attracting increasing interest in the realm of prospective memory even though this strategy has been studied in the social cognitive domain for well over a decade (e.g., Gollwitzer, 1993). In prospective memory, researchers tend to stress the memory aspect of this executing intention. For example, failures to execute an intention are explained in terms of some type of cognitive failure. In social cognition, by contrast, the memory aspect is less the focus. Rather, failure to realize one's goal or intention is explained in terms of implemental problems (e.g., one is absorbed by competing goal pursuits, wrapped up in ruminations, gripped by intense emotional experiences, or simply unmotivated). Intentions are defined more broadly with the terms goal and intention being used interchangeably. An *intention* is defined as a mental representation that has been formed in relation to a desire to accomplish a task or direct behavior to achieve some desired state in the world (Kruglanski, 1996). The concept of intention is central in human goal striving (e.g., Bandura, 1991; Gollwitzer & Moskowitz, 1996; Locke & Latham, 1990; Wicklund & Gollwitzer, 1982).

In traditional theories on goal striving, the intention to achieve a certain goal was seen as an immediate determinant (or at least predictor) of goal-directed action. Thus, it was expected that the strength of an intention (i.e., how much one wants to realize it) would determine whether it is implemented or not (Ajzen, 1991; Godin & Kok, 1996; Sheeran, 2002).

However, research shows that intention–behavior relations are modest due to the fact that people, despite having formed strong intentions, often fail to act on them (Orbell & Sheeran, 1998). Evidence has shown that forming strong intentions does not guarantee goal attainment, as there are a host of subsequent implemental problems that need to be solved successfully (Gollwitzer, 1996). For instance, after having set a goal, people may procrastinate in acting on their intentions and thus fail to initiate goal-directed behavior. Furthermore, in everyday life, people often strive to attain multiple or even competing goals, many of which require repeated efforts (e.g., buying a new car) rather than the execution of simple short-term projects. Also, to meet their goals, people have to seize viable opportunities to act, a task that becomes particularly difficult when attention is allocated elsewhere or when these opportunities are not obvious at first sight or only present themselves briefly. Therefore, in the realm of social cognitive research, a failure to execute a goal or intention is examined not solely in terms of failure of memory, but also in terms of a host of other implemental problems that are considered as potential impediments to intention realization.

Previous theories of goal pursuit emphasized conscious choice and it was thought that behavior was guided on a moment-to-moment basis (e.g., Bandura, 1986). More recently, research has shown that mental representations of goals can become activated without an act of conscious will such that behavior is guided by these goals within the current situational context (Bargh & Gollwitzer, 1994). *Automatic action initiation* is the notion that established routines linked to a relevant context are released when the necessary conditions exist, without the need for controlled or conscious intent (Bargh, 1989). Bargh, Gollwitzer, Lee-Chai, Barndollar, and Troetschel (2001) showed that representations of goal-directed activity do not need to be put into motion by an act of conscious choice. In their study, Bargh and colleagues demonstrated that nonconsciously activated goals effectively guided action, enabling participants to adapt to ongoing situational demands.

Furthermore, Gollwitzer (1993, 1999) suggested that forming a certain type of intention called an implementation intention is a powerful self-regulatory strategy that alleviates the need for conscious control by delegating control to prespecified environmental cues. More specifically, implementation intentions link anticipated opportunities with goal-directed responses and thus commit a person to respond to a certain critical situation in a stipulated manner. Implementation intentions take the format "If situation X is encountered, then I will perform behavior Y!" They are to be distinguished from the more simple structure of a goal intention, which has the form "I intend to reach Z," whereby Z may relate to a certain outcome or behavior to which the individual feels committed.

An everyday example would be the following. You need to remember to tell a colleague an important message but are in the midst of a busy day of meetings and finishing a grant application. In this example, the goal intention is "I intend to give my colleague a message." Forming an implementation intention that links this goal with a specific situational cue might be "As soon as I finish my grant application, I will call my colleague." Therefore, you establish a specific cue (finishing the application) that is linked with a desired response (remembering to call your colleague). Implementation intentions are formed in the service of more general goal intentions and specify the when, where, and how a goal-directed response will be executed. Forming implementation intentions involves the selection of a critical future situation, and it is assumed that implementation intentions lead to a heightened accessibility of the situational cue (Gollwitzer, 1999). This in turn facilitates the detection of the situational cue in the environment and alleviates the need for effortful conscious control.

There is strong evidence for this perceptual readiness effect (Aarts, Dijksterhuis, & Midden, 1999; Gollwitzer & Schaal, 1998; Webb & Sheeran, 2003). For example, Aarts et al. (1999) investigated cognitive and behavioral effects of planning (i.e., forming implementation intentions) on goal pursuit during the performance of mundane behaviors. Participants received a goal to collect a coupon in the cafeteria among a variety of other task-related behaviors. Half of the participants enriched their goal with implementation intentions, whereas the other half did not. Results showed that participants who formed implementation intentions were more effective in goal pursuit than the control group. More important, results from a lexical decision task that included target words associated with the goal showed faster latencies to words associated with the attainment of the goal. Based on the assumption that the formation of implementation intentions creates a strong link between situations and behavior in memory, these findings point to the fact that planning increased the probability of goal achievement through a heightened accessibility of the mental representations of situational features related to the goal-directed behavior.

One published study examined whether using implementation intentions enhanced the prospective memory performance of older adults relative to a group of younger adults. Chasteen, Park, and Schwarz (2001) showed that forming implementation intentions significantly enhanced older adults' prospective memory performance. The authors concluded that implementation intentions benefited older adults' prospective memory functioning by allowing them to take advantage of the fact that this technique recruits automatic rather than effortful controlled memory processes. Their results showed that creating an implementation intention allowed behavior to become reflexive, thus eliminating the need for conscious control once the prospective memory cue target was encountered. The authors concluded that encoding an implementation set stored action schemas into a state of readiness and, when the appropriate trigger conditions were satisfied, the intention could be executed without mediation of a conscious recollection of the intention. This research demonstrated that implementation intentions facilitated the attainment of goal intentions in a situation where it was easy to forget to act on them. It is important to note that instructions in the Chasteen et al. (2001) study involved an imagery component. For example, participants were instructed to picture themselves writing the day of the week as a way to help them remember to execute this intention. Implementation intentions do not typically involve an explicit imagery component. There are three crucial issues in forming implementation intentions: selecting a critical situation, selecting a suitable goal-directed response, and strongly linking the two cognitions with the relational construct of if–then. Use of imagery techniques to achieve these three tasks is optional, and it may be a good technique for some people (those high in imagery), and for some "if" and "then" components that are easy to imagine.

As mentioned previously, we devised an experiment examining whether forming an implementation intention would improve prospective memory performance and, more interestingly, whether this improvement would be at the cost of ongoing task performance. In this paradigm, we compared three conditions: a control condition (no intention), an intention only condition, and an intention + implementation intention condition. The method was largely based on that of Experiment 2 from Marsh, Hicks, Cook, Hansen & Pallos (2003). In that study, participants memorized unrelated (e.g., dog–album) and related (e.g., photo–album) word pairs. Participants were told that they should respond with the second member of the word pair if they saw the first member of the word pair in a lexical decision task. Therefore, if they encountered *dog*, they should respond by saying "album" out loud. Results showed that target–response pairings that were highly associated (e.g., photo–album) showed less interference to ongoing task performance than cue–target pairings that were not associated (e.g., dog–album).

Based on these findings, we speculated that implementation intentions that form a link or an association between two previously unassociated components may function similarly to the inherent semantic association between two related words. That is, we predicted that a condition in which an unassociated word pair was furnished with an implementation (thereby creating a link between the two components) might lead to a reduction in interference compared to an unassociated word pair condition with no implementation intention.

In our paradigm, participants in all three conditions (control, intention only, intention + implementation intention) performed a lexical decision task. Halfway through the experiment, participants were asked to memorize three unassociated word pairs. Participants in the two intention conditions were instructed to say the second member of the word pair if they saw the first member during the lexical decision task. Participants in the implementation intention condition also formed an implementation intention for one of the word pairs. They were asked to write down the following phrase three times: "If I see the word *window* at any point in the task, then I will say *wrapper* as fast as possible!" So in a sense, the implementation intentions created an association between each member of the word pair similar to the inherent association that exists between semantically associated word pairs. Therefore, we predicted that those in the intention + implementation intention condition would show improved prospective memory performance in terms of accuracy and less interference in ongoing task performance in terms of less costs than those in the intention only condition.

Our predictions were confirmed. There was a significant improvement in prospective memory accuracy for those in the intention + implementation intention condition compared to the intention only condition; however, performance was near ceiling for both conditions. Most interestingly, there was a significant main effect for ongoing task costs, with ongoing task costs reduced for those in the implementation intention condition. Specifically, post-hoc analyses revealed that there was a significant difference between ongoing task costs in the control condition and the intention only condition, but no difference between control and intention + implementation intention conditions. Furthermore, ongoing task costs were significantly higher for those in the intention only condition compared to the intention + implementation intention condition. This study showed that improvement in prospective memory performance does not necessarily come at a cost to ongoing task performance (see Figure 17.6). As Marsh et al. (2005) concluded, the relationship

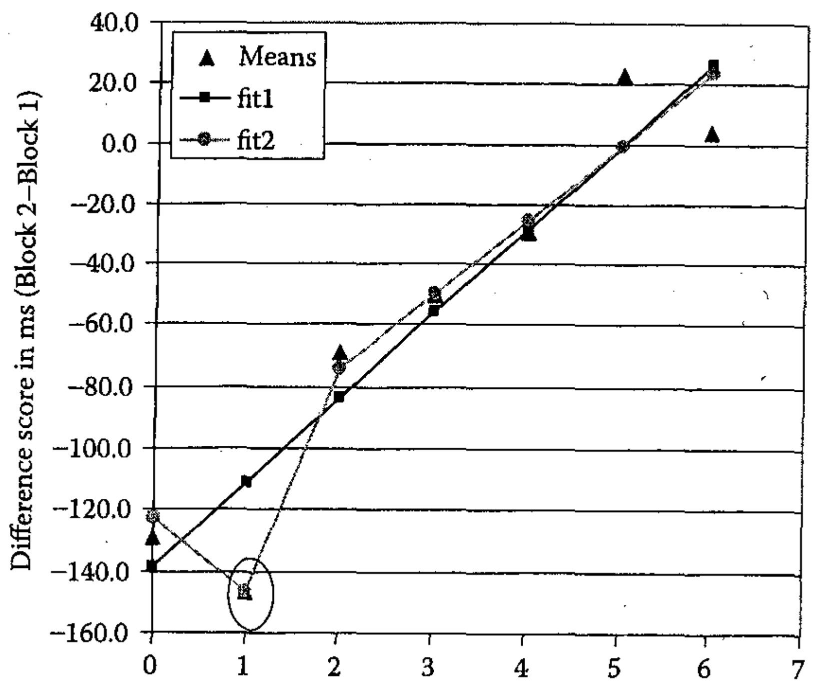

FIGURE 17.6 Reaction time latencies on ongoing lexical decision task trials in Experiment 4 as a function of condition. Bars represent standard error.

between prospective memory performance and ongoing task costs is complicated. The authors stated that slower ongoing task performance may indicate sloppy inattentive processing in which cues may go unattended. Along the lines of this statement, our findings suggest that participants in the intention only condition detected fewer cues than those in the intention + implementation intention condition, but this was not because they had faster performance in the ongoing task.

COMPARING AND CONTRASTING PROSPECTIVE MEMORY AND IMPLEMENTATION INTENTIONS

As mentioned earlier, there is increasing interest in the self-regulatory strategy of implementation intentions, perhaps due to its striking structural similarities to prospective memory. If we decompose each phenomenon into its component parts, there are some undeniable commonalities. For example, McDaniel and Einstein (1992) proposed that successful prospective memory is supported by two related component processes. The prospective component (prospective memory) is defined as the realization that some prospective action is to be performed when an appropriate cue is encountered. The retrospective component is defined as the ability to recall an intention when the prospective cue is detected. Thus, we must remember at an appropriate moment that we must do something (prospective memory component), and we have to recall what is to be done (retrospective memory component). For example, if an individual has to remember to give a friend a message, successful prospective memory requires that the appearance of the friend trigger the memory that a message has to be given (prospective component). Successful prospective memory also requires that the individual remember the content of the message (retrospective component).

Implementation intentions can be decomposed into components similar to those specified in the McDaniel and Einstein (1992) distinction. For example, when participants form an implementation intention, they say, "If situation X arises, then I will perform response Y." Therefore, the first portion of the implementation intention, "If situation X arises," is focused on specifying a situational cue that will eventually be linked with the goal-directed behavior. It focuses on the "I will have to do something when I encounter X." Therefore, this first half of the implementation intention may serve to establish the noticing process or prospective memory component of prospective memory. The second part of the implementation intention, "I will perform response Y," may serve to establish or strengthen memory for the content of the intention. This enables the individual to remember what that "something" actually is; therefore, it strengthens the search process or retrospective memory component of prospective memory. By forming an implementation intention, participants establish a link between both components. It may be this association that leads to a benefit in performance.

Ellis and Freeman (chap. 1, this volume) compare and contrast prospective memory and implementation intentions and pose important questions concerning the point at which the similarities between these two phenomena begin and end. They acknowledge that the role of commitment to one's goal or intention plays an important role in implementation intentions research but fails to be measured or acknowledged in prospective memory research. Furthermore, Ellis and Freeman suggest that implementation intention researchers fail to acknowledge sufficiently the wide variation in intention characteristics (e.g., nature of the cue, nature of the ongoing task) and in the ways that implementation intentions are encoded (e.g., written or read aloud and imagined). In the domain of prospective memory, Ellis and Freeman suggest that researchers may have become too focused on experimental paradigms and fail to acknowledge the importance of the commitment of the individual to the intention, how the intention is formed, and whether the intention is social or not social. Ellis and Freeman also question the proposed automaticity of implementation intentions. We return to this issue of automaticity in the next section, as it is important.

If we compare prospective memory and implementation intentions from the point of encoding to execution (see Figure 17.7 for a conceptual model), we can see that implementation intentions may be a special case of prospective memory tasks. In prospective memory tasks, intentions can be thought of as *cue specific* or *cue unspecific*. An example of a cue-specific intention would be "I need to give a colleague a message when I see him or her during the colloquium," with the cue being the colleague. In contrast, an example of an intention that is cue unspecific would be "I need to remember to write a recommendation letter for my student." In implementation intention research, a goal intention takes the form, "I intend to write a recommendation letter." This type of intention is thought to be unreliable in

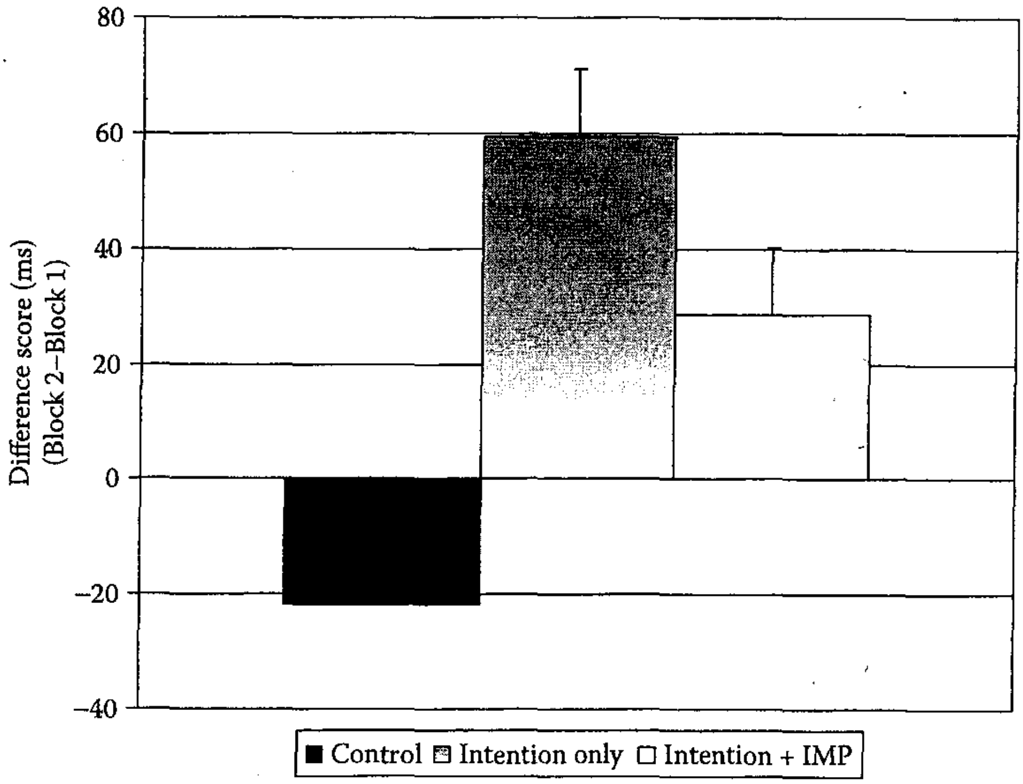

FIGURE 17.7 Conceptual model highlighting similarities and differences between prospective memory and implementation intentions.

the sense that one may not realize the goal, as there are a host of implemental problems (procrastination, distraction) that need to be solved successfully (Gollwitzer, 1996). However, when intentions take the form of an implementation intention ("If or when I finish my meeting, then I will write the recommendation letter"), a link is specified in the form of an if–then plan between a specific cue and desired response. It is in this form that there is higher likelihood that the intention will be successfully carried out. If we compare the cue-specific and cue-unspecific intentions, one can detect structural similarities between the goal intention, and the implementation intention. For example, one can see that the cue-specific intention is structurally similar to an implementation intention and the cue-unspecific intention is structurally similar to a goal intention. Therefore, it is with a cue-unspecific intention that using implementation intentions should benefit overall prospective memory performance. In cases where the cue is clearly specified, the intention already has the form of an implementation intention and benefits would not be expected. Therefore, implementation intentions can be thought of as a subpart of prospective memory in the sense that it is a strategy that helps to translate an ill-defined intention into a more clearly specified intention, which, in turn, has a higher likelihood of being successfully carried out.

As Chasteen et al. (2001) noted, implementation intentions only lead to a benefit with tasks that require a certain degree of self-initiation. In their background pattern task, implementation intentions did not lead to a significant improvement, whereas in the day-of-the-week task (which required a higher level of self-initiation), forming implementation intentions did lead to an improvement. In their background pattern task, the cue was highly integrated with the primary ongoing task. Therefore, little benefit was observed. Implementation intentions are if–then statements that are formed on top of "I will behave in such-and-such way in such-and-such situation" statements. In the statement "Please press the F1 key if you see the word *flower*," there is no selective specification of the if, or selective specification of the then. Therefore, explicit formation of an if–then link may not be achieved.

AUTOMATICITY

According to the multiprocess view (McDaniel & Einstein, 2000), successful prospective remembering can be mediated by strategic monitoring processes and in other cases by more automatic reflexive processes. This latter aspect of the multiprocess model builds on the earlier automatic associative module model (McDaniel, Robinson-Riegler, & Einstein, 1998). In this model, a cue must automatically interact with a memory trace for a prospective memory intention to be retrieved. When there is sufficient interaction between a prospective cue and an associated memory trace, this results in the memory trace for the intended action being delivered automatically to consciousness. Thus, successful prospective remembering is determined by the strength of association between the cue and the associated memory trace. If the cue does not automatically interact with a memory trace, that memory trace is not retrieved unless another memory module (prefrontal component) initiates a strategic memory search. Thus, the planning and encoding stage of prospective memory is critical for successful performance because an association between a cue and intention must be made to ensure successful prospective remembering (Kliegel, McDaniel, & Einstein, 2000).

Aspects of the automatic associative module model of prospective memory have implications for theory building in implementation intentions. Earlier in the chapter, we stated that forming an implementation intention causes the mental representation of the situational cue to become highly accessible, and that it is this heightened accessibility that makes it easier to detect the critical situation in the surrounding environment and readily attend to it even when one is busy with other ongoing activity. Moreover, this heightened accessibility should facilitate the recall of the critical situation because a strong link had been formed between the two components (situation cue + response). Implementation intentions are a strategy that can transform an intention that may require effort and attention into an intention that can be realized by more automatic processing. Thus, implementation intentions may increase the likelihood that there will be a strong association between the cue and associated memory trace, resulting in the memory trace for the intended action being delivered automatically to consciousness, as outlined by the automatic associative module model.

As stated earlier, it is important to be clear when we use the term *automaticity* in the context of implementation intentions. We use the word *automatic* in terms of Bargh's (1994) definition. Bargh argued that "mental processes at the level of complexity studied by social psychologists are not exclusively automatic or exclusively controlled but are in fact combinations of the features of each" (p. 3). Bargh suggested that there are three ways in which an individual may be unaware of a mental process: (a) A person may be unaware of the stimuli itself (e.g., subliminal perception), (b) a person may be unaware of the way in which he or she categorizes a stimulus event (e.g., stereotyping), and (c) a person may be unaware of the way in which his or her judgments or subjective feeling states are determined or influenced. For example, one may find a perceptual categorization task very fluid and easy to complete and may misattribute this feeling of ease to an incorrect cause because it is most available as an explanation. Therefore, forming an implementation intention results in a sensitivity to environmental cues that elicit a response or behavior that was previously paired with that cue, reducing the need for continued conscious control.

We understand this type of automatic action control as *strategic automaticity* or *instant habits* (Gollwitzer, 1999), as it originates from a single act of will rather than being produced by repeated and consistent selection of a certain course of action in the same situation (i.e., principles of routinization; Anderson, 1987; Fitts & Posner, 1967; Newell & Rosenbloom, 1981). Bargh and Chartrand (1999) suggested that mental representations that are designed to perform a certain function will perform that function once activated (regardless of the origin of that activation). The authors suggest that the representation does not "care" about the source of its activation because the mental representation is similar to a button being pushed. They stated, "In whatever way the start button is pushed, the mechanism subsequently behaves in the same way" (p. 476). Thus, similar to descriptions of the automatic associative model (McDaniel et al., 1998), if there is sufficient association between a situational cue and a desired behavior or response, the behavior will unfold automatically once the cue is successfully identified.

MECHANISM OF IMPLEMENTATION INTENTIONS

Automatic action initiation is the notion that established routines linked to a relevant context are released when the necessary conditions exist without the need for controlled or conscious intent (Bargh, 1989). Forming implementation intentions involves the establishment of a critical situation, and it is assumed that implementation intentions lead to a heightened accessibility of the situational cue, which in turn facilitates the detection of the situational cue in the environment. Sohn and Anderson (2001) proposed an ACT–R (adaptive control of thought–rational) model to explain task-switching costs. Their model assumes that information processing involves a sequence of production rule firings, and each of these production rules involves "retrieving some declarative information, called chunks, to transform the current goal state" (Sohn & Anderson, 2001, p. 764). They also suggested that the speed of retrieval of information depends on the level of activation of these rules. In a similar vein, implementation intentions are thought to lead to successful goal attainment based on the heightened activation level of a situational cue, which in turn eases retrieval of the associated response. Therefore, it may be that implementation intentions facilitate retrieval of intentions because the necessary "chunk" of declarative information for performing the intention is highly activated through the formation of an implementation intention.

Some confusion arises with standard prospective memory tasks, which often use instructions that resemble the wording of an implementation intention (e.g., "Press the F1 key when you see an animal word"). However, implementation intentions involve a purposeful and deliberate act in which a strong if–then link is created in a situation where the intention has not been so deliberately specified. It is possible that an individual may respond to prospective memory instructions by spontaneously forming a strong if–then link and creating conditions similar to those in implementation intentions, thereby enhancing their prospective memory performance.

MAJOR ISSUES AND FUTURE DIRECTIONS

In this chapter, we had two primary objectives. First, we examined the delicate balance between prospective memory and ongoing task performance. Second, we examined how a self-regulatory strategy known in the social cognitive domain has relevance in the realm of prospective memory. Regarding the former objective (examining the balance between prospective memory and ongoing task costs), it may be useful to consider the task-switching literature. Surprisingly, these two domains have not been thoroughly compared to date.

It is important to address the extent to which task switching and prospective memory are distinct or share common features, on the construct level and on the operational level. Often prospective memory failures are blamed on the fact that a

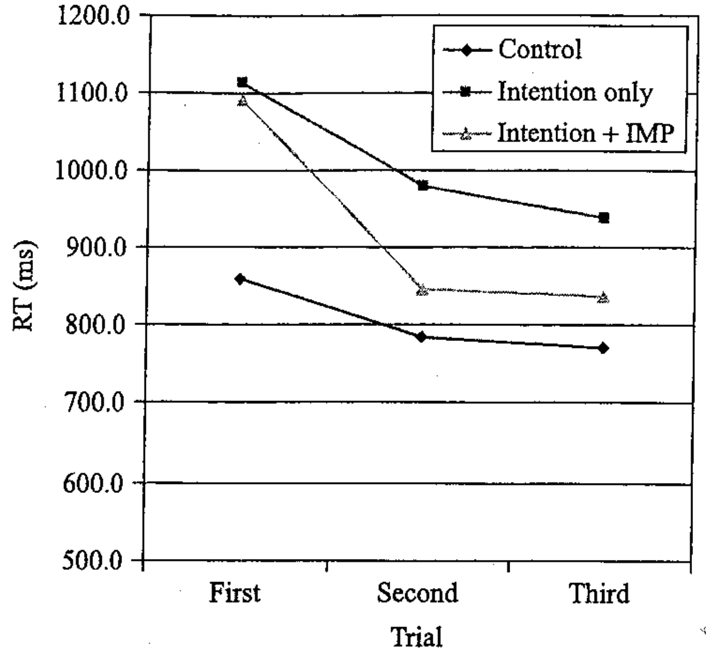

FIGURE 17.8 Reaction time latencies (switch costs) on the first three trials following a prospective memory target as a function of condition.

person becomes so engrossed in an ongoing task that he or she fails to remember to execute an intention. In other words, failures in prospective memory may be due to an inability to switch attention from ongoing task activity to execution of an intention. In our Experiment 4, we examined lexical decision task latencies on the first three trials following a prospective memory response. The resulting pattern of responding was similar to costs observed in a task-switching scenario (see Figure 17.8). That is, after making the response to the prospective memory target, there were increased costs for the first three trials before performance leveled off. This seems to suggest that there is some recovery time before participants are able to get back into the mindset of the ongoing task. Therefore, these costs may reflect a "reconfiguring of task set" similar to that described by Rogers and Monsell (1995) in the task-switching literature. Although not statistically significant, inspection of Figure 17.8 shows that those in the intention + IMP condition recovered more quickly from switch costs compared to those in the intention only condition in the second trial following a prospective memory target. An interesting future study would be to examine whether forming implementation intentions can reduce switch costs. Future research would benefit by comparing and contrasting processes shared in prospective memory and task-switching paradigms.

Another primary objective of this chapter was to examine the influence of a self-regulatory strategy on ongoing task costs. Results from Experiment 4 showed that forming an implementation intention may facilitate the switch of attention from an ongoing activity to remembering to execute an intention. Most interestingly, results showed that improvement in prospective memory performance was not necessarily at a cost to ongoing task performance.

Some researchers may have assumed that implementation intentions are a form of a motivational manipulation in the sense intentions furnished with an implementation intention may be perceived by the participant as more important compared to the ongoing task requirements. However, the lack of increased ongoing task costs in the implementation intention condition compared to the intention only condition did not support this interpretation. Implementation intentions create a strong link between an anticipated situational cue and a desired response, and this link may facilitate the switch of attention from an ongoing activity to retrieving an intention. There are two reasons why implementation intentions are thought to benefit performance. First, encoding an implementation intention leads to a heightened accessibility of the situational cue (either by increased activation or a reduced threshold), therefore helping to facilitate the detection of that cue in the environment. In a sense, they create a state of perceptual readiness. Second, implementation intentions establish a situation–behavior or response link, and in turn, established routines linked to a relevant context release the critical goal-directed behavior once the situational cue is encountered. By forming implementation intentions, people can strategically switch from conscious and effortful control of their goal-directed behaviors to behavior being automatically elicited by selected situational cues. According to automotive theory (Bargh, 1999), the heightened accessibility of goal-relevant information results in the processing of these stimuli preconsciously, which in turn leads to the direct activation of a behavior without conscious intent (Bargh, 1999). As Bargh and Chartrand (1999) suggested, mental representations that are goal directed to perform a certain function will perform that function once activated without the need for conscious control. Using this framework, it is possible that information related to an intention is processed more efficiently when that information is furnished with an implementation intention.

This examination also revealed the importance of cognitive load in determining the degree of ongoing task costs. Our results showed that there were no costs to ongoing task performance in the one-word condition and only marginal costs in the two-word condition, with significant costs emerging in the three-word condition. Similar to ideas expressed by Unsworth and Engle (2006), we suggest that there are few ongoing task costs in the one-word and two-word conditions because targets can be maintained in primary memory. Primary memory is thought to maintain four or fewer separate representations active for ongoing processing. When the number of targets exceeds this limit, they must be retrieved from secondary memory, yielding significant ongoing task processing costs (Unsworth & Engle, 2006). Furthermore, there can be instances in which primary memory is only able to hold less than its maximal limit, such as when trying to maintain information in the presence of an ongoing goal representation (i.e., lexical decision task).

To summarize, our results suggest that working memory load may influence the way that attention is allocated over the course of the task. Increased ongoing task costs may reflect the need to retrieve targets from secondary memory when the number of targets exceeds the capacity of primary memory. Results from our Experiment 4 suggest that self-regulatory strategies known as implementation intentions may help to reduce this cognitive burden by freeing up resources for ongoing task processing.

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