Abstract

According to one theory, the discrepancy-attribution theory, episodic prospective memory task retrieval involves a discrepancy-attribution mechanism. It is assumed that planning activities prime the representation of the retrieval cues involved in a prospective memory task. Therefore, when those cues are subsequently encountered – during the retrieval phase, their processing is facilitated, and this facilitation is perceived as oddly fluent, as discrepant with expectations. Previous work has shown that subjects interpret this processing discrepancy in a flexible manner. The main goal of the present study was to investigate the role of discrepancy-attribution in episodic prospective memory task retrieval under conditions where the ongoing task focused either on performance speed or on performance accuracy.

I conducted a series of experiments in which the prospective memory task required subjects to press a key on the keyboard when they noticed prospective memory cue words. To produce and manipulate the discrepancy reactions, half of the cue words in each experiment were primed (i.e. preceded by the masked presentation of the same word) and the others were shown without primes. The prospective memory cues were shown either as part of a lexical decision task, which focused on speed, or in the course of an anagram-solving task, which focused on accuracy.

The results showed the priming manipulation facilitated prospective memory task performance in all experiments. However, in the experiment where the ongoing task required making lexical decision, subliminally priming prospective memory cues benefited only the speed of making prospective memory responses, but not their accuracy. By contrast, in the anagram-solving task, the accuracy driven task, subliminally priming prospective memory cues facilitated the accuracy of prospective memory
responses, but not the speed of those responses. These findings are consistent with the discrepancy-attribution theory, as well as with prior evidence that discrepant reactions tend to be interpreted flexibly, in line with the demands of the ongoing or dominant task.
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Introduction

Prospective memory (ProM) is the ability to make plans, to retain them and to carry them out at the appropriate time or in the appropriate context (Einstein & McDaniel, 1996; Graf & Uttl, 2001; Meacham & Dumitru, 1976). Everyday life examples include remembering to get groceries en route from work, remembering to take cupcakes out of an oven, or remembering to take medication three times a day. As illustrated by these examples, there are many kinds of ProM tasks, and ProM researchers have used different labels to distinguish among them, for example, specially focusing on episodic ProM tasks (Graf, 2005; Kvavilashvili & Ellis, 1996), monitoring tasks (Ceci & Bronfenbrenner, 1985), and habitual ProM tasks (Meacham & Leiman, 1982). Episodic ProM tasks are tasks that involve a long delay between making a plan and executing it, for instance, remembering to pick up groceries after work. Monitoring tasks are tasks in which intentions are held in our consciousness throughout the retention interval, for instance, remembering to check cupcakes in the oven. Habitual ProM tasks are tasks that need to be executed repeatedly, for instance, remembering to take medications three times a day. The goal of my thesis is to understand the underlying processes involved in episodic ProM task retrieval.

My work focuses on the retrieval phase of episodic ProM tasks because it is this phase that differentiates most clearly between ProM tasks and retrospective memory (RetM) tasks. For RetM tasks, at the time of retrieval, we are aware or are made aware of the retrieval cues that are provided, and we are instructed to use those cues to recollect what happened in the past. By contrast, for ProM tasks, ProM-cues are embedded in the environment, and we may or may not be aware of them or of their significance and we are definitely not instructed to work with the cues in a ProM task relevant manner (Graf & Uttl, 2001; Kvavilashvili, 1992). Therefore, successfully carrying out a ProM task requires us
to identify and interpret ProM-cues as a signal for recollecting previously formed plans (Graf & Uttl, 2001). When I pass by a supermarket on the way home, no one reminds me that the supermarket is a cue for picking up groceries, and this is completely up to me to identify the supermarket as a cue for recollecting my previously formed plan.

Three different theoretical accounts have been proposed for the sensory, perceptual, cognitive, and attentional processes that are required for episodic ProM task retrieval: the resource model of Craik (1986), the noticing-plus-search model of Einstein and McDaniel (1996), and the preparatory attentional and memory processes theory of Smith (2003). These three theories focus on explaining whether ProM task retrieval is mediated by automatic or attention-demanding controlled processes. According to Craik (1986), all memory retrieval processes can be arranged on a continuum according to their requirements for cognitive resources, and he postulated that of all memory tasks, retrieval for ProM tasks is the most resource demanding. Craik argued that because our cognitive resource declines with age, and ProM task performance should show the largest age-related decline. According to the noticing-plus-search theory, Einstein and McDaniel (1996) argued that episodic ProM task retrieval reflects typical retrieval processes involved in recognition tasks. According to the noticing-plus-search model, Einstein and McDaniel suggested that there are two stages included in the retrieval phase of ProM tasks. In the first stage, called noticing, encountering ProM-cues may automatically elicit some feelings like familiarity, which cause the ProM-cues to be noticed or recognized. In the second stage, searching, there is a search to determine why the ProM-cues might be significant, and that would then lead to the recollection of the ProM tasks or intentions. The preparatory attentional and memory processes theory focuses on explaining the resource cost before completing ProM intentions. According to the preparatory attentional and memory processes theory, Smith (2003) suggested that
completing ProM tasks requires preparatory attention to monitor the environment for the occurrence of ProM-cues, and this controlled preparatory monitoring costs resource capacity consuming while we are holding ProM intentions. All three theories argue that resources are required at some phase during ProM task retrieval. Each theory provides its own suggestions of where the resources are required in ProM task retrieval processes.

Previous three theories have been used to explain many empirical findings in ProM studies. And because these previous theories are very influential in ProM area, most research on episodic ProM task retrieval only focus on examining and discussing whether ProM task retrieval is an automatic or a controlled process. However, there is clearly more to ProM task retrieval processes than their degree of automaticity. For example, one important feature of ProM tasks is that at the time of retrieval, when the ProM-cue occurs, we always engage in other activities. These activities are commonly called ongoing tasks in ProM studies (Einstein & McDaniel, 1990; 1996; Ellis, Kvavilashvili, & Milne, 1999). Since previous theories emphasize that the resources are important for ProM task retrieval, a lot of research guided by those theories focus on exploring whether the attentional resources required for the ongoing task influence ProM task performance (e.g., Jacova, 2003; Marsh, Hancock, & Hick, 2002). However, the ongoing task contexts vary a great deal, and besides categorizing the ongoing tasks based on the required attentional resources, there are many other ways to categorize and understand the ongoing tasks’ influence to ProM task performance. Therefore, I wish to draw attention to another theory, the discrepancy-attribution theory. The specific objective of my thesis is to examine whether the discrepancy-attribution theory helps us to understand the underlying sensory, perceptual, and cognitive processes involved in ProM task retrieval.
The discrepancy-attribution notion has been achieved its present status in connection with research on false memories (e.g., Jacoby & Dallas, 1981; Jacoby & Whitehouse, 1989; Whittlesea & Williams, 1998, 2001a, 2001b). However, the basic ideas underlying this notion date back a long way about 35 years, for example, Zajonc (1968) observed that "the mere repeated exposure of the individual to a stimulus is a sufficient condition for the enhancement of his attitude toward it" (p. 1). In one of his classic experiments (1968), he showed participants some photos of male undergraduate students in the first phase. Some of the photos were shown only once or twice to participants, while other photos were shown up 25 times. In the second phase, participants were asked to rate how much they like each man in the photo. Zajonc found that the more often a photo had been pre-exposed to the participants, the more participants claimed to "like" the man on that photo.

Recently, Whittlesea and Williams (1998, 2001a, 2001b) summarized previous research and provided an elaborated version of the discrepancy-attribution theory. According to the theory, Whittlesea and Williams (1998, 2001a, 2001b) suggested that our cognitive system has something like an expectation of how fast or how fluently an event should be processed. If the system's expectation is violated, i.e., a target event is processed more fluently than it expected by our cognitive system, the system will have a discrepancy reaction. And this discrepancy reaction is always unconsciously attributed to a cause.

How do we attribute a discrepancy reaction? Jacoby and his colleagues (Jacoby, Kelley, Brown, & Jasechko, 1989) made a compelling demonstration. In their experiment, they included two phases: a study phase and a test phase. In the study phase, participants were asked to read randomly selected names. Participants came back to the
lab 24 hours later for the test phase. In the test phase, the researchers showed participants a long list of names, of which half were famous names, and the remaining half were non-famous. Half of the non-famous names had been shown in the study phase, and the other half had not been shown in the study phase. Participants were asked to make a decision whether or not the names were famous. The results showed that participants were more likely to falsely rate the non-famous names that had been seen in the study phase as famous names than the non-famous names that had never been seen before. Jacoby and his colleagues explained their findings by arguing that the names presented in the study phase were pre-exposed to participants, and when these names were encountered again in the test phase, they were processed more fluently. Participants interpreted this odd fluency of processing in-line with the judgment task and they (mis)interpreted it as fame.

The discrepancy-attribution theory has been discussed by many researchers (e.g., Mandler, 1980, 1991; Jacoby & Whitehouse, 1989; Moscovitch & Bentin, 1993), who showed that discrepancy reactions can be interpreted in a flexible manner. For example, it can be interpreted as familiarity in a recognition task (e.g., Jacoby & Whitehouse, 1989), as liking in a preference test (e.g., Kunst-Wilson & Zajonc, 1980), or as novelty in an interestingness rating task (e.g., Berlyne, 1974). Whittlesea and Williams (1998, 2001a, 2001b) suggested that the interpretation of the discrepancy reaction is determined by the mental state or the demands of the task context, and the interpretation of the discrepancy reaction is in line with the judgment of the task.

How can we apply the discrepancy-attribution theory to ProM task retrieval? According to the discrepancy-attribution theory, when we make a ProM plan, we actually prime the ProM-cue or a context in which the ProM-cue may appear. Thus, the next time
we encounter the cue, our cognitive system should process it more fluently than expected by our system. This odd fluency may then trigger a discrepancy reaction, and then the discrepancy reaction is unconsciously attributed to our ProM task plans, and resulting in our recollection of a previously formed plan. According to the theory, three stages are involved in ProM task retrieval. The first stage occurs when the planning activities “prime” the ProM-cue. The second stage occurs at the time of retrieval when the ProM-cue appears. Our system has a discrepancy reaction when we encounter the cue for the next time. The third stage takes place as we attribute the discrepancy reaction to our ProM task and recollect our previously formed intention.

To examine whether the discrepancy-attribution theory helps us to understand the underlying processes involved in ProM task retrieval, I conducted four experiments. To assess ProM task performance, at the beginning of each experiment, participants were assigned a ProM task, which required them to press the Q-key on the keyboard when they encountered specific ProM-cues (e.g., a name of a musical instrument) in the experiment. After a retention interval, the ProM-cues appeared when participants engaged in an ongoing task. The purpose of using the ongoing task in the experiment paradigm is to simulate the ongoing activities that occur in our daily life (e.g., driving home from work), and the ProM-cues were always embedded in the course of the ongoing task. In these experiments, I used two types of ongoing tasks. In Experiments 1 to 3, the ongoing task was a lexical decision task, a speed focused task, and in Experiment 4, the ongoing task was an anagram-solving task, an accuracy focused task.

To increase the magnitude of the discrepancy reactions to the ProM-cues, I showed half of the ProM-cues with unconscious identity primes, i.e., the ProM-cues are preceded by a 40ms masked presentation of the same word, while I showed the remaining cues
without primes. There are two reasons for using unconscious primes. First, according to
the discrepancy-attribution theory, when we make plans, the representations of the
relevant cues are "primed". Therefore, the unconscious primes in my experiments should
act in someway like planning activity. Second, when the ProM-cues occur during the
retrieval phase, the unconscious primes should increase the magnitude of the
discrepancy reactions. According to the discrepancy-attribution, the general hypothesis
of my work is that the processing of subliminally primed ProM-cue words will be
"discrepant" with participants' expectations, and this discrepancy reaction will be
attributed to previous plan, and result in facilitation on ProM task performance.

Experiment 1

Method

Participants
Thirty-three undergraduate students were recruited through the Psychology department
subject pool at the University of British Columbia. They participated in return for course
credit. The experiment was conducted with the approval of the University of British
Columbia behavioral ethical review board.

Materials and Instruments
I selected 189 familiar English words as stimuli for a lexical decision task. These words
were between 5 and 7 letters long, with an average of 5.8 letters, and of high frequency,
ranging from 65 to 150 occurrence per million according to Kučera and Francis (1967). I
also created 189 pronounceable non-words by replacing one or two letters of each of the
words. I randomly selected another 50 familiar words to be used as unrelated primes for
the lexical decision task. The prime-words had between 5 and 7 letters, with a frequency
ranging between 70 to 120 occurrence per million (Kučera & Francis, 1967).
I also chose 6 words, each the name of a familiar musical instrument, from the Batting and Montague (1969) category norms: clarinet, trumpet, banjo, viola, guitar, and flute. These words served as cues for the episodic ProM task.

The neuropsychological test battery was comprised of four standardized tests: the Color-Word Stroop Test, the North American Adult Reading Test, the Verbal Learning Test, and the Digit Symbol Substitution Task. The following paragraphs give a brief description of each of these tests.

The Color-Word Stroop Test (Stroop test). The Stroop test is used for assessing attention. I used Graf, Uttl, and Tuokko's (1995) version of the Stroop test (Stroop, 1935). For Part 1 of this standardized test, participants are given a page with color words printed in black ink and are asked to read out loud the words as quickly and accurately as possible. For Part 2, participants are given a page with XXXs printed in various ink colors and they are asked to say out loud the ink color of the XXXs as quickly and accurately as possible. Finally, for Part 3, participants are given a page with color words printed in incongruently colored inks (e.g., the word green printed in red ink), and they are asked to say out loud the ink color of the printed words as quickly and accurately as possible. The experimenter records the time it takes to complete each part of the test as well as the number of corrected errors and the number of uncorrected errors.

The North American Adult Reading Test (NAART). The NAART is a test used for determining the verbal abilities of participants. For this standardized test (Blair & Spreen, 1989), participants are given a sheet of paper with 61 irregular rare words printed on it and they are asked to read each word out loud. Participants' reading of the words is recorded and the total number of words pronounced incorrectly is scored.

The Verbal Learning Test (VLT). The VLT is a modified version of the standardized Rey Auditory Verbal Learning Test (Lezak, 1995), which is used for assessing explicit
episodic RetM. For this test, I first showed participants a list of 20 words (List A) printed on index cards, each word for about 2 seconds, and then I asked participants to repeat back as many words as they could. The same list of 20 words, List A, was presented for a total of 3 identical study-test trials. After this phase, I showed participants a new list of 20 words (List B) and asked them to recall it. When participants indicated that they could no longer recall any more words from List B, they were again asked to recall all of the words they could remember from List A. Twenty five minutes later, I asked participants to recall the words they could remember from List A once again. I recorded the number of words correctly recalled on each trial.

The Digit Symbol Substitution Task (DSST). The DSST measures processing and motor speed. For this standardized test (Wechsler, 1981) participants are shown 9 written symbols on the top of a page, each symbol paired with a single digit between 1 and 9. At the bottom of the page, participants are shown 84 squares; each square contains a randomly assigned digit between 1 and 9. Participants are required to draw the matching symbol underneath each digit as quickly and accurately as possible. The experimenter records the time it takes to complete the test.

Procedure

Participants were tested individually in one session that lasted about one hour. They were informed that the experiment involved a variety of tasks, with some focusing on their ProM ability and others on their cognitive ability. After giving consent, each participant completed the sequence of activities listed in Table 1.

<table>
<thead>
<tr>
<th>Table 1</th>
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<tbody>
<tr>
<td>After giving consent, I assigned the ProM task to participants. Specifically, I instructed them to press the Q-key on the keyboard if ever they saw the name of a musical instrument anywhere in the course of the experiment. The instructions</td>
</tr>
</tbody>
</table>
emphasized that pressing the Q-key was the only correct response to the names of musical instruments. I explained the ProM task instructions until participants understood and were able to correctly repeat them. During the entire experiment, participants were not further reminded about the ProM task.

Immediately after receiving the ProM task instructions, participants completed the neuropsychological tests in the order listed in Table 1. These tests served a dual-purpose. First, they created a delay between receiving the ProM task instructions and conducting the ProM task, and second, they were useful for determining the general cognitive ability of the participants. Participants required an average of 25 minutes to complete the neuropsychological tests.

The next task, the lexical decision task, was given immediately after all of the neuropsychological tests. The lexical decision task served as the ongoing task for the experiment. Participants were given instructions and an opportunity to practice the task which required them to decide whether or not letter-strings formed valid English words. The practice phase of the lexical decision task helped to familiarize participants with the task as well as to identify participants with poor English language skills.

Each trial of the lexical decision task consisted of the sequence of events shown in Figure 1. To begin a trial, a fixation point—a plus sign—was displayed in the center of the monitor for 500 milliseconds. The fixation point was replaced by a pre-mask, and displayed for 250 milliseconds. A prime screen, which was always blank during the practice phase, replaced the pre-mask, and lasted for 40 milliseconds. The prime screen was followed by a post-mask that lasted for 250 milliseconds. After the post-mask, a letter-string was displayed. Participants responded to each letter-string by pressing the left arrow key if it was a word, and pressing the right arrow key if it was a non-word. After participants made their responses, they received feedback, specifically their decision
times on the current trial and their cumulative accuracy on the practice phase items. The feedback screen lasted for 1 second. After it, the fixation point reappeared to begin the next trial. Each participant practiced the lexical decision task for 60 trials. For this purpose, I used a randomly selected set of 30 stimuli from the word set as well as 30 stimuli from the non-word set described in the Materials section. I encouraged participants to make their decisions as quickly and accurately as possible. I also informed them that in order to continue to the critical phase of the experiment, they needed to achieve at least a 90% level of accuracy in the practice phase.

The critical phase of the lexical decision task began immediately after the practice phase. In this phase, participants received 324 trials, including 318 lexical decision task trials and 6 ProM task trials. Each trial was arranged as shown in Figure 1. Six ProM-cues were interspersed among the lexical decision task trials, the first appearing on the 51st trial of the lexical decision task, and the next 50 trials later, and so on. Half of the ProM-cues were displayed with an identity prime (i.e., with a prime word that was the same as the word shown for that trial) and the remaining half were displayed with no prime (i.e. a blank screen preceded the word shown for that trial). I counterbalanced the priming condition of the ProM-cues across participants. For the word stimuli of the lexical decision task I used three types of primes: identity primes, unrelated primes (i.e. an unrelated word preceded the word displayed for that trial), or no primes. For the prime words in the unrelated prime condition, I used the 50 words described in the Materials section. The word stimuli in the lexical decision task were divided into three 53-word sets. One set had identity primes on the prime screen; one set had unrelated primes; the last set had no primes. Across individuals, counterbalancing ensured that each lexical
decision task word appeared equally often in each priming condition. None of the non-words were displayed with primes.

Immediately after the critical phase of the lexical decision task, participants were administrated the delayed recall test of the VLT. After the recall test, I gave participants a verbal debriefing and course credit.

Results and Discussion

Data Preparation

I tested 33 participants in Experiment 1. Three participants did not achieve the required level of accuracy in the practice phase of the lexical decision task, and thus none of their data were included in any data analyses.

All of the data were checked and corrected for transcription errors until accuracy was greater than 99%. There were no missing values in any data set.

Data from the neuropsychological tests, the lexical decision task and the ProM task were examined for univariate outliers, defined as values falling more than 3 standard deviations away from the mean. Two univariate outliers were discovered in the neuropsychological test data. They were replaced with the nearest non outlying value, specifically, a score either -3 or +3 standard deviations away from the corresponding mean.

Preliminary Results

Neuropsychological Tests. There were several reasons for giving these neuropsychological tests. First, they were useful for filling the delay between the encoding phases and the retrieval phase of the ProM task. Second, as the population I sampled from has a relatively large number of students whose first language is not English, I used performance on the lexical decision task and on the NAART to screen out any participants whose English skills might be too poor to understand the ProM
instructions. The neuropsychological tests are also useful for ensuring that the participants of samples are comparable across experiments, and they are similar to those used in previous investigations. The last purpose of these tests was to examine whether neuropsychological test performance predicted RetM task performance and ProM task performance. Previous research did with older adults showed that cognitive ability is related to RetM task performance (e.g., Craik, 1986; Hasher & Zacks, 1979; Jorn, 1986; Kausler, 1991; Salthouse, 1996) and ProM task performance (e.g. Brandimonte, Einstein, & McDaniel, 1996; Cuttler, 2004; Uttl, Graf, Miller, & Tuokko, 2001; West, 1996). However, no research shows the relationship between cognitive ability and memory task performance on undergraduate students. This is likely because researchers believe that students all perform fairly well on neuropsychological tests, and therefore, their performance scores have small variances and small score ranges. Therefore, it is less likely to find any relationship between cognitive ability and memory task performance. I included these neuropsychological tests to give me a rough idea of participants' cognitive ability so that I could examine there are any relationships between participants' performance on the neuropsychological tests and memory task performance on undergraduate students.

For the Stroop test I recorded the time it took to complete each part of the test as well as the number of corrected and uncorrected errors each participant made on each part of the test. Errors were rare, and thus I pooled the corrected and uncorrected errors and calculated the total number of errors on each part of the test. To obtain the magnitude of Stroop interference, I calculated a time difference score by subtracting the amount of time each participant took to name the ink colors of the XXXs from the amount of time each participant required to name the ink colors of the incongruent color words. Higher difference scores indicate more Stroop interference. In the top part of Table 2, I report the
mean amount of time taken to complete each part of the test, the mean number of errors made on each part of the test, and the magnitude of Stroop interference. All of my scores were compared with previous results from healthy normal individuals to check whether participants in my experiment were normal. The mean score and standard deviation of each trial of the Stroop test and the magnitude of the Stroop interference I obtained were similar to the means and standard deviations from a corresponding age group reported in Uttl and Graf (1997).

Table 2

For the NAART I recorded each participant's reading of the words and scored the total number of mispronunciations. Possible scores range from 0 to 61, with higher scores indicating more mispronunciations and poorer verbal ability. The mean number of mispronunciations is reported in Table 2. The mean and standard deviation I obtained from the NAART were similar to the mean and standard deviation from a corresponding age group reported in Uttl (2002).

For the VLT I recorded the number of words correctly recalled on each trial. The test yielded 6 scores of participants' recall performance, each out of 20. Higher scores indicate better RetM task performance. Participants' recall performance on each trial of the VLT is summarized at the bottom part of Table 2. The means and standard deviations of recall performance I obtained for the VLT were comparable to the means and standard deviations from a corresponding age group reported in Vakil and Blachstein (1997).

For the DSST I recorded the time it took to complete the test. Shorter times indicate faster processing and motor speed. The mean time of completing the DSST is reported in Table 2. The mean time of completing the DSST and the standard deviation I obtained were comparable to the findings in Parkin and Java (1999).
In summary, the means and standard deviations of all the neuropsychological tests were compared with previously published scores from healthy normal individuals. I found that all of the means and standard deviations were comparable to previous findings from a corresponding age group.

To screen out participants who had poor English skills, I ran two outlier analyses on the lexical decision performance in the practice phase and the NAART scores. As described in the Data Preparation section, three participants were eliminated after the practice of the lexical decision task. No outliers were found in the NAART scores. This may be because participants with very poor English skills have been already eliminated after the practice phase of the lexical decision task.

To examine whether participants' performance on the neuropsychological tests was related to RetM task performance (e.g., Craik; 1986; Hasher & Zacks, 1979; Jorn, 1986; Kausler, 1991; Salthouse, 1996) and ProM task performance (e.g. Brandimonte, Einstein, & McDaniel, 1996; Cuttler, 2004; Uttl, Graf, Miller, & Tuokko, 2001; West, 1996), I conducted two simultaneous regression analyses. To reduce the number of VLT scores, first, I created a composite RetM score, by taking the first principal component of the six VLT scores. The composite score served as an index of episodic RetM task performance.

Then I conducted a simultaneous regression analysis to examine whether participants' performance on the neuropsychological tests predicted RetM task performance, by regressing participants' performance on the neuropsychological tests onto their VLT composite score. The regression results are reported in Table 3. The results showed that $R$ for regression was not significantly different from zero, $R = .41$, $R^2 = .17$, $\Delta R^2 = .07$, $F (3, 26) = 1.71$, $MSE = .93$, which means that participants' performance on the neuropsychological tests cannot successfully predict RetM task performance. For this and all following statistical analyses, the $\alpha$-level was set at .05.
To examine whether participants' performance on the neuropsychological tests predicted ProM task performance, I conducted a simultaneous regression analysis by regressing participants' performance on the neuropsychological tests onto their ProM task accuracy. The ProM task accuracy was the likelihood of pressing the Q-key when the ProM-cues were encountered. It was obtained by computing the proportion of successful ProM-cue responses in the ProM task, out of a maximum possible of 6. The regression results are reported in Table 4. The results showed that $R$ for regression was not significantly different from zero, $R = 0.31$, $R^2 = .10$, and $\Delta R^2 = .05$, $F(4, 25) < 1$, which means that participants' performance on the neuropsychological tests cannot successfully predict overall ProM task accuracy.

It was not surprising that participants' performance on the neuropsychological tests was not able to predict either RetM task performance or ProM task performance. As I discussed above, my participants were undergraduate students who have high performance scores on all of the neuropsychological tests and small variances on their performance scores. I believe that null findings in both regression analyses are due to the restriction of score ranges, and that affected the magnitude of correlations between neuropsychological test performance and memory task performance.

**Main Results**

**Ongoing task.** The dependent measures for the ongoing task were the portion of correct lexical decisions and the amount of time required to make lexical decisions in each priming condition. For each participant, I computed the mean proportion of correct decisions, and the median response time on trials with correct lexical decisions in each priming condition. The mean level of performance accuracy was .99, $SD = .02$, in the
identity prime condition, .98, SD = .03, in the no prime condition, and .97, SD = .02, in the unrelated prime condition. I found that participants responded faster to the words in the identity prime condition, Mean = 547.15, SD = 59.16, than to the words either in the no prime condition, Mean = 583.98, SD = 60.87, or in the unrelated prime condition, Mean = 575.83, SD = 63.46. An analysis of variance (ANOVA) was conducted on the response time data with the priming condition (identity prime, unrelated prime, and no prime) as a within-subject factor, and it revealed a significant main effect due to priming condition, F (2, 58) = 26.16, MSE = 429.26. Follow-up t-tests confirmed that lexical decisions were made significantly faster in the identity prime condition than either in the no prime condition, t (29) = - 7.94, or in the unrelated prime condition, t (29) = - 4.47.

The results of the lexical decision task are consistent with findings from previous research (e.g., Forbach, Stanners, & Hochhaus, 1974; Scarborough, Cortese, & Scarborough, 1977) that unconscious primes facilitate the subsequent lexical decision responses. Comparing to the words in the no prime condition, the amount of priming facilitation on the decision time was 36.83 ms for words in the identity prime condition; this is comparable to the results found in the experiments using similar masked priming manipulation (e.g., Forster & Davis, 1984; Segui & Grainger, 1990).

ProM task. ProM task performance was scored as successful if participants pressed the Q-key on the trial in which the cue word appeared. Late responses in which the key was pressed on a subsequent lexical decision trial were infrequent (4.44%), and to be consistent with previous research (see Marsh Hancock, & Hicks, 2002), when late responses occurred, I scored them as failed ProM task responses.

The critical dependent measures for the ProM task were response speed, the mean amount of time required to respond to ProM-cues, and performance accuracy, the likelihood of making a ProM task response to a ProM-cue in each of the priming
conditions. For each participant, response speed in each priming condition was the mean response time of successful ProM-cue responses, and performance accuracy was the proportion of successful ProM-cue responses out of a maximum possible of 3.

Figure 3

Figure 3 shows the mean amount of time required to make correct ProM task responses in each priming condition. Participants were faster to respond to the ProM-cues in the identity prime condition, Mean = 1468.41 ms, SD = 344.46 ms, than in the no prime condition, Mean = 1640.03 ms, SD = 413.20 ms, thus producing a priming effect of 171.62 ms. Because not every participant in the experiment made at least one ProM task response in each priming condition, I assessed the difference in the speed of making ProM-cue responses by means of Cohen's effect size measure, d = .54. According to Cohen (1988), this is a medium effect size.

Figure 4 shows ProM task accuracy, the likelihood of making a ProM task response to a ProM-cue in each of the priming conditions. Mean accuracy was .34, SD = .27, in the identity prime condition, and .36, SD = .32, in the no prime condition. I used a paired-samples t-test and found that there was no significant difference in performance accuracy between the two priming conditions, t (29) < 1, effect size d = .04.

Figure 4

Discussion

Based on the discrepancy-attribution theory, my hypothesis for Experiment 1 was that subliminal primes should increase the discrepancy reactions to the ProM-cues and result in facilitation on ProM task performance. The main findings from Experiment 1 showed that unconscious primes facilitated the speed of making correct ProM task responses, but they did not facilitate the ProM task accuracy. The result on speed of ProM task responses was consistent with my hypothesis. The magnitude of priming facilitation on
the performance speed was 171.62 ms in the ProM task, which was nearly 5 times bigger than what I found in the lexical decision task, 36.83 ms. This difference may indicate that the unconscious primes had more contributions to ProM-cues rather than just a simple priming effect. It shows that the unconscious primes increased the fluency of processing the subsequent ProM-cues, and therefore, reduced the time required to recognize the word as a cue for recollecting our intentions.

I did not find differences on ProM task accuracy across priming conditions. This may be because the discrepancy reaction was not unique to primed ProM-cues. In my experiment, I primed half of the ProM-cues, and a proportion of the words in the ongoing task (i.e. the lexical decision task), primed words in the ongoing task were also processes oddly fluently, and led to discrepancy reactions. Although the discrepancy reactions for the words in the ongoing task were not able to be attributed to our intentions, the priming manipulation in the ongoing task still led the discrepancy reaction not unique to primed ProM-cues. McDaniel and his colleague (2004) found that increasing the fluency of processing the stimuli in the ongoing task impaired ProM task performance. Previous research (e.g., McDaniel & Einstein, 1993) also showed that increasing the distinctiveness of ProM-cues resulted in higher ProM task accuracy. In light of this type of evidence, in Experiment 2, I increased the distinctiveness of the ProM-cues by priming only the ProM-cues, but not any other stimuli in the ongoing task. I expected that the uniqueness of discrepancy reactions on primed ProM-cues may result in increasing ProM task accuracy.

This was the first experiment that used unconscious primes to facilitate ProM task performance and applied the discrepancy-attribution theory in a ProM task situation. Therefore, the results need to be replicated. I also would like to know whether I could
boost the ProM task accuracy by increasing the uniqueness of discrepancy reactions to primed ProM-cues.

Experiment 2

Experiment 2 was designed for two purposes. The first purpose was to examine whether my results in Experiment 1 could be replicated. As the objective for current work was to examine whether the discrepancy-attribution theory helps us to understand the underlying sensory, perceptual and cognitive processes involved in episodic ProM task retrieval, I would like to examine whether my results were robust with old adults. Therefore, I included community living adults in Experiment 2 to examine whether I can replicate the result patterns from Experiment 1. I also would like to examine whether the result patterns from Experiment 1 were robust, even I changed the cues of ProM task. In Experiment 2, I changed the ProM-cues from the names of musical instruments to the names of job titles and I expected that there should not be any changes on the result patterns of ProM task performance. The second purpose was to examine whether I could boost ProM task accuracy by increasing the uniqueness of discrepancy reactions to primed ProM-cues. In Experiment 2, I add a new condition in which only half of the ProM-cues were shown with unconscious primes, and none of the words in the ongoing task were shown with primes. By doing that, the discrepancy reaction would be unique to primed ProM-cues. Therefore, I assumed the likelihood of responding to the primed ProM-cues should increase.

Method

Participants and Design

Sixty-four participants were recruited through an advertisement in a free local Vancouver newspaper. Participation in the study required approximately an hour and participants received a $15 honorarium. Participants’ age ranged from 18 to 85 years old with a mean
of 49.27 years old (SD=18.81 years). The experiment was conducted with the approval of
the University of British Columbia behavioral ethical review board.

The design included the priming conditions of the ProM-cue words (identity prime and
no prime) as a within-subjects factor, and the priming conditions of the words in the lexical
decision task (LD primed condition and LD unprimed condition) as a between-subjects
factor. Thirty-two participants were assigned randomly to the group defined by each of
the lexical decision task priming conditions.

Materials and Procedure

I chose 6 words, each the name of a common job title, from the Batting and Montague
(1969) category norms: banker, lawyer, dentist, plumber, doctor, and sailor. These words
served as the cues for the episodic ProM task. The stimuli for the lexical decision task and
for the neuropsychological tests were the same as for Experiment 1.

Participants were tested individually in one session that lasted about one hour. The
general procedure was the same as in Experiment 1, except for the lexical decision task
priming manipulation. For the LD primed condition, I used the same three types of primes
as for the word stimuli in the lexical decision task of Experiment 1: identity primes,
unrelated primes, and no primes. For the LD unprimed condition, none of the words in the
lexical decision task were shown with primes. In the LD primed condition and the LD
unprimed condition, I showed half of the ProM-cues with identity primes, and the
remaining half with no primes.

Results and Discussion

Data Preparation

I tested 64 participants in Experiment 2. Four participants did not achieve the required
level of accuracy in the practice phase of the lexical decision task, and none of their data
were included in any data analyses. For the final data analyses, I included 60 participants in total, 30 participants from each of the lexical decision task priming conditions.

All data were checked and corrected for transcription errors until accuracy was greater than 99%. There were no missing values on any data set.

The data from the neuropsychological tests, the ProM task and the lexical decision task were examined for univariate outliers, defined as values falling more than 3 standard deviations away from the mean. Two univariate outliers were discovered in the neuropsychological test data, and they were replaced with the nearest non-outlying value, specifically, a score either -3 or +3 standard deviations away from the corresponding mean. One outlier was discovered in the ProM task response latencies, it was also replaced.

Preliminary Results

Neuropsychological tests. The method for scoring each of the neuropsychological tests was the same as I used in Experiment 1. The mean levels of performance on each of the neuropsychological tests are summarized in Table 5.

Table 5

The purposes of giving the neuropsychological tests were the same as I described in Experiment 1. I compared the means and standard deviations of the neuropsychological tests I obtained to previously published data from normal healthy individuals. The mean scores and standard deviations of each of the neuropsychological tests I obtained were comparable to previous findings obtained from normal healthy individuals (Graf, Uttl, & Tuokko, 1995; Uttl, 2002; Spreen & Strauss, 1998; Parkin & Java, 1999).

To examine whether participants' performance on the neuropsychological tests is related to RetM task performance, I conducted a simultaneous regression analysis,
regressing participants’ performance on the remaining three neuropsychological tests onto their VLT composite score. The regression results are reported in Table 6. The results showed that cognitive ability can successfully predict RetM task performance, \( F(3, 56) = 5.65, MSE = .81, R = .45, R^2 = .20, \Delta R^2 = .16 \). The results also showed that DSST task performance contributed significantly to prediction for RetM task performance.

### Table 6

<table>
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<tr>
<th>Predictor</th>
<th>( F )</th>
<th>MSE</th>
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<th>( R^2 )</th>
<th>( \Delta R^2 )</th>
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<td>DSST</td>
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To examine whether cognitive ability influences ProM task performance, I conducted a regression analysis, regressing participants’ overall ProM task accuracy onto their performance on the neuropsychological tests. The summary of regression results are reported in Table 7. The results showed that participants’ performance on the neuropsychological tests can successfully predict ProM task performance, \( F(4, 55) = 3.44, MSE = .08, R = 0.49, R^2 = .24, \) and \( \Delta R^2 = .18 \). However, none of the individual predictor contributed significantly to prediction for ProM task performance.

The results showing that cognitive ability can successfully predict RetM and ProM task performance are consistent with previous results focused on aging and memory task performance (e.g., Brandimonte, Einstein, & McDaniel, 1996; Cuttler, 2004; Hasher & Zacks, 1979; Jorn, 1986; Kausler, 1991; Salthouse, 1996; Uttl, Graf, Miller, & Tuokko, 2001; West, 1996). The results are not consistent with what I found in Experiment 1. This is because in Experiment 2, participants are community living adults, they were from different age groups, and their performance scores had large variances. From the regression results, I found that DSST scores was a successful predictor for the RetM task performance, it is consistent with Salthouse’s (1996) claim that the decrease in processing speed leads to the impairments in a lot of cognitive ability, including memory. I found that participants’ overall performance on the neuropsychological tests predict ProM task performance; however, none of the individual predictor contributed
significantly for predicting ProM task performance. This is consistent with Uttl et al. (2001) findings showing that the correlation between ProM task performance and each type of cognitive ability is weaker than between cognitive ability and RetM task performance.

Table 7

Main Results

Ongoing task. The dependent measures for the ongoing task were the portion of correct lexical decisions and the amount of time required to make lexical decisions in each priming condition. For each participant, I computed the mean proportion of correct decisions, and the median response time on trials with correct lexical decisions in each priming condition. In the LD primed condition, the mean level of performance accuracy was .98, \( SD = .03 \), for words in the identity prime condition, \( Mean = .98, SD = .03 \), for the words in the no prime condition, and \( Mean = .98, SD = .02 \), for words in the unrelated prime condition. In the LD primed condition, I found that participants responded faster to the words with identity primes, \( Mean = 679.25 \) ms, \( SD = 112.22 \) ms, than to the words with either unrelated primes, \( Mean = 701.20 \) ms, \( SD = 112.10 \) ms, or no primes, \( Mean = 709.97 \) ms, \( SD = 110.45 \) ms. An analysis of variance (ANOVA) was conducted on the response time data with the priming condition (identity prime, unrelated prime, and no prime) as a within-subject factor, and it revealed a significant main effect due to the priming conditions, \( F(2, 58) = 9.91, MSE = 682.38 \). Follow-up t-tests confirmed that the lexical decisions were made significantly faster to the words with identity primes than to the words with either no primes, \( t(29) = -3.44 \), or unrelated primes, \( t(29) = -3.90 \). For the LD unprimed condition, the lexical decision accuracy for words was .97, \( SD = .01 \), mean response time for words was 754.00 ms, \( SD = 141.23 \) ms.

The results in the LD primed condition showed a typical priming effect on lexical decision speed that participants responded to the words in the identity prime condition
faster than to the words in either the unrelated prime condition or the no prime condition. The results are consistent with previous research findings (e.g., Forbach, Stanners, & Hochhaus, 1974; Scarborough, Cortese, & Scarborough, 1977) and my Experiment 1 results. The magnitude of the priming effect on response time for words in the identity prime condition was 30.72 ms, which is comparable to the magnitude of priming effect I obtained in Experiment 1 and previous findings (e.g., Forster & Davis, 1984; Segui & Grainger, 1990). In general, participants were faster to make lexical decisions in the LD primed condition than in the LD unprimed condition. This is because in the LD primed condition, unconscious primes facilitated the processing speed of the subsequent words, and those primed words are responded to faster than not primed words, and since a large proportion of the words in the ongoing task were shown with identity primes, fast mental responding speed was developed for making lexical decisions for the overall ongoing task. Whereas in the LD unprimed condition, the words in the ongoing task were shown with no primes, the mental responding state was not promoted in a high speed level, and therefore, the response times of making lexical decisions were slower in the LD unprimed condition than in the LD primed condition.

ProM task. The method of scoring ProM task performance was the same as I used in Experiment 1. Figure 5 shows the mean amount of time required to make correct ProM task responses in each priming condition. The main finding in the LD primed condition is that participants responded faster to the ProM-cues with identity primes, \( \text{Mean} = 1380.17 \text{ ms}, \ SD = 1360.82 \text{ ms} \), than to the ProM-cues with no primes, \( \text{Mean} = 1655.50 \text{ ms}, \ SD = 757.17 \text{ ms} \). The magnitude of priming facilitation on ProM task response time was 275.33 ms, and the effect size (\( d \)) measure was .43, a medium size of effect size. In the LD unprimed condition, I also found the same pattern on ProM task response speed that ProM-cues were responded to faster in the identity prime condition, \( \text{Mean} = 1519.33 \text{ ms} \),
The magnitude of priming facilitation on ProM task response time was 277.32ms, and the effect size $d = .64$.

Figure 5

Figure 6 shows ProM task accuracy, the likelihood of making a ProM task response to a ProM-cue in each of the priming conditions. In the LD primed condition, mean performance accuracy was .14, $SD = .33$, for the ProM-cues in the identity prime condition, and .17, $SD = .35$, for the ProM-cues in the no prime condition. In the LD unprimed condition, ProM task accuracy was .22, $SD = .32$, in the identity prime condition, and $Mean = .23$, $SD = .33$, in the no prime condition. There was no significant difference on ProM task accuracy between the identity prime condition and the no prime condition in either the LD primed condition or the LD unprimed condition. In the LD primed condition, $t (29) < 1$, effect size $d = .07$; in the LD unprimed condition $t (29) < 1$, effect size $d = .03$.

Figure 6

To examine whether the priming conditions of the lexical decision task facilitated the ProM task accuracy, I conducted a $2 \times 2$ mixed-model ANOVA with the ProM-cue priming conditions (identity prime and no prime) as a within-subjects factor and the priming conditions in the lexical decision task (LD primed condition and LD unprimed condition) as a between-subjects factor. There was no result reached significance, $Fs < 1$.

Discussion

Experiment 2 had two objectives: the first one was to replicate Experiment 1; the second one was to extent Experiment 1 findings and to explore whether increasing the uniqueness of discrepancy reaction to primed ProM-cues facilitated ProM task accuracy.
The results showed that unconscious primes facilitated speed of making ProM task responses, but did not facilitate ProM task accuracy. The findings are consistent with the results I obtained from Experiment 1. It indicates that my result patterns are robust even thought I changed the words used as ProM-cues.

It is surprising that I did not find any difference on ProM task accuracy at all. I expected that increasing the distinctiveness of ProM-cues should increase ProM task accuracy for the cues in the identity prime condition. I found that in general ProM task accuracy was higher in the LD unprimed condition than in the LD primed condition, even thought it did not reach a significant level. This difference may indicate that there is a possibility that the uniqueness of discrepancy reactions to ProM-cues increased overall level of ProM task performance, not only for the ProM-cues in the identity prime condition.

However, an important issue needs to be aware of is that ProM task accuracy was lower in this experiment than in Experiment 1. This may be due to several reasons. First, participants were community living adults who were not very familiar with lab settings and the computer-based experiments. Second, participants in Experiment 2 are older than in Experiment 1. Previous research (e.g. Einstein et al., 1992; Uttl et al., 2001) has shown that the older adults performed worse on the lab based ProM tasks. This low accuracy on ProM task performance may also indicate that the computer-based ProM task is too difficult to complete for older adults. Therefore, to get solid results and understanding on the ProM task accuracy I would like to replicate this experiment in Experiment 3 with undergraduate students.

Experiment 3

The purpose of Experiment 3 was to replicate Experiment 2 with undergraduate students. In Experiment 2, the ProM task accuracy was very low in the LD primed condition and the
LD unprimed condition, and I did not find any differences on ProM task accuracy between ProM-cues in the identity prime condition and ProM-cues in the no prime condition. Null finding on ProM task accuracy across ProM priming conditions may be because the ProM task was difficult for participants who were not familiar with computer-based experiments. Therefore, I would like to replicate Experiment 2 with undergraduate students. I also would like to manipulate the types of primes in the ongoing task to examine whether the results on ProM task performance is robust even if different amount of words in the ongoing task was primed. In Experiment 3, I only used two types of primes for the words in the ongoing task: identity primes and no primes. I would like to examine whether my result patterns are the same as I obtained in Experiments 1 and 2.

Method

Participants, Design, Materials and Procedure

Sixty-four undergraduate students were recruited through the Psychology department subject pool at the University of British Columbia. They participated in return for course credit. The experiment was conducted with the approval of the University of British Columbia behavioral ethical review board. The design included the priming conditions of the ProM-cue words (identity prime and no prime) as a within-subjects factor, and the priming conditions of the words in the lexical decision task (LD primed condition and LD unprimed condition) as a between-subjects factor. Thirty-two participants were assigned randomly to the groups defined by each of the lexical decision task priming conditions. The materials and general procedure were the same as for Experiment 2, except for the lexical decision task priming manipulation in the LD primed condition. I used only two types of primes for the word stimuli in the lexical decision task: identity primes and no primes. Half of the words were shown with identify primes, the other half were shown with no primes.
Results and Discussion

Data Preparation

I tested 64 participants in this experiment. Four participants did not achieve the required level of accuracy in the practice phase of the lexical decision task. None of their data were included in any data analyses. For the final data analyses, I included 60 participants in total, 30 participants for each of the lexical decision task priming conditions.

All data were checked and corrected for transcription errors until accuracy was greater than 99%. There were no missing values on any data set.

Data from the neuropsychological tests, the ProM task, and the lexical decision task were examined for univariate outliers, defined as values falling more than 3 standard deviations away from the mean. Two univariate outliers were discovered in the neuropsychological test data. They were replaced with the nearest non outlying value, specifically, a score either -3 or +3 standard deviations away from the corresponding mean.

Preliminary Results

Neuropsychological tests. The method for scoring each of the neuropsychological tests was the same as I used in Experiment 1. The mean levels of performance on each of the neuropsychological tests are summarized in Tables 8.

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The purposes of giving these neuropsychological tests were the same as I described in Experiment 1. To examine whether my sample was normal, I compared the means and standard deviations of the neuropsychological tests I obtained to previously published data from normal healthy individuals (Graf, Uttl, & Tuokko, 1995; Uttl, 2002; Spreen & Strauss, 1998; Parkin & Java, 1999). I found that all of the means and standard deviations were comparable to previous findings from a corresponding age group.
To examine whether participants' performance on the neuropsychological tests predicted RetM task performance (e.g., Craik, 1986; Hasher & Zacks, 1979; Jorn, 1986; Kausler, 1991; Salthouse, 1996) and ProM task performance (e.g. Brandimonte, Einstein, & McDaniel, 1996; Cuttler, 2004; Uttl, Graf, Miller, & Tuokko, 2001; West, 1996), I conducted two simultaneous regression analyses.

To examine whether participants' performance on the neuropsychological tests predicted RetM task performance, I regressed participants' performance on the remaining three neuropsychological tests onto their VLT composite score. The summary of regression results are reported in Table 9. The results showed that participants' performance on the neuropsychological tests cannot successfully predict RetM task performance, $F (3, 56) < 1, R = .18, R^2 = .03, \Delta R^2 = -.02$.

<table>
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| To examine whether participants' performance on the neuropsychological tests predicted ProM task performance, I regressed participants' performance on the neuropsychological tests onto their overall ProM task accuracy. The summary of regression results are reposted in Table 10. The results showed that participants' performance on the neuropsychological tests cannot successfully predict ProM task performance, $F (4, 55) = 2.24, MSE = 3.25, R = 0.37, R^2 = .14, and \Delta R^2 = .08$. 

The results were consistent with Experiment 1 findings that participants' performance on the neuropsychological tests cannot successfully predict either RetM task or ProM task performance. This is likely due to the same reason for Experiment 1 that the restriction of score ranges affected the magnitude of the correlations between participants' performance on the neuropsychological tests and either RetM task or ProM task performance. |
Main Results

Ongoing task. The dependent measures for the ongoing task were that the portion of correct lexical decisions and the amount of time required making lexical decisions in each priming condition. In the LD primed condition, the mean accuracy of the lexical decision task was .98, \(SD = .03\), for the words in the identity prime condition, and \(Mean = .97, SD = .03\), for the words in the no prime condition. I also found that words in the identity prime condition, \(Mean = 552.27 \text{ ms, } SD = 62.48 \text{ ms}\), were responded to faster than in the no prime condition, \(Mean = 592.75 \text{ ms, } SD = 61.61 \text{ ms}\). A paired t-test confirmed this observation, \(t(29) = -6.02\). In the LD unprimed condition, the mean accuracy for words in the lexical decision task was .98, \(SD = .02\), and mean response time for words in the lexical decision task was 619.67 ms, \(SD = 89.68 \text{ ms}\).

The same as first two experiments, the results of the lexical decision task in the primed condition also showed a typical priming effect in Experiment 3. The results are consistent with previous findings (e.g., Forbach, Stanners, & Hochhaus, 1974; Forster & Davis, 1984; Scarborough, Cortese, & Scarborough, 1977) and results I found in first two experiments. The magnitude of priming facilitation on the response time was 40.48 ms which is similar to what I found in Experiments 1 and 2.

ProM task. The method of scoring ProM task performance was the same as I used in Experiment 1. Figure 7 shows the mean amount of time required to make correct ProM task responses in each priming condition. In the LD primed condition, I found that primed ProM-cues were responded to faster in the identity prime condition, \(Mean = 326.78 \text{ ms, } SD = 224.75 \text{ ms}\) than in the no prime condition, \(Mean = 1474.91 \text{ ms, } SD = 262.73 \text{ ms}\). The magnitude of priming facilitation on ProM task response time was 148.13 ms in the LD primed condition. The effect size on response times across priming conditions was .60, a medium size of effect. In the LD unprimed condition, I found a similar pattern of
results that participants responded faster to ProM-cues in the identity prime condition, 
\( \text{Mean} = 1466.23 \text{ ms}, \ SD = 196.74 \text{ ms} \) than to ProM-cues in the no prime condition, \( \text{Mean} = 1532.98 \text{ ms}, \ SD = 222.42 \text{ ms} \). The magnitude of priming facilitation on ProM task response time was 66.75 ms in the LD unprimed condition, \( d = .32 \), a small size of effect.

Figure 7

Figure 8 shows ProM task accuracy, the likelihood of making a ProM task response to a ProM-cue in each of the priming conditions. In the LD primed condition, ProM task accuracy was .40, \( SD = .41 \), in the identity prime condition, and .32, \( SD = .34 \), in the no prime condition. In the LD unprimed condition, ProM task accuracy was .51, \( SD = .35 \), in the identity prime condition, and .53, \( SD = .31 \), in the no prime condition. There was no significant difference on the ProM task accuracy between the identity prime condition and no prime condition in either the LD primed condition or the LD unprimed condition. For the LD primed condition, \( t (29) = 1.05 \), effect size \( d = .20 \), and for the LD unprimed condition \( t (29) < 1 \), effect size \( d = .07 \).

Figure 8

To examine whether the priming manipulation in the lexical decision task facilitated ProM task accuracy, I conducted a 2 \( \times \) 2 mixed-model ANOVA with the ProM-cue priming conditions (identity prime and no prime) as a within-subjects factor and the priming conditions in the lexical decision task (LD primed condition and LD unprimed condition) as a between-subject factor. The results showed a significant main effect due to the priming conditions in lexical decision task, \( F (1, 58) = 4.20, \ MSE = .19 \). ProM-cues were more likely to be responded to in the LD unprimed condition than in the LD primed condition. No other effects reached significance. Follow-up t-tests showed that there was no significant difference on ProM task accuracy between the LD primed condition and LD
unprimed condition in the ProM-cue with identity prime condition, $t(58) = -1.13$. However, there was a significant difference on ProM task accuracy between the LD primed condition and the LD unprimed condition in the ProM-cue with no prime condition, $t(58) = -2.49$.

**Discussion**

The primary objective for Experiment 3 was to replicate Experiment 2. I replicated, strengthened the results from Experiments 1 and 2 that unconscious primes facilitated the response times of ProM task performance but they did not facilitate the performance accuracy. I also found that priming manipulation in the lexical decision task influenced the ProM task accuracy. Participants were more likely to respond to ProM-cues in the LD unprimed condition than in the LD primed condition.

Comparing the response times of making lexical decisions in the LD primed condition with those in the LD unprimed condition, I found that in general participants were faster to make lexical decisions in the LD primed condition than in the LD unprimed condition. As I discussed in Experiment 2, I assumed that participants' mental processing speed was faster in the LD primed condition than in the LD unprimed condition, and the mental processing speed could be a factor that influenced ProM task accuracy. I also found that the magnitude of priming facilitation on response time was different between the LD primed condition and the LD unprimed condition, the magnitude of priming facilitation on ProM task response time was $148.13$ ms for the LD primed condition, whereas for the LD unprimed condition, it was $66.75$ ms. It seems that the unconscious primes showed larger influence on ProM task response time in the LD primed condition than in the LD unprimed condition. I do not know whether the differences of priming facilitation on ProM task response speed are due to the differences on mental processing
speed between LD primed condition and LD unprimed condition. In General Discussion, I provide more discussion of these findings.

Although three experiments showed the same result pattern, so far it is still not very clear why the unconscious primes facilitated only one aspect of ProM task performance but the other one. In the discrepancy-attribution theory, Whittlesea and Williams (1998) claimed that the discrepancy reaction can be interpreted in a flexible manner, and it is always attributed in line with the demands of the ongoing task. This claim was made from previous studies, in which participants were required to perform only one task. However, in my experiments, participants were actually assigned two tasks: an ongoing task and a ProM task. To my knowledge neither a study nor a theory has explained how we attribute the discrepancy reaction when we are engaging in a ProM task situation. Therefore, I applied the statement made by Whittlesea and Williams in the ProM task situation and provided a potential explanation for my results. The potential explanation of my findings is that the demands of the ongoing task decide which aspect of ProM task performance should be facilitated. In Experiments 1 to 3, the ongoing task was the lexical decision task which was a relatively easy task for participants, and thus, participants focused on making responses in the ongoing task as fast as possible. Therefore, in first three experiments, the unconscious primes showed the facilitation only on ProM task response speed but not on ProM task accuracy. If my speculation was correct, I would find that when changing the demands of the ongoing task from response speed to task accuracy, unconscious primes should facilitate ProM task accuracy, but not speed of making ProM task responses. Therefore I conducted Experiment 4 to examine whether my speculation was correct.

**Experiment 4**
The purpose of Experiment 4 was to examine whether changing the ongoing task to an accuracy focused task would facilitate ProM task accuracy. In Experiment 4, I changed the ongoing task to an anagram-solving task, which is much harder than the lexical decision task. Previous research showed that primes increased the accuracy and reduced the time required of solving anagrams (McAndrews & Moscovitch, 1990), and therefore, to increase the difficulty level of the ongoing task, only half of the ProM anagrams were shown with unconscious primes, and none of the anagrams in the ongoing task were shown with primes. Based on Whittlesea and William's (1998, 2001a, 2001b) notion that discrepancy reaction is interpreted in a flexible manner, and it is attributed in line with the demands of the ongoing task, I expected that in Experiment 4, when the ongoing task focused on task performance accuracy, the unconscious primes should facilitate ProM task accuracy.

**Method**

*Participants*

Twenty-six undergraduate students were recruited through the Psychology department subject pool at the University of British Columbia. They participated in return for course credit. The experiment was conducted with the approval of the University of British Columbia behavioral ethical review board.

*Materials*

I used the 189 words described in the Materials section of Experiment 1 to construct 189 word-anagrams by applying one of three different rearrangement methods: putting the first letter after the third letter of the original word (e.g., “dance” was made into “andce”), putting the first letter after the forth letter of the original word (e.g., “dance” was made into “ancde”), and putting the first letter after the fifth letter of the original word (e.g., “dance” was made into “anced”).
I also created 6 ProM-cue anagrams with the job title words used for Experiment 2. The ProM-cue anagrams were all made by using one method: putting the first letter after the forth letter.

Procedure

Participants were tested individually in a session that lasted about an hour. They were informed that the experiment involved variety of tasks, with some focusing on their ProM task performance and others on their general cognitive abilities. After giving consent, each participant completed the sequence of the activities listed in Table 11.

Table 11

Immediately after giving consent, I assigned the ProM task to participants. Specifically, I instructed participants to press the Q-key if ever they saw or heard a word that was a job title in the course of the experiment. I emphasized that as soon as they saw or heard a job title word in the experiment, they needed to press the Q-key as quickly as possible. I explained the ProM task instructions until participants fully understood and were able to correctly repeat them. After this, participants were not further reminded about the ProM task instructions.

After receiving the ProM task instructions, participants completed the same series of neuropsychological tests as described in Experiment 1. Immediately after the neuropsychological tests, they were informed about the anagram-solving task. In this experiment, I use an anagram-solving task as the ongoing task. Participants were given instructions and an opportunity to practice the anagram-solving task which required them to solve word-anagrams as quickly and accurately as possible. I explained the rules that had been used for creating the anagrams and encouraged them to use those rules to solve the anagrams.
Each trial of the anagram-solving task consisted of the sequence of events shown in Figure 8. To begin a trial, a fixation point—a plus sign—was shown in the center of the monitor for 500 milliseconds. It was replaced by a pre-mask lasting for 250 milliseconds. The pre-mask was replaced by a prime screen, which was always blank in the practice phase. The prime screen was shown for 40 milliseconds and it was replaced by a post-mask that lasted for 250 milliseconds. After that, a word-anagram was displayed for 400 milliseconds, and participants needed to solve the anagram. They solved the anagrams by saying out loud the solution words, and I pressed the enter-key on the keyboard to record their response times. I asked participants to spell the solution words, and as they did so, I entered them into a data-base. Participants practiced the anagram-solving task for 20 trials. For this purpose, I randomly selected a set of 20 stimuli from the anagram set described in the Materials section.

After practice, participants immediately continued to the critical phase of the anagram-solving task. In the critical phase, participants received 175 trials, which included 169 ongoing task anagram trials and 6 ProM-cue trials. Each trial was arranged as shown in Figure 8. Six ProM-cue trials were interspersed among the anagram-solving task trials, the first appearing on the 26th trial of the anagram-solving task, and the next 25 trials later, and so on. Half of the ProM-cue anagrams were primed by their solutions (i.e. original word used to create the ProM-cue anagram); the other ProM-cue anagrams were shown without primes. The priming conditions of ProM-cues were counterbalanced across participants. None of the anagrams in the ongoing task were shown with primes.

Immediately after completing the anagram-solving task, participants were administrated the delayed recall test of the VLT. After completing all of the tasks, I gave participants a verbal debriefing and course credit.
Results and Discussion

Data Preparation

I tested 26 participants in Experiment 4, and all participants were included in the data analyses.

All data were checked and corrected for transcription errors until accuracy was greater than 99%. There were no missing values on any data set.

Data from the neuropsychological tests, the ProM task and the anagram-solving task were examined for univariate outliers, defined as values falling more than 3 standard deviations away from the mean. One univariate outlier was discovered in the neuropsychological test data. The outlier was replaced with the nearest non outlying value, which was plus 3 standard deviations from the mean.

Preliminary Results

Neuropsychological tests. The methods for scoring the neuropsychological tests were the same as I used in Experiment 1. The mean levels of performance on each of the neuropsychological tests are summarized in Table 12. To screen out participants who had poor English skills, I ran an outlier analysis on the NAART scores. I did not find any outlying value.

<table>
<thead>
<tr>
<th>Table 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>To examine whether my sample was normal, I compared the means and standard deviations of the neuropsychological tests I obtained with previously published data from normal healthy individuals (Graf, Uttl, &amp; Tuokko, 1995; Uttl, 2002; Spreen &amp; Strauss, 1998; Parkin &amp; Java, 1999). In summary, I found that all of the means and standard deviations were comparable to previous findings from a corresponding age group. To ensure that any difference on ProM task performance cannot be attributed to any differences on participants' cognitive abilities. I compared the means and standard</td>
</tr>
</tbody>
</table>
deviations of the neuropsychological tests among Experiment 1, 3, and 4. I found that means and standard deviations of participants' performance on the neuropsychological tests were similar across three experiments.

To examine whether participants' performance on the neuropsychological tests was related to RetM task performance (e.g., Hasher & Zacks, 1979; Jorn, 1986; Kausler, 1991; Salthouse, 1996) and ProM task performance (e.g. Brandimonte, Einstein, & McDaniel, 1996; Cuttler, 2004; Uttl, Graf, Miller, & Tuokko, 2001; West, 1996), I conducted two simultaneous regression analyses.

To examine whether participants' performance on the neuropsychological tests predicted to RetM task performance, I regressed participants' performance on the remaining three neuropsychological tests onto their VLT composite score. The results showed that participants' performance on the neuropsychological tests cannot successfully predict RetM task performance, $F(3, 22) = 2.08, MSE = .89, R = .47, R^2 = .22, \Delta R^2 = .11$. The summary of regression results are reposted in Table 13.

<table>
<thead>
<tr>
<th>Table 13</th>
</tr>
</thead>
</table>

To examine whether participants' performance on the neuropsychological tests predicts ProM task performance, I regressed participants' performance on the neuropsychological tests onto their overall ProM task accuracy. The results showed that participants' performance on the neuropsychological tests cannot successfully predict ProM task performance, $F(4, 21) = 1.69, MSE = 4.40, R = .49, R^2 = .24, \Delta R^2 = .10$. The summary of regression results are reported in Table 14. The results showing that participants' performance on the neuropsychological tests cannot successfully predict either RetM task or ProM task performance. The results were consistent with the findings in Experiments 1 and 3.

<table>
<thead>
<tr>
<th>Table 14</th>
</tr>
</thead>
</table>
Main Results

Ongoing task. I collected the amount of time required to solve anagrams and the portion of correctly solved anagrams. The mean response time required to solve anagrams was 1285.81 ms, $SD = 244.60$ ms, and the mean accuracy of the anagram-solving task was .78, $SD = .10$.

ProM task. ProM task performance was scored as successful if participants remembered to press the Q-key any time between participants spoke out the ProM anagram solutions and the end of that trial. The critical dependent measures for the ProM task were performance speed, the mean amount of time required to solve ProM-cue anagrams, and performance accuracy, the likelihood of making a ProM task response to a ProM-cue in each priming condition. For each participant, the performance speed in each priming condition was the mean amount of time required to solve ProM anagrams on the trials with successful ProM-cue responses, and performance accuracy was the proportion of successful ProM-cue responses out of a maximum possible of 3.

Figure 9 shows the mean amount time required to solve ProM anagrams. There was no significant difference on response time of solving ProM-cue anagrams between identity prime condition, $Mean = 1359.41$ ms, $SD = 858.52$ ms, and no prime condition, $Mean = 1404.50$ ms, $SD = 595.67$ ms, $t (15) < 1$, effect size $d = .08$. The magnitude of priming facilitation on the solving speed was 45.09 ms.

Figure 10 shows the likelihood of correctly making a ProM task response to a ProM-cue. I found that the ProM-cues in the identity prime condition, $Mean = .53$, $SD = .42$, were more likely to be responded to than those in the no prime condition, $Mean = .35$, $SD = .36$. A paired t-test confirmed the observation, $t (25) = 3.38$, effect size $d = .46$. 

Figure 9

Figure 10
Discussion

The objective of Experiment 4 was to explore whether subliminal primes would facilitate ProM task accuracy if the ongoing task was an accuracy demanding task. The results showed that when the ongoing task changed to an anagram-solving task, which is an accuracy driven task, unconscious primes facilitated accuracy of ProM task performance but not speed of solving ProM anagrams.

I argue that the anagram-solving task is an accuracy driven task is because the accuracy of completing the anagram-solving task was .78, which was much lower than the accuracy of performing the lexical decision task I obtained from previous three experiments. The accuracy of performing the lexical decision task in previous experiment was between .97 and .99. The findings showed that in the anagram-solving task, participants were involved in a task context that required them to put their efforts on achieving a high performance level.

Comparing the response times of solving anagrams, I found that ProM anagrams required longer time to be responded to than non-ProM anagrams. Even those ProM anagrams shown with unconscious primes took longer to be solved than non-ProM anagrams. This is likely because when participants were working on solving the anagrams, at the same time they identified the anagram was a cue for conducting a ProM task. When participants spoke out the solution of the ProM anagrams, they have made their decisions of pressing the Q-key at the same time or right after they spoke out the ProM anagram solution. Making the decision of carry out the ProM task is the reason why participants spent more time on solving ProM-cue anagrams trials.

My findings from Experiment 4 are consistent with my speculation discussed in Experiment 3 that unconscious primes can facilitate either speed of making ProM task
responses or ProM task accuracy; however, which aspect of ProM task performance should be facilitated is decided by the demands of the ongoing task.

General Discussion

The goal of my thesis is to understand episodic ProM task retrieval. The specific objective of current study is to examine whether the discrepancy-attribution theory helps us to understand the underlying sensory, perceptual, and cognitive processes involved in episodic ProM task retrieval.

Two main findings emerged from the present study. First, my results showed that the priming manipulation facilitated ProM task performance in all experiments. Second, unconscious primes facilitated different aspects of ProM task performance between experiments. In the Experiments 1 to 3, where the ongoing task required making lexical decisions, subliminal primes facilitated only the speed on responding to ProM-cues, but not ProM task accuracy. By contrast, in Experiment 4, the ongoing task was an anagram-solving task, the accuracy driven task, subliminal primes facilitated the ProM task accuracy, but not the speed of making correct ProM task responses. My findings are consistent with the discrepancy-attribution theory, as well as with prior evidence that discrepancy reactions tend to be interpreted flexibly, in line with the demands of the ongoing or dominant task.

According to the discrepancy-attribution theory, there are two stages involved at the retrieval phase of ProM tasks. The first phase is that at the time we encounter the ProM-cue, the cue should be processed oddly fluently and this odd fluency is discrepant with our system's expectations, and thus our cognitive system will have a discrepancy reactions. Therefore, to examine whether ProM task performance can be influenced by the discrepancy reactions, the first step of my experiments was to explore whether any manipulation can be used to enhance the fluency of processing the ProM-cues and
increase the magnitude of the discrepancy reaction. In my four experiments, I used unconscious primes to enhance the fluency of processing the subsequent ProM-cue, and therefore, increasing the magnitude of the discrepancy reactions. My results indicate that unconscious primes worked efficiently on increasing the fluency of processing the subsequent displayed ProM-cues. In all four experiments, participants responded to primed ProM-cues faster than to not primed ProM-cues, even though the time difference between two priming conditions on solving ProM anagrams was much smaller than in Experiment 4.

According to the discrepancy-attribution theory, the second phase at episodic ProM task retrieval is the attribution phase, the discrepancy reaction is attributed to previously formed plan. Therefore, my second step was to understand how we attribute the discrepancy reaction. Whittlesea and Williams (1998, 2001a) argued that the discrepancy reaction is interpreted in a flexible manner, and it needs to be attributed in line with the mental state of the ongoing task. For example, if participants engage in a recognition task, they should unconsciously interpret the discrepancy reaction into familiarity or the item is old (Jacoby & Whitehouse, 1989). My work applied Whittlesea and Williams’ notion into ProM task situation, in which participants engaged in two tasks: the ongoing task and the ProM task. As ProM-cues appear occasionally, the dominant ongoing task decides the mental state for the context ProM-cues appear. When the ongoing task was the lexical decision task, in which participants can easily achieve a high accuracy level, the mental state of the ongoing task was set to be responding to the stimuli as fast as possible, and that resulted in facilitation on speed of making ProM task responses. By contrast, the anagram-solving task was a much harder task that required participants to focus on their performance accuracy, and even required them to scarify some response speed to achieve their satisfied accuracy level for task performance. In
this task, participants thought about their solutions carefully before they made their responses. Therefore, the context ProM-cues appeared was set to focus on “whether my answer is correct”, and that resulted in facilitation on ProM task accuracy.

The current work attempted to use a new perspective, the discrepancy-attribution theory, to explore ProM task retrieval. However, it does not indicate that my findings are contradicted with previous theories on ProM task retrieval (Craik, 1986; Einstein & McDaniel, 1996; Smith, 2003). I believe each of these theories can provide a reasonable explanation of my results. According to the resource model of Craik (1986), ProM task retrieval processes demand cognitive resource. According to the resource model, the unconscious primes in my experiments were used to increase the fluency of processing the subsequent ProM-cues, and it may also reduce the amount of required resources to complete ProM task responses. Therefore, the unconscious primes facilitated ProM task performance. According to the noticing-plus-search model of Einstein and McDaniel (1996), ProM task retrieval processes include two stages: noticing and search. In the noticing stage, they argued that we need to recognize the ProM-cue is significant and it is related to some of our intentions. In my experiments, primed ProM-cues should be processed oddly fluently, and that should help the cues to be identified. In the search stage, they argued that we have a controlled search process to determine what we need to do with the cue. Based on their search notion, my results can be interpreted as different search processes are required when we engage in different types of the ongoing tasks. When participants had a speed focus task as the ongoing task, they may have a fast search process, and therefore the primed ProM-cues are identified faster. Whereas, when participants had an accuracy focus task as the ongoing task, they may search more carefully, and therefore, primed ProM-cues were more likely to be correctly responded to. According to the preparatory attentional and memory processes theory of Smith (2003),
the ProM task retrieval processes are not automatic. Actually, we are monitoring the occurrence of the ProM-cues. Based on the preparatory attentional and memory processes, my results may indicate that we use different monitoring strategies among different tasks. When we engage in a speed demanding ongoing task, our monitoring system may respond fast to recognize ProM-cues. Whereas, when we engage in an accuracy demanding ongoing task, our monitoring system needs to identify whether the target is really different from other stimuli, if it is significantly different from other stimuli, the monitoring system then recognizes it as a cue for retrieving intentions. And this interpretation may explain why in my results primed ProM-cues are more likely to be responded when the ongoing task is an accuracy driven task.

All the previous theories can provide explanations for my results. However, theories are not used only for explaining existing results; they should also be used to guide new research. Previous theories cannot inspire me of using a new perspective to understand ProM task retrieval, because they focus on arguing whether ProM task retrieval is an automatic or a controlled process, they fail to provide any guide of what other possible research method can be used to understand ProM task retrieval. Consider the priming manipulation in my study. Priming manipulation has been used in RetM research for many years (e.g., Graf & Ryan, 1990, Graf & Schacter, 1989), especially, in false memory research, the unconscious primes were used to understand the underlying cognitive processes involved in false recognitions (e.g., Jacoby and Whitehouse, 1989). However, this is the first time unconscious primes were used in ProM research. The reason that the priming manipulation is rarely used in ProM research is because most researchers guided by previous theories focused on discussing whether the retrieval processes of ProM tasks is an automatic process or a controlled search process, they did
not focus on discussing at the time when we encounter the cues, what the quality of processing decides whether or not we recognize the ProM-cues.

My results showed that the discrepancy reaction produced by the unconscious primes is interpreted in a flexible manner, and it is attributed in line with the demands of the ongoing task. No previous research focused on exploring whether that changing the demands of the ongoing task from responding speed to task accuracy would influence different aspects of ProM task performance. This is likely because in all previous theories, researchers make general prediction of ProM task retrieval and they do not mention explicitly whether the retrieval processes of ProM tasks are the same across task situations. If my research was guided by one of the previous theories to understand ProM task retrieval, I would use either only the speed focus ongoing task, the lexical decision task, or only the accuracy driven ongoing task, the anagram-solving task, as the ongoing task, because I would assume that I need one type of the ongoing tasks to examine whether the retrieval processes of ProM task is an automatic or a controlled process. In the noticing-plus-search theory, Einstein and McDaniel (1996) mentioned that this is something like a discrepancy reaction helps us noticing the significance of ProM-cues, but they failed to find future evidence to support their theory. This is because they followed their theory and they did not realize the importance of the demands of the ongoing task (according to a personal conversation with McDaniel).

One question that has not been answered in my work is that why the distinctiveness of ProM-cues did not facilitate ProM task accuracy. In Experiments 2 and 3, only half of the ProM-cues were showed with identity primes in the LD unprimed condition; none of the words in the ongoing task were shown with primes. As only the primed ProM-cues were processes oddly fluently, and the discrepancy reaction was unique to ProM-cues with unconscious primes, I expected that the distinctiveness
manipulation could increase ProM task accuracy for primed ProM-cues. However, contradicting with my expectation, I did not find any differences on ProM task accuracy across priming conditions in the LD unprimed condition. My potential explanation is that in Experiments 2 and 3, the ongoing task was a speed focus task. The mental set from the ongoing task was so fast that there was not enough time to attribute the discrepancy reaction to our intentions. Therefore, I only observed that the unconscious primes facilitated the speed of making correct ProM task responses, but not on the ProM task accuracy in the LD unprimed condition. My explanation also raises another question that needs to be considered in future research. It is that not only the demands of the ongoing task, but the mental processing speed required by the ongoing task may also influence ProM task performance (Graf, 2005). When the ongoing task required only high responding speed, and regardless performance accuracy, we may be more likely to forget our intentions. My thesis cannot answer this question is because in my experiment instructions I emphasized both response speed and performance accuracy to participants. I cannot conclude that participants focus on only response speed or only performance accuracy on the ongoing task and totally ignore the other aspect of the task performance. To manipulate mental processing speed of the ongoing task, future research should choose appropriate instructions and tell participants to make responses as fast as they can or instruct participants to make responses as accurately as they can.

Conclusion

Einstein and McDaniel (1996) were the first research group that suggested that some discrepancy reaction mechanism might be involved in episodic ProM task retrieval. However, in the past 10 years, researchers seldom discussed or examined the claim about the discrepancy reactions. Even at the second international conference of
prospective memory (2005), when researchers discussed episodic ProM task retrieval, most of them still focused on exploring whether episodic ProM task retrieval is an automatic processing or a controlled processing. To my knowledge, my research is the first one that demonstrates the discrepancy-attribution is involved in our episodic ProM task retrieval. The current research provides us a new perspective to understand ProM task retrieval. And the discrepancy-attribution theory will inspire more research on exploring episodic ProM task retrieval in the future.
References


Table 1 A List of All Instruments and Tasks Assigned to Participants, Arranged According to When They were Administered, with the Time Required to Complete Each of Them.

<table>
<thead>
<tr>
<th>Task/Instrument</th>
<th>Approximate Time to Complete (in minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning: Prospective Memory Task Assigned</td>
<td>5</td>
</tr>
<tr>
<td>Neuropsychological Tests</td>
<td></td>
</tr>
<tr>
<td>Color-Word Stroop Test</td>
<td>8</td>
</tr>
<tr>
<td>North American Adult Reading Test²</td>
<td>4</td>
</tr>
<tr>
<td>Verbal Learning Test³</td>
<td>7</td>
</tr>
<tr>
<td>Digit Symbol Substitution Test⁴</td>
<td>7</td>
</tr>
<tr>
<td><em>Lexical decision Task; the Prom-cues were presented in the course of this test</em></td>
<td>25</td>
</tr>
<tr>
<td>Verbal Learning Test Delayed Recall³</td>
<td>2</td>
</tr>
<tr>
<td>Debriefing</td>
<td>3</td>
</tr>
</tbody>
</table>

¹ Graf, Utli, and Tuokko (1995)
² Blair & Spreen (1989)
³ Adapted from Lezak (1995)
⁴ Wechsler (1981)
Table 2 Mean Level of Performance and Standard Deviations for Each of the Variables Assessed by Each of the Neuropsychological Tests in Experiment 1.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroop test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word reading</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>30.80</td>
<td>3.88</td>
</tr>
<tr>
<td>Errors</td>
<td>0.03</td>
<td>0.16</td>
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<tr>
<td>Color naming</td>
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<td></td>
</tr>
<tr>
<td>Time</td>
<td>43.37</td>
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</tr>
<tr>
<td>Errors</td>
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<td>0.00</td>
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<tr>
<td>Incongruent color naming</td>
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<td></td>
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<tr>
<td>Time</td>
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<tr>
<td>Errors</td>
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<td>0.49</td>
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<tr>
<td>Stroop interference</td>
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<tr>
<td>Time differences</td>
<td>29.98</td>
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</tr>
<tr>
<td>NAART&lt;sup&gt;2&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>29.33</td>
<td>9.26</td>
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<tr>
<td>VLT&lt;sup&gt;3&lt;/sup&gt;</td>
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<tr>
<td>List A (trial 1)</td>
<td>10.33</td>
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<tr>
<td>List A (trial 2)</td>
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<td>List A (trial 3)</td>
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<td>List B</td>
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<td>List A (trial 4)</td>
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<tr>
<td></td>
<td>115.87</td>
<td>18.73</td>
</tr>
</tbody>
</table>

<sup>1</sup> Graf, Uttl, and Tuokko (1995)  
<sup>2</sup> Blair & Spreen (1989)  
<sup>3</sup> Adapted from Lezak (1995)  
<sup>4</sup> Wechsler (1958)
Table 3 Summary of a Simultaneous Multiple Regression Analysis for Predicting Retrospective Memory Task Performance by Means of Performance on Three Neuropsychological Tests in Experiment 1.

<table>
<thead>
<tr>
<th>Variables</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.55</td>
<td>1.43</td>
<td></td>
</tr>
<tr>
<td>Stroop Interference</td>
<td>-.05</td>
<td>.02</td>
<td>-.40</td>
</tr>
<tr>
<td>NAART</td>
<td>-.01</td>
<td>.02</td>
<td>-.12</td>
</tr>
<tr>
<td>DSST</td>
<td>.002</td>
<td>.01</td>
<td>.04</td>
</tr>
</tbody>
</table>
Table 4 Summary of a Simultaneous Multiple Regression Analysis for Predicting Prospective Memory Task Performance by Means of Performance on Four Neuropsychological Tests in Experiment 1.

<table>
<thead>
<tr>
<th>Variables</th>
<th>$B$</th>
<th>SE $B$</th>
<th>$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-.08</td>
<td>2.02</td>
<td>.12</td>
</tr>
<tr>
<td>Stroop Interference</td>
<td>.02</td>
<td>.03</td>
<td>.12</td>
</tr>
<tr>
<td>NAART</td>
<td>.01</td>
<td>.03</td>
<td>.04</td>
</tr>
<tr>
<td>VLT composite score</td>
<td>-.24</td>
<td>.27</td>
<td>-.18</td>
</tr>
<tr>
<td>DSST</td>
<td>.01</td>
<td>.01</td>
<td>.16</td>
</tr>
</tbody>
</table>
Table 5 Mean Level of Performance and Standard Deviations for Each of the Variables Assessed by Each of the Neuropsychological Tests in Experiment 2.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroop test¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word reading</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>37.18</td>
<td>6.20</td>
</tr>
<tr>
<td>Errors</td>
<td>0.06</td>
<td>0.23</td>
</tr>
<tr>
<td>Color naming</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>51.68</td>
<td>8.83</td>
</tr>
<tr>
<td>Errors</td>
<td>0.23</td>
<td>0.54</td>
</tr>
<tr>
<td>Incongruent color naming</td>
<td>91.88</td>
<td>24.71</td>
</tr>
<tr>
<td>Errors</td>
<td>0.52</td>
<td>0.85</td>
</tr>
<tr>
<td>Stroop interference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time differences</td>
<td>40.20</td>
<td>19.59</td>
</tr>
<tr>
<td>NAART²</td>
<td>24.29</td>
<td>12.39</td>
</tr>
<tr>
<td>VLT³</td>
<td></td>
<td></td>
</tr>
<tr>
<td>List A (trial 1)</td>
<td>7.87</td>
<td>2.63</td>
</tr>
<tr>
<td>List A (trial 2)</td>
<td>11.55</td>
<td>3.02</td>
</tr>
<tr>
<td>List A (trial 3)</td>
<td>13.42</td>
<td>3.41</td>
</tr>
<tr>
<td>List B</td>
<td>6.60</td>
<td>2.63</td>
</tr>
<tr>
<td>List A (trial 4)</td>
<td>8.71</td>
<td>4.34</td>
</tr>
<tr>
<td>Delay Recall</td>
<td>8.92</td>
<td>4.34</td>
</tr>
<tr>
<td>DSST⁴</td>
<td>151.44</td>
<td>36.25</td>
</tr>
</tbody>
</table>

¹ Graf, Utlt, and Tuokko (1995)  
² Blair & Spreen (1989)  
³ Adapted from Lezak (1995)  
⁴ Wechsler (1958)
Table 6 Summary of a Simultaneous Multiple Regression Analysis for Predicting Retrospective Memory Task Performance by Means of Performance on Three Neuropsychological Tests in Experiment 2.

<table>
<thead>
<tr>
<th>Variables</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>2.17</td>
<td>.59</td>
<td></td>
</tr>
<tr>
<td>Stroop Interference</td>
<td>-.003</td>
<td>.01</td>
<td>-.08</td>
</tr>
<tr>
<td>NAART</td>
<td>-.01</td>
<td>.01</td>
<td>-.18</td>
</tr>
<tr>
<td>DSST</td>
<td>.01</td>
<td>.01</td>
<td>-.39*</td>
</tr>
</tbody>
</table>

* indicates p < .05.
Table 7 Summary of a Simultaneous Multiple Regression Analysis for Predicting Prospective Memory Task Performance by Means of Performance on Four Neuropsychological Tests in Experiment 2.

<table>
<thead>
<tr>
<th>Variables</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>3.90</td>
<td>1.22</td>
<td></td>
</tr>
<tr>
<td>Stroop Interference</td>
<td>-.004</td>
<td>.01</td>
<td>-.05</td>
</tr>
<tr>
<td>NAART</td>
<td>-.03</td>
<td>.02</td>
<td>-.21</td>
</tr>
<tr>
<td>VLT composite score</td>
<td>.49</td>
<td>.25</td>
<td>.26</td>
</tr>
<tr>
<td>DSST</td>
<td>-.01</td>
<td>.01</td>
<td>-.24</td>
</tr>
</tbody>
</table>
Table 8 Mean Level of Performance and Standard Deviations for Each of the Variables Assessed by Each of the Neuropsychological Tests in Experiment 3.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroop test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word reading</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>32.75</td>
<td>4.34</td>
</tr>
<tr>
<td>Errors</td>
<td>0.15</td>
<td>0.39</td>
</tr>
<tr>
<td>Color naming</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>43.37</td>
<td>6.74</td>
</tr>
<tr>
<td>Errors</td>
<td>0.31</td>
<td>0.54</td>
</tr>
<tr>
<td>Incongruent color naming</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>72.50</td>
<td>15.57</td>
</tr>
<tr>
<td>Errors</td>
<td>0.92</td>
<td>1.01</td>
</tr>
<tr>
<td>Stroop interference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time differences</td>
<td>29.13</td>
<td>11.70</td>
</tr>
<tr>
<td>NAART^2</td>
<td>29.17</td>
<td>10.46</td>
</tr>
<tr>
<td>VLT^3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>List A (trial 1)</td>
<td>8.62</td>
<td>1.98</td>
</tr>
<tr>
<td>List A (trial 2)</td>
<td>12.75</td>
<td>2.41</td>
</tr>
<tr>
<td>List A (trial 3)</td>
<td>14.65</td>
<td>2.40</td>
</tr>
<tr>
<td>List B</td>
<td>7.58</td>
<td>2.25</td>
</tr>
<tr>
<td>List A (trial 4)</td>
<td>10.78</td>
<td>3.04</td>
</tr>
<tr>
<td>Delay Recall</td>
<td>10.37</td>
<td>3.32</td>
</tr>
<tr>
<td>DSST^4</td>
<td>106.95</td>
<td>13.94</td>
</tr>
</tbody>
</table>

^1 Graf, Utzl, and Tuokko (1995)  
^2 Blair & Spreen (1989)  
^3 Adapted from Lezak (1995)  
^4 Wechsler (1958)
Table 9 Summary of a Simultaneous Multiple Regression Analysis for Predicting Retrospective Memory Task Performance by Means of Performance on Three Neuropsychological Tests in Experiment 3.

<table>
<thead>
<tr>
<th>Variables</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-.07</td>
<td>1.10</td>
<td></td>
</tr>
<tr>
<td>Stroop Interference</td>
<td>-.01</td>
<td>.01</td>
<td>-.16</td>
</tr>
<tr>
<td>NAART</td>
<td>.01</td>
<td>.01</td>
<td>.13</td>
</tr>
<tr>
<td>DSST</td>
<td>.001</td>
<td>.01</td>
<td>.01</td>
</tr>
</tbody>
</table>
Table 10 Summary of a Simultaneous Multiple Regression Analysis for Predicting Prospective Memory Task Performance by Means of Performance on Four Neuropsychological Tests in Experiment 3.

<table>
<thead>
<tr>
<th>Variables</th>
<th>$B$</th>
<th>SE $B$</th>
<th>$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>4.59</td>
<td>1.98</td>
<td></td>
</tr>
<tr>
<td>Stroop Interference</td>
<td>-.01</td>
<td>.02</td>
<td>-.05</td>
</tr>
<tr>
<td>NAART</td>
<td>-.06</td>
<td>.02</td>
<td>-.31*</td>
</tr>
<tr>
<td>VLT composite score</td>
<td>.41</td>
<td>.24</td>
<td>.22</td>
</tr>
<tr>
<td>DSST</td>
<td>-.001</td>
<td>.02</td>
<td>-.01</td>
</tr>
</tbody>
</table>
Table 11 A List of All Instruments and Tasks Assigned to Participants in Experiment 4, Arranged According to When They were Administered with the Time Required to Complete Each of Them.

<table>
<thead>
<tr>
<th>Task/Instrument</th>
<th>Approximate Time to Complete (in minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Planning: Prospective Memory Task Assigned</strong></td>
<td>5</td>
</tr>
<tr>
<td><strong>Neuropsychological Tests</strong></td>
<td></td>
</tr>
<tr>
<td>Color-Word Stroop Test(^1)</td>
<td>8</td>
</tr>
<tr>
<td>North American Adult Reading Test(^2)</td>
<td>4</td>
</tr>
<tr>
<td>Verbal Learning Test(^3)</td>
<td>7</td>
</tr>
<tr>
<td>Digit Symbol Substitution Test(^4)</td>
<td>7</td>
</tr>
<tr>
<td>Anagram-solving Task; the ProM-cues were presented in the course of this test (^2)</td>
<td>25</td>
</tr>
<tr>
<td>Verbal Learning Test Delayed Recall(^3)</td>
<td>2</td>
</tr>
<tr>
<td>Debriefing</td>
<td>3</td>
</tr>
</tbody>
</table>

\(^1\) Graf, Uttl, and Tuokko (1995)  
\(^2\) Blair & Spreen (1989)  
\(^3\) Adapted from Lezak (1995)  
\(^4\) Wechsler (1958)
Table 12 Mean Level of Performance and Standard Deviations for Each of the Variables Assessed by Each of the Neuropsychological Tests in Experiment 4.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stroop test</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word reading</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>31.53</td>
<td>5.15</td>
</tr>
<tr>
<td>Errors</td>
<td>0.19</td>
<td>0.36</td>
</tr>
<tr>
<td>Color naming</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>43.16</td>
<td>9.33</td>
</tr>
<tr>
<td>Errors</td>
<td>0.27</td>
<td>0.71</td>
</tr>
<tr>
<td>Incongruent color naming</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>70.12</td>
<td>13.10</td>
</tr>
<tr>
<td>Errors</td>
<td>1.04</td>
<td>0.92</td>
</tr>
<tr>
<td>Stroop interference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time differences</td>
<td>26.85</td>
<td>8.89</td>
</tr>
<tr>
<td><strong>NAART</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>32.50</td>
<td>9.38</td>
</tr>
<tr>
<td><strong>VLT</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>List A (trial 1)</td>
<td>8.03</td>
<td>2.45</td>
</tr>
<tr>
<td>List A (trial 2)</td>
<td>12.34</td>
<td>3.06</td>
</tr>
<tr>
<td>List A (trial 3)</td>
<td>14.19</td>
<td>2.14</td>
</tr>
<tr>
<td>List B</td>
<td>6.28</td>
<td>1.94</td>
</tr>
<tr>
<td>List A (trial 4)</td>
<td>10.81</td>
<td>3.47</td>
</tr>
<tr>
<td>Delay Recall</td>
<td>9.94</td>
<td>3.21</td>
</tr>
<tr>
<td><strong>DSST</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>107.97</td>
<td>13.77</td>
</tr>
</tbody>
</table>

1 Graf, Uttl, and Tuokko (1995)
2 Blair & Spreen (1989)
3 Adapted from Lezak (1995)
4 Wechsler (1958)
Table 13 Summary of a Simultaneous Multiple Regression Analysis for Predicting Retrospective Memory Task Performance by Means of Performance on Three Neuropsychological Tests in Experiment 4.

<table>
<thead>
<tr>
<th>Variables</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>4.10</td>
<td>2.33</td>
<td>-</td>
</tr>
<tr>
<td>Stroop Interference</td>
<td>-.004</td>
<td>.02</td>
<td>-.06</td>
</tr>
<tr>
<td>NAART</td>
<td>-.001</td>
<td>.03</td>
<td>-.01</td>
</tr>
<tr>
<td>DSST</td>
<td>.04</td>
<td>.02</td>
<td>-.44</td>
</tr>
</tbody>
</table>
Table 14 Summary of a Simultaneous Multiple Regression Analysis for Predicting Prospective Memory Task Performance by Means of Performance on Four Neuropsychological Tests in Experiment 4.

<table>
<thead>
<tr>
<th>Variables</th>
<th>$B$</th>
<th>SE $B$</th>
<th>$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>11.30</td>
<td>5.56</td>
<td></td>
</tr>
<tr>
<td>Stroop Interference</td>
<td>-.11</td>
<td>.05</td>
<td>-.66</td>
</tr>
<tr>
<td>NAART</td>
<td>-.16</td>
<td>.07</td>
<td>-.64</td>
</tr>
<tr>
<td>VLT composite score</td>
<td>-.04</td>
<td>.48</td>
<td>-.05</td>
</tr>
<tr>
<td>DSST</td>
<td>.004</td>
<td>.04</td>
<td>.23</td>
</tr>
</tbody>
</table>
Figure Captions

Figure 1. The Figure Shows the Sequence of Events that Occurred on Each Trial of the Lexical Decision Task.

Figure 2. Mean Amount of Time Required to Make Correct ProM task responses (Vertical Bars Indicate Standard Errors) in Each Priming Condition in Experiment 1.

Figure 3. Mean Accuracy of ProM Task Performance (Vertical Bars Indicate Standard Errors) in Each ProM Priming Condition in Experiment 1.

Figure 4. Mean Amount of Time Required to Make Correct ProM task responses (Vertical Bars Indicate Standard Errors) in Each Priming Condition in Experiment 2.

Figure 5. Mean Accuracy of ProM Task Performance (Vertical Bars Indicate Standard Errors) in Each ProM Priming Condition in Experiment 2.

Figure 6. Mean Amount of Time Required to Make Correct ProM task responses (Vertical Bars Indicate Standard Errors) in Each Priming Condition in Experiment 3.

Figure 7. Mean Accuracy of ProM Task Performance (Vertical Bars Indicate Standard Errors) in Each ProM Priming Condition in Experiment 3.

Figure 8. The Figure Shows the Sequence of Events that Occurred on Each Trial of the Anagram-Solving Task.

Figure 9. Mean Amount of Time Required to Make Correct ProM task responses (Vertical Bars Indicate Standard Errors) in Each Priming Condition in Experiment 4.

Figure 10. Mean Accuracy of ProM Task Performance (Vertical Bars Indicate Standard Errors) in Each ProM Priming Condition in Experiment 4.
Figure 1. The Figure Shows the Sequence of Events that Occurred on Each Trial of the Lexical Decision Task.
Figure 2. Mean Amount of Time Required to Make Correct ProM task responses (Vertical Bars Indicate Standard Errors) in Each Priming Condition in Experiment 1.
Figure 3. Mean Accuracy of ProM Task Performance (Vertical Bars Indicate Standard Errors) in Each ProM Priming Condition in Experiment 1.
Figure 4. Mean Amount of Time Required to Make Correct ProM task responses (Vertical Bars Indicate Standard Errors) in Each Priming Condition in Experiment 2.
Figure 5. Mean Accuracy of ProM Task Performance (Vertical Bars Indicate Standard Errors) in Each ProM Priming Condition in Experiment 2.
Figure 6. Mean Amount of Time Required to Make Correct ProM task responses (Vertical Bars Indicate Standard Errors) in Each Priming Condition in Experiment 3.
Figure 7. Mean Accuracy of ProM Task Performance (Vertical Bars Indicate Standard Errors) in Each ProM Priming Condition in Experiment 3.
Figure 8. The Figure Shows the Sequence of Events that Occurred on Each Trial of the Anagram-Solving Task.
Figure 9. Mean Amount of Time Required to Make Correct ProM task responses (Vertical Bars Indicate Standard Errors) in Each Priming Condition in Experiment 4.
Figure 10. Mean Accuracy of ProM Task Performance (Vertical Bars Indicate Standard Errors) in Each ProM Priming Condition in Experiment 4.