ABSTRACT

KIM, PAUL YOUNGHOON. The Relationship between Planning and Prospective Memory: Examining the Role of Working Memory Task Load. (Under the direction of Dr. Christopher B. Mayhorn.)

Articulatory suppression / manipulations of working memory (i.e., poetic language) were examined in relationship to planning and prospective memory. Two experiments were conducted. Experiment 1 required participants to answer 90 trivia questions and complete embedded time- and event-based prospective memory tasks. The 36 participants were divided into three equal groups: no working memory (WM) load, low WM load, and high WM load. Results from that experiment did not support the hypotheses because the performance of the low WM load group was worse (though not statistically significant) than the performance of both the no WM load and high WM load groups. Experiment 2 required participants to do an errand-planning task and complete embedded time- and event-based prospective memory tasks. The 36 participants, who did not participate in Experiment 1, were also divided into three groups that varied by WM load: no WM load, low WM load, and high WM load. The hypotheses for the second experiment were not supported. One interesting finding was prospective memory performance correlated with a measure of planning: the Tower of Hanoi task. These experiments, their findings, and general discussion are discussed.
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The Relationship between Planning and Prospective Memory: 
Examining the Role of Working Memory Task Load

by
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A dissertation submitted to the Graduate Faculty of
North Carolina State University
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

Psychology

Raleigh, North Carolina

2013

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DEDICATION

To my parents, Tong Hui and Sun Hae Kim

my brother, Peter Kim and his wife, Alyssa Farley Kim
BIOGRAPHY

Paul Younghoon Kim was born on September 20, 1981 in Raleigh, North Carolina at 6:00pm. He looked almost exactly like his older brother as a baby that his mother asked why is Peter here. In 1986, Paul entered Stough Elementary School. He was apprehensive at first, but got used to school life quickly. However in the summer of 1989, his mother, brother Peter, he, and a friend of the family were involved in a car accident. He sustained the most injuries, having lost the left dominant side of his brain. He lay in a coma for four and a half months in a bed at Lenox Baker Children’s Hospital. Miraculously, he opened his eyes.

The next several months were hard on the family. Paul, his mother, and a nurse aide would travel to Lenox Baker every morning, so Paul could have his dose of rehabilitation while his father went to work and Peter went to school. After a time, Paul went back to school, only losing one year.

Back to the present after finishing his master’s degree in 2009, Paul presented the master’s thesis work, Exploring Age-Related Differences in Prospective Memory Inside and Outside of the Lab, at the North Carolina Cognition Conference in Winston-Salem, N.C. as a poster in February, 2010. Later, he presented the work as a power-point presentation at the Human Factors and Ergonomics Society’s Annual Meeting in San Francisco, CA, September 27 – October 1, 2010. Again, he presented the work as a poster in the Annual Graduate Student Research Symposium at North Carolina State University in March, 2011.
ACKNOWLEDGMENTS

I would like to thank Dr. Christopher B. Mayhorn for being my adviser, mentor, and chair on this committee, giving me insight, wisdom, and experience on this process and other matters. I appreciate Dr. James W. Kalat, Dr. Anne C. McLaughlin and Dr. Ronald P. Endicott for being on this committee and asking some pertinent questions of my doctoral dissertation.

I would like to thank Dr. Steven B. Katz for the poetry references for the manipulations in working memory task loads for my dissertation work.

I would also like to thank my father for helping/clarifying the instructions for some of the student participants during data collection.
# TABLE OF CONTENTS

LIST OF TABLES ............................................................................................................ vii
LIST OF FIGURES .......................................................................................................... viii

Introduction ....................................................................................................................... 1
   Three Types of Intentions .......................................................................................... 1
   Laboratory vs. Naturalistic Methods ....................................................................... 2
   Working Memory ....................................................................................................... 6
   Planning .................................................................................................................... 9
   Exploring Planning during Prospective Memory .................................................... 10
   Purpose of this Study ............................................................................................... 12
   What we know / What we do not know ................................................................. 13
   Research Hypotheses for Experiment 1 ............................................................... 13
   Research Hypotheses for Experiment 2 ............................................................... 14
   Research Hypothesis for Experiment 1 and Experiment 2 ................................... 15

Experiment 1
   Method ....................................................................................................................... 15
   Participants ............................................................................................................... 15
   Design ...................................................................................................................... 16
   Materials/Apparatus ............................................................................................... 17
   Procedure ............................................................................................................... 17
   Results ..................................................................................................................... 18
   Post Hoc Tests ....................................................................................................... 19
   Regression Analyses ............................................................................................. 20
   Summary of Results ............................................................................................... 20
   Discussion ............................................................................................................... 21

Experiment 2
   Method ....................................................................................................................... 22
   Participants ............................................................................................................... 22
   Design ...................................................................................................................... 22
   Procedure ............................................................................................................... 23
   Results ..................................................................................................................... 24
   Post Hoc Tests ....................................................................................................... 25
   Regression Analyses ............................................................................................. 26
   Summary of Results ............................................................................................... 26
   Discussion ............................................................................................................... 27

Cross Experiment Comparisons .................................................................................. 28
   Discussion ............................................................................................................... 29

General Discussion .................................................................................................... 29
LIST OF TABLES

Table 1  Participants’ number of correct answers (score) on 90 questions................. 39
Table 2  Descriptive Statistics for Experiment 1 ......................................................... 40
Table 3  One-way ANOVAs using Ospan Absolute Score and Ospan Total Correct upon Time- and Event-based Tasks in Experiment 1 ............................... 41
Table 4  Descriptive Statistics for Experiment 2 .......................................................... 42
Table 5  One-way ANOVAs using Ospan Absolute Score and Ospan Total Correct upon Time- and Event-based Tasks in Experiment 2 ................................. 43
LIST OF FIGURES

Figure 1 Completion rates (%) of prospective memory tasks and different working memory loads under artificial condition (Experiment 1) ................................  44

Figure 2 Completion rates (%) of prospective memory tasks and different working memory loads under naturalistic condition (Experiment 2) ............................  45
Introduction

Prospective memory is essential because it refers to one’s ability to remember and execute intentions in the future. For example, if you plan to pick up your younger brother after school but forget, you will be considered irresponsible or preoccupied with other matters (cf., Meacham, 1982; Sinnott, 1986). While prospective memory has been studied for several decades now, a number of empirical questions remain. For instance, how do other cognitive processes such as working memory and planning impact prospective memory performance? Likewise, does prospective memory performance in the laboratory generalize to the real-world given situational issues such as task interruption?

To further explore these unanswered questions, this dissertation is organized into the following sections that address a number of related topics used to devise two experiments that explored the relationship between prospective memory, working memory, and planning. The initial sections explore the three types of intentions, differences between laboratory and naturalistic settings, and the association between working memory and prospective memory. Specifically, working memory task load is described and discussed as an important manipulation. Lastly, a section on planning demonstrates the differences between the Tower of Hanoi and the Tower of London tasks and how the impact of interruption could potentially hinder the likelihood of achieving goals.

Three types of intentions

Einstein and colleagues have theorized that prospective memory can be divided into two different types of intentions: event- and time-based intentions (Craik, 1986; Einstein, Holland, McDaniel, & Guynn, 1992; Einstein & McDaniel, 1990; 1996; Einstein, McDaniel,
Richardson, Guynn, & Cunfer, 1995). An additional third type, activity-based intentions, has been a much more recent theoretical contribution to the literature (Kim & Mayhorn, 2008; Kvavilashvili & Ellis, 1996). Activity- and event-based intentions have an external cue that signals someone to remember and complete a task such as remembering to give a message to a friend when seeing him or her. Time-based intentions, however, are tasks that rely on the specificity of time and must be performed within a specified time period, and use self-initiated retrieval processes where remembering is accomplished without the use of external cues (Craik, 1986; Einstein et al., 1992; Einstein & McDaniel, 1996; Marsh & Hicks, 1998). An example of a time-based task is continuously glancing at a clock to monitor the time because you need to remember to meet your college buddy at the train station at 4:00. The distinction among the three intentions is that event- and time-based intentions rely on an interruption to accomplish the prospective memory task while activity-based intentions do not (Kvavilashvili & Ellis, 1996). An example of an event-based task is remembering to relay a message to call his mother when you see your roommate at the library while you are conducting your own research on dinosaurs. In effect, you have to interrupt your own work to relay the message. By contrast, an activity-based task, using the same example, would require you to continue researching dinosaurs until finished before giving the message to your roommate. Thus, an activity-based task requires the completion of an ongoing activity before starting the next activity (Kvavilashvili & Ellis, 1996).

Laboratory vs. Naturalistic Methods

Most of the studies that have investigated prospective memory have been conducted in the highly controlled environment of the laboratory (e.g., Einstein et al., 1992; Einstein,
McDaniel, Richardson, Guynn, & Cunfer, 1995). The required task is to perform a future action that is embedded within another laboratory task, preferably a retrospective memory task (Rendell & Thomson, 1999) such as remembering to ask for a red pen to draw a circle (Dobbs & Rule, 1987), remembering to ask for a hidden belonging, remembering to give a message (Zelinski, Gilewski, & Anthony-Bergstone, 1990), pressing a particular key on a computer keyboard when a target word appears (Einstein et al., 1992; Einstein & McDaniel, 1990; Park, Hertzog, Kidder, Morrell, & Mayhorn, 1997), or circling the trial number whenever a face having a beard or wearing glasses appears during a “famous people naming task” (Maylor, 1993; Maylor, 1996; Rendell & Thomson, 1999). The strength of this approach is that researchers can impose experimental control in an effort to isolate variables of interest and minimize the effects of extraneous or confounding variables. Indeed, it has been argued that “the laboratory tradition is strong in method and rich in theory” (Winograd, 1988, pp. 19). With these benefits of laboratory investigation come related limitations that leave the research open to criticism. For instance, the ecological validity of lab-based prospective memory tasks is often questioned because the intentions being measured belong to the experimenter (not the participants) and the distracting task is often superfluous or unrelated to the primary prospective memory task. Also, the performance of intentions in the lab seems not to be congruent to everyday intentions because the prospective tasks in the lab are repetitions of the same task (Marsh, Hicks, & Landau, 1998). Efforts to study prospective memory outside the confines of the laboratory have been termed the ecological approach. Such efforts promise to add to the richness of the prospective memory literature (Winograd,
by exploring how people remember to accomplish their own intentions even though a portion of experimental control is sacrificed (Marsh, Hicks, & Landau, 1998).

There have been several studies that have been conducted outside of the laboratory to investigate people’s naturalistic prospective memory performance (e.g., Devolder, Brigham, & Pressley, 1990; Harris, 1980; Intons-Peterson, & Fournier, 1986; Marsh, Hicks, & Landau, 1998; Meacham, & Leiman, 1975; Park, & Kidder, 1996; Park, Morrell, Frieske, & Kincaid, 1992; Poon, 1985; Schaffer, & Poon, 1982; West, 1988). Most of these studies utilized self-reports, measures of medication adherence, mailing postcards on certain days, telephoning on specified days, or diary methods (Cohen, 1989). One of the earliest studies conducted was that of Meacham and Leiman (1975) where participants were asked to mail postcards on specific dates ranging from 16 or 32 days later. At the end, the researchers asked how the participants remembered to mail the postcards. The majority of the participants reported using external retrieval cues such as checking calendars or leaving cards in a conspicuous location. Very few reported using purely cognitive abilities (internal cues).

A more recent study using the ecological\(^1\) approach was conducted by Marsh, Hicks, and Landau (1998) who completed three experiments outside the laboratory using diary data collected from undergraduate students. Based on self-report data about how intentions are generally remembered, students were classified as either recorders or non-recorders. Recorders used external cues such as calendars and planners to remember intentions whereas non-recorders did not use any type of external cue, but they reported rehearsing their

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\(^1\) “Ecological” in terms of this use is a naturalistic or ecologically-valid setting outside of the lab or called field experiment in that some experimental control is lost, nothing more or less. There is no cultural or other component involved.
intentions mentally several times a day. In general, students described six categories of intentions: a) commitments and appointments (e.g., a dentist appointment), b) intentions to commit (e.g., calling to establish an appointment), c) intentions to complete (e.g., having to return something or to borrow something from a friend), d) intentions to study (e.g., doing homework), e) intentions to communicate (e.g., writing, telephoning, e-mailing, or sending a letter), and f) miscellaneous intentions (e.g., taking medicine or feeding a friend’s pet).

Results from the first experiment revealed a number of reasons why planned intentions were not completed. Participants reported that prospective intentions were often forgotten, reprioritized, canceled, or were impossible for the six categories of plans. The most frequently reported reason for not completing an intention was termed “reprioritization” whereby intentions were organized according to subjective importance such that some intentions were placed “on hold” while other more important intentions were completed.

The second and third experiments focused on students’ use of external cues to prompt the retrieval of intentions. In the second experiment, the researchers provided a green neon wristband such that half of the recorders and half of the non-recorders’ had access to a retrieval cue to remind them to review their intentions daily. The four conditions were: (1) recorders without band, (2) recorders with band, (3) non-recorders without band, and (4) non-recorders with band. Results indicated that wearing a wristband enhanced participants’ efforts to review intentions; however, the effect was not statistically significant. In the third experiment, the experimenters manipulated access to the participants’ own use of external cues such that half of the recorders did not have access to their daily planners and half of the non-recorders were required to use planners. Findings indicated that giving planners to non-
recorders lessened the number of intentions forgotten because of the added assistance of writing intentions down.

*Working memory*

Before going into the association between working memory and prospective memory, a discussion about working memory is necessary. There are many theories about individual differences in working memory. One theory suggests that working memory has a detrimental effect concerning high-level interference and that controlled attention is necessary for successful task performance as illustrated by Redick, Calvo, Gay, and Engle (2011). Redick et al. (2011) recruited low and high working memory capacity (WMC) participants (i.e., retaining participants whose composite scores fell in the 25 percentile and 75 percentile of their database after completing three working memory span tasks on a previous visit) to view a light that flickered (prosaccade) and not view the light (antisaccade) scenarios. As it turned out, both low and high WMC groups did comparably well on the prosaccade; however, only the high WMC did well with the antisaccade. The low WMC could not inhibit the urge to look at the light even though they were in the antisaccade scenario.

This leads to reduction in working memory (WM) due to articulatory suppression which is an integral component that was manipulated in the current studies. Soto and Humphreys’ (2008) studies used the articulatory suppression method that required participants to recite two random digits between 1 and 9. The participants (i.e., college students in University of Birmingham, England) had to recite the articulatory suppression (2 repetitions/sec) task while remembering the memory items (i.e., circle, diamond, square, triangle, or hexagon as well as their corresponding colors: red, green, blue, yellow, or pink).
Essentially, the authors conducted four experiments. However, the articulatory suppression experiments were Experiments 2 and 4. In Experiment 2, they discovered impairments of WM items due to the articulatory suppression task in the low WM load as opposed to Experiment 1 that did not have the articulatory suppression. The high WM load (i.e., remembering two memory items rather than one as manipulated in Experiment 2) added to the impairments in Experiment 4 because the authors added a rotated hexagon (90%) and the color black into the memory items alongside the articulatory suppression task.

In the present studies, poetic language was used as an articulatory suppression method as well as working memory task load rather than digits or foreign words. Consistent with previous work (e.g., Papagno, Baddeley, & Valentine, 1989; Soto & Humphreys, 2008), participants performed a secondary task such as answering questions or doing an errand-planning task while reciting the poetic word or words.

Given this manipulation of articulatory suppression / working memory, the association between working memory and prospective memory needs to be addressed further. Because prospective memory tasks often occur in complex situations where multiple tasks are ongoing, working memory is also related to the completion of the prospective memory task. For example, when the primary task involves a low working memory load, then prospective memory is not affected. However previous research by Kidder, Park, Hertzog, and Morrell (1997) suggests that high working memory load associated with a complex primary task will decrease the likelihood of successful prospective memory performance. In their study, Kidder et al. (1997) recruited adult participants (both young and older) to participate in an experiment where they had to view words on a computer screen and recall
the last two or three words (different working memory load conditions). The prospective memory task was to identify when the background changed (manipulated by one or three target backgrounds). The results showed that when the condition had low (two words) working memory load and low prospective memory load (one target background), both age groups’ performances were at or near ceiling level. However, when the condition involved high (three words) working memory load and high prospective memory load (three target backgrounds), age differences appeared. The young age group performed the task near ceiling level (but had a lower overall score than the low load condition); the older age group was differentially affected by the load manipulations. Interestingly, these results seem to conflict with the previous hypotheses of Einstein and McDaniel (1990; 1996) that suggest that there should be minimal age effects in prospective memory tasks reliant on external cues (Kidder, Park, Hertzog, & Morrell, 1997).

Marsh and Hicks (1998) also conducted a series of experiments, varying the extent of working memory involvement through the use of high vs. low vs. no load conditions. They concluded that prospective memory performance suffered when working memory tasks emphasized the involvement of the executive control and/or the visuospatial sketchpad. However when manipulating the articulatory loop component of working memory, it seemed that it did not involve the executive control, allowing prospective memory to have no adverse effect. For the experiments, performance on the prospective memory task was worst in the high load condition whereas prospective performance during the low load condition was similar to that of no load condition.
Planning is obviously related to prospective memory but it has received little attention in the literature. Planning is an everyday task. To make a plan for an errand during an outing, we must define what constitutes a plan. Planning is the predetermination of a sequence of actions to achieve a goal; containing memory components to retrieve past experiences from long-term memory for formulating possible diagrams and evaluating hypothetical events (Cohen, 1989; Hayes-Roth & Hayes-Roth, 1979). A classic example from the literature was illustrated by Hayes-Roth and Hayes-Roth (1979) where participants had to plan how to traverse a rectangular town, picking up necessary or essential items on the list such as flowers at the florist shop, and so on within a time limit (i.e., actually they did the task on a computer screen). It was essential for the participants to keep in mind what items they had already picked up and what items they needed, reducing the number of backtracks. Another illustration is provided by Dreher and Oerter (1987) where participants had to strategically plan out how to accomplish a set number of items/visits such as buying canned meat at the grocery for a camping trip the next day, arriving at train station to meet boy/girlfriend, meeting boss, getting bicycle repaired, and so on. Two points of view can be taken: one considering time limits and the other considering items/locations/visits and the importance of each one.

Planning is important in life and problem-solving. Commonly available measures of problem-solving include experimental tasks such as the Tower of Hanoi and the Tower of London that are often considered to be synonymous with plan-making, whether efficient or not. To achieve the primary task, the person must accomplish secondary subtasks that come
closer to the primary task. For example, the Tower of London problem originally devised by Shallice (1982) was used in clinical settings to examine the executive functioning of frontal-lobe impaired patients in comparison to a representative sample of “non-impaired” people. In the same vein, the current work uses the Tower of Hanoi problem, another type of tower-transfer task to examine the “planfulness” of participants.

*Exploring Planning during Prospective Memory*

Meacham (1982) states that planning an action requires two principles: 1) that processes are acquired as independent, goal-directed acts towards and employed in a means-end relationship to be funneled into another process and 2) demonstrated by Soviet research, that the superordinate activity or social context establishes the relationships of the specific acts and processes utilized in that context. On that note, remembering is an essential process in the execution of planned actions. It is because even though the remembering is in the past, the intention to do something (e.g., meeting a friend for lunch) is in the present and future.

A method of planning illustrated by Rabbit (1996) shows an example. Time-keeping requires the use of a clock or timer to schedule planned activities, most of the time. However when someone becomes an expert at time-keeping, he or she uses environmental support (e.g., cues) for “time-cued prospective memory” such as an expert cook “observing the critical changes in the ingredients as they are simmering, thus using the cooking process itself as a reliable clock” (Rabbitt, 1996, pp. 242).

In a study by Craik & Bialystok (2006), they examined planning behavior for the familiar task of cooking breakfast. Both younger and older adults participated in the study. The experimental procedure required participants to prepare various items such as toast, and
coffee while simultaneously switching tasks and preparing the table with plates, forks, knives, etc. The first experiment consisted of those two tasks displayed on a computer monitor, one screen for both tasks. The result revealed that the younger participants started cooking the various food items on time while the older participants lagged a little behind and had more trouble. Although both groups burned their food items, the younger participants stopped the timer earlier than the older participants.

The second experiment’s procedure was the same as the first experiment’s procedure except that the computer monitor had two screens to switch from: the cooking food items’ display and the setting of utensils/plates display. The outcome was the same; however, it was harder. The older participants’ group had more difficulty switching tasks as well as remembering the present state of the cooking times of the foods. It was worse than the first experiment. The third experiment was the same except, this time, the computer monitor had six screens; each of the five food items plus the setting of utensils/plates on the table. The result showed a detrimental effect of older participants’ plans of starting/cooking times and the setting of the table. They burned the food items because of an overloaded working memory and prospective memory. In essence, the older participants’ executive control was overloaded from the one-screen to the six-screen monitors (Craik & Bialystok, 2006).

Another planning method, means-end analysis, often associated with problem solving, requires seeing the initial state and the eventual outcome, and systematically planning how to accomplish the task. One example of such a task involved requiring groups of children in kindergarten, first, third, and fifth grades to remember to bring skates to school on the following day (Kreutzer, Leonard, & Flavell, 1975). Results suggested that the older kids
were more likely to use means-end analysis than younger children such that they reported a variety of mnemonic efforts such as placing the skates at the door to remind them or writing a note about the upcoming task and placing it on the child’s dresser (Kreutzer, Leonard, & Flavell, 1975).

Kliegel, Martin, McDaniel, and Phillips (2007) provided evidence that older participants fared as well as young participants on an errand planning task (established by Bisiacchi, 1996) conducted within a familiar setting (i.e., using a city map to accomplish the 6 itemized errand tasks). However when the situation changed to an unfamiliar setting, older participants fared poorly compared to their younger counterparts. The artificial situation was the same as the familiar situation except that the place was in outer space, hopping from one planet to another to accomplish the 6 itemized errand tasks (i.e., using a space map). To reemphasize, older adults can compensate for their declining cognitive processes by using a map and having a familiar recognizable setting or situation as well as young adults. They had to do the real-world tasks all their adult lives. On the other hand, the unfamiliar and artificial situation was so bizarre that the older adults could not compensate or transfer their knowledge of the familiar to the unfamiliar situation.

Purpose of this study

The current work explores how other cognitive processes such as articulatory suppression / working memory and planning influence prospective memory performance. Even though there is a clear distinction between time-based intentions and event-based intentions, both were included with the planning task (discussed more in the Method section) in an effort to explore any potential differences between task types. For each type of
prospective task, working memory load was manipulated in classic laboratory based and more realistic venues. However, comparisons might not be advisable. To assess the impact of planning on prospective memory, a 5-disk Tower of Hanoi problem was used to examine correlational findings between the time- and event-based tasks prior to the different conditions. But first, a discussion of what we know and what we do not know.

What we know / What we do not know

Because previous studies (e.g. Papagno et al., 1989; Soto & Humphreys, 2008) used digits or foreign words as articulatory suppression methods, it is unclear whether different articulatory suppression methods are as effective. Broadly speaking, this dissertation explores this topic by addressing the following research questions: How do manipulations of working memory / articulatory suppression affect prospective memory and planning? More specifically, how does poetic language (articulatory suppression / working memory manipulations) influence planning of prospective memory tasks?

Research Hypotheses

Experiment 1

From previous research, high working memory has a detrimental effect on prospective memory as illustrated by Kidder et al. (1997). Time-based as opposed to event-based prospective memory will be affected more during Experiment 1 as previously hypothesized by Einstein and McDaniel (1990; 1996). The interaction between the two (i.e., high working memory and time-based tasks) will have an adverse effect as opposed to high working memory and event-based tasks. The setting is in the lab with instruction and
condition being artificial as opposed to an ecologically valid setting. The following hypotheses are tested in Experiment 1:

H₁ – There will be a main effect for task type such that event-based prospective memory task performance will be better than time-based prospective memory task performance in the multiple choice test / prospective memory planning (artificial) condition (Einstein et al., 1992; Einstein & McDaniel, 1990; 1996; Kim & Mayhorn, 2008; Park et al., 1997; Park & Kidder, 1996; Park et al., 1992).

H₂ – There should be a main effect for working memory load such that prospective memory performance will be worst in the high working memory load in the multiple choice test / prospective memory planning condition while there will be similar non-significant results for the no and low load working memory groups (Kidder et al., 1997; Marsh & Hicks, 1998).

H₃ – An interaction between task type and working memory (WM) load should occur in the multiple choice test / prospective memory planning condition. It is predicted that there will be detrimental effects between time-based task and high WM load (Marsh & Hicks, 1998).

Experiment 2

Although the setting for this experiment is in the lab, the instruction and condition is more naturalistic than in Experiment 1 because it is an errand-planning task (Bisiacchi, 1996). The following hypotheses are tested in Experiment 2:

H₄ – There will be a main effect of task type such that event-based prospective memory task will outperform time-based prospective memory task in spatial planning

H₅ – There should be a main effect for working memory load such that prospective memory performance will be worst in the high WM load and a significant effect in the spatial planning condition while there will be similar non-significant effects for the no and low load WM groups (Kidder et al., 1997; Marsh & Hicks, 1998).

H₆ – An interaction should occur for the prospective memory tasks and the high working memory (WM) load in the spatial planning condition particularly the detrimental effects between the time-based tasks and the high WM load (Kliegel, Martin, McDaniel, Einstein, & Moor, 2007; Kidder et al., 1997; Marsh & Hicks, 1998).

Experiment 1 and Experiment 2

The situation involving the Tower of Hanoi has a time component rather than having an external cue, in essence the combined hypothesis. Thus, the following hypothesis is tested in both experiments:

H₇ – Correlation coefficient would be higher and in the same direction concerning the Tower of Hanoi and time-based tasks vs. the Tower of Hanoi and event-based tasks.

Experiment 1

Method:

Participants

Thirty-six people participated in this study (18 women, 18 men; $M = 18.47$, $SD = 0.81$). They were recruited from a large southeastern U.S. university student participant pool.
They were enrolled in introductory psychology classes and recruited to fulfill their class research requirement.

*Design*

The design was a 2 (prospective memory tasks (EB & TB)) × 3 (working memory: no load vs. low load vs. high load) mixed model. The within-participant variable consisted of the two different prospective memory task types: event- and time-based. The between-participant variable consisted of manipulations of working memory load (i.e., no load vs. low load vs. high load). The dependent variable of interest was the task performance as measured by the number of completed prospective memory tasks for each combination of task type and working memory load in the artificial lab environment. Task performance was converted later into percentage correct for analysis.

The articulatory suppression / working memory component divided the participants into three 12-member groups. One group was to receive no working memory load, the second low load, and the third high load. For the low working memory load group, each participant had to recite ‘bit’ one or two times per second continuously during the whole artificial session. For the high working memory load group, each participant had to recite ‘long blood oozes down’ once per four or five seconds continuously during the artificial session. The conception of the low and high working memory loads was based on poetry in a manner consistent with previous research (Katz, 1996; Nims & Mason, 2000). For example, ‘bit’ has a short sounding of the word while ‘long blood oozes down’ has a stretching of ‘o’ or ‘oo’ sound of the phrase making it seem longer or lengthier. The manipulations or the number of word or words of the working memory loads were based on Cowan (2010; 2000).
Materials / Apparatus

A Dell desktop computer with operating system, Windows 2000 was used to present experimental stimuli via PowerPoint slides. Ninety trivia questions chosen from various popular press books and specialty websites were presented, one question per slide, to the participants. An example is illustrated in Appendix A.

Trivia questions were organized into six blocks of 15 items. Each block of questions was answered on a separate page of the answer sheet provided to the participants. The time-based prospective memory task required participants to inform the experimenter to make a phone call (Kvavilashvili & Fisher, 2007, Study 2) after 20 minutes had elapsed from the beginning of the experiment. By contrast, the event-based prospective memory task required participants to request a red pen (Dobbs & Rule, 1987) after answering the first two questions on the last page of the answer sheet and making an asterisk on that page.

Procedure

Participants were tested individually in one session that lasted approximately two hours. After the consent form (see Appendix B), they filled out a demographics questionnaire devised to query gender, age, ethnicity, and years of education (Appendix C). After that, they were tested on a computerized task, the automated Operation Span Task (Ospan) (Unsworth, Heitz, Schrock, & Engle, 2005) for working memory capacity. Later, they were asked to complete the computerized Tower of Hanoi 5-disk problem for a maximum of 5 minutes. The number of moves and how long it took in minutes and seconds were recorded. After that, the participant read the instructions of the main task (see Appendix D) presented on the computer monitor before starting the 90 trivia questions (artificial distracter task) (see
Appendix E for the ninety questions and answers). Each question was projected for 20 seconds. Each block of questions lasted 5 minutes, and there were no stoppages between blocks. The participants’ correct answers, mean, and one-way ANOVAs are illustrated in Table 1. As stated in the Materials / Apparatus subsection above, the time-based prospective memory task was for the participant to inform the experimenter to make a call on the 20th minute (Kvavilashvili & Fisher, 2007, Study 2): 40 seconds before or after the 20th minute was acceptable. It was assessed by viewing the numerical question on the 90 trivia questions which is #60 for the 20th minute. The event-based prospective task required participants to request a red pen (Dobbs & Rule, 1987) after answering the first two questions on the last page of the answer sheet and making an asterisk on that page.

Results

Experiment 1 measured the ability of participants to carry out memory tasks in the artificial condition. A 2 × 3 mixed model analysis of variance was utilized to analyze the planning tasks and the manipulations of working memory in the multiple choice test / prospective memory planning condition. Descriptive statistics for groups 1, 2, and 3 are illustrated in Table 2 and one-way ANOVAs by Ospan Absolute Score and Ospan Total Correct is illustrated in Table 3. Figure 1 shows the percentage correct for the prospective memory tasks and different working memory loads under multiple choice test / prospective memory planning condition. Alpha levels were set at .05.

Results did not reveal a main effect of prospective task; $F(1, 33) = 0.319$, $p = .576$, $\eta^2 = .01$ (Power = 0.05) (Faul, Erdfelder, Lang, & Buchner, 2007) such that $H_1$ was not supported favoring event-based prospective memory tasks over time-based prospective

The analysis did not reveal a main effect for H2, in which prospective memory performance was not worst in the high working memory load as well as no and low load of the working memory had no effect with the prospective memory tasks; $F(2, 33) = 1.10, p = .345, \eta^2 = .06$ (Power = 0.06) (Faul, Erdfelder, Lang, & Buchner, 2007) (Kidder et al., 1997; Marsh & Hicks, 1998).

An interaction effect (H3) did not occur between the prospective memory tasks and the high WM load particularly between time-based task and high WM load; $F(2, 33) = 0.558, p = .578, \eta^2 = .03$ (Power = 0.05) (Faul, Erdfelder, Lang, & Buchner, 2007) (Kliegel, Martin, McDaniel, Einstein, & Moor, 2007; Kidder et al., 1997; Marsh & Hicks, 1998).

Post Hoc Tests

Post hoc tests, using Scheffé test, were conducted to examine if there were any significant simple effects among the prospective memory tasks and the working memory loads.

There were no statistically significant simple effects found for the time-based task in the multiple choice test / prospective memory planning condition; $F(2, 33) = 0.320, p = .728$. The mean difference was small comparing no load to low load; 0.17 or no load to high load; 0.08. The mean difference between low load and high load was the worst; -0.08, $p = .923$.

The event-based task in the multiple choice test / prospective memory planning condition did not fare as well; $F(2, 33) = 1.571, p = .223$; mean difference between no load and low load was 0.25, no load to high load; -0.08, and low load to high load; -0.33.
Regression Analyses

Based on zero-order correlations, multiple regression analyses were used to determine how age, education, Ospan absolute score, Ospan total correct, Tower of Hanoi (# of moves), Tower of Hanoi (min:sec), and working memory group correlated with performance on the various prospective memory task types and working memory manipulations. As this set of analyses was largely exploratory, it was inappropriate to formulate directional hypotheses.

All predictor variables except Tower of Hanoi (# of moves) and Tower of Hanoi (min:sec) were inter-correlated with each other in Experiment 1. All were incorporated in the background elimination method analyses. However, no predictor variables were statistically significant for the time-based task in the artificial condition. $R^2$ values were .106 for Step 1, .106 for Step 2, .102 for Step 3, .073 for Step 4, .042 for Step 5, and .000 for Step 6.

There were no significant predictor variables for the event-based task in the artificial condition. The $R^2$ values were .028 for Step 1, .027 for Step 2, .023 for Step 3, .019 for Step 4, .005 for Step 5, and .000 for Step 6.

Summary of Results

There were neither main effects nor an interaction effect to be reported. No post hoc tests to be reported. The predictor variables utilized for the regression analyses for the performances of time- and event based tasks were age, education, Ospan absolute score, Ospan total correct, Tower of Hanoi (# of moves), Tower of Hanoi (min:sec), and working memory group. All predictor variables were included except Tower of Hanoi (# of moves) and Tower of Hanoi (min:sec) in the multiple choice test / prospective memory planning
condition. However, none were significant to the time- or event-based tasks in the artificial condition.

Discussion

None of the hypotheses were supported. The hypothesis (H1) predicted that there would be a significant main effect of prospective memory favoring event-based task over time-based task in the multiple choice test / prospective memory planning condition. There was not. From the data sheet, participants remembered and executed more time-based tasks than event-based tasks. No main effect for H2, which had high working memory being statistically significant to no and low load manipulations, was found. No interaction effect (H3) was present for the prospective memory tasks and high load manipulation.

From previous research, the distinction between time-and event-based tasks is clear, so the finding that time-based performance was higher (though not significantly so) than event-based performance was unexpected. The explanation for this trend in the data is not entirely clear and one potential factor could be that the tasks differed in complexity in Experiment 1 (i.e., remembering to make a phone call on the 20\textsuperscript{th} minute or asking for red pen and making an asterisk after answering the first two questions on the last page of the answer sheet). Another possibility is that in the United States and most of the industrialized world, we are conscious of time. It is essential in our daily lives and we are trained to think of time when we set foot in a school classroom. The time-based task in this experiment might have been easier to remember than the complex event-based task, but do compare Einstein et al., (1992); Einstein et al., (1995); Kvavilashvili and Fisher (2007).
For H$_2$ and the interaction effect, there were no significant effects. Again, this lack of significant results is surprising given work by Yudes, Macizo, and Bajo (2012) where complexity of the articulatory suppression and the meaningfulness of the words (i.e., dog, cat, mouse vs. de, de, de) interfered with the primary memory task. It is likely that the methodological deviation used in the current study from that described by Yudes et al. (2012) eliminated any observable effects (See Figure 1). Why did the participants perform worse on the prospective memory task during low load (one word) than during high load (four words) in Experiment 1?

Experiment 2

Method:

Participants

Thirty-six people participated in this study (21 women, 15 men; $M = 18.44$, $SD = 0.70$). They were recruited from a large southeastern U.S. university student participant pool. They were enrolled in introductory psychology classes and recruited to fulfill their class research requirement.

Design

The design was a 2 (prospective memory tasks (EB & TB)) × 3 (working memory: no load vs. low load vs. high load) mixed model. The factors were arranged in the same format as in Experiment 1 but in the naturalistic condition.

The articulatory suppression / working memory manipulation was the same as in the multiple choice test / prospective memory planning condition described in Experiment 1.
Procedure

After signing the consent form, each participant was tested individually in sessions that lasted approximately 2 hours. Participants also completed a demographics questionnaire devised to query gender, age, ethnicity, and years of education and then do the automated Ospan (Unsworth et al., 2005) and the Tower of Hanoi problem. Lastly, they were presented with a more naturalistic prospective memory task that required them to plan out a route to accomplish six errands (i.e., mailing a package at post office, buying hot cocoa in an international cocoa shop, etc) within a hypothetical city using a city map with the least backtracking (see Appendices F for scenario description, G for the hypothetical city map (used Visio) and H for city map instruction). A time limit of 2 hours was described as the window in which participants had to accomplish the six errands. Because the task was conducted in the lab, two minutes were provided so that participants could plan their routes while the rest of the 28 minutes required them to record in a notebook the proposed sequence of doing the various tasks. It was a spatial planning task because the tasks one had to plan were related to the outside environment, a real-world situation unlike a multiple choice test / prospective memory task situation. However, the prospective memory tasks were experimenter-driven rather than participant-driven. So in terms, the participants might have used more event-based rather than time-based prospective memory tactics to remember as shown in Kim and Mayhorn (2008). The errand-planning task was based on a reduced version of the Wisconsin Card Sorting Task in which participants had to plan out sequences of actions to complete 10 errands such as going to hospital, post office, etc always considering shortest route (Bisiacchi, 1996). Kliegel et al. (2007) also utilized the errand-
planning task but compared older and younger adults in familiar and unfamiliar settings. They based the tasks on participants’ real-world experiences in the familiar setting and uncommon, novel tasks in the unfamiliar setting. They used 6 errands for their study. So this experiment also used only 6 errands embedded with time-based or event-based or both prospective memory tasks.

**Results**

This experiment measured the ability of participants to carry out memory tasks in the spatial planning condition. A 2 × 3 mixed model analysis of variance was utilized to analyze the planning tasks and the manipulations of working memory in the naturalistic condition. Descriptive statistics for groups 1, 2, and 3 are illustrated in Table 4 and one-way ANOVAs by Ospan Absolute Score and Ospan Total Correct is illustrated in Table 5. Figure 2 shows the percentage correct for the prospective memory tasks and different working memory loads under the spatial planning condition. Alpha levels were set at .05.

The results of Experiment 2 revealed a main effect of prospective task such that H4 was not supported favoring time-based prospective memory tasks over event-based prospective memory tasks in the spatial planning condition; \( F(1, 33) = 5.923, p = .021, \eta^2 = .15 \) (Power = 0.14) (Faul, Erdfelder, Lang, & Buchner, 2007) (Einstein et al., 1992; Einstein & McDaniel, 1990; 1996; Kim & Mayhorn, 2008; Park et al., 1997; Park & Kidder, 1996; Park et al., 1992). Time-based tasks were more likely to be performed than their event-based counterparts.

The analysis revealed a main effect for the working memory load manipulations; \( F(2, 33) = 5.677, p = .008, \eta^2 = .26 \) (Power = 0.25) (Faul, Erdfelder, Lang, & Buchner, 2007) but
did not support H₅. It was expected that high working memory load would produce a statistically significant deficit in prospective memory performance within the spatial planning condition while no and low load of the working memory would have little or no effect (Kidder et al., 1997; Marsh & Hicks, 1998). The opposite was shown by the result, the participants in the no working memory load condition performed better than those in either the low or high working memory loads in the spatial planning condition.

Contrary to H₆, an interaction effect (H₆) was not observed between the prospective memory tasks in the spatial planning condition and the high load; $F(2, 33) = 0.121, p = .887, \eta^2 = .01$ (Power = 0.05) (Faul, Erdfelder, Lang, & Buchner, 2007) (Kliegel, Martin, McDaniel, Einstein, & Moor, 2007; Kidder et al., 1997; Marsh & Hicks, 1998).

Post Hoc Tests

Post hoc tests, using Scheffé test, were used to examine if there were any significant simple effects among the prospective memory tasks and the working memory loads.

For the naturalistic condition (i.e., errand-planning task), it was shown that the mean difference between no load and low load as well as no load and high load were the same, 0.58, $p = .020$ from the time-based task; $F(2, 33) = 5.923, p = .006$. So, low load and high load did not have any difference, in contrast to the prediction in H₅.

The mean differences between no load and low load, no load and high load, and low load to high load were not significant for the event-based task in the spatial planning condition; $F(2, 33) = 2.826, p = .087; 0.75, p = .155, 0.75, p = .155$, and $0.00, p = 1.000$, respectively.
Regression Analyses

Based on zero-order correlations, multiple regression analyses were used to determine how age, education, Ospan absolute score, Ospan total correct, Tower of Hanoi (# of moves), Tower of Hanoi (min:sec), and working memory group correlated with performance on the various prospective memory task types and working memory manipulations. As this set of analyses was largely exploratory, it was inappropriate to formulate directional hypotheses.

Not all predictor variables were inter-correlated, only Ospan absolute score, Ospan total correct, and working memory group. These predictor variables were used in the backward elimination method analyses. Only working memory group showed any statistical significance for the naturalistic time-based task; (Step 3: $B = -0.292$, $\beta = -.445$, $p = .007$). $R^2$ values were .235 for Step 1, .234 for Step 2, and .198 for Step 3.

The predictor variable (Ospan total correct) was significant for the spatial planning event-based task only; (Step 3: $B = 0.025$, $\beta = .475$, $p = .003$). $R^2$ values were .228 for Step 1, .227 for Step 2, and .225 for Step 3.

Summary of Results

There were two significant main effects (i.e., task type in spatial planning condition and working memory load manipulation). Those two were the spatial planning time-based task and the no working memory manipulation. The interaction effect was non-significant. The post hoc tests used were the Scheffé test. There were no significant post hoc tests except with the time-based task by the various manipulations of working memory in the spatial planning condition. The predictor variables utilized for the regression analyses for the performances of time- and event-based tasks were age, education, Ospan absolute score,
Ospan total correct, Tower of Hanoi (# of moves), Tower of Hanoi (min:sec), and working memory group. Only Ospan absolute score, Ospan total correct, and working memory group were correlated and used. The predictor variable working memory group was significant for the naturalistic time-based task. Ospan total correct was the only significant predictor for the spatial planning event-based task.

Discussion

A main effect of prospective task type was present; however, it favored time-based tasks rather than event-based tasks in the spatial planning condition, rejecting H4. There was a main effect for the working memory manipulations; however, it favored the no working memory load over the low and high loads in the spatial planning condition, rejecting H5. No interaction effect (H6) was present for the prospective memory tasks and high load manipulation. The only related variable from Experiment 1 and the present experiment was the planning of the prospective memory task at hand. However, the prospective cues were different because in Experiment 1, the participants had to wait for the cue to appear near the end of the 90 trivia questions. This experiment had the cues present all the time because they were directly tied to the prospective memory tasks. So again, these two experiments are not comparable.

For H4 and H5, time-based tasks and no working memory load were better performed than event-based tasks and low or high load conditions. A possibility is that the errand-planning task spatial planning condition was done in the lab, not in an ecologically-valid setting. So distraction was reduced and time-based tasks could be performed optimally as well as having no distracting word or phrase to say.
However, the complex nature of the errand-planning task may have played a part in not remembering much of the time- and event-based tasks (see Appendix F). It is possible because only one participant remembered four out of five event-based tasks and that was from the no load group. Another participant remembered both time-based tasks. The majority of the participants remembered one time-based task or none and one or no event-based task. So, maybe simplicity is better than having multiple components (time- and event-based tasks) in a larger task per my speculation. Unfortunately, the experimental procedure did not include post-interviews to collect qualitative comments that might further inform these contentions regarding the results.

Another possibility is that because of the different numbers of time- and event-based tasks in the errand-planning task, it would seem that time-based tasks prevailed over event-based tasks. However, there were only two time-based tasks as compared to five event-based tasks. Perhaps if equal numbers of time- and event-based tasks are present, then event-based tasks might be better overall in any condition compared to time-based tasks (e.g., Craik, 1986; Herrmann, 1996; Mayhorn, Lanzolla, Wogalter, & Watson, 2005).

Cross Experiment Comparisons:

Correlating Prospective Memory Results from Experiment 1 with Experiment 2

Experiment 1 and Experiment 2

The correlational results showed a modest performance (i.e., medium effect) and in a positive direction for both the Tower of Hanoi 5-disk problem and time-based task than the Tower of Hanoi and event-based task supporting $H_7$; $r (71) = .256, p = .03$. 
Discussion

The only hypothesis (H7) that was supported was the correlation, favoring Tower of Hanoi and time-based tasks over Tower of Hanoi and event-based tasks. As stated there is a time component involved with the Tower of Hanoi; however, no external cue was involved.

General Discussion

One of the contributions of the present work is that it addresses the cognitive impact of naturalistic articulatory suppression that we experience daily. Consider, for instance, someone walking to the post office to mail a letter (primary task) and while walking, he or she recites foreign words for memorization in preparation for an upcoming test (naturalistic articulatory suppression). Because this person is engrossed in study, he or she passes the post office and walks on. In the two experiments presented here, a research question explored whether or not poetic language could act as an articulatory suppression tactic. It did; however, the hypotheses were not supported. Any type (digits, foreign words, meaningful words, or poetic words) would interfere with the primary task it seems (cf., Kidder et al., 1997). The best is to have a quiet, distraction-free room. In reality, most often, it is unlikely to have that, so efforts might concentrate on trying to block or ameliorate extraneous noises.

Another research question addressed how articulatory suppression / working memory load impacts prospective memory performance. From previous research (Kidder et al., 1997; March & Hicks, 1998), it is understood that working memory is associated with prospective memory in that one needs to keep in mind the delayed intention while remembering words or phrases or other important matters. The latter study manipulated the executive control, visuospatial sketchpad, and articulatory loop of working memory. What Marsh and Hicks
(1998) found was that all the components in working memory affected prospective memory badly except articulatory loop. Thus, the finding that articulatory suppression does have an impact on prospective memory is novel.

Likewise, it is likely that planning is associated with prospective memory but the empirical support for this content is lacking in the literature. Consider how one might plan an intention to be carried out later in the day or a few days later. During the process, a person can keep checking the clock to remember and execute the planned/delayed intention (time-based intention) or writing the intention down on scratch paper, using personal digital assistants, or using smartphones (event-based intention). Given the current results that demonstrate a correlation between prospective task performance and a measure of planning (i.e., the Tower of Hanoi), a further contribution of the present work is to provide evidence of this relationship between cognitive processes within the literature.

While the correlational data described above suggest that the nature of the relationship between planning and prospective memory varies by task type (i.e., event-based vs. time-based), the likelihood that such relationships varied by experimental context was also explored in the current work. The results presented here indicate that there are differences in performance when testing occurs in the laboratory or in a more naturalistic setting. One factor is distraction, which abounds in a naturalistic or ecologically valid setting while the laboratory is relatively quiet and participants are less likely to encounter distracting stimuli. The laboratory approach allows researchers to impose experimental control in an effort to isolate variables of interest and minimize the effects of extraneous or confounding variables. It has been argued that “the laboratory tradition is strong in method and rich in
theory” (Winograd, 1988, pp. 19). However, the prospective memory tasks researchers impose are experimenter-driven rather than participant-driven and the distracter task is often superfluous. To counter that, the ecologically valid setting was implemented in which some experimental control was given up to learn the ways participants handled certain tasks. Examples from previous research include having the intention of bringing skates to school the next day (Kreutzer et al., 1975) or having daily planned intentions that participants had to remember to execute (Marsh, Hicks, & Landau, 1998).

**Limitations**

As with all experiments, there are a number of methodological shortcomings that should be considered when the quality of the results is evaluated. For instance, the sample used in the current work consisted entirely of college students, mostly freshmen and the sample was quite small, only having 36 participants in each experiment. In Experiment 1, only one Asian, one African, two Hispanics, and five African-Americans participated. The rest were Caucasian. In Experiment 2, 2 mixed, 3 Hispanics, 3 Asians, and 4 African-Americans participated. The rest were Caucasian. So, the findings might not be generalizable to the wider population and demographics at large, but maybe to the concentrated group of college students. The use of poetic working memory task manipulations might not have been the best idea to test and was exploratory but it did show that articulatory suppression can have an impact on prospective memory. Thus, further research is needed to address these issues.
Conclusion

In essence, the topic of prospective memory remains as enigmatic as ever. However, the current work did provide results that illustrate how this one type of cognition is related to other processes such as planning and working memory. Given the importance of prospective memory in daily life, such research is essential in informing the fields of cognitive psychology and human factors/ergonomics as such environments and technology are designed to support human capabilities.
REFERENCES


Table 1

*Participants’ number of correct answers (score) on 90 questions (n = 36)*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Score</th>
<th>Participant</th>
<th>Score</th>
<th>Participant</th>
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*M* = 29.06, *SD* = 6.01

One-way ANOVA for time-based task: *F*(17, 18) = 1.238, *p* = .328

One-way ANOVA for event-based task: *F*(17, 18) = 1.158, *p* = .379

*Note*: Both one-way ANOVAs’ post hoc tests were not computed because at least one group had fewer than two cases.
Table 2

Descriptive Statistics for Experiment 1

<table>
<thead>
<tr>
<th></th>
<th>Group 1*</th>
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<td>30.08</td>
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</table>

*n = 12 for each group.
a = All data taken while participants reciting “bit” throughout the entire session including Ospan task.
b = All data taken while participants reciting “long blood oozes down” throughout the entire session including Ospan task.
Table 3

One-way ANOVAs using Ospan Absolute Score and Ospan Total Correct upon Time- and Event-based Tasks in Experiment 1

<table>
<thead>
<tr>
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<th>F-test</th>
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<td>Event-based by Ospan Total Correct</td>
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*Note.* --- All four one-way ANOVAs’ post hoc tests were not computed because at least one group had fewer than two cases.
Table 4

*Descriptive Statistics for Experiment 2*

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<td>11.40</td>
<td>7.33</td>
<td>7.48</td>
</tr>
<tr>
<td>Ospan Total Correct</td>
<td>56.33</td>
<td>8.68</td>
<td>25.08</td>
<td>14.56</td>
<td>28.75</td>
<td>12.31</td>
</tr>
<tr>
<td>Tower of Hanoi (# of moves)</td>
<td>59.33</td>
<td>17.86</td>
<td>55.42</td>
<td>17.73</td>
<td>75.50</td>
<td>25.77</td>
</tr>
<tr>
<td>Tower of Hanoi (min:sec)</td>
<td>4:00</td>
<td>1:08</td>
<td>4:16</td>
<td>1:22</td>
<td>4:26</td>
<td>0:54</td>
</tr>
<tr>
<td>Time-based task</td>
<td>0.75</td>
<td>0.62</td>
<td>0.17</td>
<td>0.39</td>
<td>0.17</td>
<td>0.39</td>
</tr>
<tr>
<td>Event-based task</td>
<td>1.25</td>
<td>1.28</td>
<td>0.50</td>
<td>0.67</td>
<td>0.50</td>
<td>0.67</td>
</tr>
</tbody>
</table>

*n = 12 for each group.
a = All data taken while participants reciting “bit” throughout the entire session including Ospan task.
b = All data taken while participants reciting “long blood oozes down” throughout the entire session including Ospan task.
Table 5

One-way ANOVAs using Ospan Absolute Score and Ospan Total Correct upon Time- and Event-based Tasks in Experiment 2

<table>
<thead>
<tr>
<th>Experiment 2</th>
<th>F-test</th>
<th>p-value</th>
<th>Post hoc (Sceffé)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time-based by Ospan Absolute Score</td>
<td>3.06</td>
<td>.021</td>
<td>---</td>
</tr>
<tr>
<td>Event-based by Ospan Absolute Score</td>
<td>1.47</td>
<td>.239</td>
<td>---</td>
</tr>
<tr>
<td>Time-based by Ospan Total Correct</td>
<td>1.54</td>
<td>.272</td>
<td>---</td>
</tr>
<tr>
<td>Event-based by Ospan Total Correct</td>
<td>1.78</td>
<td>.200</td>
<td>---</td>
</tr>
</tbody>
</table>

*Note.* --- All four one-way ANOVAs’ post hoc tests were not computed because at least one group had fewer than two cases.
Figure 1. Completion rates (%) of prospective memory tasks and different working memory loads under artificial condition (Experiment 1)
Figure 2. Completion rates (%) of prospective memory tasks and different working memory loads under naturalistic condition (Experiment 2)
APPENDICES
APPENDIX A

An Example of the Multiple-Choice Questionnaire
1. When was the Bolshevik Revolution?
   A) 1918
   B) 1916
   C) 1915
   D) 1917

   Answer: D) 1917
APPENDIX B

Informed Consent Form

(Experiment 1)

(Experiment 2)
What are some general things you should know about research studies?
You are being asked to take part in a research study. Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate or to stop participating at any time without penalty. The purpose of research studies is to gain a better understanding of a certain topic or issue. You are not guaranteed any personal benefits from being in a study. Research studies also may pose risks to those that participate. In this consent form you will find specific details about the research in which you are being asked to participate. If you do not understand something in this form it is your right to ask the researcher for clarification or more information. A copy of this consent form will be provided to you. If at any time you have questions about your participation, do not hesitate to contact the researcher(s) named above.

What is the purpose of this study?
The purpose of this research study is to examine how people plan routine memory-related tasks.

What will happen if you take part in the study?
If you agree to participate in this study, you will be asked to come to the laboratory one time. After you sign the consent form, you will move to a computer and work on a test to assess your planning abilities for approximately 5 minutes. After that, you come back to the table and read the instructions before starting the 90 trivia questions. You may ask any questions for clarification. Your participation will last approximately two hours. The research study will take place in Poe 700-D.

Risks
Beyond the risks associated with light office work, there are no foreseeable risks involved with this study.

Benefits
No direct benefit is expected to the participants. However, our findings may be beneficial to the general public.

Confidentiality
The information in the study records will be kept strictly confidential. Your identity will be protected by a code number that is linked to your I.D. Data will be stored securely and will be made available only to persons conducting the study unless you specifically give permission in writing to do otherwise. No reference will be made in oral or written reports which could link you to the study. No reference will be made in oral or written reports which could link you to the study.

Compensation
For participating in this study you will receive 4 research credits. If you withdraw from the study prior to its completion, you will receive 2 research credits. Please be aware another way to earn the same amount of credit is by writing a paper relevant to psychology.

What if you have questions about this study?
If you have questions at any time about the study or the procedures, you may contact the researcher, Paul Y. Kim, at pykim@ncsu.edu or 919-781-3645.
What if you have questions about your rights as a research participant?
If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact Deb Paxton, Regulatory Compliance Administrator, Box 7514, NCSU Campus (919/515-4514).

Consent To Participate
“I have read and understand the above information. I have received a copy of this form. I agree to participate in this study with the understanding that I may choose not to participate or to stop participating at any time without penalty or loss of benefits to which I am otherwise entitled.”

Subject's signature_______________________________________ Date _________________
Investigator's signature__________________________________ Date _________________
North Carolina State University
INFORMED CONSENT FORM for RESEARCH
The Relationship between Planning and Prospective Memory: Examining the Role of Working Memory Task Load
Paul Y. Kim Christopher B. Mayhorn

What are some general things you should know about research studies?
You are being asked to take part in a research study. Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate or to stop participating at any time without penalty. The purpose of research studies is to gain a better understanding of a certain topic or issue. You are not guaranteed any personal benefits from being in a study. Research studies also may pose risks to those that participate. In this consent form you will find specific details about the research in which you are being asked to participate. If you do not understand something in this form it is your right to ask the researcher for clarification or more information. A copy of this consent form will be provided to you. If at any time you have questions about your participation, do not hesitate to contact the researcher(s) named above.

What is the purpose of this study?
The purpose of this research study is to examine how people plan routine memory-related tasks.

What will happen if you take part in the study?
If you agree to participate in this study, you will be asked to come to the laboratory one time. After you sign the consent form, you will move to a computer and work on a test to assess your planning abilities for approximately 5 minutes. After that, you come back to the table and read the instructions before starting the errand-planning task. You may ask any questions for clarification. Your participation will last approximately two hours. The research study will take place in Poe 700-D.

Risks
Beyond the risks associated with light office work, there are no foreseeable risks involved with this study.

Benefits
No direct benefit is expected to the participants. However, our findings may be beneficial to the general public.

Confidentiality
The information in the study records will be kept strictly confidential. Your identity will be protected by a code number that is linked to your I.D. Data will be stored securely and will be made available only to persons conducting the study unless you specifically give permission in writing to do otherwise. No reference will be made in oral or written reports which could link you to the study.

Compensation
For participating in this study you will receive 4 research credits. If you withdraw from the study prior to its completion, you will receive 2 research credits. Please be aware another way to earn the same amount of credit is by writing a paper relevant to psychology.
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Consent To Participate
“I have read and understand the above information. I have received a copy of this form. I agree to participate in this study with the understanding that I may choose not to participate or to stop participating at any time without penalty or loss of benefits to which I am otherwise entitled.”

Subject's signature ___________________________ Date ____________
Investigator's signature ___________________________ Date ____________
APPENDIX C

Demographics Questionnaire
Demographics Questionnaire

Gender:  M    F    Age:   ______

Race:   ______________________   Years of Education   ___________________
APPENDIX D

Artificial Condition Instructions
Artificial Instructions

While answering the ninety trivia questions, you should remember to remind the experimenter to make a phone call when the 20th minute comes around.

After answering the first two questions on the last page of the answer sheet, you should remember to ask for a red pen and make an asterisk on that page.
APPENDIX E

General-knowledge Questions and Answers
General-knowledge Questions

1. Prague is located in which country?
   A) Slovakia
   B) Czech Republic
   C) Slovenia
   D) Croatia

2. Who was the 11th President of the United States?
   A) John Tyler
   B) Zachary Taylor
   C) James K. Polk
   D) Millard Fillmore

3. Which island contains Japan’s capital, Tokyo
   A) Honshu
   B) Kyushu
   C) Shikoku
   D) Hokkaido

4. What country claims to be the oldest republic in the world?
   A) San Marino
   B) Monaco
   C) Vatican City
   D) Iraq

5. What is our state beverage?
   A) Milk
   B) Water
   C) Orange Juice
   D) Ginger Ale

6. When was the Bolshevik Revolution?
   A) 1918
   B) 1916
   C) 1915
   D) 1917

7. What is Europe’s second longest river?
   A) Danube River
   B) Volga River
   C) Seine River
D) Thames River

8. Which element has the highest melting point?
   A) Carbon
   B) Hydrogen
   C) Uranium
   D) Tungsten

9. Infant beavers are called what?
   A) Cubs
   B) Kittens
   C) Joeys
   D) Kids

10. Who was the first American to be awarded the Nobel Peace Prize?
    A) Theodore Roosevelt
    B) Jimmy Carter
    C) Martin Luther King, Jr.
    D) Woodrow Wilson

11. Who invented the telephone?
    A) Thomas Watson
    B) Marconi
    C) Alexander G. Bell
    D) Thomas Edison

12. Who was the first Black actor to win an Oscar?
    A) Denzel Washington
    B) Halle Berry
    C) Sidney Poitier
    D) Cuba Gooding, Jr.

13. Who was the first explorer to reach the North Pole?
    A) James Cook
    B) Robert E. Peary
    C) Francis Drake
    D) George Vancouver

14. Who was the U.S. President who wanted to increase the size of the Supreme Court from nine to fifteen?
    A) James Buchanan
    B) Franklin Roosevelt
    C) Millard Fillmore
15. Who has the most statues in the United States?
   A) George Washington
   B) Robert E. Lee
   C) Thomas Jefferson
   D) Sacajewa

16. Which state was the first to allow women to vote?
   A) Georgia
   B) Wyoming
   C) Ohio
   D) New York

17. Which plant bears fruit a mere 15 months after planting?
   A) Orange
   B) Apple
   C) Banana
   D) Apricot

18. The study of insects is called
   A) Etymology
   B) Insectology
   C) Entomology
   D) Ethology

19. The word "honcho" came from
   A) China
   B) Japan
   C) Spain
   D) Portugal

20. A 'jiffy' is an actual unit of time for
   A) 1 second.
   B) 1/10th of a second
   C) 1/100th of a second
   D) 1/1000th of a second

21. What was the highest denomination bill ever released for public circulation by the United States?
   A) $100
   B) $500
   C) $1,000
22. Which saying is attributed to Henry David Thoreau?
   A) Any fool can make a rule
   B) Fool’s money soon parts
   C) Fools don’t make good leaders
   D) Fools should die

23. In 1884, people of what U.S. city were annoyed by enormous amounts of power and telephone lines along their streets?
   A) Chicago
   B) New York City
   C) San Francisco
   D) Washington, D.C.

24. What is a doggerel?
   A) Tree
   B) Instrument
   C) Poem
   D) Star

25. Which country is not considered a kingdom?
   A) Belgium
   B) Denmark
   C) Monaco
   D) Sweden

26. What does it mean to “anthropomorphize”?
   A) To act like an anthropologist
   B) To do the “typical, stupid human thing” (with animals)
   C) To influence an animal with human ways, so it is less like its relatives in the wild
   D) To treat animals as if they were like humans

27. What is a pheromone, technically speaking?
   A) An interspecies signaling system
   B) A chemical used with members of the same species to communicate over a distance
   C) By definition it is a sexual attractant
   D) Any chemical which causes strong attraction or repulsion
28. What is a “chunk,” in short term memory?
   A) A partial memory, not complete
   B) A single organized thing or item
   C) A “magic number” which aids retrieval
   D) A binary “bit” of information

29. By the 1920s a new definition of psychology gained favor. Psychology was said to be the science of
   A) Mind
   B) Consciousness
   C) Behavior
   D) Philosophy

30. What chemical burns violently when mixed with water, but not at all in kerosene?
   A) Tellurium
   B) Sodium
   C) Chlorine
   D) Manganese

31. Which is not a fruit?
   A) Quince
   B) Marengo
   C) Pomegranate
   D) Loquat

32. Which British title of nobility is “highest”?
   A) Baron
   B) Viscount
   C) Earl
   D) Duke

33. Which was the largest land empire in history?
   A) British Empire
   B) Empire of Alexander the Great
   C) Mongol Empire
   D) Roman Empire

34. What was the first capital of Ancient Egypt?
   A) Memphis
   B) Thebes
   C) Alexandria
   D) Cairo
35. Which of these language families is the Magyar tongue of Hungary a member of?
   A) Arabic
   B) Germanic
   C) Romance
   D) Greek

36. The oldest living trees in the world are the bristlecone pines. They grow in which area of the United States?
   A) West
   B) East
   C) South
   D) North

37. Which was the Roman name for Scotland?
   A) Caledonia
   B) Helvetia
   C) Gallia
   D) Galatia

38. When the world’s first adhesive postage stamp was issued in Great Britain in 1840, how much did it cost?
   A) Farthing
   B) Penny
   C) Half crown
   D) Crown

39. On which continent are you most likely to see a bowerbird in the wild?
   A) Australia
   B) North America
   C) South America
   D) Asia

40. What is animism?
   A) Rapid, excited discourse
   B) The attribution of conscious life to nature or natural objects
   C) The behavior of a wild animal
   D) Acquiring animalistic characteristics

41. The leotard gets its name from an aerial gymnast of what country?
   A) India
   B) France
   C) Britain
   D) The United States
42. Which of the eight planets in the solar system did the Voyager 2 spacecraft fly by in January 1986?
   A) Saturn
   B) Venus
   C) Uranus
   D) Jupiter

43. In what U.S. state was the first toll road operated?
   A) New Jersey
   B) New York
   C) Maryland
   D) Virginia

44. The commercial wireless telephone was first introduced in Chicago in 1982 by
   A) AT&T
   B) Bell South
   C) Ameritech
   D) Sprint

45. What desert receives the smallest amount of annual rainfall?
   A) Sahara Desert
   B) Kalahari Desert
   C) Gobi Desert
   D) Atacama Desert

46. Ayers Rock or Uluru, is a giant outcrop that draws visitors to the interior of which continent?
   A) Australia
   B) South America
   C) Africa
   D) Asia

47. What was the average age at death in the U.S. in 1900?
   A) 45 years
   B) 47 years
   C) 40 years
   D) 43 years

48. What is green film that forms on copper or bronze from long exposure called?
   A) Panacea
   B) Patina
   C) Panache
   D) Paregoric
49. What is a hamburg muscat?
   A) Black grape
   B) Fancy pastry
   C) Squirrel stew
   D) Freshwater fish

50. Writer Anais Nin is best known for her ten-volume what?
   A) History of the world
   B) Diary
   C) Lives of the presidents
   D) Women’s encyclopedia

51. All of these are kinds of boats or ships except:
   A) Brigantine
   B) Funicular
   C) Ketch
   D) Trimaran

52. Who was the first secretary-general of the United Nations?
   A) Sidney Holland
   B) Reinhard Heydrich
   C) Trygve Lie
   D) Dag Hammerskjold

53. Which two countries are located on the same island?
   A) Haiti – Dominican Republic
   B) Trinidad – Tobago
   C) Suriname – Guyana
   D) Antigua – Bermuda

54. Who said, ‘I can resist everything except temptation’”?
   A) Will Rogers
   B) Groucho Marx
   C) Oscar Wilde
   D) Ernest Hemingway

55. In the New Testament, people referred to as “publicans” were:
   A) Tax collectors
   B) Religious leaders
   C) Slaves
   D) Governors
56. Which French town was history’s greatest military evacuation?
   A) Dunkirk
   B) Bordeaux
   C) Lyons
   D) Nice

57. The greatest single volcanic explosion in the last 3000 years was the eruption of:
   A) Vesuvius
   B) Mauna Kea
   C) Cotopaxi
   D) Krakatoa

58. An autopsy showed more than 10 drugs in his system, who was that man?
   A) Harry Houdini
   B) Jim Morrison
   C) Elvis Presley
   D) John Belushi

59. The Witch of Endor is a sorceress in:
   A) The Bible
   B) Goethe’s Faust
   C) In a Celtic myth
   D) In the Salem witch trials

60. Which baseball player topped Babe Ruth’s single-season home run record?
   A) Willie Mays
   B) Joe DiMaggio
   C) Roger Maris
   D) Mickey Mantle

61. Which term denoted a southern supporter of the reconstruction after the Civil War?
   A) Carpetbagger
   B) Mugwumper
   C) Teetotaler
   D) Scalawag

62. Most of the world’s production of _____ is used for heat-resistant and magnetic alloys:
   A) Selenium
   B) Rubidium
   C) Cobalt
   D) Tungsten
63. Where was the original “Skid Row”?
   A) Seattle
   B) New York City
   C) Chicago
   D) New Orleans

64. The 1920’s city of Zenith is the setting for which famous novel?
   A) East of Eden
   B) Babbitt
   C) Mainstreet
   D) The Great Gatsby

65. Dr. Seuss is the nom de plume of:
   A) William Sidney
   B) Theodore Geisel
   C) Charles Perrault
   D) A. A. Milne

66. Which person would you go to if you needed to have a barrel repaired?
   A) Wainwright
   B) Gaffer
   C) Cooper
   D) Podiatrist

67. Who was the first U.S. President to have a telephone on his desk at the White House?
   A) Herbert Hoover
   B) Calvin Coolidge
   C) Theodore Roosevelt
   D) Woodrow Wilson

68. Which pitcher allowed the most grand slams in baseball history?
   A) Nolan Ryan
   B) Milt Pappas
   C) Wilbur Wood
   D) Jerry Koosman

69. By a 1919 agreement, a vacancy in its crown forces Monaco to become a protectorate of:
   A) France
   B) Belgium
   C) Italy
   D) England
70. Which event took place the same year that World War I began?
   A) Perry reaches North Pole
   B) San Francisco earthquake
   C) Panama Canal opened
   D) McKinley gets shot

71. Which animal cries when in distress?
   A) Gorilla
   B) Asian elephant
   C) Red kangaroo
   D) Humpback whale

72. Soyuz, Vostok, Salyut, and Venera are all names of:
   A) Soviet space programs
   B) Polish festivals
   C) Black Sea islets
   D) Czech aeronautical programs

73. Poet Carl Sandburg wrote a six-volume biography of this famous American:
   A) Henry Ford
   B) Abraham Lincoln
   C) Mark Twain
   D) George Washington

74. In which city are you most likely to be served couscous?
   A) Paris
   B) Casablanca
   C) Rio de Janeiro
   D) Munich

75. The Provincetown Players theater group discovered this major playwright:
   A) Arthur Miller
   B) Tennessee Williams
   C) Noel Coward
   D) Eugene O’Neill

76. What animal is University of Arkansas football team named for?
   A) Tomcat
   B) Beaver
   C) Bull
   D) Razorback hog
77. Little boots, little cords, and little tongues are the translated names of:
   A) Danish pastries
   B) Russian soups
   C) Italian pasta
   D) German sausages

78. The Chinook is the largest member of this fish family:
    A) Tuna
    B) Salmon
    C) Sunfish
    D) Marlin

79. Who is referred to as the “father of the atomic bomb”?
    A) Albert Einstein
    B) Enrico Fermi
    C) Niels Bohr
    D) Robert Oppenheimer

80. The world’s highest active volcanoes are found on this continent:
    A) South America
    B) Europe
    C) Asia
    D) Australia

81. Which country does not border the Red Sea?
    A) Sudan
    B) Yemen
    C) Ethiopia
    D) Turkey

82. The elegy for Abraham Lincoln, “When Lilacs Last in the Dooryard Bloom’d,” is by:
    A) Henry W. Longfellow
    B) Emily Dickinson
    C) Walt Whitman
    D) Oliver Wendell Holmes

83. The German and Russian Struves are a noted family of:
    A) Physicists
    B) Astronomers
    C) Chemists
    D) Geologists
84. What does the medical specialty of nosology deal with?
   A) Artificial limbs
   B) Back problems
   C) Holistic medicine
   D) Disease classification

85. Who was not a famous pirate?
   A) William Kidd
   B) Edward Teach
   C) Henry Cavendish
   D) Jean Lafitte

86. The “con” in con man is short for:
   A) Conniving
   B) Confidence
   C) Convicted
   D) Consternation

87. In the Gershwin opera “Porgy and Bess,” Porgy is a:
   A) Beggar
   B) Criminal
   C) Store clerk
   D) Railroad conductor

88. Which river empties into the North Sea?
   A) Ebro
   B) Elbe
   C) Po
   D) Rhone

89. What physicist discovered that a wave’s frequency changes when the source and observer are in motion relative to one another?
   A) Max Planck
   B) Christian Doppler
   C) Enrico Fermi
   D) Albert Einstein

90. To which language group does modern Arabic belong?
   A) Semitic
   B) Dravidian
   C) Slavic
   D) Romance
Answers

1. (B) Czech Republic
2. (C) James K. Polk
3. (A) Honshu
4. (A) San Marino
5. (A) Milk
6. (D) 1917
7. (A) Danube River
8. (A) Carbon (melts at 3550 °C. Tungsten melts at 3410 °C)
9. (B) Kitten
10. (A) Theodore Roosevelt
11. (C) Alexander G. Bell
12. (C) Sidney Poitier
13. (B) Robert E. Peary
14. (B) Franklin Roosevelt
15. (D) Sacajewa

16. (B) Wyoming
17. (C) Banana
18. (C) Entomology
19. (B) Japan
20. (C) 1/100th of a second
21. (D) $10,000 (It is no longer being printed. Since 1945, no bill higher than $100 has been printed.)
22. (A) Any fool can make a rule
23. (B) New York City
24. (C) Poem
25. (C) Monaco
26. (D) To treat animals as if they were like humans
27. (B) A chemical used with members of the same species to communicate over a distance
28. (B) A single organized thing or item
29. (C) Behavior
30. (B) Sodium

31. (B) Marengo
32. (D) Duke
33. (C) Mongol Empire (At its peak, the Mongol Empire stretched from the Pacific Ocean across most of continental Asia to the Danube River in Europe, and to the Persian Gulf in the Middle East.)
34. (A) Memphis
35. (A) Arabic
36. (A) West
37. (A) Caledonia
38. (B) Penny
39. (A) Australia
40. (B) The attribution of conscious life to nature or natural objects
41. (B) France (from Jules Leotard)
42. (C) Uranus
43. (D) Virginia
44. (C) Ameritech
45. (D) Atacama Desert

46. (A) Australia
47. (B) 47 years
48. (B) Patina
49. (A) Black grape
50. (B) Diary
51. (B) Funicular
52. (C) Trygve Lie
53. (A) Haiti – Dominican Republic
54. (C) Oscar Wilde
55. (A) Tax collectors
56. (A) Dunkirk
57. (D) Krakatoa
58. (C) Elvis Presley
59. (A) The Bible
60. (C) Roger Maris

61. (D) Scalawag
62. (C) Cobalt
63. (A) Seattle
64. (B) Babbitt
65. (B) Theodore Geisel
66. (C) Cooper
67. (A) Herbert Hoover
68. (A) Nolan Ryan
69. (A) France
70. (C) Panama Canal opened
71. (B) Asian elephant
72. (A) Soviet space programs
73. (B) Abraham Lincoln
74. (B) Casablanca
75. (D) Eugene O’Neill
76. (D) Razorback hog
77. (C) Italian pasta
78. (B) Salmon
79. (D) Robert Oppenheimer
80. (A) South America
81. (D) Turkey
82. (C) Walt Whitman
83. (B) Astronomers
84. (D) Disease classification
85. (C) Henry Cavendish
86. (B) Confidence (for “confidence game” that con men used to pull)
87. (A) Beggar
88. (B) Elbe
89. (B) Christian Doppler
90. (A) Semitic
APPENDIX F

Scenario Description
City Map Script:

You leave your office early, so you can see (1) the mayor about allowing you to have a pet llama, bringing with you a picture of the llama. The mayor’s secretary tells you before you leave to drop by at 2:30 pm to see the mayor about the prospects of your acquisition. In the meantime it is happy holidays time, your significant other calls you and reminds you that you must send (2) the happy holidays package to your relatives in Toronto, Ontario, Canada via the postal office. The significant other also reminds you to (3) buy happy holiday cactus with a card saying “I love you. Happy Birthday and Happy Holidays!” to your mother-in-law who was born on December 25. You remember you need to (4) see your friend at the hospital to cheer him up from being in a motorcycle accident a week ago and for him to call your house whether he can come and have poker night two weeks after the festivities. Your significant other tells you that you need to go to the (5) International Hot Cocoa Shop and get a pound of chili-infused cocoa beans which your mother loves and give that to your mother as a happy holidays present. Your call ends and you flip your phone lid closed. While you are at the Hot Cocoa shop, you spot a colorful holiday stuffer with a bag of Italian cocoa beans inside. You decide to get that for your significant other. You see that you need to fill up the gas in your car before coming home but you decide to postpone that until you’ve finished all your other tasks. At home, you need to check (6) the tracking number of your package at 4:00 pm which the postal worker gave you when you dropped off the package.

You will only have 2 minutes to plan out your route, remembering in real life you would have 2 hours to complete the task. The rest of the 28 minutes will require you to write
down in a notebook your actual sequence of doing the various tasks like you are actually
doing the tasks in real life. However, you do not need to actually complete the task.
Remember, it is most efficient to conduct this task with the least amount of backtracking.
APPENDIX G

Hypothetical City Map
APPENDIX H

City Map Instruction
Diary/City Map Instructions

You actually do (in hypothetical sense) go to the various places and do the various tasks.

You must write down the specific task and what you must do (e.g. see grocery store – remember and execute to buy a bag of gummy bears; 1:00pm meet friend at train station).