11-4-2015

Investigation of the Effects of Impulsivity and Executive Function on a Complex Prospective Memory Task

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by

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A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Arts
Department of Psychology
College of Arts and Sciences
University of South Florida

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Date of Approval:
September 24, 2015

Keywords: Event-based, Time-based, UPPS-P, Regression

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Abstract

Prospective memory is colloquially known as “remembering to remember” and refers to forming an intention in the present time to fulfill at some point in the future. It has previously been studied within the context of executive functioning (i.e., purposive and goal directed behavior) and impulsive behaviors (e.g., gambling, risk seeking) within clinical populations. This study sought to further elucidate the relationships of impulsivity and executive functions to prospective memory in a non-clinical population. One hundred and nine undergraduates completed the UPPS-P impulsivity self-report questionnaire, three cognitive tasks measuring components of executive function, (i.e., planning, inhibition, and switching), and a Complex Prospective Memory Task that included Time- and Event-based cues. The UPPS-P and executive function tasks did not significantly predict the Complex Prospective Memory Task. However, executive function was found to be a significant predictor above and beyond that of impulsivity for a component of the Time-based prospective memory task. Implications of the results and future directions are discussed.

Introduction

Prospective memory refers to the process of remembering to complete an intended action in the future. In order to successfully complete the future action, various techniques can be used to facilitate memory such as setting an alarm or writing a note to remind oneself of the proper time to execute the future intention. Prospective memory may be disrupted by a number of different causes such as traumatic brain injury (Fish et al., 2007), excessive alcohol use (Heffernan et al., 2006), diseases such as HIV (Woods et al., 2007) and Alzheimer's disease (Kixmiller, 2002), and even normal aging (Henry, MacLeod, Phillips, & Crawford, 2004).

Prospective memory has also been studied in relation to the cognitive processes of executive functioning and, most recently, to the behavioral construct of impulsivity. Prospective memory studies have shown that a decrease in executive function is associated with worse performance on tasks of prospective memory (e.g. Martin, Kliegel, & McDaniel, 2003).
In relation to impulsivity, research has suggested there is a negative relationship between impulsivity and prospective memory such that higher levels of impulsivity result in decreased prospective memory performance (Cuttler, Relkov, & Taylor, 2013; Chang & Carlson, 2013). The constructs of executive function and impulsivity share some of the same subcomponents such as inhibition, attention, and planning. This overlap has motivated researchers to investigate the relationship between the two constructs (e.g., Whitney, Jameson, and Hinson, 2004). The similarities between the two constructs raises the question about how each construct either contributes or detracts from the successful completion of a prospective memory task. While a relationship has been shown to exist between prospective memory and executive functioning

(e.g., Martin, Kliegel, & McDaniel, 2003) and more recently between prospective memory and impulsivity (Cuttler et al., 2013), researchers have just begun to measure both constructs in the same study in order to investigate which construct may be more predictive of performance on a prospective memory task.

In conclusion, the main purpose of this study is to investigate how varying levels of impulsivity and executive function affect event-based and time-based prospective memory. To that end, the relevant literature on prospective memory will be reviewed. Next, executive functions will be described and how the cognitive processes are related to prospective memory. Following executive function, a discussion of the relation between executive function and impulsivity will be put forth. Finally, the current research involving prospective memory and impulsivity will be discussed.

Prospective Memory

Prospective memory is colloquially known as "remembering to remember" and is a form of memory specific to remembering to do something in the future. Prospective memory is related to episodic memory in that both memory systems draw from and refer to events in time and space (Tulving, 2002). However, whereas episodic memory refers mainly to remembering events that occurred in one's past, prospective memory refers to remembering an intention created in the past and then bringing that intention to the present time in order to successfully complete that intention. To further distinguish prospective memory from other types of memory such as retrospective memory, McDaniel and Einstein (2000) made a distinction between tasks of prospective memory and retrospective memory (i.e., memory for past events). While similar in nature since both prospective memory tasks and retrospective memory tasks require the participant to encode and retrieve information at a future time, the tasks differ in how the execution of the retrieval of the information is elicited. In tasks of retrospective memory, participants are prompted by a researcher to recall the intended information. However in tasks of prospective memory, the participant is expected to recall of the intended information at a specified time without the overt prompting from a researcher.

Prospective memory can be broken down into four subcomponents with each contributing to successful completion of the prospective memory task. Those four subcomponents are: 1) plan formation, 2) plan retention, 3) plan initiation, and 4) plan execution (Kliegel, Martin, McDaniel, & Einstein, 2002). Plan formation involves planning out the steps in order to successfully complete the prospective memory task. Plan retention is the process of encoding and storing the plan into retrospective memory so that it can be accessed at a future point in time. Plan initiation occurs when the person recognizes the particular prospective memory context or cue to begin the task. Finally, plan execution is the actual successful completion of the prospective memory task.

The task of going to the grocery store can illustrate the four-step process of a prospective memory task. First, in the morning a person realizes that he is out of milk. Subsequently, he plans to stop at the grocery store that is on his way home from work (plan formation). Next, he encodes that plan into memory and believes that he will be able to remember to stop at the store sometime in the future (plan retention). Then, after he finishes his work for the day and is driving home, he sees the grocery store and remembers that he made a plan in the morning to stop at the store on his way home (plan initiation). He successfully completes his task of buying the milk after he enters the store and makes his purchase (plan execution). An example of a failed prospective memory task would be if the same person completed the plan formation and plan retention steps for remembering to buy milk after work, however, on his way home from work after seeing the grocery store he either does not recognize the prospective memory cue or sees the grocery store and remembers that he was supposed to remember to do something but cannot recall the task. The first scenario in which he does not recognize the grocery store as the prospective memory cue is a failure of plan initiation and subsequently plan execution. The second scenario in which he does recognize the cue, but does not recall the task of buying milk, is an example of failed plan execution.

Prospective memory is a broad term regarding remembering to do something in the future, however, it can be further studied by dividing the type of tasks into event-based and time-based tasks. An event-based task refers to remembering to do something when a specific external cue or event is realized (McDaniel & Einstein, 2000). In the example above, the grocery store served as the event-based cue to remember to pick up milk from the grocery store on the way home from work. A time-based task refers to remembering to perform a certain action when the appropriate time arrives (McDaniel & Einstein, 2000). Time-based cues rely mainly on self-initiation, whereas event-based cues exist mostly, if not always, external to the individual. An example of a time-based cue is remembering to take medication at 8 o'clock in the morning. Studying a naturalistic time-based prospective memory task is difficult due to the use of alarms or other external devices to signal the arrival of the cue. The use of an alarm would change the task from a time-based task to more of an event-based task. Thus the process of remembering to complete the time-based task would be much less self-initiated. A third type of prospective memory task is a habitual task in which the participant is asked to respond to the same cue (either event-based or time-based) over a period of time (Einstein, McDaniel, Smith & Shaw, 1998). For example, a habitual time-based task would involve the participant striking a computer key every three minutes over a 20 minute time period.

Neuroimaging studies have found persuasive results indicating that the rostral prefrontal cortex (rPFC: Brodmann Area 10) is activated during prospective memory processes. There is also evidence of activation of the precuneus and parietal lobe (Brodmann Area 7 and 40 respectively) during prospective memory tasks (Burgess, Gonen-Yaacovi, & Volle, 2011). The lateral rostral PFC is associated with maintaining an intention, whereas the medial rostral PFC is more active during the ongoing or distractor task (see Gonen-Yaacovi & Burgess, 2012 for review). Research has also shown that higher frontal lobe function is predictive of patterns of time monitoring, accuracy of time estimation, and plan elaboration in a time-based prospective memory task (McFarland & Glisky, 2009).

A recent fMRI study conducted by Gonneaud et al. (2013) investigated brain activation during event- and time-based prospective memory tasks. Results of the study showed that during event-based tasks there was significant activation of many areas throughout the brain including occipital regions such as the cuneus, the lingual, fusiform, and middle occipital gyri. Additionally, activation was also significantly increased during the event-based tasks in the bilateral parietal lobes, the left postcentral and inferior frontal gyri, and the bilateral middle frontal gyrus. During the time-based prospective memory tasks, fMRI imaging revealed significant activation again throughout the occipital regions such as the cuneus and lingual gyrus and extending down to the cerebellum. Additionally, activation was also revealed in the left postcentral gyrus, the superior parietal lobe, the right inferior parietal lobe, the right precuneus, the insula, and the middle and superior frontal gyri. In summary, the imaging results revealed significant activation in the middle frontal gyrus regions, inferior and left superior parietal lobes, postcentral gyrus, and the occipital regions. Specifically, the event-based tasks revealed more activation in the occipital region, whereas the time-based tasks showed greater activation in the dorsolateral prefrontal cortex and the cuneus/precuneus (Gonneaud et al., 2013). *Prospective Memory and Executive Function*

Successful completion of a prospective memory task may be somewhat dependent on the cognitive processes of executive functions, which can be defined as the "… capacities that enable a person to engage successfully in independent, purposive, self-directed, and self-serving behavior." (Lezak, Howieson, Bigler, & Tranel, 2012, p. 20). Executive function is not a unitary cognitive function, but rather a multidimensional construct comprised of many cognitive processes. Some of the higher order cognitive processes that have been conceptualized as executive functions include set-shifting, planning, response inhibition, working memory, and problem solving (Alvarez & Emory, 2006).

The prefrontal cortex (PFC) located in the frontal lobes and its frontal-subcortical projection systems are the main brain regions associated with the cognitive processes of executive function. A review by Suchy (2009) identifies three regions of the PFC that are associated with separate components of executive functioning. The first region, the dorsolateral PFC and its connections with the parietal lobe, is associated with working memory. The superomedial region of the PFC is associated with sustained attention, response selection, and motivation. Finally, the ventral region is associated with the processes of inhibition, social appropriateness, and sensitivity to rewards and punishments. Other regions of the brain outside of the PFC also provide anatomical projections and therefore also support for executive functions. For example, response initiation is associated with projections from the PFC to areas such as the basal ganglia and regions within the thalamus such as the dorsomedial nucleus. As noted above, prospective memory and executive functions do not occur in isolation in the brain, the processes overlap and border many of the same brain regions. For example, neighboring the rostral PFC (which is the brain region mainly associated with prospective memory) is the dorsolateral PFC and noted above, one of the main brain regions associated with executive functioning (Fuster, 2000).

A short review by Stuss (2011) summarizes that the frontal lobes are necessary for successfully navigating complex and novel situations. One may argue that some prospective memory tasks are complex and require planning in order to successfully accomplish the task. As such, the higher order cognitions associated with PFC are essential for successful completion of prospective memory tasks. Referring back to the four subcomponents of prospective memory (i.e., plan formation, plan retention, plan initiation, and plan execution), it is possible to predict the specific components of executive functions that may underlie most of the prospective memory processes. For example, the executive function component of planning may be most associated with plan formation because one has to plan the steps of how they are going to accomplish the prospective memory task. After the plan formation stage, the created plan needs to get moved into retrospective memory in order to be accessed at a later point in time. There is some controversy over whether or not the executive function of working memory and/or updating are necessary for plan retention (Schnitzspahn, Stahl, Zeintl, Kaller, & Kliegel, 2013). It may be that successful plan retention is mainly associated with retrospective memory. Finally, the underlying executive functions that may be associated with plan initiation and plan execution are monitoring, cognitive flexibility (set-shifting), and inhibition (Kliegel, Jäger, Altgassen, & Shum, 2008, Kliegel, McDaniel & Einstein, 2000).

Furthering the support of the involvement of executive function in prospective memory, clinical populations known to have impairment in executive functioning such as individuals with substance abuse history (e.g., Heffernan et al., 2001; Rendell, Mazur, & Henry, 2009), Parkinson's disease (Pirogovsky, Woods, Filoteo, & Gilbert, 2012), HIV (Woods et al., 2008), and traumatic brain injury (Fish et al., 2007) have also demonstrated significant impairment in tasks of prospective memory. In a non-clinical population, Martin, Kliegel, and McDaniel (2003) investigated the involvement of three specific components of executive function (i.e., set-shifting, inhibition, and planning) on the successful completion of three different prospective memory tasks (i.e., both event- and time-based tasks, and a complex prospective memory task) in both healthy, neurologically intact younger and older adults. Their research provided evidence that associations between executive functions and prospective memory could be seen across a variety of paradigms and that age differences in prospective memory performance may be due to cognitive decline in older age, specifically as the prospective memory task becomes more complex.

Extending the research of Martin and colleagues (2003), Mioni and Stablum (2013) used a habitual time-based prospective memory task to investigate the role of executive functions on time perception. They found that updating, as measured by an n-back task, seemed to predict prospective memory accuracy and that inhibition was predictive of time monitoring. In an earlier study, Mioni, Stablum, McClintock, and Cantagallo (2012) found that inhibition, as measured by the Stroop task, was negatively correlated with accuracy on a time-based prospective memory task, such that individuals with strong inhibition skills could perform more accurately on a time-based prospective memory task.

Impulsivity

Impulsivity has been defined as "... actions that appear poorly conceived, prematurely expressed, unduly risky, or inappropriate to the situation and that often results in undesirable consequences (Daruna & Barnes, 1993, p. 23)." As the definition implies, impulsivity is a multidimensional construct that includes factors such as non-planning, risk taking, sensation seeking, and loss of inhibitions which, when acted upon, may result in a negative outcome. High levels of impulsivity have been reported in many clinical populations including borderline personality disorder (Bornovalova, Lejuez, Daughters, Zachary Rosenthal, & Lynch, 2005; Links, Heslegrave, & Van Reekum, 1999), eating disorders (Claes, Vandereycken, & Vertommen, 2005), substance abuse disorders, gambling (Petry, 2001), and attention deficit hyperactivity disorder (ADHD) (Winstanley, Eagle, & Robbins, 2006).

Methods including both self-report and behavioral measures have been devised to study both the trait and state features of impulsivity. Self-report measures such as the Barrett Impulsivity Scale – 11 (BIS-11: Patton et al., 1995) and the UPPS-P (i.e., Negative Urgency, Premeditation, Perseverance, Sensation Seeking – Positive Urgency) Impulsive Behavior Scale (Lynam, Smith, Cyders, Fischer, & Whiteside, 2007; Whiteside & Lynam, 2001) seem to assess trait impulsivity in that people are asked to respond to questions regarding the way people think and act across time. The self-report questionnaires also encompass the multidimensional nature of impulsivity by reporting on the various facets of impulsivity. However, self-report measures conceptualize impulsivity differently. For example, the BIS-11 conceptualizes three facets of impulsivity: Attentional, Non-planning, and Motor. Whereas the UPPS-P Impulsive Behavior Scale measures five dimensions of impulsivity: Negative Urgency, Positive Urgency, Premeditation (lack of), Perseverance (lack of) and Sensation Seeking (Lynam et al., 2007; Whiteside & Lynam, 2001).

Conversely, lab based tasks are designed to measure behavioral impulsivity at a single point in time which may measure an impulsive state rather than a personality trait. Dick and colleagues (2010) suggest behavioral measures of impulsivity measure the underlying cognitive processes that contribute to impulsive behavior. The researchers also discuss support for five different facets of impulsivity that are measured by behavioral tasks: resistance to distractor interference, prepotent response inhibition (i.e., the inability to stop a response that has already been initiated), resistance to proactive interference (i.e., resisting previously learned material not relevant to the task), inability to delay response even when a larger reward could be obtained, and distortions in estimating the amount of time elapsed. Two examples of behavioral tasks that measure impulsivity are the Go/No Go task (Miller, Schaffer, & Hackley, 1991) which measures a prepotent response inhibition and the Eriksen Flanker task (Eriksen & Eriksen, 1974) which measures a person's ability to resist distracting information. These tasks help researchers to understand the cognitive processes underlying impulsivity and the specific brain regions associated with the various components of impulsivity when administered with various imaging techniques.

However, researchers are discovering that self-report and behavioral measures of impulsivity may not necessarily be measuring the same underlying facets of impulsivity even when administered within the same test paradigm (e.g, Cyders & Coskunpinar, 2011, Cyders & Coskunpinar, 2012). These findings may indicate that the two approaches may be measuring different components of impulsivity. Cyders and Coskunpinar (2011) in a recent meta-analysis investigated whether or not behavioral measures of impulsivity and self-report measures of impulsivity were capturing similar facets of impulsivity. Their results showed that there was a significant overlap between self-report measures and behavioral measures of impulsivity. However, the overlap was so small that Cyders and Coskunpinar (2011) suggest that it is more likely that the two different measures are measuring different facets of impulsivity than the same construct.

While some research may suggest that the various measures of impulsivity are conceptualizing the construct differently, one method may not necessarily be superior to the other. The specific research question informs the investigator to use either a self-report questionnaire to measure trait impulsivity or a behavioral lab task to measure impulsivity or perhaps both. For the purposes of this study, there is greater interest in trait impulsivity due to the interest in the possible predictive ability of the enduring trait on performance of future prospective memory tasks.

To assess impulsivity in the current study, the UPPS-P Impulsive Behavior Scale mentioned above will be used and the following discussion provides a brief background of the measure. The original scale, the UPPS Impulsive Behavior Scale (Whiteside and Lynam, 2001), was developed to identify the different facets of impulsivity in both clinical and non-clinical populations. This scale measures four different dimensions of impulsivity including: Urgency, Premeditation, Perseverance, Sensation Seeking. Urgency refers to having a strong desire to act (i.e., impulse) when experiencing negative emotions in order to alleviate those emotions. Premeditation refers to the ability to think through the act and the consequences of the act before any action is taken. A low score on the UPPS would indicate someone who deliberates and considers the consequences before acting. Alcohol abusers have been found to score high on the premeditation scale of the UPPS (Whiteside, Lynam, Miller, & Reynolds, 2005). Individuals who score low on the UPPS subscale perseverance are able to stay focused on the task at hand and are not easily distracted, whereas high scorers on the perseverance scale may give up on a task if they are not interested in it or become distracted by another more appealing task. Whiteside and Lynam (2001) further postulate that the perseverance scale may be related to disorders such as ADHD in that the scale measures the ability to focus on the task at hand and ignore distracting outside influences. Finally, the subscale of sensation seeking includes both pursuing activities that are seen as exciting and risky (e.g., sky diving, cliff jumping) and also being open to try novel experiences both good and bad (Whiteside & Lynam, 2001). The sensation seeking subscale has been associated with borderline personality disorder, pathological gamblers, and antisocial personality disorder (Whiteside et al., 2005).

In 2007, Lynam, Smith, Cyders, Fischer, and Whiteside revised the UPPS and added an additional 14 items in order to differentiate between Negative Urgency and Positive Urgency. Whereas in the original UPPS, the Urgency scale only identified individuals who tended to engage in rash actions when experiencing negative affect. The now retitled UPPS-P also identifies individuals who engage in rash actions when experiencing positive affect (Cyders & Smith, 2008). The UPPS-P has been used to predict illegal drug use, risky sexual behavior, nicotine dependence among other behaviors (Zapolski, Cyders, & Smith, 2009; Spillane, Smith, & Kahler, 2010).

Impulsivity and Executive Function

As described earlier, executive function includes planning, inhibition, working memory, and goal directed behavior. Similarly, the dimensions of impulsivity, as measured by the UPPS, which may overlap with executive function, are: Urgency or the lack of inhibition; Premeditation, which may be similar to planning; Perseverance, the ability to stay on task and achieve a goal; and Sensation Seeking which may be similar to inhibition. The overlap in constructs has led many researchers to investigate the link between impulsivity and executive functions (e.g., Whitney, Jameson, and Hinson, 2004). For example, Wing, Rabin, Wass, and George (2013) found that increased impulsivity was associated with worse performance on both a test of executive function (i.e., the Wisconsin Card Sorting Task: WCST) and a test of decision making (i.e., the Iowa Gambling Task: IGT).

Researchers Cheung, Mitsis, and Halperin (2004) used Barkley's (1997) conceptualization that behavioral inhibition is separate but necessary for the efficient workings of executive functions. As described earlier, most investigators consider behavioral inhibition to be an integral part of executive function. Nevertheless, to investigate the relationship of behavioral inhibition and executive functions among young adults, Cheung and colleagues used the BIS-11 as a self-report measure of impulsivity, four laboratory measures of impulsivity, and nine measures of executive functions. Interestingly, their findings did not show a relationship between laboratory measures of impulsivity and self-report measures of impulsivity, i.e., BIS-11 total score. However, they did find that some of their measures of impulsivity correlated significantly with some, but not all, measures of executive functions, leaving room for further investigation.

A study conducted by Young, Morris, Toone, and Tyson (2007) used a computerized version of the Tower of London (TOL) task to measure the planning ability of adults with ADHD. They found that in comparison to controls, the ADHD participants did not increase their planning time in relation to problem sets increasing in difficulty. Subsequently, ADHD participants did perform more moves to complete the problem then did controls indicating that a lack of planning had negative consequences on efficient problem solving. While the researchers did not administer a self-report questionnaire of impulsivity, they did measure impulsivity based on the DSM-IV diagnosis. They then correlated the impulsivity value with the difference score in planning time between level 3 and level 5 on the TOL and found a significant negative correlation ($r = -.34$, $p = .049$) indicating that impulsivity was related to less time planning. What would be interesting in light of this finding, would be to investigate whether the Perseverance or Premeditation subscale of the UPPS-P would also show a significant relationship between impulsivity and planning ability

Impulsivity and Prospective Memory

A recent paper published by Cuttler, Relkov, and Taylor (2013) was the first to report on the relationship between self- reported impulsivity and prospective memory. In order to investigate the relationship between the two constructs, the researchers administered 3 self-report measures on both impulsivity and prospective memory and 2 prospective memory tasks. The 3 self-report measures consisted of one measure of impulsivity, the Barrett Impulsivity Scale – 11 (BIS-11), and two measures of prospective memory: Prospective Memory Questionnaire (PMQ) and Prospective and Retrospective Memory Questionnaire (PRMQ). The BIS-11 measures 3 different dimensions of impulsivity: attentional, motor, and non-planning as well as total impulsivity. The PMQ has 4 subscales that measure episodic, habitual, and internally cued prospective memory, and memory aiding cues. The PRMQ measures both the frequency of prospective memory failures and retrospective memory failures.

Of the two prospective memory tasks, the first task was a habitual laboratory prospective memory test in which participants were instructed to select the first response on every last question on each page of a survey. With this task, the researchers were able to generate a score ranging from 0 – 20 with lower scores indicating better prospective memory performance. The second task was a naturalistic event-based prospective memory task (i.e., the event-based cue occurs outside of the research environment) in which the participants were instructed to call the research laboratory exactly one week after the experiment. Participants received a score of either a 0 or a 1 depending on successful completion of the task. Again, lower scores indicated better prospective memory performance.

Results of the study found significant correlations between both the BIS-11 and the PMQ and between the BIS-11 and the PRMQ. Uniquely, the non-planning subscale for the BIS-11 was correlated with the memory-aiding strategies dimension of the PMQ. Additionally, non-planning was the only dimension of impulsivity to be correlated with the self-report prospective memory questionnaires, the habitual laboratory task, and the natural event-based prospective memory task. The findings also revealed that non-planning impulsivity significantly predicted overall failures of prospective memory as measured by the PRMQ and prospective memory as measured by the PMQ. The attentional subscale of the BIS-11 significantly predicted prospective memory as measured by the PMQ. Lastly, the total score from the BIS-11 was found to significantly predict habitual prospective memory as measured by the PMQ.

Following the Cuttler et al. (2013) paper, researchers Chang and Carlson (2013) published an exploratory study of trait impulsivity and prospective memory abilities. Similar to Cuttler et al. (2013), they also used the BIS-11 to measure impulsivity and the PMQ as a self-report measure of prospective memory abilities. Chang and Carlson also administered both an event- and time-based prospective memory task. First, they administered a simple event-based prospective memory task in which they asked participants for a personal item (e.g., watch, cell phone) and then instructed the participants to request the item back after a specific action was taken (i.e., switching computers to complete different tasks). Next, they administered a habitual time-based prospective memory task in which they asked participants to strike a computer key every four minutes while listening to an audio recording. From this task, they were able to record the number of times participants checked the clock using a computer monitoring program, the number of missed 4-minute targets, and the accuracy of the timing responses.

While Chang and Carlson found that the BIS-11 correlated with the PMQ, they did not find significant correlations between the BIS-11 scores and the time- and event-based prospective memory measures. The only behavioral measure of prospective memory to be significantly correlated with the PMQ measure was clock checking.

Although a relationship between the self-report measure of impulsivity and prospective memory was not revealed in this study, the methodology of the study may account for the null findings. For example, Chang and Carlson considered an accurate completion of a time-based task if the person was within 2 minutes of the target time. It is possible that Chang and Carlson did not have stringent enough cut off times in order to accurately gage successful completion of the time-based tasks. Other studies looking at time-based cues have used much stricter criteria for correct responses. For example, Mioni and Stablum (2013) allowed participants only 10 seconds outside of the target time in order for their response to be accurate. A stricter cut off time in the Chang and Carlson study may have increased the variability of the prospective memory scores and thus possibly increased the association between the BIS-11 and prospective memory.

Purpose of the Current Study

The research by Cuttler et al. (2013) and Chang and Carlson (2013) have provided a useful framework for studying the effects of impulsivity on prospective memory. To my knowledge, these are the only two studies to date that have investigated the relationship between normal variations of impulsivity and how it relates to prospective memory in a non-clinical population. In building on the findings from previous research, this study sought to further understand the effects of impulsivity on predicting prospective memory. In contrast to the research done by Cuttler et al., to study impulsivity, this study used the UPPS-P, a self-report questionnaire which not only measures total impulsivity but also five subcomponents of impulsivity, i.e., Positive Urgency, Negative Urgency, Premeditation, Perseverance, and Sensation Seeking. Because the UPPS-P has five subcomponents as opposed to the three subcomponents of the BIS-11 (i.e., Attentional, Motor, and Non-Planning), the UPPS-P will provide a more complete and more specific measure of the multidimensional construct of impulsivity. In particular, the Premeditation and Perseverance subscales maybe more sensitive subscales for predicting performance on a complex prospective memory task in comparison to the Cuttler et al. (2013) findings which showed that only the Non-Planning dimension from the BIS-11 was significantly related to the behavioral measures of prospective memory.

Studies have also shown the subcomponents of both the UPPS and the UPPS-P to be a more reliable measure of impulsivity then the BIS-11. Whiteside and Lynam (2001) reported internal reliabilities for the UPPS subscales ranging from 0.82 - 0.91 and Cyders (2013) reported internal reliabilities ranging from 0.82 – 0.94 for the UPPS-P. However, Stanford et al., (2009) reported reliabilities for the three subscales of the BIS -11 ranging from 0.59 - 0.74.

In addition to using a more complex, specific, and reliable multidimensional measure of impulsivity (i.e., the UPPS-P), this study also furthered the understanding of the relationship between impulsivity and prospective memory by using a complex prospective memory task adapted from the work of Kliegel, McDaniel, and Einstein (2000). The complex prospective memory task builds on the findings from both the habitual laboratory task and the episodic field task used by Cuttler et al. by incorporating plan formation, plan retention, plan initiation, and successful plan execution steps of prospective memory. In addition, two time-based prospective memory tasks were embedded into the complex prospective memory task in order to investigate the possible unique relationship between impulsivity and the successful completion of a time-based prospective memory task.

Finally, executive functions have been shown to be related to both complex prospective memory (Martin, Kliegel, & McDaniel, 2003; McAlister & Schmitter-Edgecombe, 2013) and impulsivity (Whitney, Jameson, & Hinson, 2004). Since executive functions have been linked to both impulsivity and prospective memory, it is important to investigate whether executive functions, particularly inhibition, planning, and set-shifting, are able to predict successful completion of a prospective memory task above and beyond impulsivity. Investigating this possible relationship furthers the understanding of the complex relationships between the three multidimensional constructs of executive function, impulsivity, and prospective memory.

In summary, the purpose of the current study was to investigate whether subcomponents of impulsivity as measured by the UPPS-P (Lynam et al., 2007) (i.e., Positive Urgency, Negative Urgency, Perseverance, Premeditation, and Sensation Seeking) were able to predict performance on time and event-based prospective memory tasks. In addition, this study examined whether contributions from executive functioning could further predict performance on a prospective memory task above and beyond that of impulsivity.

Aims

Aim 1: Investigate whether impulsivity has a negative impact on accurate execution of Event-Based and Time-Based Prospective Memory Tasks.

Aim 2: Investigate the predictive ability of the five dimensions of impulsivity as measured by the UPPS-P to prospective memory.

a) The predictive ability of the subcomponents of impulsivity to Event-Based Prospective Memory.

b) The predictive ability of the subcomponents of impulsivity to Time-Based Prospective Memory.

Aim 3: Investigate whether executive function is a significant predictor of prospective memory above and beyond the five dimensions of impulsivity.

Hypotheses

Hypothesis 1*:* Participants who report high impulsivity as indicated on the UPPS-P will perform worse on Event-Based and Time-Based Prospective Memory Tasks.

Hypothesis 2*:* Of the five subcomponents from the UPPS-P, Premeditation and Perseverance will better predict Event-Based and Time-Based Prospective Memory than Positive Urgency, Negative Urgency and Sensation Seeking.

Hypothesis 3*:* The composite score from the Executive Function tasks will be a significant predictor of the composite score of the Complex Prospective Memory Task above and beyond that of the subcomponents of Impulsivity.

Method

Participants

116 male and female undergraduate students were recruited from undergraduate psychology courses to participate in the present study. Participants received SONA credits for participating in the research. Exclusionary criteria included, a history of serious mental health disorders (i.e., bipolar disorder, schizophrenia) and current use of psychotropic medication, and traumatic brain injuries with a loss of consciousness for longer than 10 minutes.

Measures

<u>Impulsivity Measures:</u>

UPPS-P Impulsive Behavior Scale (UPPS-P: Lynam, Smith, Cyders, Fischer, & Whiteside, 2007): The UPPS-P impulsive behavior scale is a 59 item self-report questionnaire designed to assess total impulsivity and five subcomponents of impulsivity. Statements such as, “I have trouble resisting my cravings”, “My thinking is usually careful and purposeful”, “Unfinished tasks really bother me”, and “I’ll try anything once” tap into the five subcomponents of impulsivity: Negative Urgency, Positive Urgency, Premeditation, Perseverance, and Sensation Seeking. Participants rate each statement on a four point Likert-type scale where 1 indicates “Agree Strongly” and 4 indicates “Disagree Strongly”. A score for each subscale can be tallied as well as a composite score for an overall measure of impulsivity. Higher scores on the UPPS-P indicate greater impulsivity. These five subcomponents have been reported to have high internal consistencies (.89, .95, .88, .84, .85 respectively) (Cyders & Coskunpinar, 2012).

Alcohol, Smoking, and Substance Involvement Screening Test (ASSIST: WHO Group, 2002): The ASSIST is an eight item questionnaire designed to screen for use of psychoactive substances (e.g., tobacco, alcohol, cannabis, cocaine). The questionnaire can be administered in 5 – 10 minutes. It assesses for both lifetime and current use as well as the level of risky use associated with each substance. The ASSIST has been shown to have good psychometric properties. It was shown to have concurrent validity with measures such as the AUDIT (r = 0.82) and discriminant validity in its ability to discriminate between substance use, abuse, and dependence (Humeniuk et al., 2008).

Executive Function Measures:

Executive functions have been defined in numerous ways, but broadly they are understood to support goal directed behavior (Suchy, 2009). The cognitive processes of execution functions are composed of many different processes including: organization and planning, inhibition, updating, and set-shifting. For this particular study, measures associated with three distinct domains of executive function that may be most relevant to components of prospective memory were selected: Stroop (inhibition), Mazes (planning and impulse control), and Trail Making Test A and B (set-shifting).

Stroop Color-Word Test (Stroop: Golden, 1978): The Stroop task is a test of inhibition in which the participant must inhibit a more automatic, overlearned response in order to provide the correct response for the task. The Stroop task is composed of 3 subtests. In the first subtest, participants are allowed 45 seconds to read as quickly as they can the words “RED”, “BLUE”, “GREEN” which are presented in black ink. In the second subtest, participants are again given 45 seconds to name as quickly as they can the color of ink (either red, blue, or green) of a set of X's. Finally, in the third subtest, the words "RED', "BLUE", and "GREEN" appear but are presented in a different color ink than what is written. Participants are instructed to report the color of ink the word is printed in rather than read the word which is an overlearned more automatic response. The Stroop's three components: Word, Color, and Color-Word have been shown to have good test – retest reliability. Golden (1975) reported test –retest reliabilities for individual performances of .86, .82, and .73. In a follow-up study Franzen et al. (1987) also found no significant differences between reliability coefficients from one-week to two-week testing intervals.

Mazes (Stern & White, 2003): The maze task is a sub-section of the Executive Function Module of the Neuropsychological Assessment Battery (NAB). This timed test consists of 7 different mazes that increase in difficulty as the participant progresses. The maze task must be completed within a certain time limit and participants are awarded scores based on the speed with which they complete the maze. The primary cognitive functions measured by the maze task are planning ability, impulse control, and psychomotor speed. The task has been shown to have good reliability (overall average alpha = .77).

Trail Making Test A and B (TMT-A and TMT-B: Army Individual Test Battery, 1944): The TMT is a timed measure of set-shifting attention, and cognitive flexibility. The TMT consists of two parts: A and B. The first part, TMT-A, instructs the participant to connect a series of numbered circles from 1 to 25 in order, as quickly as they can. TMT-A is simple measure of visual scanning and visuomotor speed and reinforces an overlearned response (connecting numbers in order). The second part, TMT-B, again instructs the participant to connect a series of circles, however, the participant must switch connecting between a number and a letter (e.g., 1, A, 2, B, 3, C, etc.) in order as quickly as they can. In a normal adult population Giovagnoli et al. (1996) reported test-retest reliability of the TMT-A to be $r = 0.75$ and for TMT-B, $r = 0.85$. Bornstein, Baker, and Douglass (1987) reported test-retest reliabilities of $r = 0.55$ and $r = 0.75$ for TMT-A and TMT-B respectively after 3 weeks.

Prospective Memory Measure:

Complex Prospective Memory Test (CPMT: Kliegel, McDaniel, & Einstein, 2000): This prospective memory test was designed to measure overall prospective memory ability, as well as the four specific components of prospective memory, i.e., Plan Formation, Plan Retention, Plan Initiation, and successful Plan Execution. The CPMT was based on the original task designed by Shallice and Burgess (1991). Participants have 6 minutes to complete 3 tasks (i.e. a word find, math problems, and picture naming) in which each task has an equivalent version A and B for a total of 6 tasks (see Table 1).

Table 1. Distractor tasks: 3 different tasks with 2 versions each

	Word Find	Math Problems	Picture Naming
Versions	A	A	A
	B	B	B

Each subtest was designed to take over a minute to complete, so the participants were not expected to complete all 6 tasks within the time allotted. In addition, participants were instructed to shift between sets of tasks and to try to maximize their score by completing as much of the 2 sets of 3 tasks as possible. Participants also learned and followed a set of rules in order to successfully complete the task. Examples of the tasks and rules can be found in Appendix B.

The rules and instructions as described by Kliegel and colleagues (Kliegel, McDaniel, & Einstein, 2000, pg. 1043) are as follows:

1. Your aim is to maximize your score.
    a. Earlier pictures/problems/word groups will be given more points than later ones in each subtask.
    b. Points will be given for correct answers. Performance errors or omissions will be penalized.
    c. Each of the six subtests will be given equal weight, however, tests completed earlier will be weighted more.
2. You are not allowed to do two subtasks (A) and (B) of the same type one after the other.
3. You will have 6 minutes.
4. Please press the start-button of this stopwatch to start the timing of the tasks yourself.

In addition, participants were given a naturalistic prospective memory task and two time-based prospective memory tasks imbedded within the CPMT. For the naturalistic prospective task, participants were asked at the beginning of the testing session to hand the examiner either their watch or cell phone to hold onto throughout the testing session. Participants were instructed to ask for their item back when the examiner said, "That is the end of the testing session." For the two time-based tasks, participants were first instructed to say to the examiner after three minutes into the CPMT, "I am half-way through the task." For the second task they were asked to say five minutes into the task, "There is one minute left." A computerized stopwatch was placed behind the participant so that in order to monitor the time, the participant needed to physically turn around and to view the timer.

Piloted Procedure

A total of 5 undergraduate Research Assistants were asked to be volunteer participants in the current study's pilot procedure. The main goals of the pilot study were to review procedure, perfect participant instructions, estimate length of study time, and determine whether the event-based and time-based cues showed variability. The first two goals, reviewing procedure and instructions, were met and modifications were made to facilitate the flow and understanding of the instructions. The layout of the lab in which the study took place was also modified. The computer on which the participant was able to monitor the time during the CPMT was placed directly behind the participant and within easy eyesight of the examiner. This arrangement allowed for the examiner to easily record the times the participant turned around to monitor the timer. The results of the pilot study indicated that the entire procedure would take an hour to an hour and a half to complete after including an estimated time to review the consent form and debrief the participant. Finally, participants showed variability on completing both the event- and time-based cues. Results from the piloting can be found in Appendix A. However, the only measure that did not show variability was the naturalist event-based task in which no participant verbally asked for either his or her watch or cell phone back. This may have been due to the ambiguous ending of the study and that participants wanted to talk about what the study entailed. In the future, the participants were told to ask for their item back when the examiner said, "That is the end of the testing session."

Procedure

First, the examiner reviewed the consent form with participants before they were asked to participate in the study. After signing the consent form, participants were asked to hand either their cell phone or watch to the examiner. Participants were told that they were going to complete some timed tasks and would be provided with a stopwatch. The participants were then also instructed to remind the examiner at the end of the study to return their personal item to them. After the examiner received the personal item and placed it off to the side of the table, participants were read the instructions and rules for the Complex Prospective Memory Test (CPMT). Participants were instructed to begin the CPMT when asked to respond to the question regarding their birthdate from a demographics questionnaire (which was shown to them). The question from the demographics form, "What is your date of birth?" served as the Event-Based cue. In order to assess time-based prospective memory cues, participants were given two Time-Based cue instructions. For the first time-based task, participants were instructed to say three minutes into the CPMT, "I am half-way through the task." For the second-time based task, participants were to say after five minutes had passed, "There is one minute left." Participant understanding was monitored throughout the administration of the CPMT instructions and rules by asking participants to recite back the rules to the examiner as well as asking if they had any questions or needed clarification of the rules. This was done to ensure that the participant was paying attention and learning the rules. After they received instructions on the task, participants were asked to formulate a comprehensive plan regarding how they were going to proceed with the task in order to maximize efficiency and their score. The examiner then recorded the plan.

After the plan was recorded, participants completed the self-report impulsivity measure, the UPPS-P Impulsivity Scale. Once the UPPS-P was completed, the examiner reviewed the questionnaire to make sure all questions were answered. Participants were then asked to verbally recall their original plan for the CPMT and recite the plan to the examiner exactly as they did before. The examiner again recorded the participant's response verbatim. In order to stop rehearsal of the plan a second time, the participant was administered the three Executive Function tasks in a counterbalanced order: Stroop, TMT-A/B and Mazes.

Following the executive function tasks, the demographic questionnaire was presented to the participant to complete. After answering the question "What is your date of birth?" the participant was expected to begin the CPMT. If the participant did not begin the CPMT at the appropriate time, the examiner waited until the participant had finished the questionnaire to see if the participant would then begin the CPMT at that point. If the participant still did not begin the CPMT, the examiner queried the participant if they had forgotten anything. If the participant did not recall that they were to begin the CPMT, the examiner instructed them to do so.

While the participant was completing the CPMT, the examiner recorded the order in which the tasks were completed. In addition, the examiner also recorded whether or not the participant correctly recalled the time-based cues. The examiner also monitored how many times and at what times the participant turned around to check the computerized stopwatch. Cue recall within + or – 10 seconds of the target time was considered accurate.

After the CPMT was completed, the participant was administered the remaining questions from the demographic questionnaire (if they had not already completed the questionnaire). The examiner then administered the ASSIST to screen for current and lifetime substance use. Participants were provided information on where they could seek help for both mental health and substance abuse issues on the USF campus. Finally, participants were asked to complete an online survey for an additional .5 SONA point. Participants were instructed that they must complete the survey the following day, but they were able to choose the one-hour time block in which to complete the survey. Participants were provided instructions on where to find the survey and were informed that the survey would take less than 15 minutes to complete. Participants were then debriefed, thanked for participating, and awarded SONA credit.

Following administration, the tasks were scored and double scored by trained Research Assistants to ensure accuracy of the data. The procedures for scoring the various tasks are as follows. Each Executive Function task (i.e., Stroop, Mazes, and Trails A and B) was scored according to their respective manuals. The scores were then converted to Z scores in order to be combined into the Executive Function Composite Score. For the prospective memory tasks including the Naturalistic Prospective Memory Task, the Event-Based Task, and two Time-Based Tasks, the range of scores possible for each task was 0 – 3. A full score of 3 indicated that the participant executed the task correctly and at the correct time without prompting. A score of 2 indicated that the participant correctly executed the task, however, at either an earlier or later time than was instructed. A score of 1 was received if the participant either forgot or did not recognize the appropriate cue and subsequently needed to be prompted by the examiner asking, "Was there something you were supposed to remember?". A score of 0 was given if after being prompted, the participant still did not recall what they were supposed to do. The Survey Task served as the third Event-Based Task. The possible range of scores for the Survey Task were 0 – 2. The participant was awarded 2 points for completing the survey during the one-hour time block they selected. One point was given if the participant completed the survey either before or after the selected time and 0 points were awarded if the participant did not complete the task. Participants received SONA credit for completing the survey regardless of when they completed it.

For the analyses, the Event-Based Composite Score was the sum of the Survey task and the Event-Based Task (i.e., correctly beginning the CPMT after answering the question about their birthdate). The Naturalistic task was not used in the analysis due to nearly every participant successfully completing the task and thus there was no variability in the scoring. The Time-Based Composite Score was the sum of the two Time-Based tasks. Lastly, the Composite Prospective Memory Score was the sum of the Survey task, Event-Based task, and the two Time-Based tasks.

Results

The final sample size consisted of 109 undergraduate students in which 79 were female. The average age was 19.4 (SD = .45). Ethnicity varied in that 41.3% of the sample identified as White, 23.9% aligned with African American, 14.7% associated with Asian, 16.5% identified as Hispanic, and 3.7% chose other due to either being of mixed heritage or choosing to not respond to the question. Seven people were excluded for reasons including a history of mental health disorder such as depression and anxiety, loss of consciousness for longer than 10 minutes, age outside of criteria (> 65 years old), and history of syncope resulting in multiple mild concussions. Table 2 displays pertinent demographic information.

Table 2. Descriptive statistics

Variable	**N**	**Mean (SD)**	**Range**
Age	109	19.44 (2.44)	18 - 34
Education	109	13.06 (1.41)	12 – 20
Variable	**N**	**Percentage**	
Gender			
Male	30	27.5	
Female	79	72.5	
Ethnicity			
White	45	41.3	
African American	26	23.9	
Asian	16	14.7	
Hispanic	18	16.5	
Other	4	3.7	

Raw Data Transformations to Z scores

The executive function raw scores were first transformed to z-scores. Normative data adjusted for age and education were obtained from Tombaugh (2003) and mean and standard deviations from this normative data were used to create TMT A and B z scores. Age adjusted normative data for TMT B minus TMT A were obtained from Drane et al. (2002). The Interference Stroop z score was found by first calculating the Interference raw score using the formula: Color/Word raw score minus Predicted Color/Word score (based on Word raw score and Color raw score) and then converting the Interference raw score to T score (Golden, 2002). The Maze total raw score was adjusted based on age, gender, and education, and using normative data (e.g. mean and standard deviation) from the NAB manual (Stern & White, 2003), scores were used to create z scores. The Executive Function Composite Score was created by adding the z scores from TMT B minus TMT A, the Calculated Interference Stroop score, and total Maze score together.

The Composite Time Based Cue was comprised of the scores from the 3 Minute Time Based Cue and the 5 Minute Time Based Cue. The Composite Event Based Cue was created by adding the PM Cue and the Survey (i.e., the successful completion of the online survey at least 24 hours after completion of the study).

Data Checks for Outliers, Normality and other Test Assumptions

The data were examined for significant outliers and variables were analyzed for normality. Regarding the predictor variables, of the five UPPS-P subscales, Negative Urgency and Sensation Seeking were found to be normally distributed. After log transformations, Premeditation, Perseverance, and Positive Urgency also became normally distributed. Of the three executive function measures, only Stroop was normally distributed. The skewness and kurtosis values of the Maze variable indicated a non-normal distribution, however there were no significant outliers to delete to improve the distribution. The Q-Q plot indicated that the variable was approaching a normal distribution. Regarding the Trail Making Task A and B (TMT), one significant outlier from the TMT B raw scores was deleted (time to complete was > 240 seconds with 5 errors). The calculated Trail Making Task score (TMT B – TMT A) was not normally distributed. There were an additional three participants with z-scores above 3.3, however removing those participants did not significantly improve the distribution. Two Executive Function Composite scores were created by adding the Stroop Interference z-score, Maze z-score, and TMT B – A z-score with and without the three outliers. Although the distribution of the Executive Function Composite improved slightly with the deletion of the outliers, both composite scores remained non-normally distributed based on skewness and kurtosis values. Separate hierarchical regression analyses were done each using one of the two different Executive Function Composite scores. After examination of the remaining outliers (z-score > 3.3), it was determined that the values were not far enough away from the other of the scores to cause a significant impact on the analyses.

Next, the main predictor and criterion variables were analyzed for normality and values are displayed in Table 3. The main criterion variables (i.e., 3 Minute Cue, 5 Minute Cue, Composite Time Based Cue, PM Cue, Survey, and Composite Event Based Cue) were shown to be non-normal based on the Shapiro Wilk test of normality (i.e., $p < .05$). After visual examination of the respective Q-Q Plots, skewness, and kurtosis values of the PM Cue, Survey, and Composite Event Based Cue, it was determined that the variables did not violate the assumption of normality. Various transformations of the 3 Minute Cue and the 5 Minute Cue were attempted to improve normality such as adding a constant to the variables in order to log transform the variables and applying a square root transformation. However, transformation of the variables did not significantly improve the distribution and in some instances negatively impacted the distribution. As such, the Time cues were not transformed and the original variables were used in the analyses.

Table 3. Descriptive and normality statistics

Variable	**N**	**Range**	**Mean (SD)**	**Skewness**	**Kurtosis**
Impulsivity Measure					
UPPS-P Total	102	73 - 170	120.0 (21.1)	< .01	-.55
Negative Urgency	109	13 – 43	24.8 (7.1)	.40	-.46
Premeditation*	107	1.0 – 1.5	1.3 (.1)	.03	-.23
Perseverance*	107	1 – 1.5	1.2 (.1)	-.30	-.58
Sensation Seeking	103	18 – 48	33.9 (7.5)	-.24	-.79
Positive Urgency*	107	1.2 – 1.7	1.4 (.1)	.19	-.93
Executive Function (z-scores)					
EF Composite Score	103	-4.9 – 3.6	0.6 (1.6)	-.79	.77
Mazes	109	-2.7 – 1.1	-.1 (.8)	-.88	.65
Stroop Interference	109	-1.0 – 2.7	.7 (.7)	.15	.09
TMT (B – A)	103	-4.6 – 1.3	.0 (.8)	-1.18	1.82
Complex Prospective Memory Task					
PM Composite	95	0 - 11	8.1 (2.4)	-.75	.24
Time Based Composite	109	0 – 6	4.9 (1.5)	-1.62	2.00
3 Minute Cue	109	0 - 3	2.4 (.9)	-1.34	.89
5 Minute Cue	109	0 - 3	2.5 (.9)	-1.69	1.62
Event Based Composite	95	0 - 5	3.1 (1.6)	-.23	-1.13
PM Cue	109	0 – 3	1.7 (1.3)	-.22	-1.73
Survey	95	0 - 2	1.3 (.9)	-.61	-1.38

Note: *Log transformed

Correlations Among Predictor Variables

The Cronbach's alphas for the five UPPS-P subscales: Negative Urgency, Premeditation, Perseverance, Sensation Seeking, and Positive Urgency were .89, .80, .79, .86, and .93 respectively. Next, the correlations among variables were examined. The correlation matrices displaying the associations between the UPPS-P and the Executive Function measures, the UPPS-P and the Prospective Memory measures, and the Executive Function measures and Prospective Memory measures can be seen in Table 4, 5, and 6 respectively. Of note, the UPPS-P subscales were correlated amongst each other with Negative Urgency and Positive Urgency being the most highly correlated ($r = .741$, $p < .001$). Additionally, within the executive function measures, Mazes was significantly correlated with both Trails (B minus A) ($r = .222$, $p = .022$) and Stroop Interference ($r = .235$, $p = .014$). Stroop Interference was the only executive function significantly negatively correlated with the UPPS-P subscale Perseverance ($r = -.216$, $p = .026$).

Correlations of Predictors and Criterion Variables

After correlating the UPPS-P with individual scores from the Prospective Memory Task, the score from the 5 Minute Cue was significantly correlated with Negative Urgency ($r = .209$, $p = .029$) and with Positive Urgency ($r = .237$, $p = .014$). Finally, after correlating the individual executive function scores and the Executive Composite score with the individual scores from the prospective memory tasks, again the 5 Minute Cue was significantly correlated with Mazes ($r = .326$, $p = .001$), Stroop Interference ($r = .264$, $p = .006$), and the Executive Function Composite Score ($r = .272$, $p = .005$). The Composite Time Cue was significantly correlated with Maze ($r = .210$, $p = .028$).

Table 4. Correlation matrix displaying the associations between the UPPS-P and executive functions

Variable	1	2	3	4	5	6	7	8	9	10
1. Neg. Urgency	--									
2. Premeditation	.391***	--								
3. Perseverance	.265**	.442***	--							
4. Sens. Seeking	.105	.211*	-.006	--						
5. Pos. Urgency	.757^	.353***	.194*	.227*	--					
6. Total UPPS-P	.798**	.635**	.456**	.520**	.833**	--				
7. TMT B – A	.095	.097	.054	.034	-.067	.042	--			
8. Mazes	.095	.057	-.051	.072	.082	.081	.222*	--		
9. Stroop Interference	-.005	.023	-.216*	.101	-.008	-.004	.019	.235**	--	
10. Exec. Function Comp.	.105	.095	-.067	.090	.002	.067	.718**	.719**	.532**	--

Note: * = p < .05, ** = p < .01, ^ = p < .001. The log transformed variables of Positive Urgency, Perseverance, and Premeditation were used in the correlational analyses.

Table 5. Correlation matrix displaying the associations between the UPPS-P and prospective memory

Variable	1	2	3	4	5	6	7	8	9	10
1. Neg. Urgency	--									
2. Premeditation	.391***	--								
3. Perseverance	.265**	.442^	--							
4. Sens. Seeking	.105	.221*	-.006	--						
5. Pos. Urgency	.757^	.355^	.194*	.227*	--					
6. Total UPPS-P	.798**	.635**	.456**	.520**	.833**	--				
7. 3 Minute Cue	.111	.058	.027	.023	.151	.144	--			
8. 5 Minute Cue	.226*	.105	.091	.126	.242*	.227*	.497***	--		
9. PM Cue	-.035	-.083	-.060	-.024	-.063	-.045	.272**	.269**	--	
10. Survey	.067	-.040	-.020	-.074	-.140	-.053	.128	.085	.012	--

Note: * = p < .05, ** = p < .01, *** = p < .001. The log transformed variables of Positive Urgency, Perseverance, and Premeditation were used in the correlational analyses.

Table 6. Correlation matrix displaying the associations between executive functions and prospective memory

Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1. TMT B - A	--							
2. Mazes	.222*	--						
3. Stroop Interference	.019	.235*	--					
4. Exec. Function Composite	.718**	.719**	.532**	--				
5. 3 Minute Cue	-.002	.029	.015	.001	--			
6. 5 Minute Cue	.016	.326**	.264**	.272**	.497***	--		
7. PM Cue	.120	.155	-.007	.141	.272**	.269**	--	
8. Survey	-.033	-.123	.109	-.024	.128	.085	.012	--

Note: * = p < .05, ** = p < .01, *** = p < .001. The log transformed variables of Positive Urgency, Perseverance, and Premeditation were used in the correlational analyses.

Main Analyses

Hypothesis 1: Participants who report high impulsivity as indicated on the UPPS-P will perform worse on Event Based and Time Based Prospective Memory Tasks.

Two separate standard regression analyses were used to test if the Total UPPS-P score significantly predicted participants' performance on either the Composite Time Based Prospective Memory tasks or the Composite Event Based Prospective Memory tasks. In order to control for Type 1 error, Bonferroni adjusted alpha levels (p = .01) were used for all five subsequent a priori regression analyses. Results revealed that the Total UPPS-P score did not significantly predict performance on the Composite Time Based Prospective Memory tasks (β = .215, p = .030). The results indicated that the Total UPPS-P score accounted for 4.6% of the variance (R^2=.046, F (1, 100) = 4.83, p = .030) for the Composite Time Based Prospective Memory tasks. The Total UPPS-P score did not significantly predict performance on the Composite Event Based Prospective Memory tasks (β = -.118, p = .272). Additionally, Total

UPPS-P score accounted for 1.4% of the variance ((R^2=.014, F(1, 87) = 1.22, *p* = .272) for the Composite Event Based Prospective Memory tasks.

Hypothesis 2: Premeditation and Perseverance will be better predictors of Composite Event Based and Composite Time Based Prospective Memory than Positive Urgency, Negative Urgency and Sensation Seeking.

Two separate multiple regression models were used to assess whether the UPPS-P subscales Premeditation and Perseverance were better predictors of Composite Time Based Prospective Memory than Negative Urgency, Positive Urgency, and Sensation Seeking. The five subscales from the UPPS-P were entered into the regression model with the Composite Time Based Prospective Memory serving as the dependent variable. The overall regression model was not significant (R^2=.056, F (5, 96) = 1.14, *p* = .345). The results did not reveal any of the five UPPS-P subscales to be significant predictors of Time-Based Prospective Memory. Table 7 displays the regression coefficients, standard error, and standardized coefficients.

A second multiple regression model was used to test whether the Composite Event Based Prospective Memory would be better predicted by Premeditation and Perseverance than by the Negative Urgency, Positive Urgency, and Sensation Seeking. The five subscales from the UPPS-P were entered into the regression model with the Composite Event Based Prospective Memory serving as the dependent variable. The overall model was not significant (R^2=.086, F(5, 84) = 1.58, *p* = .175). The results indicate that Perseverance and Premeditation were not better predictors of the Composite Event Based Prospective Memory than Negative Urgency, Positive Urgency, and Sensation Seeking. However, Positive Urgency was trending as a negative predictor (β = - .406, *p* = .017) of the Composite Event Based Prospective Memory whereas

Negative Urgency was trending as a positive predictor (**β** = .331, *p* = .048). Table 8 displays the regression coefficients, standard error, and standardized coefficients.

Table 7. Regression model time-based prospective memory

	B	***SE B***	**β**
Constant	1.38	2.72	
Negative Urgency	0.01	0.04	0.06
Positive Urgency	2.03	1.81	0.18
Sensation Seeking	0.01	0.02	0.04
Perseverance	0.11	1.69	0.01
Premeditation	-0.01	1.89	< 0 .01

Note: The log transformed variables of Positive Urgency, Perseverance, and Premeditation were used in the regression analysis.

Table 8. Regression model event-based prospective memory

	B	***SE B***	**β**
Constant	9.73	2.84	
Negative Urgency	0.07	0.04	0.33†
Positive Urgency	-4.60	1.88	-0.41†
Sensation Seeking	< -0.01	0.02	-0.01
Perseverance	-.017	1.76	-0.01
Premeditation	-1.47	1.97	-0.09

Note: Trending results are indicated with † $p < .05$ after adjusting the alpha to $p = .01$ using the Bonferroni approach. The log transformed variables of Positive Urgency, Perseverance, and Premeditation were used in the regression analysis.

Hypothesis 3: The composite score from the Executive Function Tasks will be a significant predictor of the composite score of the Complex Prospective Memory Task above and beyond that of Impulsivity.

A hierarchical regression was used to investigate whether the Executive Function Composite score would be a significant predictor of the Composite Prospective Memory Score (sum of the Time Based and Event Based Cue) above and beyond the measure of Impulsivity. The variables entered in the first step of the hierarchical regression were the five subscales of the UPPS-P. The Executive Function Composite Score was entered into the second step of the hierarchical regression. The results revealed that neither model was significant, Step 1: R^2=.063, F(5, 84) = 1.13, p = .354, Step 2: R^2=.081, F(6, 83) = 1.22, p = .307 and that the Executive Function Composite Score did not significantly predict the Composite Prospective Memory Score above and beyond the UPPS-P (ΔR^2 = .018, p = .205). The first step of the model revealed Negative Urgency to be trending as a positive predictor of Prospective Memory (β = .377, p = .027). Negative Urgency remained a trending positive predictor of Prospective Memory in the second step of the mode (β = .343, p = .045). Table 9 displays the regression coefficients, standard error, and standardized coefficients.

Additionally, two separate hierarchical regressions were performed, one using Composite Event Based Prospective Memory and the other using Composite Time Based Prospective Memory as the dependent variables. Neither hierarchical regressions yielded significant change in R^2 results (ΔR^2 = .01, p = .297; ΔR^2 = .03, p = .108 respectively) indicating that the Executive Function Composite Score was not a significant predictor above and beyond that of the UPPS-P subscales when predicting either Composite Event Based or Composite Time Based Prospective Memory.

A third hierarchical regression was conducted to investigate whether the Executive Function Composite Score was a significant predictor of the Composite Prospective Memory Score above and beyond that of the Total UPPS-P score when controlling for substance use

(ASSIST Total Score). Results of the hierarchical regression did not yield a significant R^2 change from Step 2 of the model (i.e., the five UPPS-P subscales) to Step 3 (Executive Function Composite) ($R^2 = .01$ for Step 1, $\Delta R^2 = .05$ for Step 2 ($p = .445$), $\Delta R^2 = .02$ for Step 3 ($p = .234$)) indicating that Composite Executive Function Score was not a significant predictor above and beyond the total UPPS-P even when controlling for substance use.

Finally, since both the Total UPPS-P score and Execution Function Composite score were significantly correlated with the 5 Minute Time Based Prospective Memory cue, a hierarchical regression was used to investigate whether the Executive Function Composite Score would be a significant predictor of the 5 Minute Time Based cue above and beyond that of the Total UPPS-P score. The results indicated that Step 1 of the model was trending towards significance (using Bonferroni alpha correction of $p = .01$), Step 1: $R^2 = .05$, $F(1, 98) = 5.31$, $p = .023$, and that Step 2 was significant, Step 2: $R^2 = .12$, $F(2, 97) = 6.48$, $p = .002$. The change in R^2 was also significant ($\Delta R^2 = .07$, $p = .008$) indicating that Executive Function Composite Score was a significant predictor of the 5 Minute Time Based Prospective Memory cue above and beyond that of the Total UPPS-P score.

Table 9. Hierarchical regression model predicting the composite score of prospective memory

	B	*SE B*	β
Step 1			
Constant	12.48	4.40	
Negative Urgency	0.13	0.06	0.38†
Positive Urgency	-4.58	2.93	-0.26
Sensation Seeking	-0.01	0.04	-0.04
Perseverance	0.43	2.74	0.02
Premeditation	-1.10	3.06	-0.05
Step 2			
Constant	12.09	4.40	
Negative Urgency	0.12	0.06	0.34†
Positive Urgency	-4.07	2.94	-0.24
Sensation Seeking	-0.02	0.04	-0.05
Perseverance	0.80	2.74	0.04
Premeditation	-1.45	3.06	-0.06
Executive Function Composite	0.20	0.15	0.14

Note: $R^2 = .06$ for Step 1; $\Delta R^2 = .02$ for Step 2 ($p = .205$). Trending results are indicated with † $p < .05$ after adjusting the alpha to $p = .01$ using the Bonferroni approach. The log transformed variables of Positive Urgency, Perseverance, and Premeditation were used in the regression analysis.

Discussion

The purpose of the current study was to elucidate the relationships between impulsivity, executive function, and prospective memory and to ascertain the ability of impulsivity and executive function to predict prospective memory ability in a non-clinical sample. The main hypotheses of this study were minimally supported by the results. The first hypothesis stated that the total UPPS-P score would separately predict worse performance on the Composite Time Based and Composite Event Based Prospective Memory. The results indicated that the total UPPS-P score was trending as a significant predictor of the Composite Time Based Prospective Memory tasks, but was not predictive of performance on the Composite Event Based Prospective Memory tasks.

The second hypothesis stated that Perseverance and Premeditation would be better predictors of Composite Time Based Prospective Memory than Negative Urgency, Positive Urgency, and Sensation Seeking. Likewise, the second hypothesis also stated that Perseverance and Premeditation would be better predictors of Composite Event Based Prospective Memory than Negative Urgency, Positive Urgency, and Sensation Seeking. Neither hypothesis was supported. However, Positive Urgency and Negative Urgency were both trending as significant predictors of Composite Event Based Prospective Memory whereas only Negative Urgency was trending as a significant predictor of Composite Time Based Prospective Memory.

The third hypothesis stated that the Composite Executive Function score would be a significant predictor of the Composite Prospective Memory score above and beyond that of the individual UPPS-P subscales. Results of the hierarchical regression did not support the third hypothesis. As a follow-up to this regression, another hierarchical regression was conducted using the correlation matrix as a guide to selection of appropriate variables. In Table 5 and 6 significant correlations were observed between performance in the 5 Minute Time Based Prospective Memory Task and the Total UPPS-P and between the 5 Minute Time Based Prospective Memory Task and Executive Function Composite, respectively. The 3 Minute Time Based Prospective Memory Task did not correlate with either composite score nor with any individual subtest/subscale comprising those composites. This suggests that perhaps the 3 Minute Time Based Prospective Memory Task was not as sensitive as the 5 Minute task. Results of the hierarchical regression in which the Total UPPS-P and the Executive Function Composite score were entered in separate predictors of the 5 Minute Time Based Prospective Memory cue did, in fact, reveal that the Executive Function Composite score was a significant predictor of the Time Based cue above and beyond Impulsivity.

Cuttler, Relkov, and Taylor (2013) were among the first to study the associations between impulsivity and prospective memory in a non-clinical sample. In their 2013 study, they found significant associations between a measure of impulsivity, i.e., BIS-11, and self-report measures of prospective memory as well as associations between the BIS-11's non-planning subscale and tasks of prospective memory.   These findings from the Cuttler (2013) study provided the impetus for the first and second hypotheses of the present study, which investigated the degree to which impulsivity as measured by the UPPS-P, predicted prospective memory ability. However, the present study sought to further the findings of Cuttler and colleagues (2013) by investigating prospective memory based on the type of cue, either Event based or Time based.

The first hypothesis of the present study stated that the total UPPS-P score would be predictive of both the Composite Time Based Prospective Memory tasks and the Composite Event Based Prospective Memory tasks. Results revealed that the total UPPS-P score was only predictive of the Composite Time Based Prospective Memory and not the Composite Event Based Prospective Memory. Time based cues may be more challenging in that they require internal monitoring rather than relying on an external cue, and as such, may be more sensitive to changes in Executive Function ability and levels of Impulsivity than the Event Based cues. Nevertheless, it is noteworthy that the present study generally replicates the study conducted by Cuttler and colleagues in that it demonstrated that Impulsivity may be predictive of Prospective Memory performance in a non-clinical sample.

As mentioned earlier, the second hypothesis of the present study stated that Premeditation and Perseverance would be better predictors of prospective memory than Negative Urgency, Positive Urgency, or Sensation Seeking. In a prior study, Cuttler and colleagues (2013) found that the non-planning subscale of the BIS-11 was both significantly correlated and predictive of self-reported prospective memory ability. In theory, both the non-planning subscale of the BIS-11 and the Premeditation subscale of the UPPS-P aim to measure the lack of planning ability associated with impulsive behavior. However, contrary to the results of the Cuttler (2013) study, which only found associations between the non-planning subscale of the BIS-11 and the laboratory tasks of prospective memory, the separate regression analyses of the present study failed to support either hypothesis that Premeditation and Perseverance would be better predictors of Composite Time Based Prospective Memory and Composite Event Based Prospective Memory. However, the regression analysis did reveal Positive Urgency and Negative Urgency to both be trending as significant predictors of Composite Event Based

Prospective Memory. Results suggest that as scores on Positive Urgency increased, performance on the Composite Event Based Prospective Memory decreased. Likewise, Negative Urgency was also trending as a significant predictor of Composite Event Based Prospective Memory. Contrary to Positive Urgency, as scores on Negative Urgency increased, performance on the Event Based prospective memory also increased. This result is counterintuitive to the hypothesis that as measures of impulsivity increase, prospective memory performance decreases. However, the high collinearity between Positive Urgency and Negative Urgency may be distorting the results when both are included in a regression analysis. This was addressed by creating a separate composite score using Negative Urgency and Positive Urgency. The combined urgency score was then used in separate regression analyses (along with Premeditation, Perseverance, and Sensation Seeking) to predict Composite Time Based Prospective Memory and Composite Event Based Prospective Memory. Again, neither model was significant, however, the combined urgency score was predictive of Composite Time Based Prospective Memory, but was still not predictive of Composite Event Based Prospective Memory

The third hypothesis stated that the Composite Executive Function score would be a better predictor of the Composite Prospective Memory score above and beyond that of the individual UPPS-P impulsivity scales. This hypothesis was supported by various research studies investigating the utility of the UPPS-P in predicting impulsive behaviors (Carlson, Pritchard, & Dominelli, 2013), how individuals with impulsive behaviors perform on tasks of prospective memory (Altgassen, Koch, & Kliegel, 2014), and on how people with executive function deficits perform on tasks of prospective memory (Woods et al., 2007).

Regarding the use of the UPPS-P in predicting impulsive behaviors, previous research has found that higher levels of Positive Urgency as measured by the UPPS-P are predictive of illegal substance use and risky sexual behaviors in college age individuals (Zapolski, Cyders, & Smith, 2009). Additionally, research has also shown that substance abusers (e.g., cocaine dependent individuals) report higher levels of Positive Urgency and Negative Urgency as well as perform poorly on executive function tasks measuring inhibition and working memory (Albein-Urios, Martinez-González, Lozano, Clark, & Verdejo-García, 2012). Likewise, individuals who use illegal substances, and thus according to previous research are likely to have higher levels of impulsivity, and who perform poorly on tests of executive function, have also performed poorly on measures of prospective memory (e.g., Heffernan et al., 2001; Weinborn, Woods, O'Toole, Kellogg & Moyle, 2011).

The third hypothesis extended the previous research in that it was hypothesized that the Executive Function Composite Score would be a better predictor of prospective memory above and beyond that of impulsivity. Although there was support in the literature that executive function would be a significant predictor of prospective memory, the hypothesis was not supported in the current non-clinical population. It is important to note that this was the first study to incorporate both measures of executive function and impulsivity in one study and examine their influence on prospective memory ability in a non-clinical population.

As stated above, many studies have found associations between prospective memory and executive functioning, however, there is controversy in the literature depending on the population being studied. In congruence with the results in this study, Martin, Kliegel and McDaniel (2003) found no association in younger adults between executive functioning and prospective memory; but rather found the association between executive functioning and prospective memory in older adults. Contrary to the results in this study, Mioni, Stablum, McClintock, & Cantagallo (2012) found in individuals with traumatic brain injury negative associations between inhibition, as measured by a computerized Stroop paradigm, and success on time-based prospective memory and negative associations between updating and time-based prospective memory. However, in the control group they found a negative association only between inhibition and time-based prospective memory (i.e., lower levels of inhibition and better performance on prospective memory task). Taken together, these results indicate that the severity level of executive function impairment may be a better a predictor of prospective memory impairment. That is, non-clinical populations with relatively intact executive functions may not perform poorly enough or with enough variability to show significant association with a prospective memory task.

This study is not without its limitations. As noted above, the non-clinical sample used in this study may not have exhibited significantly elevated levels of the different facets of impulsivity as measured by the UPPS-P that would result in similar findings regarding associations between impulsivity and executive function and between impulsivity and prospective memory as those observed in clinical or elderly populations. Although some researchers have found associations among impulsivity and either executive functions or prospective memory in the healthy controls (e.g., Mioni, Stablum, McClintock, & Cantagallo, 2012; Wing, Rabin, Wass, & Georgo, 2013), many have not found that same relationship and have instead obtained significant findings within the clinical sample being studied or in the older adult group when comparing to younger adults (Martin, Kliegel, & McDaniel, 2003).

Additionally, although the study was appropriately powered, initial data analyses revealed non-normally distributed variables. A larger and more diverse sample may have been able to better correct the issue of non-normality. Another limitation regarding participant characteristics was that English as a first language was not specified within the inclusion criteria.

The rationale behind this decision was to be as inclusive as possible regarding participant recruitment. Through administration of study procedures, examiners became aware that some participants spoke multiple languages but all participants did demonstrate adequate understanding of study procedures. Even still, language may have impacted their performance. In order to investigate this, non-native English speaking participants were identified by their mass testing data available through the SONA system. Twelve participants were identified through this process and the primary regression analyses were repeated excluding these participants. These results revealed that the UPPS-P total score was no longer a significant predictor of Composite Time-Based Prospective memory, however the results were trending. The UPPS-P total continued to be a non-significant predictor of Composite Event-Time Based Prospective Memory. The second set of regression analyses revealed that none of the five subscales of the UPPS-P were significant predictors of Composite Time-Based Prospective Memory or Composite Event-Based Prospective memory. However, Positive Urgency was trending as a significant predictor of Composite Event-Based Prospective Memory. Lastly, the hierarchical regression was run excluding the non-native English speaking participants, and again, neither model was significant and the Executive Function Composite Score was not a significant predictor above and beyond that of the measure of Impulsivity.

In general, the patterns of results when excluding the twelve non-native English speakers were generally in the same direction as when the entire sample was used. Despite the fact that the non-native English speaking participants did not appear to adversely influence the results, in future studies, it will be prudent to specify that English as a first language be required due to time-sensitive tasks such as the Stroop which requires overlearned, relatively automatic processes such as quickly reading words and identifying colors and Trails B which requires rapid responding to elements of the English alphabet.

Lastly, the prospective memory tasks, particularly the Event Based Tasks, may have had too few cues that restricted the range of possible scores. Many researchers have used a habitual prospective memory paradigm in which participants are given either the same event based cue or a time based cue several times (e.g., 20) over the course of the study. In a non-clinical sample, the habitual prospective memory cue may become one that assesses ongoing attention rather than assessing the ability to remember to perform a future intention. However, a habitual prospective memory paradigm may be more relevant to study within a clinical sample due to the ecological value of assessing the ability to remember to perform a repeated act on a daily basis for example within the context of medication adherence (Doyle et al., 2015).

In the future, it will be important to investigate the relationship between the UPPS-P and other self-report measures of prospective memory such as the PMQ and PRMQ. The present study did not administer a self-report measure of prospective memory ability and so it not possible to make comparisons regarding the significant correlations between self-reported impulsivity and prospective memory of this study with the study conducted by Cuttler and colleagues (2013).

Additionally results showed there were associations among the predictors and dependent variables as well as the ability of components of the impulsivity scale to predict prospective memory performance. Although trending, findings provide support for the ability of impulsivity to predict Time Based Prospective memory and replicate general findings reported by Cuttler and colleagues (2013). However, the hypothesized ability of executive function to predict prospective memory performance above and beyond impulsivity was only observed for one component of the Time Based prospective memory task. This suggests that other factors besides executive function may better explain variability of performance on a prospective memory task in non-clinical samples. For example, motivation and the relative importance of the prospective memory task may impact whether the individual is successful in completing the task more so than trait impulsivity or minor difficulties in executive functioning. Within this study, the Event Based Prospective Memory task in which participants were asked to request their cell phone back after a specific cue at the end of study was nearly perfectly executed by all participants because their cell phone was viewed as a very important item. Likewise, students who were in greater need of receiving SONA points may have been more motivated to complete the online survey for the additional .5 point.

Although several of the specific hypotheses of the present study were not supported, findings do provide trending support for the ability of impulsivity to predict to Time Based Prospective Memory within a non-clinical college age sample. These findings replicate the general findings of Cuttler and colleagues (2013). However, this is the first study to demonstrate that impulsivity as well as executive functions predict to a prospective memory task in a nonclinical sample. Moreover, this study demonstrated that executive functions contributed to prediction of performance in prospective memory task above and beyond that of impulsivity.

Several studies using clinical populations have reported predictive relationships among impulsivity, prospective memory, and executive functions. However, one clinical population in which there is very little research on prospective memory is individuals who are either at risk or who clinically manifest Huntington's disease. Individuals with or at risk for Huntington's disease may exhibit executive function deficits and/or impulsive behaviors. Additionally, individuals at risk for Huntington's disease may notice changes in cognitive abilities before a clinical diagnosis of Huntington's disease is made based on observation of motor symptoms. As such, prospective memory may begin to decline before a clinical diagnosis of Huntington's disease is made. Deficits in prospective memory would be important to note in clinical populations such as Huntington's disease because of the potential negative impact on many activities of daily living such as medication management, arriving on time for doctor's appointments, and responsible financial management.

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Appendices

Appendix A: Results from Pilot Study

Demographics	Sub 1	Sub 2	Sub 3	Sub 4	Sub 5	Avg.
Age	19	21	31	28	22	24.2
Education	13	15	15	16	15	14.8
GPA	3.2	3.75	3	2.89	2.3	3.03
UPPS-P						
Negative Urgency	20	14	27	31	24	23.2
Positive Urgency	18	19	15	32	32	23.2
Premeditation	19	12	17	21	13	16.4
Perseverance	13	10	19	-	11	13.3
Sensation Seeking	36	18	15	25	47	28.4
Total	106	73	93	-	127	99.8
Executive Function (sec.)						
Mazes	14	24	16	16	19	17.8
Trails A	52	10	36	28	15	28.2
Trails B	103	40	49	41	41	54.8
Stroop Word	104	110	90	100	88	98.4
Stroop Color	92	80	57	81	84	78.8
Stroop Interference	68	56	35	46	46	50.2
CPMT						
Plan Formation	4	2	4	4	7	4.2
Plan Retention	2	2	3	4	4	3.0
Plan Initiation	1	1	3	1	3	1.8
Plan Execution	3	5	3	3	5	3.8
Time-based Cue: 3 min	2	3	1	2	1	1.8
Time-based Cue: 5 min	3	3	1	3	1	2.2
Clock Monitoring	8	7	0	10	0	5.0

You must follow these rules:

1. To maximize your score

- **Earlier** pictures/problems/word groups will be given **more points** than later ones in each subtask.

- **Points** will be given for **correct** answers, performance,
errors or **omissions** will be **penalized**.

- Each of the six subtasks is given **equal weight**.

1. You are **not allowed** to do **two subtasks** (A) and (B) of **the same type one after the other**.

2. You have to work on **all subtasks**.

3. You have **6 min** time.

4. Please **press the start-button** of this stop-watch to start these tasks by yourself.

Here you see examples of the three task-types:

1. Finding the actual word:

You are given groups of four words. In each group there are three nonsense-words and one actual existing word. The words are similar and might only differ in one letter.
Please circle in each group the existing word. There is only one.

Example (2 x 35 groups):

a) dar - car - kar - carr.

2. Solving arithmetic problems

You are given arithmetic problems. You cannot use a calculator, but you may make notes on the sheet if you want.

Example (2 x 10 problems)

a) 20 - 7 + 45 =

3. Writing down the names of pictures.

You are given a set of pictures. You have to write down a proper name of these pictures. There is no perfect answer. Just write down, whatever you think is the appropriate label.

Example (2 x 20 pictures):

a)

Word Find A

1. bef	-	bed	-	ged	-	het.
2. gipp	-	ripp	-	ship	-	kipp.
3. hanny	-	beny	-	penny	-	panny.
4. senter	-	winter	-	finter	-	vinter.
5. breakfast	-	braekfast	-	brakfest	-	brekfest.
6. repair	-	preper	-	remair	-	prear.
7. faric	-	frabic	-	fabrick	-	fabric.
8. assumble	-	assamable	-	assemble	-	assamble.
9. enourmous	-	enaumbus	-	enormous	-	emurmous.
10. conceal	-	concill	-	cauncil	-	concel.
11. saentance	-	sentence	-	santance	-	santence.
12. consume	-	confume	-	congrume	-	consum
13. regulat	-	gerulat	-	regulate	-	gurulate.
14. termainate	-	ferminate	-	terminate	-	germinete.
15. commence	-	convence	-	conmence	-	cormence.
16. domestique	-	domestoce	-	domnestic	-	domestic.
17. franquil	-	tranquil	-	trangville	-	fragville.
18. ponder	-	pondor	-	fonter	-	fronder.
19. designate	-	densignate	-	degnisate	-	dangsinate.
20. refluctant	-	freluctant	-	frelucted	-	reluctant.
21. obstuct	-	abstact	-	obstruct	-	abstruct.
22. sanctuary	-	functuary	-	vanctuary	-	phanctuary.
23. corpassion	-	compassion	-	confasion	-	confassion.
24. avasive	-	evasive	-	envasive	-	evansion.
25. ermorse	-	ernorse	-	renorse	-	remorse.

26. Perigeter	-	herimeter	-	perimeter	-	milimeter.
27. Generate	-	gerenate	-	genarate	-	generete.
28. matchless	-	metchless	-	catchless	-	fleshles.
29. fontitute	-	fortinute	-	folminute	-	fortitude.
30. tangible	-	tengible	-	tangile	-	tucticle.
31. palgiarize	-	plagriaze	-	plagiarize	-	pallgiarize.
32. Omnious	-	ominous	-	omninous	-	oninous.
33. emcomber	-	embcomber	-	enboumber	-	encumber.
34. audicious	-	audiacus	-	audiciaous	-	audacious.
35. shirade	-	tirade	-	chirade	-	cyrade.

Word Find B

1. schair	-	chair	-	cheir	-	feir
2. bag	-	bagg	-	weg	-	bak
3. latar	-	blatter	-	letter	-	leter
4. spreng	-	fring	-	gringe	-	spring
5. dinar	-	denar	-	ginar	-	dinner
6. plant	-	glant	-	glent	-	glante
7. glorios	-	glorious	-	glurious	-	glorius
8. drivet	-	dift	-	trift	-	drift
9. portrait	-	portreit	-	portrate	-	poutraire
10. misstreat	-	miszdreet	-	misdeed	-	mizdeed
11. bifurcation	-	befurcation	-	bifrucation	-	befrucation
12. hamp	-	hemp	-	hempe	-	humpe
13. frigenerate	-	fregenerate	-	phregenate	-	regenerate
14. breviary	-	bruriary	-	braviry	-	breerary
15. scurp	-	farp	-	scarp	-	pharp
16. zement	-	sement	-	cement	-	xement
17. woop	-	whoop	-	toop	-	toob
18. eby	-	abb	-	aby	-	ebb
19. mortar	-	fortar	-	nortar -	mnortar	
20. ortodox	-	othodox	-	orthodox	-	orthotox
21. ford	-	phort	-	gorde	-	gorte
22. truch	-	thrush	-	ruch	-	guch
23. suffona	-	supoena	-	suppoena	-	subpoena
24. mina	-	nime	-	mime	-	mimme
25. oviation	-	ovation	-	aviaton	-	oubiation

26. rutting - ruffin - ruting - durring

27. meander - neamber - manender - meamber

28. felor - fellov - velor - velour

29. shism - sicm - schisma - schism

30. confilation - compilaton - convilation - compilation

31. bivocal - bevogal - bifocal - bediagonal

32. isotope - isotof - irosop - isitop

33. amery - emery - enamy - emamy

34. reliquary - relegy - reliquery - reflequee

35. chemon - denom - xenom - xenon

Math Worksheet A

1. 7 x 6 =

2. 144 / 6 =

3. 87 + 14 - 25 =

4. 300 / 6 x 4 =

5. (14+86) - (32 + 13) =

6. 55 / 11 + 5 =

7. (3 + 15) / (24 - 21) =

8. (210 / 7) x 2 =

9. 80 + 20 + 56 - 47 =

10. (8 x 9) - 2 =

Math Worksheet B

1. 8 x 9 =

2. 126 / 3 =

3. 45 + 24 - 16 =

4. 200 / 5 x 3 =

5. (27+63) - (32 + 13) =

6. 120 / 6 + 25 =

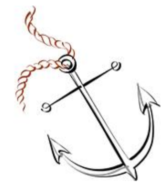
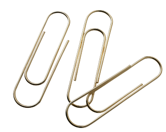
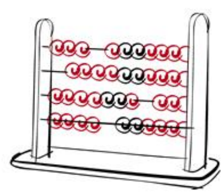
7. 7 + 45 + 4 - 56 =

8. 144 - 54 + 22 - 10 =

9. (7 x 5) + (4 x 8) =

10. (7 x 9) - (4 x 3) =

Picture Identification: A

<u>Picture Identification: B</u>

Subject Information Form

1. Title (please circle one): Miss Mrs. Ms. Mr.

2. Sex (please circle one): Female Male

3. Date of Birth: ___________________

4. Age: _______________

5. Please check one:
   - ______ American Indian or Alaskan Native
   - ______ Asian or Pacific Islander
   - ______ African-American (not Hispanic)
   - ______ Hispanic
   - ______ White (not Hispanic)
   - ______ No answer

6. Handedness (please circle one): Right Left

7. Last completed year in school (please check one):
   - ______ High School
   - ______ Freshman
   - ______ Sophomore
   - ______ Junior
   - ______ Senior

8. What is your current GPA? _________________________________

9. Have you ever been diagnosed with either ADD or ADHD? YES NO

10. If yes, which one? ADD ADHD

11. Have you ever had open or closed head injury? YES NO

12. If yes, did you lose consciousness? YES NO

13. If yes, for how long? ________________________________

Appendix C: Letter of IRB Approval

UNIVERSITY OF SOUTH FLORIDA

RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd., MDC035 • Tampa, FL 33612-4799
(813) 974-5638 • FAX (813) 974-7091

6/11/2014

Emily Kellogg
USF Department of Psychology
4202 E. Fowler Ave.
Tampa, FL 33620

RE: **Expedited Approval for Initial Review**
IRB#: Pro00017547
Title: The effects of personality and cognitive processes on prospective memory

Study Approval Period: 6/11/2014 to 6/11/2015

Dear Ms. Kellogg:

On 6/11/2014, the Institutional Review Board (IRB) reviewed and **APPROVED** the above application and all documents outlined below.

Approved Item(s):
Protocol Document(s):
Kellogg Thesis Proposal_Final.docx

Consent/Assent Document(s)*:
Informed Consent.pdf

*Please use only the official IRB stamped informed consent/assent document(s) found under the "Attachments" tab. Please note, these consent/assent document(s) are only valid during the approval period indicated at the top of the form(s).

It was the determination of the IRB that your study qualified for expedited review which includes activities that (1) present no more than minimal risk to human subjects, and (2) involve only procedures listed in one or more of the categories outlined below. The IRB may review research through the expedited review procedure authorized by 45CFR46.110 and 21 CFR 56.110. The research proposed in this study is categorized under the following expedited review category:

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

As the principal investigator of this study, it is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB. Any changes to the approved research must be submitted to the IRB for review and approval by an amendment.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely,

John A. Schinka, Ph.D.

John Schinka, Ph.D., Chairperson
USF Institutional Review Board