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The Relation between Self-Reported Alcohol and Cannabis Use and Prospective Memory in College Students

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Abstract

The aim of this study was to examine the relation between drug use and prospective memory performance. Prospective memory is the ability to remember to do something in the future and is a vital aspect of everyday living. Prospective memory can be broken down into regular, irregular and event-based or time-based components. Most research on prospective memory has primary examined differences between young and old adults (e.g., Einstein & McDaniel, 2005; Rendell & Craik, 2000; Schnitzpahn et al., 2014). The current study examined possible effects of self-reported alcohol and cannabis use on prospective memory performance. A computer based Virtual Week task to assess prospective memory and a questionnaire to assess substance use were administered to college students at a large Midwestern university. It was hypothesized that prospective memory scores would be lower in college students who reported both alcohol and cannabis consumption.

Memory is one of the most important capacities humans possess. Prospective memory is being able to make plans and to remember to execute said plans and intentions at a specific time and place (Arana et al., 2011). Not only is prospective memory vital for personal functioning, it is also important in the area of social, occupational and health domains (Cuttler, McLaughlin, & Graf, 2012; Einstein & McDaniel, 2005). Prospective memory is necessary to take a prescribed medication at a specific time or with a certain task (eating dinner) and is also used when remembering to go to a particular event or to do a precise job at work. Aberle, Rendell, Rose, McDaniel, and Kliegel (2010) described how prospective memory is being able to remember "delayed intentions." Having good prospective memory is essential to succeed in life (Rose, Rendell, McDaniel, Aberle, & Kliegel, 2010). If one forgets to do something as important as taking a medication, the results could be fatal. Though most research examined prospective memory ability in older adults, prospective memory is also critical for functioning during other stages of the lifespan including emerging adulthood. The current study explored how substance use (i.e., alcohol and cannabis) in college students may have contributed to prospective memory failure and the implications for their daily functioning. Since drug use may become even more prominent in emerging adulthood, it is important to understand the repercussions these substances have on memory.

General Prospective Memory

Prospective memory has two main components: event based or time based (Einstein & McDaniel, 2005). Event based tasks include remembering to do a task with a certain activity (e.g., taking a medication with one's breakfast). Time based tasks require remembering to do something at a certain time (e.g., weighing oneself at exactly nine a.m. every morning or picking up one's children at 3:15 pm from school). Prospective memory can also be activity based (e.g.,

see Griffiths et al., 2012), doing something following the completion of a specific activity. Understanding the differences between types of prospective memory is important to understand the mechanisms that underlie it.

Prospective memory is a complex system that involves multiple parts of the brain. Not only is memory used, but cognitive control is also needed. The cognitive mechanisms underlying prospective memory are unclear (Schnitzpahn et al., 2014). Prospective memory relies on the prefrontal and frontal lobes (Heffernan, 2008). The hippocampus also plays an important role in prospective memory functioning. Considering that the hippocampus controls memory, it is reasonable to assume that it also plays a major role in prospective memory. It also is understandable that the prefrontal lobe is involved because it controls executive functioning, which is important to remember when to do tasks. Many aspects of the brain are not fully developed until individuals enter their mid-twenties (Arnett, 2013). It is important to note that prospective memory failures in young adults may in part be due to normal age-related changes in the brain during this early part of the lifespan.

Multiple aspects of memory are utilized within prospective memory. Working memory is an important component of prospective memory (Einstein & McDaniel, 2005). Working memory is necessary to plan and remember the task while focusing on alternative tasks (Rose et al., 2010). Therefore, working memory and prospective memory are interrelated specifically when performing a prospective memory task. Einstein and McDaniel (2005) examined the performance of individuals during a lexical-decision task consisting of remembering different words. Those who also had to complete a prospective memory-task were slower at responding during the working memory task. This finding indicates a possible relation between working memory and prospective memory.

Retrospective memory is another important aspect of prospective memory. Retrospective memory is the ability to remember information previously taught (Cuttler et al., 2012). Even though prospective memory is similar to retrospective memory, it does not rely on external stimuli for retrieval, but involves other processes that may be internal (Einstein & McDaniel, 2005). On the contrary, Aberle et al., (2010) consider retrospective memory to be the opposite of prospective memory. Bearing in mind one is based on the past while the other is used in the future, this claim is reasonable.

Prospective memory has multiple ways of recovering the task needing to be done. There is monitoring as well as spontaneous retrieval (Rose et al., 2010). When monitoring, individuals are in constant retrieval mode when expecting a prospective memory task to occur (Einstein & McDaniel, 2005). This monitoring may require a lot of attentional resources. In fact, retrieval monitoring demands more cognitive resources than spontaneous retrieval mode because one is continually evaluating the environment for cues (Rose et al., 2010). For example, one may need to remember to drop off mail on their way home from work. Instead of constantly reminding oneself (monitoring), it would be more cognitively beneficial to rely on spontaneous retrieval. Monitoring may interfere with other activities and therefore the spontaneous retrieval mode may be more efficient (Einstein & McDaniel, 2005). However, spontaneous retrieval mode may be confounded by individual differences, uniqueness of the event, and processing of the event (Einstein & McDaniel, 2005). Finally, Einstein and McDaniel (2005) consider reflexive-associate theory. It is necessary for individuals to find a relation between the target cue and the intended task to help remember to perform the task. Using the example from above, it would be remembering to drop off the mail after seeing the mailbox because those two are associated together. More research is needed to explore the role of and form of retrieving modes of

prospective memory to truly understand and find the most effective method. Prospective memory is a fascinating aspect of memory that is still not clearly understood. In fact, the empirical study of prospective memory is a recent phenomenon in comparison to other areas of cognitive psychology (Einstein & McDaniel, 2005).

Most research on memory has only been tested in lab settings, not in real-life situations (Ling et al., 2003). This is notable, because lab experiments do not always capture what is really happening in daily living. By finding ways to study prospective memory in natural settings, one may be able to better understand how it really works and if different factors, such as alcohol and cannabis, affect performance.

Scientists are beginning to explore prospective memory in a somewhat more realistic manner such as with the Virtual Week Task. Virtual Week is a prospective memory task designed to be representative of everyday life tasks (Rendell & Craik, 2000; Rendell & Henry, 2009). Virtual Week is structured like a board game where participants roll a die and make decisions about daily activities. They are also told to match their choices to options they would likely pick in real life. The task requirement's personalize the activity and make the experience more unique for each individual. Prospective memory is tested by containing repeated and non-repeated tasks that individuals have to complete (Rose et al., 2010). The Virtual Week Task is a relatively new method to test prospective memory and a computerized version that became recently available was utilized in the present study (Rendell & Craik, 2000).

Age and Prospective Memory

Many research studies have focused on age-related differences between younger and older adults on prospective memory tasks. Prospective memory is assumed to decline with age; however other studies have reported no age-related differences (Einstein & McDaniel, 2005).

Schnitzpahn et al., (2014) emphasized that most studies have reported that prospective memory decreases with age. Nevertheless, differences in findings may be due to several factors. One major discrepancy is between natural and lab settings. Little to no age-related differences have been reported in studies conducted in natural settings (Rendell & Craik, 2000) with results of a meta-analysis (Aberle et at., 2010) indicating older adults performed better overall than young adults on real-life prospective memory tasks. Conversely, young adults tend to do better than older adults in lab-based settings (Aberle et al., 2010). Rendell and Craik (2000) proposed that although young adults may do better within the lab-setting, in real-life settings, the results are often reversed (i.e., those skills are not generalized to real life tasks). The difference between natural and lab settings raises some important questions. Are the lab settings really measuring what they are intended to? Why are findings from natural settings inconsistent with those reported from lab settings?

The fact that older adults do better in natural settings than lab settings compared to young adults is known as the 'age prospective memory paradox' (Aberle et al., 2010, p. 1444). There are many possible reasons for this paradox. The differences between lab and natural setting task results could in part be due to motivation, external aids, lifestyle and task differences (Rendell & Craik, 2000). Aberle et al., (2010) suggested that the specific setting, a structured life and personality could also play a role. The structured life aspect tends to stand out the most. Older adults tend to live much more routine lives than college students. These structured daily lives can help support prospective memory in older adults (Rendell & Craik, 2000). For example, a typical college student has classes that change every semester, inconsistent meetings with professors and groups and social events that can pop up last minute. On the other hand, older adults tend to have either a consistent job or planned activities that do not change often, e.g., either weekly or

monthly scheduled meetings or appointments and jobs that are roughly the same every day. The older adults also have had more time to establish a pattern with their day-to-day lives. Prospective memory is extremely important for older individuals because of its relation to independence (Schnitzpahn et al., 2014). As adults get older, being able to continue self-care is vital to live life freely. If an individual is unable to remember to take their medicine or go to a scheduled appointment, their life could be in danger and they are not suitable to care for themselves (Schnitzpahn et al., 2014). A similar problem occurs when one is under the influence of substance use; they may not be able to take care of their day-to-day responsibilities.

Alcohol Use and Prospective Memory

Alcohol is a very popular substance used among young and older adults. In fact, alcohol is the most commonly used recreational drug (Heffernan, 2008). In fact, 90% of the population has consumed alcohol and 30% has developed some alcohol-related disorder. This number is astronomical and shows just how much alcohol is present in the lives of everyone. Though alcohol can have beneficial qualities, it can also be very damaging and even harmful (Heffernan, 2008). It is important to understand alcohol use and both the psychological and physical effects it has on individuals.

Binge drinking is included within the domain of alcohol use - binge drinking is consuming more than the suggestive amount of alcohol in a given setting and is a huge problem among emerging adults (Heffernan, 2008). It has become somewhat socially acceptable for college students to participate in binge drinking. In fact, 44% of college students binge drink every two weeks and 19% have three or more binge drink nights a week (Heffernan, 2008) and the percentages have only risen over the years. It is important to comprehend the implications of alcohol use and how it can affect young adults, especially cognitively (Heffernan, 2008). Since

this is such a well-known and consumed drug on college campuses, individuals need to know that there are negative cognitive consequences to drinking (Heffernan, 2008; Ling et al., 2003).

Alcohol can cause a variety of problems for individuals and society at large. It is known that alcohol affects problem solving and decision-making (Ling et al., 2003). However, little research has examined the influence of alcohol use on everyday memory performance (Heffernan, 2008; Ling et al., 2003). Considering memory is important to normal functioning, the fact that there has not been much research on the matter is alarming. No study to date has examined a direct relation between alcohol dependence and prospective memory (Griffiths et al., 2012). However, alcohol dependent individuals and frequent alcohol users do exhibit difficulties with short and long term memory, remembering word lists, and general working memory (Ling et al., 2003). It is reasonable to expect that prospective memory performance may also be compromised with excessive drinking.

Recently, Griffiths et al., (2012) used the Virtual Week task as a measure of prospective memory in social drinkers and alcohol dependent individuals. Those with alcohol dependence did significantly worse than social drinkers on the prospective memory task (Griffiths et al., 2012). In another study, over 700 participants filled out self-report questionnaires for memory, one of which particularly pertained to prospective memory. The individuals also answered a questionnaire regarding their alcohol use. Heavy drinkers compared to low/no drinkers reported significantly worse prospective memory impairments (Ling et al., 2003). Therefore, both of these studies found a relation between alcohol use and prospective memory. Heffernan (2008) noted two separate studies, which reported that teens and young adults whom consume large quantities of alcohol had poor long and short-term prospective memory. Amount of alcohol consumed and the length of use are variables that may contribute to prospective memory deficits. Additional

factors to consider include the age an individual began drinking, their current age, amount of education, and family background (Heffernan, 2008).

These findings are very disturbing and indicate a substance that so many have access to could have such adverse effects. There currently is no study that has examined whether abstinence from alcohol can improve prospective memory functioning (Heffernan, 2008). If memory could be improved after quitting, then the results from these studies would not be as shocking. Another interesting connection between alcohol and prospective memory is the therapy used for addicts. Many therapies tell the clients to apply "anti-relapse strategies when encountering high-risk situations" (Griffiths et al., 2012, p. 1809). If an individual has poor prospective memory, especially if they were once heavy alcohol users, then they may have problems remembering to use the therapeutic strategies. Therefore, understanding that alcohol users have issues with prospective memory could revolutionize treatment plans to better accommodate past alcohol users (Griffiths et al., 2012). By finding an alternative treatment plan, past users could have a more effective strategy when encountering risky circumstances.

More research is necessary to examine the relations between prospective memory and alcohol use. Many research limitations include self-report measures and co-morbidity (Heffernan, 2008). Individuals may lie about their in-take and how well they remember to do things. Some individuals may over exaggerate their alcohol consumption, because they think it will allow them to fit in more with their peers. Others, though, may under estimate their use, because they are worried about judgment. Also, participants may be using additional drugs that may affect prospective memory or may have other stressors such as depression that might contribute to their task performance. Another area that needs further study is the exact mechanisms underlying prospective memory with alcohol use. Late teens experience changes in

the brain and these areas can be highly modified by alcohol use or can even shrink the brain (Heffernan, 2008). It is therefore important to understand age-related differences in prospective memory that may be related to substance use/abuse.

Cannabis Use and Prospective Memory

Another popular drug is cannabis. Cannabis is more formally known as marijuana. In fact, this substance is the most widely used illegal drug (Cuttler et al., 2012). In Europe alone, cannabis, cocaine, ecstasy and amphetamines are the most used drugs (Arana et al., 2011). To put into perspective how many individuals use this drug, there are an estimated 129-191 million users worldwide (Cuttler et al., 2012). Though many individuals use marijuana in early adolescence, it is much more prominently used in later adolescence (Dougherty et al., 2013). The word "illegal" is used loosely here, because this drug is becoming legal in some parts of the world, even some states within the United States (e.g., Colorado, Washington, Oregon).

There are negative effects related to marijuana consumption. Marijuana use can result in permanent brain changes especially when used in adolescence (Dougherty et al., 2013). Knowing there are a large number of young individuals using this drug, this assumption is worrisome. Marijuana is found to contribute to memory problems across all age groups (Dougherty et al., 2013). According to Cuttler et al., (2012), the most well-known cannabis effects involve executive functioning and retrospective memory. It should be noted these same mechanisms are affected by alcohol. However, chronic cannabis users also have issues with encoding, storage, manipulation and retrieval (Cuttler et al., 2012). Gallagher et al., (2014) noted how cannabis users along with ecstasy users have abnormalities in the prefrontal cortex and hippocampus. The prefrontal cortex and hippocampus are also affected by alcohol. It can therefore be hypothesized that cannabis may also affect prospective memory in the same ways alcohol does.

Because of its recent legalization in some states, marijuana research has become a huge scientific endeavor. Lab-based studies have found cannabis use does affect memory, attention and learning (Montgomery Seddon, Fisk, Murphy, & Jansari, 2012). However, few studies have focused specifically on cannabis use and prospective memory (Cuttler et al., 2012). Since prospective memory is an important aspect of everyday living, it is important to understand the implications of cannabis use on that system. It has even been argued that cannabis may affect prospective memory more than working memory (Montgomery et al., 2012).

Cuttler et al., (2012) examined performance on a prospective memory test and a self-report prospective memory test. The participants were divided into three groups (no use, little use, chronic use). There was not a significant difference between no use and little use. However, chronic users had problems with internally-cued prospective memory (Cuttler et al., 2012). These findings have extremely important implications because moderate use of the drug does not necessarily have damaging effects. However, those that consume the drug multiple times a week are more likely to be at risk for prospective memory deficits.

Many studies on substance users have found differences based on short or long term prospective memory and time-based versus event-based prospective memory tasks. According to Cuttler et al., (2012), cannabis users performed worse on long-term time-based prospective memory tests than non-users, and short term time-based performance was even worse. Interestingly, though, there were no issues found with event-based tasks. Arana et al., (2011) observed prospective memory issues during short-term and internally cued tasks among cannabis users. Gallagher et al., (2014) also reported that cannabis users had poorer short-term time-based prospective memory task performance compared to non-drug users. Short-term memory problems can continue to exist in adolescents even after quitting the drug (Dougherty et al.,

2013). Clearly, a link between short-term memory and time-based prospective memory and cannabis use is evident.

Cannabis users did not do as poorly as poly-drug users (Gallagher et al., 2014). Participants were asked to pair words together while also remembering to push a certain key each time to measure their prospective memory performance. Poly-drug users are those who use more than just one drug. In fact, it is hard to separate cannabis users from poly-drug users (Cuttler et al., 2012). Often those who use cannabis are often using other drugs. Therefore, it is important to understand that some results may be confounded because of variation in drug use and type.

Miscellaneous Drug Use and Prospective Memory

Studying drug use can be difficult for multiple reasons. It is difficult to separate drug users from those that only use one drug to those that use several (Arana et al., 2011). For example, if one is looking for effects of cannabis on prospective memory, one must control for alcohol and all other drug consumption to make sure there are no confounds. Another reason it is hard to study drug use is because most of the drugs are illegal (Arana et al., 2011). Researchers cannot force someone to ingest the drug or advocate for one. Lastly, Arana et al., (2011) pointed out that most prospective memory studies dealing with drug users have to rely on self-reports. This information can easily be skewed and inaccurate.

Drugs are known to affect important functions in individuals. For instance, drugs are known to affect neuropsychological and cognitive abilities (Arana et al., 2011) and can have varying effects on these systems. In fact, some studies have found nicotine to actually improve prospective memory because it increases attention; however other studies have found poorer performance (Arana et al., 2011). Heffernan and O'Neill (2013) reported that smoking tobacco

could have effects on cognitive abilities, particularly on memory. Another interesting finding was that secondhand smoke was related to cognitive impairments. Secondhand smoke victims had lower prospective memory performance scores than non-smokers, but not as poor as current smokers (Heffernan & O'Neill, 2013). This is truly unfortunate since secondhand smokers are typically not in that situation by choice.

Though research into prospective memory has increased over the years, it is just now being studied in relation to drug use. Most research on prospective memory and drug use has been on ecstasy (Cuttler et al., 2012). Most ecstasy users have problems with long term prospective memory (Arana et al., 2011), in contrast to cannabis users whose short-term memory is usually the most affected. Further research into drug use and prospective memory is extremely important because more individuals begin experimenting with them, especially in adolescence and emerging adulthood. Since alcohol and even cannabis are legal in some parts of the United States, individuals may not realize long-term effects, in particular deficits with prospective memory.

Overall, prospective memory is affected by substance use. Though research on this topic is limited, it is important to continue to examine the effects that popular drugs have on the body. The purpose of this study was to specifically see if alcohol, cannabis and the combination of the two had differing effects on prospective memory in college students. It was expected that alcohol only and cannabis only users would have comparable prospective memory based on the Virtual Week Task, whereas those that used both would have substantially more prospective memory failures.

Method

Participants

Seventy college students (37 Women, 33 Men, Mean Age = 19.54 years, Age Range = 18-35) were recruited through an undergraduate introductory psychology college course at a large Midwestern University. Students received course credit for their participation. Alternative opportunities were given to students who did not wish to take part in the study.

Materials

Two separate measures were used to test for the effects of drug use on prospective memory, in addition to a demographic questionnaire (see Appendix A). A self-report substance abuse questionnaire and a computerized task were utilized and are described below.

Substance Use Questionnaire

A sample of questions from the *CORE Alcohol and Drug Survey* (Presley, 1994) was used for the current study to examine frequency use among college students. This questionnaire assesses drug use both for the past and current use. The survey includes a range of different drugs (e.g., alcohol, marijuana, cocaine, ecstasy). The survey also inquires about where the drugs were first used (e.g., school, parties, home). (See Appendix B).

Virtual Week Task

Prospective memory was assessed with the Virtual Week Task (Rendell & Henry, 2009). Virtual Week is a computerized task that allows participants to move across a board as though they are moving through a typical day (See Appendix C). There is a time clock in the middle and each tile on the board is equivalent to seven minutes. One time around the board represents one full day (7 am to 10 pm). Individuals click on a dice to begin. They subsequently ‘roll’ the dice again to be able to continue to move. Some sections of the tasks require a specific roll to allow the individual to move on. This additional roll serves as a distraction from the prospective

memory tasks. Throughout the game, there are tasks that need to be completed either at specific times or at certain events. For example, the student must remember to take their medication at dinner and use the asthma inhaler at 9 pm. There are roughly three time-based activities and three event-based activities in a given day. Questions pop up which allow the students to personalize the experience to what they would choose in real life, for instance, what type of dish they want for dinner or how they want to spend their afternoon. Individuals are scored based upon how many prospective memory tasks they complete relative to how many were assigned. A brief version of the Virtual Week Task (2 days and a trial day) was used for the current study. A trial day was included for the student to become comfortable with the game, and then two full days with no aid by the researcher was provided.

Procedure

Students were individually tested in a quiet room. The testing session lasted between 45 minutes to one hour. The student first completed a demographic sheet. The researcher then explained the board game procedure to the student and explained how one circuit around the board represented one day. The required tasks throughout the game were explained to the student. It was emphasized that when they were asked a question during the game, to choose as closely as they would in their own life. The student then completed the trial day. After successfully navigating the trial day, the student completed Day 1 and Day 2 of the Virtual Week on their own. After completion of the Virtual Week task, the student filled out the Big Five Inventory (John, 1990) and the CES-D (Radloff, 1977), which were used as part of a larger project. Lastly, the student completed the drug and alcohol survey. The students placed the completed packet in a secure folder and received their debriefing form.

Hypotheses and Statistical Analysis

After the measures were collected, the data was split into five groups; non-users, alcohol only users, cannabis only users, alcohol and cannabis users, and poly-drug users (i.e., those who use substances in addition to alcohol and cannabis). The amount of drug use was the independent variable, while prospective memory performance was the dependent variable. An ANOVA and correlations were used to determine which group experienced the most prospective memory failures.

The hypothesis was that non-users would have no significant prospective memory impairment. Alcohol only and cannabis only users would have similar prospective memory failure. Alcohol and cannabis users would have significantly worse prospective memory failure than those that only use one drug. Lastly, poly-drug users would have the highest rate of error on the prospective memory task.

Results

The current study was designed to examine the relations between different levels of drug use and prospective memory. It was hypothesized that poly-drug users would have the most prospective memory failures, followed by alcohol and cannabis-combined users. Alcohol-only and cannabis-only users were predicted to have slighter better scores than the combined users with non-users performing the best. The sample consisted of 70 participants (Female = 37, Male = 33, Mean Age = 19.54 with a Standard Deviation of 2.42, Age Range = 18-35). The sample contained 50% Caucasian, 32.9% African American, 12.9% Hispanic, 2.9% Pacific Islander/Asian and 1.4% reported other. The majority of the participants were in their first year of college (77.1%) followed by sophomores (12.9%). The participants were mainly comprised of unemployed students (74.3%) that lived on the college campus (84.3%).

Pearson's correlations were used to examine the relations between drug use and prospective memory performance. An independent samples t-test was used to analyze whether a difference was found on all prospective memory tasks between those that reported drug use and those that reported no drug use. No significant difference between the two groups was observed, t (68) = 1.04, p = .304. Therefore, prospective memory performance was not predicted by drug use.

There were significant effects regarding measures not related to prospective memory on drug use. Many personality traits were related to one another, for instance, there was a positive relation between Agreeableness and Conscientiousness, r (68) = .462, p = .000, whereas Neuroticism was negatively correlated with Agreeableness r (68) = -.273, p = .022, with Extraversion, r (68) = -.239, p = .046, and with Conscientiousness r (68) = -.370, p = .002, indicating that those high in neuroticism would be more likely to be low in agreeableness, low in extroversion and low in conscientiousness.

Scores on the CES-D, which measures depression, were significantly related to personality, drug use and prospective memory. A positive relation between depression and Neuroticism, r (68) = .391, p = .001 was observed. Conversely, a positive relation between depression and Conscientiousness, r (68) = -.284, p = .017 was found. A positive relation also was observed between depression and tobacco use, r (68) = .237, p = .048, indicating that those who use tobacco are more likely to be depressed. Lastly, a relation between depression and all regular prospective memory tasks, r (68) = .249, p = .037 was found. These results indicate that those who reported higher depression levels actually performed better on the prospective memory task.

Significant relations were found between personality traits, drug use and prospective memory performance. Conscientiousness and alcohol-use were negatively related, r (68) = -.284, p = .017, indicating that in this sample those low on conscientiousness were more likely to use alcohol. On the other hand, a positive relation between Openness to Experience and Cannabis use, r (60) = .347, p = .003 was evident. Surprisingly, Agreeableness was negatively related to all time prospective memory task conditions, r (68) = -.284, p = .017, indicating that those scoring low on agreeableness would perform better on time-related prospective memory tasks.

A repeated measures mixed ANOVA was also computed. The independent variables being drug use, personality traits and depression levels and the dependent variable being irregular and regular prospective memory tasks. There were no significant effects regarding drug use and prospective memory evident in this sample. However, an interaction was observed between cue and task, which is to be expected, because they both deal with prospective memory performance, F (3,49) = 4.94, p = .031, with participants performing better on regular time prospective memory tasks than on irregular event tasks.

Discussion

The purpose of this study was to determine if there a relation between drug use and prospective memory existed in college students. Participants were recruited through an undergraduate class and given questionnaires to assess drug use, personality, and depression. A Virtual Week Task was used to assess prospective memory performance. It was hypothesized that the more drugs one used, the worse their prospective memory would be. There were no significant relations between drug use and prospective memory performance. However, prospective memory was related to other variables such as agreeableness and depression. Low agreeableness was related to all time tasks and depression was related to regular event or time

tasks. Time tasks are tasks that must be performed at a specific time, for example, taking one's medication at 5 pm every day would be an example of a regular time event. Going to a job interview at 2 pm tomorrow would be an example of irregular time event. Therefore, those that had lower agreeableness scores would have a harder time remembering to do either of those tasks, whereas those who reported higher levels of depression would have a harder time remembering to take the medication, but would not necessarily forget to attend the interview. These results are different than what past research has reported. Typically, conscientiousness is positively related to prospective memory performance (Smith, Persyn & Butler, 2011). The discrepancy could be due to the lack of subjects in the current study. Since the sample was relatively small in the current study, more participants could enhance the results and make them align with more research on the topic.

There were also interesting significant findings between drug use and personality. For instance, conscientiousness was negatively related to alcohol use. Therefore, those that are less conscientious are more inclined to use alcohol. This is a similar finding to Livingston, Oost, Heck and Cochran (2014), who found that substance use was related to conscientiousness and extraversion. A significant relation with extraversion and drug use was not observed in the current sample, but further research with more participants could explain this variance. Another substance that produced significant results was cannabis use. It was strongly related to openness to experience. Since those who score high on this trait are typically more likely to try new things and take more risks, this finding is not too surprising.

Depression scores also yielded some interesting findings. First, depression was related to those who score low on conscientiousness. Since individuals who score lower on a conscientious scale often are less motivated, less goal-oriented, and lack self-control (Wilson,

Boyle, Yu, Segawa, Sytsma & Bennett, 2015), it is not unreasonable to understand why those individuals may be more prone to depressive tendencies. Higher depression scores also were related with higher neuroticism scores. Since neuroticism is emotional instability, it is not surprising at all that the two are related. It was surprising that depression and tobacco use were connected specifically, and not with alcohol or marijuana.

Heavy alcohol-use compared with no/little use contributes to more prospective memory failures (Ling et al., 2003; Griffiths et al., 2012). Considering the small sample size, the results of the current study could be seen as inconclusive. This variance could also be attributed to the differences between samples between the different studies. The current study's participants, being largely college freshmen, may not have consumed as much or at the levels of participants in other studies.

Chronic cannabis use is associated with prospective memory errors relative to little/no use (Cuttler et al., 2012). In the current study, cannabis use was not related to prospective memory performance. One limitation of the study was that it was difficult to find individuals who only used cannabis and no other substances. Therefore it is hard to conclude what effects cannabis use alone contributed to prospective memory performance in the current sample of college students. It was also difficult to classify the drug use pattern of each individual, as there were many different combinations of drug use. With such a small sample, it was not possible to conclude the contribution of different drug combinations to prospective memory performance.

Another limitation of this study was possible motivation dilemmas. Specifically, the participant pool came from an introductory psychology course where the students may not have cared to thoroughly answer the questions and/or try their best. It would have been beneficial to add some sort of motivation measure to assess the individual's desire to do their best. Lastly, it

would have been interesting to ask more specific questions regarding drug use, such as if they had used any substance within the last 24 hours and/or last year, instead of just asking about the last 30 days. This would allow a more comprehensive picture of overall drug use and current state when coming in for testing. Future research examining the influence of drug use on prospective memory performance should consider classifying different combinations of drug use within a larger sample to obtain a more comprehensive portrayal of how drug use impacts cognitive performance in college students.

Despite the limitations of the current study, there were many strengths and important implications as well. By understanding that college students who are depressed are more likely to use tobacco, specific intervention strategies can be developed and employed. There is high drug use on a college campus, most commonly alcohol with 44% of college students' binge drinking every two weeks and 19% having three or more binge drink nights a week (Heffernan, 2008). Students should understand the full effect these drugs may or may not have on them. In some cases, this is the first place someone may experiment with different drugs. The university, in particular advisors, college counselors and resident assistants, can use this information and past research to inform incoming students regarding the ramifications of drug use for their future.

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Appendix A

Demographic Questionnaire

Assigned ID #_____

Gender (Circle One): M F Other_____

Age: _____

Race (Circle One):

Caucasian/White African American/Black Hispanic Asian/Pacific Islander Multiracial Other_____

Year in School (Circle One): Freshman Sophomore Junior Senior

Major: _____ or Undecided

Overall GPA _____

Major GPA _____

ACT Score _____

Are you employed? Y N

Do you live on-campus? Y N

Are you involved in a fraternity or sorority? Y N

Appendix B

Alcohol and Drug Survey **Assigned ID #_____**

The following questions ask about your history of drug and alcohol use. Please remember that this survey is completely confidential, so it is important to be as honest and accurate as possible. Please answer directly on this form.

1. A drink is defined as a bottle of beer, a glass of wine, a wine cooler, a shot glass of liquor, or a mixed drink. How many drinks, on average, do you consume in a week?

   _____

2. Think back over the last two weeks. How many times have you had five or more drinks at a sitting? _____

At what age did you first use:

3. Caffeine (coffee, tea, soda, energy drinks) _____
4. Tobacco (smoke, chew, snuff) _____
5. Alcohol (beer, wine, liquor) *other than a few sips _____
6. Marijuana (pot, hash, hash oil) _____
7. Cocaine (crack, rock, freebase) _____
8. Amphetamines (diet pills, speed) _____
9. Sedatives (downers, ludes) _____
10. Hallucinogens (LSD, PCP) _____
11. Opiates (heroin, smack, horse) _____
12. Inhalants (glue, solvents, gas) _____
13. Designer drugs (ecstasy, MDMA) _____
14. Steroids _____

15. Other illegal drugs _____

During the past 30 days, on how many days did you have:

1. Tobacco (smoke, chew, snuff) _____
2. Alcohol (beer, wine, liquor) *other than a few sips _____
3. Marijuana (pot, hash, hash oil) _____
4. Cocaine (crack, rock, freebase) _____
5. Amphetamines (diet pills, speed) _____
6. Sedatives (downers, ludes) _____
7. Hallucinogens (LSD, PCP) _____
8. Opiates (heroin, smack, horse) _____
9. Inhalants (glue, solvents, gas) _____
10. Designer drugs (ecstasy, MDMA) _____
11. Steroids _____
12. Other illegal drugs _____

Where have you used: (Mark all that apply)

13. Caffeine (coffee, tea, soda, energy drinks)

____ Never used	____ Where you live
____ During a creative activity	____ In a car
____ Private parties	____ Other
____ On campus events	____ Residence hall
____ Frat/sorority	____ Bar/restaurant

14. Tobacco (smoke, chew, snuff)

____ Never used	____ Where you live

____ During a creative activity ____ In a car

____ Private parties ____ Other

____ On campus events ____ Residence hall

____ Frat/sorority ____ Bar/restaurant

15. Alcohol (beer, wine, liquor) *other than a few sips

____ Never used ____ Where you live

____ During a creative activity ____ In a car

____ Private parties ____ Other

____ On campus events ____ Residence hall

____ Frat/sorority ____ Bar/restaurant

16. Marijuana (pot, hash, hash oil)

____ Never used ____ Where you live

____ During a creative activity ____ In a car

____ Private parties ____ Other

____ On campus events ____ Residence hall

____ Frat/sorority ____ Bar/restaurant

17. Cocaine (crack, rock, freebase)

____ Never used ____ Where you live

____ During a creative activity ____ In a car

____ Private parties ____ Other

____ On campus events ____ Residence hall

____ Frat/sorority ____ Bar/restaurant

18. Amphetamines (diet pills, speed)

____ Never used ____ Where you live

____ During a creative activity ____ In a car

____ Private parties ____ Other

____ On campus events ____ Residence hall

____ Frat/sorority ____ Bar/restaurant

19. Sedatives (downers, ludes)

____ Never used ____ Where you live

____ During a creative activity ____ In a car

____ Private parties ____ Other

____ On campus events ____ Residence hall

____ Frat/sorority ____ Bar/restaurant

20. Hallucinogens (LSD, PCP)

____ Never used ____ Where you live

____ During a creative activity ____ In a car

____ Private parties ____ Other

____ On campus events ____ Residence hall

____ Frat/sorority ____ Bar/restaurant

21. Opiates (heroin, smack, horse)

____ Never used ____ Where you live

____ During a creative activity ____ In a car

____ Private parties ____ Other

____ On campus events ____ Residence hall

____ Frat/sorority ____ Bar/restaurant

22. Inhalants (glue, solvents, gas)

____ Never used
____ During a creative activity
____ Private parties
____ On campus events
____ Frat/sorority
____ Where you live
____ In a car
____ Other
____ Residence hall
____ Bar/restaurant

23. Designer drugs (ecstasy, MDMA)

____ Never used
____ During a creative activity
____ Private parties
____ On campus events
____ Frat/sorority
____ Where you live
____ In a car
____ Other
____ Residence hall
____ Bar/restaurant

24. Steroids

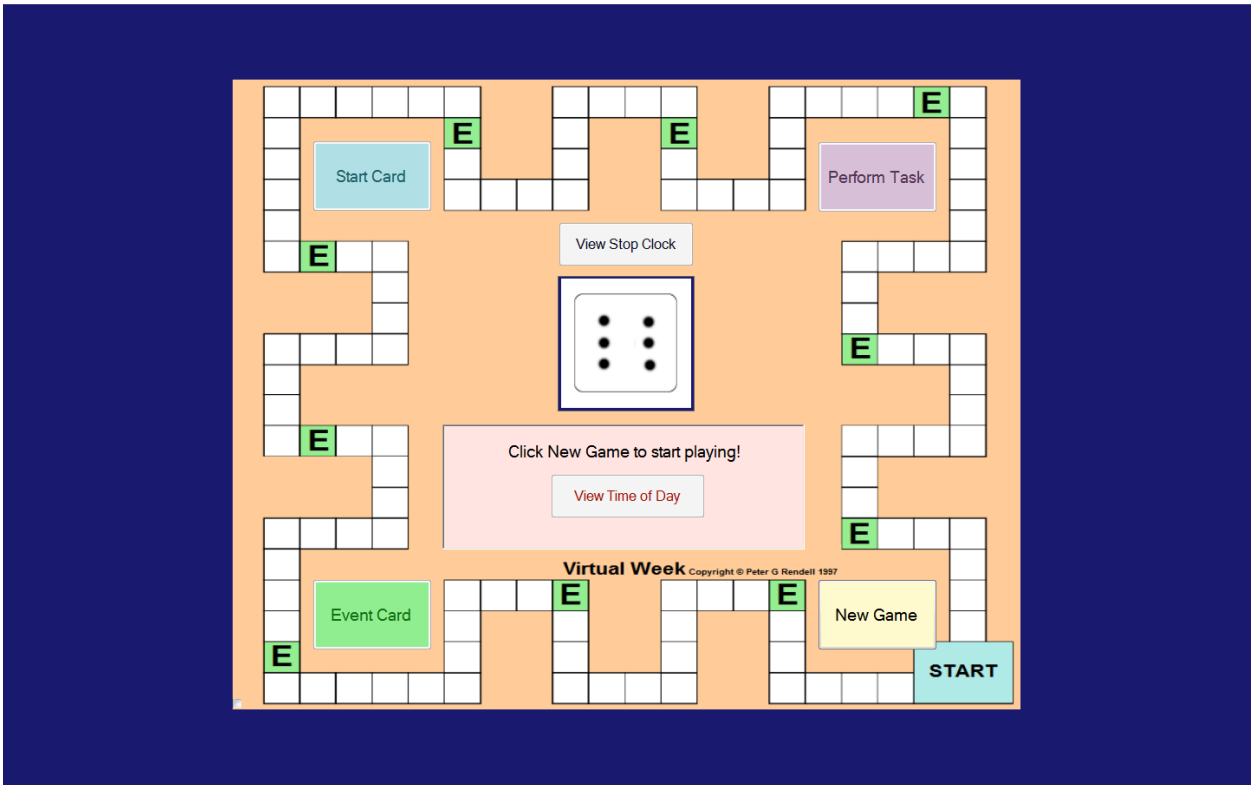
____ Never used
____ During a creative activity
____ Private parties
____ On campus events
____ Frat/sorority
____ Where you live
____ In a car
____ Other
____ Residence hall
____ Bar/restaurant

25. Other illegal drugs

____ Never used
____ During a creative activity
____ Private parties
____ On campus events
____ Where you live
____ In a car
____ Other
____ Residence hall

____ Frat/sorority ____ Bar/restaurant

Appendix C



Virtual Week Task (Rendell & Craik, 2000)