9-13-2018

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Daniel Pillersdorf
University of Windsor

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By

Daniel A. A. Pillersdorf

A Thesis
Submitted to the Faculty of Graduate Studies
through the Department of Psychology
in Partial Fulfillment of the Requirements for
the Degree of Master of Arts
at the University of Windsor

Windsor, Ontario, Canada

2018

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by

Daniel A. A. Pillersdorf

APPROVED BY:

_____

D. Stanley
Faculty of Education

_____

D. Ledgerwood
Department of Psychology

_____

A. Scoboria, Advisor
Department of Psychology

August 27, 2018

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ABSTRACT

While the association between cannabis use and verbal and working memory impairment is well documented, the relationships between cannabis use and autobiographical memory are less understood. This study investigated the relationship between cannabis use and two phenomenon associated with autobiographical memory: the fading affect bias (FAB) and memory specificity. The FAB occurs when the intensity of affect associated with negative memories fades faster than the intensity of affect associated with positive memories. Memory specificity refers to the level of detail with which an event is recalled (with more details signifying more specificity). Few studies have examined the relationships between substance use and memory specificity or the FAB. Cannabis using (N = 47) and non-using (N = 52) participants recalled positive and negative autobiographical events, which they rated on affect intensity at the time of the original event and currently. Participants also recalled additional autobiographical memories using a free-recall procedure, which were coded for specificity. The affect of unpleasant events for cannabis users faded significantly less than for non-users, and memory specificity was lower in cannabis users compared to non-users.

Keywords: cannabis, autobiographical memory, specificity, fading affect bias

ACKNOWLEDGEMENTS

I would like to thank all the undergraduate students who devoted their time to help me carry out this thesis project. Specifically, Elizabeth Harvey, Misbah Noor, Rachel Hicks, and Matt Levang ran most of the participants through this study and I would not have been able to collect enough data, given the time constraints, without them.

Thank you to my supervisor, Dr. Alan Scoboria, for the ongoing support and advice through all stages of this thesis project. I was especially appreciative of your patience when deadlines drew near. I would also like to thank my committee members, Dr. David Ledgerwood and Dr. Darren Stanley, for their interest in my project, for asking challenging questions, and for providing helpful feedback.

I would like to extend my sincerest gratitude to my wife, family, and friends for their ongoing support over the past two years. I thank my partner, Jenna, for her unwavering emotional support throughout this project. I will forever be grateful to my father, Sam, my sister, Sarah, and my brother, Ben, for always showing interest in my research and checking in with me often to make sure that I was doing well. Lastly, I want to thank my friends, Jann MacIsaac and Derrick Biso, for their ongoing support and encouragement throughout the making of this thesis document.

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CHAPTER I

Introduction

Williams, Conway, and Cohen (2008) proposed that remembering past autobiographical events is adaptive because the emotion associated with an event can be regulated through memory recall, making it easier to cope with negative events and to develop emotional resilience. An area of the brain called the amygdala contributes to tagging personal episodic memories with appropriate emotional cues (Markowitsch & Staniloiu, 2011). By charging events with emotional significance, successful searching and reactivation of certain memories of our personal histories becomes more likely. Indeed, events that are emotionally charged are generally better remembered than less emotional events. Further, pleasant emotions associated with past autobiographical events fade more slowly than do negative emotions (Walker & Skowronski, 2009), which suggests that the qualities of positively and negatively recalled events are not equivalent.

Substance use is one among many factors that is known to impair basic memory processes. For example, alcohol consumption has been found to impair episodic encoding (Soderlund, Parker, Shwartz & Tulving, 2005). Consumers of alcohol may experience a *blackout*, an encoding problem where the activity of neurons in memory areas of the brain become suppressed (Lee, Roh & Kim, 2009) and the ability to form new episodic memories is impaired. Furthermore, both cocaine (Muriach et al., 2010;) and heroin use (Mitrovic, Dickov, Vuckovic, Mitrovic & Budisa, 2011) have been associated with memory impairment. Compared to individuals who do not use these substances, users of cocaine and heroin have been found to have greater difficulty in successfully completing verbal and working memory tasks (Mittenberg

& Motta, 1993; Ornstein, Iddon & Balacchino, 2000; Vonmoos et al., 2014; Wang et al., 2008; Yan et al., 2014).

Cannabis is the most commonly used illicit substance in Canada (Health-Canada, 2014) and in the USA (SAMSHA, 2016a). Schoeler and Bhattacharyya (2013) highlight that cannabis use is associated with verbal and working memory impairments. However, few studies have explored the relationship between cannabis consumption and autobiographical memory. According to the National Institute on Drug Abuse (NIDA; 2018) cannabis use causes verbal and working memory problems (Auer et al., 2016) because the drug's active ingredient, delta-9-tetra-hydrocannabinol (THC), modifies how the brain's hippocampus processes information. Typically as individuals age, the rate of neurogenesis in the hippocampus slows (Yang et al., 2015) and the ability to learn new information decreases (NIDA, 2018). The typical reduction in neurogenesis due to aging may be intensified and accelerated by chronic cannabis use (NIDA, 2018).

Riedel and Davies (2005) note that research examining cannabis use and memory are often hampered by small sample sizes and confounding use of other substances. While the studies that they review are consistent in associating cannabis with deficits in working memory, further research is required to gain a better understanding of the effects of cannabis consumption on autobiographical memory processes. In this study, the relationship between two phenomena associated with autobiographical memory, the Fading Affect Bias (FAB) and overgeneral memory (OGM) and their respective relationships with cannabis use, are explored.

Autobiographical Memory (AM)

Definition of AM. AM refers to the database of knowledge one holds about oneself and encompasses recollections of specific and personal events (Holland & Kensinger, 2010). The definition of AM has been influenced by Tulving's (1972, 1983) proposed division of semantic and episodic memory systems, which has been used to conceptually divide AM into personal semantic and personal episodic memory (Holland & Kensinger, 2010). Personal semantic memory includes recalling and knowing facts about oneself, such as what one enjoys eating or knowing where one was born. This type of memory does not depend on recalling specific events; rather semantic AM involves knowledge of facts about oneself. Tulving (1972) coined the term "episodic memory" to encourage the differentiation between knowing (which is more semantic) and remembering (episodic). Recalling personal episodic memories involves remembering unique events, such as one's first day at a new job. The retrieval of personal episodic information involves recollecting and re-experiencing specific past events (Holland & Kensinger, 2010). Tulving (1984) outlined three components of episodic memory recollection. These properties include having a subjective sense of time, having a connection to oneself, and having an associated autonoetic consciousness (AC). AC refers to the ability to mentally place oneself in the past or future and examine one's own thoughts about the past or future and how these imagined experiences may affect or define oneself. Relatedly, memory for specific episodic events can trigger episodic learning (Baars & Gage, 2007). For instance, developing a fear of cats after being scratched by a cat is a result of episodic learning.

Functionality of AM. AMs are often intentionally recalled, reflected on, and shared with others to aid individuals in daily functioning. Bluck et al. (2005) suggested that AMs have practical utility in the self, social, and directive domains. AM has been theorized to serve as a

foundation in maintaining the continuity of self (Bluck & Levine, 1998). Indeed, possessing knowledge of one's past and projecting personal details into the future has been viewed as an important type of self-knowledge (Neisser, 1988). The quality of autobiographical knowledge is contingent on its capability to promote self-continuity (Conway, 1996). In maintaining a coherent sense of self over time, Conway (2005) proposed that personal recollections are consistent with an individual's self-beliefs and goals. Life events are selectively encoded into memory, depending on one's goals and currently experienced themes (Conway, 1996; Conway & Rubin, 1993). The connection between the self and AM forms a coherent system where beliefs and knowledge about the self are confirmed by recollection of specific personal events.

The value of AM in the development and upkeep of social bonds has been frequently discussed (Bluck, 2003; Pillemer, 1998; Nelson, 1993). Autobiographic recollections provide material that is frequently used in conversations between individuals (Bluck et al., 2005). Pillemer (1992) noted that augmenting a conversation with a recount of a personal memory can make one's assertions more credible and persuasive. Moreover, those who provide others with personal semantic information are more likely to initiate new social relationships (Cohen, 1998). Information about one's self can also be provided when personal episodic memories are shared with individuals who were not present at the described event. Sharing episodic memories with others who were present at the event can encourage deeper intimacy between speakers and listeners (Fivush, Haden & Reese, 1996) and maintain and strengthen relationships (Hyman & Faries, 1992). Hearing about others' AMs may also encourage the listeners to be more empathic towards others (Cohen, 1998), especially if the speaker elicits a memory of a similar experience (Bluck et al., 2005).

AMs can also be used as models for appropriate present or future behavior and can provide direction for successful problem solving or adaption (Pillemer, 2003). Abelson (1981) outlined that general expectations or scripts, which develop across experiences that are repeated, direct behavior. When unique situations arise, in which established scripts apply less directly, the direction that memories for specific events provide can be vital for successful navigation of the present environment (Pillemer, 2003). For example, a storeowner, who typically has positive interactions with his customers, may think back to how he or she behaved in a past job as a customer service representative, when attempting to satisfy a frustrated shopper. The retrieval and evaluation of AMs grants the ability to pose new questions of old information in order to contemplate and solve problems in the present, predict future events, and plan future behavior (Baddeley, 1987).

AM Retrieval. Hauer (2008) outlines two ways memories are retrieved. Note that while not always so, both modes can lead to retrieval of the same autobiographical event. *Direct retrieval* is a bottom-up process where a retrieval cue directly maps onto a specific episodic memory. A retrieval cue is a stimulus that assists in retrieving a particular item (or event) from memory. *Direct retrieval* can be described as automatic or spontaneous recollecting and does not require much attention or effort (Hauer, 2008). Hauer provides an example of pouring an espresso and being immediately reminded of time spent in the San Marco Square in Venice, where the smell of espresso was pungent (in this example, the retrieval cue was the act of pouring and smelling the espresso). Direct retrieval may or may not be related to an individual's active goals (Hauer, 2008). Conversely, *generative retrieval* is theorized to be a top-down process, which requires the deliberate search for cues in order to retrieve specific memories. For example, when discussing past vacations with an acquaintance, one might actively search for

cues linked to a vacation in Venice, resulting in retrieval of the same memory of the San Marco Square. Thus, generative retrieval activity is often theorized to be more consistent with currently active goals.

One prominent AM recall model is Conway and Pleydell-Pearce's (2000) Self-memory System (SMS), proposes that autobiographical knowledge is organized hierarchically, based on the level of specificity of memory. The most general levels are *lifetime periods*. According to the model, this level of AM identifies distinct periods of one's life with recognizable beginning and endings, for example, *when I was in college, when I lived with person X,* or *when the children were little.* Lifetime periods contain general knowledge of plans, goals, activities, locations, and social relationships that characterize a given time period (Conway & Pleydell-Pearce, 2000). It is noteworthy, that within a given period of time there can be multiple lifetime periods, for example, *when I lived with person X* may overlap with *when I was in college.* Additionally, lifetime periods can be grouped thematically to form higher order themes, such as a work or relationship theme (Conway, 1992).

General events are the second and intermediate level of AM recall and are more specific than lifetime periods (Conway & Pleydell-Pearce, 2000). Repeated events, such as *every Thanksgiving,* and single events, such as *going on a picnic,* are included in this category (Barsalou, 1988). General event memories cluster together based on theme. When general events are activated in memory, related specific events are also cued and recalled (Conway & Pleydell-Pearce, 2000). Groupings of events tend to cluster around themes of achievement, failure, and personal goals (Conway & Pleydell-Pearce, 2000). Event-specific knowledge (*ESK)* is the third and most detailed stage of self-memory, and describes vivid information about a specific event (Conway & Pleydell-Pearce, 2000). ESK includes the sensory and perceptual details associated

with events (Holland & Kensinger, 2010). For instance, on a specific picnic outing, one may remember the tastes of the food and the spatial layout of the items placed on the blanket. When an individual is cued to recall a memory, mental search begins at the more *general events* level and through elaborative retrieval, becomes more specific to access more detailed information (Conway & Pleydell-Pearce, 2000).

AM Specificity. As outlined above, AM retrieval can vary in the level in which details are recalled. How individuals are prompted to remember events affects the level of specificity of retrieved material. Barsalou (1988) asked students to remember events from the most recent summer in a series of studies and found that of students asked to engage in free recall, 21% retrieved specific memories, whereas 40% of students who were cued to remember events retrieved specific memories. AM recall can also be more specific when it is explicitly requested that recall be more detailed. Raes, Hermans, Williams, and Eelen (2007) found that when participants were specifically instructed to retrieve specific memories, just 12% provided overgeneral responses, compared to an average of 36% of overgeneral answers in a control group, who were instructed to recall and describe their memories as they pleased.

Moreover, as Tulving and Thomson (1973) suggest, the recall of memories is most effective when the conditions at the time of encoding a memory match the conditions at the time of retrieval. Termed the *encoding specificity principle* (ESP), Tulving and Thomson argued that in addition to using a specific memory cue in retrieving a memory (cue that is often semantically related to the information being remembered), one also uses contextual cues from the environment at the time that memories are retrieved. For instance, according to this principle, a student's knowledge about a given school subject will be more accurately recalled if the student

is cued to retrieve the course material in the same classroom that the material was learned, compared to the recall of material in a different classroom.

Overgeneral Autobiographical Memory. Certain individuals are more likely to recall events at a general rather than specific level on average. This is termed overgeneral memory (OGM) (Holland & Kensinger, 2010; Williams et al., 2007). As noted previously in the SMS model, memory retrieval sometimes commences at the *general events* level and moves down the hierarchy to more specific memories. Past studies have shown that individuals suffering from dysphoria or clinical levels of depression (Brewin, Reynolds & Tata, 1999; Watkins & Teasdale, 2001; Williams & Broadbent, 1986) tend to recall autobiographical memories in less detail and are prone to recall more repeated or categorical memories, compared to non-depressed individuals (Holland and Kensinger, 2010). A proposed mechanism for this OGM effect is called functional avoidance, or the idea that searching for aspects of AM at a general level of specificity allows individuals to avoid reexperiencing negative or uncomfortable details (Williams et al., 2007). A review by Williams et al. (2007) corroborated this idea. Individuals who reported more avoidance behavior provided less specific responses on an AM cue word task. When asked to retrieve autobiographical memories, many individuals who exhibit symptoms of depression or suicidality tend to summarize categories of events rather than retrieve single memory episodes (Williams et al., 2007). For example, when a person who exhibits OGM is asked to remember a happy event, the individual may say, “When I was on vacation last month” (Sumner, Griffith, & Mineka, 2010), instead of remembering a more specific incident, such as, “When I defended my master’s thesis.” OGM has been implicated as a predictor of the course of depression, (Sumner, et al., 2010), and has also been associated with post-traumatic stress disorder (PTSD) (Dalgleish, Rolfe, Golden, Dunn & Barnard, 2008; Schönfeld, Ehlers, Böllinghaus & Rief, 2007; Sutherland

& Bryant, 2008) and eating disorders (Ball, Singer, Kemps & Tiggemann, 2010; Dalgleish et al., 2003).

OGM has additionally been associated with several functional deficits. In a study with para-suicidal patients, Evans, Williams, O'Loughlin and Howells (1992) found that these individuals provided less effective problem-solving strategies than a matched control group and that low effectiveness in problem solving was associated with OGM. OGM has also been associated with difficulties in interpersonal and everyday problem solving (Sutherland and Bryant, 2008; Raes et al., 2005), rumination, (Sumner, 2012) and difficulty in imagining future events (Williams et al., 1996). Peeters, Wessel, Merckelbach and Boon-Vermeeren (2002) found that OGM was associated with delayed recovery from affective disorder episodes. Given the extant literature on the association of OGM with psychopathology, it is important to more thoroughly understand the underlying causes of this memory recall tendency in order to better address the prevention and treatment of the emotional disorders with which it is associated. For example, treatments designed to target the specificity of memory retrieval are showing promise in treating mood disorders. Neshat-Doost et al. (2013) found that adolescents with depressive symptoms, who received memory specificity training over time, were able to recall a higher proportion of specific memories at follow up and reported lower levels of depression than comparable adolescents who did not receive such training. Similar findings have been found in adults with depressive symptomatology (Raes, Williams, & Hermans, 2009) and found in adults with PTSD (Moradi et al., 2014).

Autobiographical Memory and Cannabis Use. Few studies have examined potential links between cannabis use and AM. Mercuri et al. (2018) employed an adapted version of Levine et al.'s (2002) Autobiographical Interview (AI), where participants describe

autobiographical events from their past or a future event in response to cue words (Mercuri et al., 2018). Using a nonclinical sample, the authors found that regular cannabis users recalled less episodic details than both recreational users and non-users, when asked to recall past events. Gandolphe and Nandrino (2011) administered the autobiographical memory test (AMT) to 51 cannabis users and found that for both positive and negative autobiographical memories, specificity became more general as the frequency of reported cannabis use increased.

While the AMT has been widely used in research involving clinical populations, some evidence suggests that this test is not sufficiently sensitive to measure OGM in non-clinical populations (Raes et al., 2007). Anderson, Boland, and Garner (2016) highlight that nonclinical samples (relative to depression) may be able to overcome the tendency to think in overgeneral terms because of the more complex instruction given during AM cue word tasks (such as the AMT) and the repeated directive to provide specific events. Consequently, more sensitive measures of AM specificity have been developed for use with general, non-clinical populations (Raes, Watkins, Williams & Hermans, 2008; Raes et al., 2007). Given that cued-recall procedures (the AMT and AI) were used to measure OGM in these studies, and significantly different memory specificity results have been found when a cued-recall procedure is used compared to when a free-recall procedure is used (Barsalou, 1988, Raes et al., 2007), further investigation is needed that uses free-recall measures with non-clinical samples, to gain a deeper understanding of the effect of cannabis use on AM specificity.

Other research has not completely separated cannabis use from other substance use when measuring how drug consumption is related to autobiographical memory recall in substance using clinical populations (Oliveira, Scheuer & Scivoletto, 2007). The small body of research that speaks to substance use and AM suggests that substance users, including consumers of

cannabis, have more difficulty in remembering AMs than non-users. Cannabis use is also associated with impairments in verbal and working memory (Schoeler & Bhattacharyya, 2013) as well as executive functioning (Crean et al., 2011), processes that are also involved in AM (Piolino et al., 2010). Based on these studies, there is reason to believe that cannabis use affects AM.

Autobiographical Memory and Emotion. This review has offered evidence that memory and emotion are not mutually exclusive. Similar to the encoding specificity principle, memories associated with a specific emotion will be more accurately remembered in moods that correspond to the emotion produced by these memories (Lewis & Critchely, 2003). For example, happy individuals recall more details of memories that are congruent with their mood, while unhappy individuals demonstrate specificity for memories of negative emotional valence (Leoffler, Myrtek & Peper, 2013; Mayer, McCormick & Strong, 1995). Ergo, individuals suffering from depression or dysphoria remember unpleasant events in greater detail than pleasant events (Reynolds & Salkovsiks, 1992), while those without these conditions tend to better recall autobiographical events deemed pleasant rather than events deemed unpleasant (Walker, Vogl, & Thompson, 1997).

The Fading Affect Bias (FAB)

Based on the interactions between memory and emotion discussed above, the literature would suggest that it would be adaptive to have the ability to suppress longer lasting negative affect associated with past personal memories. The *fading affect bias* (Walker & Skowronski, 2009) is a psychological mechanism that is proposed to encourage the tendency for individuals to better recall pleasant rather than unpleasant memories. The FAB is defined as a phenomenon

where the intensity of affect associated with negative AMs fades faster than affect associated with positive AMs (Walker et al., 1997) (see Appendix A for graphical representation). A prominent interpretation of the FAB is that it functions as a type of psychological immune system (Walker, Skowronski, Gibbons, Vogl & Thompson, 2003). The relatively larger volume of negative emotion that fades over time, compared to positive emotions associated with AMs, fosters a general perception that life is more pleasant than unpleasant. Walker and Skowronski (2009) highlight that this bias encourages the construction of positive and meaningful life narratives and note that the FAB reduces the cognitive burden of re-experiencing the negative emotions associated with memories when they are retrieved. In summary, the FAB is a normative aspect of AM processing which supports the regulation of emotion, aids in maintaining positive self-conceptions, and promotes a hopeful outlook about the future (Walker & Skowronski, 2009).

Cason (1932) was the first to describe the FAB. Participants recalled past events and rated their level of emotion at the time of the event and at the time of recall. Cason's findings suggested that positive emotions associated with memories maintained their level of intensity across time more than negative emotions associated with memories. A criticism of their study is that due to the retrospective assessment of emotion, retrospective biases could have explained the FAB-consistent findings. However, as Walker and Skowronski (2009) assert, such biases do not explain the FAB. Results from several non-retrospective studies support the FAB as a robust phenomenon (Walker & Skowronski, 2009). Homes (1970) asked 26 participants to record events in a diary for a week and to rate the intensity of emotion of each event. Subsequently, participants were asked to recall and provide a current rating of emotional intensity for each event. Homes found that negative emotions prompted by unpleasant events faded more over time

than did positive emotions prompted by pleasant events. Walker et al. (1997) replicated these findings using a similar diary procedure, testing participants after three and a half months, one year, and three years. Results confirmed the FAB: Emotion associated with unpleasant events faded more over time than affect associated with pleasant events. Additionally, they found that the longer the time interval between the initial and second affect rating of the event, the larger the decrease in affect ratings. By using a larger sample and measuring the FAB over longer periods of time, Walker et al.'s study provided further evidence for the existence of the FAB and its trend across time. Their findings provide evidence that the FAB is not a reflection of the forgetting of events. Memory ratings for pleasant and unpleasant events did not significantly differ. The intensity of emotion at event recall was the best predictor of how well participants remembered past events. This suggests that the FAB is a reproduction of better recall for the affect associated with positive rather than negative events.

Subsequent research examining the FAB has used either diary procedures (Ferguson, 2003; Ritchie et al., 2014; Ritchie & Skowronski, 2008) or retrospective recall procedures (Gibbons et al., 2015; Muir, Brown & Madill, 2015; Walker et al., 2003), where participants are prompted to recall an event and provide a rating of pleasantness at the time that the event occurred and a current pleasantness rating of the recalled event. Other research has used both procedures in the same body of work (Walker, Yancu & Skowronski, 2014). This literature suggests that both methodological approaches to measuring the FAB converge to produce similar patterns of findings that support the view that the FAB is a genuine phenomenon that is not an artifact of the methods of measurement. Further, while the FAB has been most robustly demonstrated using samples of Caucasian undergraduate students (Walker et al. 1997), additional research indicates that the FAB is an emotional regulation mechanism that is present

in individuals across a variety of cultures (Bond et al., 2016; Ferguson, 2003; Ritchie et al., 2015).

Mood Affects the FAB. Walker et al. (2003) studied the FAB in individuals with dysphoria and found that the fading of affect associated with pleasant and unpleasant AMs did not significantly differ (see Appendix B for a conceptual representation). They also reported that higher levels of dysphoria were associated with increased fading of positive affect and reduced fading of negative affect, compared to those with lower levels of dysphoria.

Walker et al. (2014) examined the relationship between high trait anxiety and the FAB over three studies. Results showed a substantial FAB in individuals with low anxiety and a weaker FAB in individuals with high anxiety. Specifically, higher levels of anxiety were associated with less affect fading for when recalling either positive or negative recalled events. Walker et al. theorized that higher levels of anxiety might produce a heightened sense of arousal, which intensifies the emotion experienced at the time of recall, resulting in highly anxious individuals reporting less affect fading than those with less anxiety across time.

Substance Use Affects the FAB. Two existing studies suggest that substance use may disrupt the FAB. In a study that assessed the FAB when recalling emotionally arousing dreams, Ritchie and Skowronski (2008) did not observe a FAB pattern for individuals who reported consuming alcohol or other recreational drugs prior to the dream, which mimics the dysphoric FAB pattern found by Walker et al. (2003). However, Ritchie and Skowronski used only one item that asked about general drug use, hence the potential impact of use of any specific substance could not be determined. Gibbons et al. (2013) examined whether alcohol consumption was associated with changes in the FAB and found that high levels of alcohol use was associated with a larger FAB for memories of events involving alcohol. The authors also

found that for ordinary memories, high levels of alcohol use was associated with less affect fading for unpleasant events. The study measured participant alcohol consumption using a modified version of the National Institute on Alcohol Abuse and Alcoholism Quantity and Frequency Questionnaire (NIAAA, 2005), allowing for a more valid measure substance use and its association with the FAB, compared to the earlier work by Ritchie and Skowronski (2008).

Rationale for the Present Study

As discussed above, a limited number of studies have examined the effects of cannabis use on AM recall and a portion of this literature is confounded due to cannabis being grouped with other drugs. While cannabis use has been associated with difficulties in managing and regulating emotions within the context of emotional intelligence (Claros & Sharma, 2012), no study has examined the relationship between the FAB and cannabis consumption. This is surprising when one considers how cannabis is the most commonly used illicit substance in Canada (Health-Canada, 2014) and in the USA (SAMSHA, 2016a). According to the National Epidemiological Survey on Alcohol and Related Conditions, self-reported past-year use has more than doubled, from 4% to 9.5%, between 2001 and 2013 (Ghose, 2015), and rose to 33% among individuals aged 18-25 and to 11% among individuals aged 26 or older, in 2016 (NIDA, 2018). Furthermore, cannabis will be recreationally legalized in Canada in 2018 (Tasker, 2018). Since the impact of cannabis use on AM recall specificity in non-clinical populations necessitates further study, the influence of cannabis use on the FAB is unknown, and the legalization of cannabis is within the foreseeable future, gaining a more thorough understanding of the effects of cannabis on these aspects of memory is warranted.

As a comparison, when cannabis was recreationally legalized in Colorado, reported past month cannabis use among adults increased by 63% compared to reported use two years before cannabis became legalized (SAMHSA, 2016b). National adult past month cannabis use increased by 21% during the same time period (SAMSA, 2016b). If a similar increase in cannabis use is observed in Canada, a greater portion of the population may experience disruptions in aspects of memory due to cannabis use, than if cannabis was not legalized. Possessing a deeper understanding of the emotional and autobiographical memory impairments caused by cannabis use may position healthcare professionals to better prevent and treat these memory problems. Additionally, a better grasp of how AM is influenced by cannabis use can aid policy makers in creating regulations that might limit potential increases in this drug usage.

Purpose and Hypotheses

The purpose of the present study was two-fold. First, the study sought to determine whether AM specificity in cannabis users was significantly different than AM specificity of non-users. For the purposes of this study, cannabis use was defined as the consumption of cannabis by means of smoking. Secondly, the study examined whether cannabis use was associated with differences in the FAB.

Given that the level of specificity of AMs in cannabis users has been found to be more general than the specificity of AMs in control subjects in two past studies (Mercuri et al., 2018; Gandolphe & Nandrino, 2011), it was hypothesized that this finding would be replicated in the current study.

Furthermore, based on the current literature, it was predicted that cannabis use would be associated with an increased risk for the development of depression (Lev-Ran et al., 2014; Patton

et al., 2002), such that the drug's effect would mimic dysphoria's influence on the FAB (Appendix B), or produce a less pronounced difference between affect fading for pleasant events and affect fading for unpleasant events. A more modest FAB would play a role in explaining cannabis users' increased risk for developing depressive symptoms.

Additionally, an overarching hypothesis was made *a priori*, that a linear relationship would be found between cannabis use and AM specificity and cannabis use and the FAB. Higher levels of cannabis use are predicted to be associated with greater overgeneral memory recall and either a lack of a FAB or a significantly smaller FAB in cannabis users, compared to non-users.

CHAPTER II

Method

Participants

Samples used in prior studies of the FAB (Gibbons et al., 2013; Ritchie, Sedikides & Skowronski, 2016; Ritchie & Skowronksi, 2008; Walker et al., 2014; Walker et al., 2003) and AM specificity in cannabis users (Mercuri et al., 2018; Gandolphe & Nandrino, 2011; Oliveira et al., 2007) have ranged from 25 to 235 participants. Given the size of preceding effects, a minimum of 50 cannabis-using and 50 non-cannabis-using participants were sought to achieve sufficient statistical power.

The final sample included 100 university students (Mean age = 21.17, SD = 2.71, ranging from age 17 to age 31; 71% female, 18% male, 2% non-binary, 9% not specified); The majority of participants ethnically/racially self-identified as Caucasian (63%), Middle Eastern (9%), African-Canadian (3%), or did not specify (12%). The remaining 13% identified as Vietnamese, Italian, Asian, Bengalis, Arab, Aboriginal, Filipino, Ugandan, or Mauritian. The sample included

47 chronic cannabis users and 52 non-user controls (see Table 1 for means and standard deviations across study variables). One participant was excluded from the cannabis user group due to appearing to be under the influence of cannabis at the time of testing.

Recruitment. Students enrolled in the study through the University of Windsor Psychology Participant Pool. A screening question was included in the Participant pool, that asked all students who enrolled in the Pool, "How often do you smoke cannabis (within the past year)?" (anchored: "Never", "Not in the past year", "1-2 times a month", "3-4 times a month", "More than 4 times a month", or "Prefer not to answer"). The Participant Pool is able to trace responses back to the student who provided an answer. Thus, the screening item was intentionally general in nature, to limit the data regarding cannabis use that was associated with a student's identity. To keep track of cannabis-using and non-using participant enrollment, individuals who indicated that they had never smoked cannabis or smoked "1-2 times a month" were initially able to enroll in the study as non-users and individuals endorsing the use of cannabis "3-4 times a month" or more were initially able to enroll as users. Group membership was confirmed using responses on the CUDIT-R (described below). Chronic use was defined as smoking two to four times a month or more over the past year, consistent with definitions used in preceding research (e.g., Greenwood, Broyd, Croft, Todd, & Michie, 2014; Nicholls, Bruno, & Matthews, 2015; Norberg, Mackenzie, & Copeland, 2012). While this definition was set as the minimum requirement for inclusion in the cannabis-using group, a majority of the sample (55%) reported smoking cannabis four or more times a week over the past year. No subgroups were created within these 47 participants because no significant differences were found between differing levels of cannabis use frequency and the associated impacts on OGM and the FAB.

Exclusion criteria. Six participants were screened for potential exclusion due to memory problems related to traumatic brain injury. Given that there were no notable differences in the findings when these individuals were included or excluded, their data was retained.

Table 1

Means, Standard Deviations, and 95% Confidence Intervals of Cannabis Use, Alcohol Use, Depression, and Anxiety Measure Scores for Cannabis-Users an Non-Users

	Cannabis Users (N=47)			*Non-users (N=52)*		
Variable	*M*	*95% CI*	*SD*	*M*	*95% CI*	*SD*
Cannabis Use (CUDIT)	*13.36*	*[11.45, 15.27]*	*6.49*	*1.15*	*[0.33, 1.97]*	*2.93*
Alcohol Use (AUDIT)	*6.85*	*[5.36, 8.34]*	*5.07*	*4.40*	*[3.02, 5.78]*	*4.94*
Depression (PHQ-9)	*9.40*	*[7.88, 10.92]*	*5.17*	*8.21*	*[6.66, 9,76]*	*5.57*
Anxiety (BAI)	*19.23*	*[15.32, 23.14]*	*13.31*	*15.25*	*[11.75, 18.75]*	*12.58*

Measures

Sentence Completion for Events from the Past (SCEPT) (Raes et al., 2007). The SCEPT is a sentence completion task designed to measure specificity of AM recall in non-clinical samples. The measure contains 11 non-valenced sentence stems, for example, *"Last year I..."*. Participants complete each sentence stem by describing a recalled event. The SCEPT has been shown to have good interrater agreement (87%, $K = .82$) and has been used in other studies measuring OGM in non-clinical populations (Anderson et al., 2016; Raes, et al., 2008).

After completing each stem, participants are asked to code the specificity of their responses by indicating whether each completed stem referred to a specific moment at a particular time, a repeated event or a category of similar events without specifying a particular time (e.g. playing with my grandmother when I was little), or an extended period of time. The SCEPT coding system is provided in Appendix C.

Subsequently, the PI and an independent rater coded the sentence stems (kappa = .91) as: Specific Memory, Categorical Memory, Extended Memory, or Omission. If it was unclear what code should be given, the code provided by the participant was included as the final categorization. The number of overgeneral sentence completions (repeated events, categories of events, and extended periods of time), comprised the OGM score for each participant.

Cannabis Use Disorder Identification Test – Revised (CUDIT-R) (Adamson et al., 2010). The CUDIT-R is an eight-item self-report questionnaire that measures cannabis use frequency, abuse, dependence, and other cannabis-related problems (See Appendix D). Items are answered on a 5-point likert scale, ranging from 0 (*Never)* to 4 (*Daily or almost daily)*. Scores range from 0 to 32 with 91.3% of test-takers with a recognized cannabis use disorder earning a score of 13 or above (Adamson et al., 2010). The test has high sensitivity (91%) and high

specificity (90%). The CUDIT-R was used because of its short length and ability to validly measure frequency of cannabis use.

Alcohol Use Disorder Identification Test (AUDIT) (Babor, De La Fuente, Saunders & Grant, 1992). The AUDIT is a 10-item self-report questionnaire that assesses alcohol consumption, drinking patterns, and alcohol-related issues (See Appendix E). Items are answered on a 5-point likert scale, ranging from 0 (*Never)* to 4 (*Daily or almost daily)*. Scores range from 0 to 40 with a score of eight or higher suggesting harmful alcohol use. Past research has shown that alcohol use is associated with deficits in AM recall (D'argembeau, Linden, Verbanck & Noël, 2006; Nandrino et al., 2016), hence measuring and controlling for drinking habits permitted controlling for alcohol use as a possible confound.

Patient Health Questionnaire (PHQ-9) (Kroenke, Spitzer & Williams, 2001). The PHQ-9 is a nine-item self-report questionnaire that measures the severity of depression (See Appendix F). Items are answered on a 0 to 3 point scale, with scores ranging from 0 to 27. The PHQ-9 is a brief and easily administered questionnaire that is consistent with the DSM definition of depression. The PHQ-9 was administered in order to control for depression as a potential confound.

Beck Anxiety Inventory (BAI) (Beck, Epstein, Brown & Steer, 1988). The BAI is a 21-item self-report questionnaire that measures the severity of anxiety (See Appendix G). BAI scores range from 0 to 63. Items are answered on a scale, ranging from 0 to 3. The BAI was administered in order to control for anxiety as a potential confound.

Demographic Form. This form (See Appendix H) included questions related to age, gender, race/ethnicity, past or current cannabis, cocaine, heroin, or ecstasy use, a general history

of substance use and addiction, presence or absence of withdrawal symptoms, and past or current memory problems due to various causes.

Procedure

On signing up for the study, all participants were asked to not be under the influence of any substance when completing the study. Participants completed a one-hour session during which they completed informed consent (Appendix I), following which they completed the measures in in the following order: Demographics, SCEPT, CUDIT-R, AUDIT, PHQ-9, BAI.

The FAB was measured using the procedure from Walker et al., (2003). Participants were asked to recall six emotionally intense memories (three pleasant, three unpleasant) that occurred over the past year (See Appendix J). The order in which participants recalled pleasant and unpleasant memories was determined by a dice roll. Participants were prompted to write a description of each memory and to include as many details as possible, for example specifying the time, location, and sensory details.

Participants then provided *initial affect* and *current affect* ratings for the six memories (See Appendix K). Both ratings were made on a 21-point scale ranging from *extremely unpleasant* (-10) to *extremely pleasant* (+10), with zero as a neutral marker of pleasantness. Initial affect was defined as memory for the affect associated at the time that the event occurred. Current affect was defined as the affect experienced at the time of recalling the event. As in Walker et al. (2003), participants were told that event pleasantness or unpleasantness may or may not change. Thereafter, students were debriefed. Participants received both a verbal description of the study from the researcher and a document to read that outlined the objectives of the study (Appendix L), and any questions were answered.

CHAPTER III

Results

Autobiographical Memory Specificity

As predicted, cannabis users provided a higher proportion of overgeneral memory responses on average compared to non-users (see Figure 1), $M_{diff} = 0.12$, [95% CI .06, .18], $d_{unb} = .85$ [.44, 1.27]. Controlling for depression, anxiety, and alcohol use did not alter this finding. Correlations between these covariates and OGM approximated zero. Severity of cannabis use correlated positively with OGM, r = .33 [.17, .49].

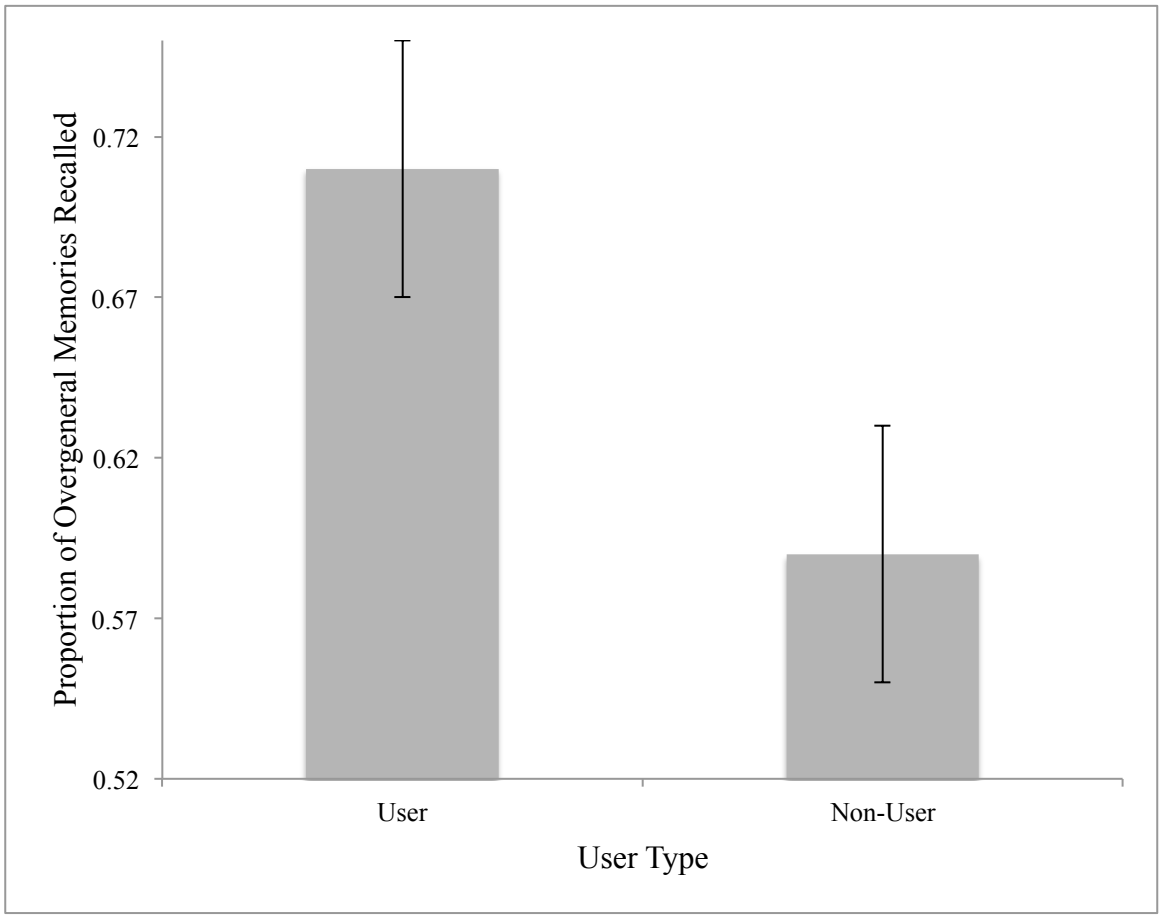

Figure 1. Mean Proportion of overgeneral memories recalled between cannabis users and non-users. Error bars depict 95% confidence intervals for mean proportion OGM recall values.

Fading Affect Bias (FAB)

To establish whether the FAB was present, the average initial affect intensity for events was compared to the average current affect intensity for events. Consistent with past research, a typical FAB pattern was found such that initial affect intensity (M = 7.77 [7.52, 8.01], SD = 1.21), was significantly greater than current affect intensity for the events (M = 6.62, [6.28, 6.95], SD = 1.69), M_{diff} = 1.15 [95% CI .90, 1.4], d_{unb} = .79 [.38,1.20]. With a typical FAB pattern present, it was possible to examine if cannabis use affected the FAB.

Missing Data. Two participants provided ratings for only two pleasant memories and a third participant provided only two unpleasant memories. For these participants, the average of the scores that they did provide were included in the analyses.

Assumptions of ANCOVA. Following the guidelines of Field (2013), independent samples t-tests were conducted to determine if the variables differed across the cannabis-using and non-using groups (assumption of independence between the covariate and IV). Both anxiety $t(97) = -1.53$, $p > .129$, 95% M_{diff} = -3.98 [95% CI -9.15, 1.18], and depression $t(97) = -1.10$, $p > .273$, 95% M_{diff} = -1.19 [95% CI -3.34, .96] did not significantly differ across groups. However, self-reported alcohol use differed across the groups, $t(97) = -2.43$, $p < .017$, Cohen's d = .49, 9 M_{diff} = -2.45 [95% CI -4.44, -.45], d_{unb} = .49 [.09, .89], such that cannabis-users (M =6.85 [5.36, 8.34], SD = 5.07), reported consuming more alcohol than non-users (M =4.40 [3.03, 5.78], SD = 4.94). Therefore, the alcohol use variable could not be included in the ANCOVA. The assumption of parallelism of the regression planes, assumes that the relationship between affect fading scores and each covariate (anxiety and depression) is the same in both cannabis-using and non-using groups. This assumption was checked using SPSS and was found to be met, F (2, 93) = 1.37, $p > .258$. The third assumption was that a linear relationship exists between the

dependent variable (affect fading) and each of the two covariates. This linear relationship applies in both the cannabis-using and non-using groups. Scatterplots of these relationships were reviewed and acceptable linear relationships were observed. The fourth assumption, that the covariates are measured without error, was likely violated because there is always some form of error in measurement in any variable. To minimize the potential for measurement error, measures with good reliability were used to measure depression (Kroenke et al., 2001) and anxiety (Beck et al., 1988) and the method of evaluating affect fading was based on previous research (Gibbons et al., 2015; Muir et al., 2015; Walker et al., 2003).

Main Analysis – FAB. A 2 (Cannabis User, Non-User) X 2 (Event Valence: Pleasant, Unpleasant) mixed-factor ANCOVA was conducted to determine if cannabis use impacted the FAB. Because past research has shown that depression (Walker et al., 2003), and anxiety (Walker & Yancu, 2014) can affect the FAB, these variables were included as covariates. The dependent variable in this analysis was the average change in affect between the initial event rating and the current affect intensity rating for each of the three pleasant and three unpleasant events. As in Walker et al. (2003), difference scores for events were calculated by subtracting current affect intensity ratings from initial affect intensity ratings. A significant Cannabis X Event Valence interaction was found, F (1, 95) = 7.91, p = .006, η_p^2 = .077 (see Table 2). The covariates were not statistically significant (anxiety, p = .519; depression, p = .178).

As seen in Figure 2, affect associated with memories of unpleasant events decreased more in non-users compared to users, M_{diff} = 1.61 [95% CI .67, 2.54], d_{unb} = .69 [.28, 1.09]. Affect associated with memories of pleasant events did not differ between non-users and cannabis users, M_{diff} = .03 [95% CI -.52, .57]. Furthermore, within the cannabis-using group,

affect fading between unpleasant and pleasant event memories was found to differ, approximating a typical FAB pattern, M_{diff} = -.83 [95% CI -1.59, -.05], d_{unb} = .45 [-.13, 1.03].

Correlations between the main study variables are in Table 3. The *a priori* hypothesis that a linear relationship would exist between cannabis use and the FAB was confirmed. Severity of cannabis use was significantly and negatively correlated with the mean for affect fading for unpleasant memories. The correlations also revealed that alcohol use significantly and negatively correlated with the mean for affect fading for unpleasant memories. This correlation is consistent with past research that found that high levels of alcohol use was associated with less affect fading for unpleasant, ordinary events (Gibbons, et al., 2013).

Table 2

Means, Standard Deviations, and 95% Confidence Intervals of Average Affect Fading in Cannabis Users and Non-users for Pleasant and Unpleasant Memories

	Pleasant Memories			*Unpleasant Memories*		
Group	*M*	*95% CI*	*SD*	*M*	*95% CI*	*SD*
Cannabis Users	*.40*	*[-.07, .88]*	*1.62*	*1.23*	*[.62, 1.84]*	*2.07*
Non-users	*.43*	*[.13, .73]*	*1.09*	*2.83*	*[2.12, 3.55]*	*2.56*

Note. Higher mean change scores indicate greater affect fading.

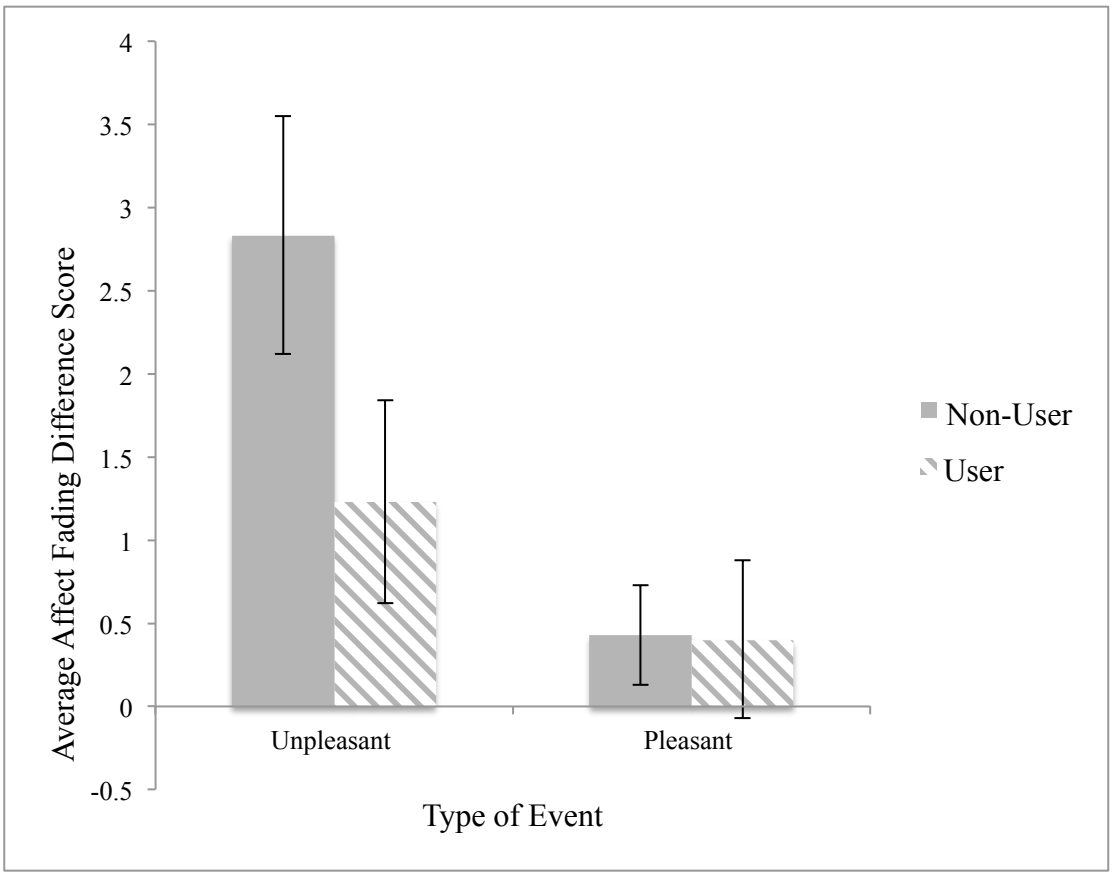

Figure 2. Mean fading of affect intensity for pleasant and unpleasant events for cannabis users and non-users. Error bars depict 95% confidence intervals on group means.

Table 3

Correlations between Cannabis Use, Alcohol Use, Depression, Anxiety, Affect Fading for Unpleasant Memories, and Affect Fading for Pleasant Memories with 95% Confidence Intervals

Variable	1	2	3	4	5
1. Cannabis Use					
2. Alcohol Use	.29** [.05, .51]				
3. Depression	.20* [-.03, .40]	.17 [-.08, .36]			
4. Anxiety	.17 [-.04, .38]	.05 [-.11, .24]	.57** [.42, .71]		
5. Fading Affect – Pleasant	.03 [-.21, .24]	-.05 [-.24, .19]	-.08 [-.31, .13]	-.04 [-.27, .16]	
6. Fading Affect - Unpleasant	-.24* [-.42, -.02]	-.28** [-.47, -.06]	-.13 [-.29, .05]	-.04 [-.24, .16]	.06 [-.13, .27]

Note. *indicates $p < .05$. **indicates $p < .01$.

Follow-up Analysis – FAB. A two-step hierarchical multiple regression was carried out to explore the relationship between alcohol use and the FAB. Following the guidelines of Field (2013), statistical assumptions were checked and were found to be satisfied. Affect fading for unpleasant memories was the dependent variable in the analysis. Depression, Anxiety, and Cannabis Use were entered in the first step to control for these variables. Alcohol was entered at the second step. Regression statistics are provided in Table 4.

At Step One, Depression, Anxiety, and Cannabis Use did not significantly contribute to the model (F (3,95) = 2.22, p>.05) and accounted for 6.6% of the variation in affect fading for unpleasant memories. Nevertheless, Cannabis Use accounted for a significant amount of variance in the model. Adding Alcohol Use to the model led to accounting for an additional 5.5% of variance in affect fading for unpleasant memories (R^2 = .11, F (1,94) = 4.61, p<.05). At Step Two, Alcohol Use remained as the only significant predictor of affect fading for unpleasant memories.

Table 4

Summary of Hierarchical Regression Analysis for Variables Predicting Affect Fading for Unpleasant Memories

Step and Variable	*B*	*SE B*	β	*t*	CI	R^2
Step One						.06
Depression	-.05	.06	-.12	-.96	[-.16, .06]	
Anxiety	.01	.02	.06	.50	[-.03, .06]	
Cannabis Use	-.07	.03	-.22	-2.21*	[-.13, -.01]	
Step Two						.11
Depression	-.04	.06	-.08	-.67	[-.15, .07]	
Anxiety	.01	.02	.04	.34	[-.04, .05]	
Cannabis Use	-.05	.03	-.17	-1.60	[-.12, .01]	
Alcohol Use	-.11	.05	-.22	-2.15*	[-.20, -.01]	

Note. *N = 99;* *indicates $p < .05$. CI = 95% Confidence Intervals.

CHAPTER IV

Discussion

Overview

The purpose of the present study was to determine whether AM specificity in cannabis users significantly differed from AM specificity of non-users and to examine whether cannabis use was associated with differences in the Fading Affect Bias (FAB), compared to non-users. The results from the current study serve to replicate and extend literature regarding emotional and autobiographical memory impairments associated with cannabis use.

Consistent with past research, the hypothesis that cannabis users would produce a greater number of overgeneralized memories was supported. To our knowledge, the current study is the first to measure the association between OGM and cannabis use using a free-recall procedure, whereas previous research has used cued-recall procedures (Mercuri et al., 2018; Gandolphe & Nandrino, 2011). Anderson et al. (2016) outline several potential limitations in measuring AM using cued-recall procedures. The authors discuss that emotional cue-word tasks do not necessarily simulate how people retrieve memories in daily life. Indeed, instances where an individual would be prompted to recall a memory with an obvious positive or negative cue, would occur relatively infrequently in real life, compared to bottom-up retrieval of AM (free-recall), which becomes activated during a variety of circumstances. A second difference between these two methods concerns the level of memory specificity. Past research has shown that involuntary memories (non-cued memories) do not elicit the same OGM effect that voluntarily (cued) retrieved memories do in individuals with depression (Watson, Berntsen, Kyuken, & Watkins, 2013). Specifically, Watson et al. (2014), found that individuals with depression were able to recall specific memories on a free-recall diary task (non-cued), but recalled memories

with an OGM bias when given a cue to facilitate memory recall. Furthermore, when researchers have reduced the amount of instruction given on cue-word memory retrieval tests, which more closely resembled free recall procedures, the sensitivity to detect OGM in non-clinical samples has improved (Debeer, Hermans, & Raes, 2009; Dritschel, Beltsos, & McClintock, 2014). The existing literature suggests that the use of free recall procedures in the measurement of AM specificity in non-clinical samples provides a more accurate rating of memory specificity than ratings of memory specificity obtained using cued-recall tasks. Therefore, as in the current study, it is important to explore whether free recall memory retrieving procedures produced similar OGM findings to more conventional cueing methods, in non-clinical cannabis users.

Using a free-recall procedure to measure AM specificity, a robust association was found between OGM and chronic cannabis use. In addition to the results being consistent with past studies investigating the relationship between AM and cannabis use, the findings also mirror the OGM effect that is seen in individuals with depression (Daele, Griffith, Bergh, & Hermans, 2014; Liu et al., 2017; Ridout, Dritschel, Matthews, & O'Carroll, 2016). Interestingly the level of depression between cannabis users and non-users in the current study did not significantly differ, which implies that a relationship between OGM and cannabis use may exist that is independent of an association with depression. For example, heavy cannabis use has been found to be associated with smaller volumes of the left and right hippocampus (Ashtari et al., 2011). Further, the loss of neurons in the hippocampus due to aging may be intensified and accelerated by chronic cannabis use (NIDA, 2018). Alternatively, the impact that cannabis use has on memory retrieval may be associated with the development of future depressive episodes. While the existence of a causal relationship between depression and OGM remains unclear, evidence

suggests that lower levels of AM specificity predict more intense depressive symptoms (Sumner et al., 2010) and that OGM is a risk factor for depressive episodes (Williams et al., 2007).

Accordingly, one goal of future studies would be to replicate the association between OGM and cannabis found here, in order to continue to investigate if a relationship exists between chronic cannabis use and the development of depression via a pattern of OGM retrieval. While a significant correlation was found between depression and cannabis use, the current study did not find a relationship between depression and OGM. The absence of a correlation between these two variables is surprising given the extensive literature that highlights a relationship between depression and OGM (e.g. Kleim & Ehlers, 2008; Liu et al., 2017; Williams et al., 2007; Williams & Scott, 1988; Wilson & Gregory, 2018). The nonexistence of a correlation may be explained by the non-clinical sample used. The majority of our sample was below the clinical cut-off on the study's measure of depression, which may have made it difficult to observe a relationship between these two variables. Our finding is also consistent with past research that has found that individuals with dysphoria (non-clinical levels of depression) do not evidence an overgeneral memory bias (Anderson & Evans, 2014). Notwithstanding, given that an association between OGM and depression has been found repeatedly, and that OGM was significantly correlated with cannabis use in the current study, the possibility that cannabis use influences the development or course of depression is plausible and merits further investigation. Administering a free-recall AM test to chronic cannabis users and non-users across a series of time points, as well as measuring participant' mood over time, should elucidate the impact of persistent cannabis use, on AM specificity, as well as depression, over time.

Moreover, the link between cannabis users and OGM found in this study suggests that chronic cannabis users may experience similar functional deficits to others who evince an OGM

retrieval pattern, such as those with depression, (Sumner et al., 2010), post-traumatic stress disorder (Dalgleish et al., 2008), or eating disorders (Ball et al., 2010). Such impairments may include poor problem solving ability (Sutherland and Bryant, 2008), rumination, (Sumner, 2012), and difficulty in imagining future events (Williams et al., 1996).

The findings concerning the FAB are consistent with literature that highlights an association between heavy cannabis use and depression (Hodgson et al., 2016; Lev-Ran et al., 2014; Patton et al., 2002) and are consistent with the idea that chronic cannabis use increases an individual's risk of developing depression. Significantly more affect associated with memories for unpleasant events persisted over time in cannabis users compared to non-users. The more enduring negative affect observed with unpleasant memories in this study for cannabis users, is concerning. Individuals who maintain the negative affect associated with events are more likely to show enhanced recall for negative information (Bradley et al., 1993; Rusting, 1999) or negative autobiographical memories (Macleod, Andersen, & Davies, 1994), which could serve to reinforce depressed mood, thinking, and behavior.

On the other hand, the FAB supports the regulation of emotion, aids in maintaining a positive self-conception, and promotes a hopeful outlook about the future (Walker & Skowronski, 2009). If chronic cannabis use disrupts the benefits associated with the FAB, the likelihood of developing problems with mood may increase. While the cannabis users in our sample exhibited significantly less affect fading for unpleasant memories than non-users, it is noteworthy that affect fading for unpleasant memories was significantly greater than the affect fading for pleasant memories. Accordingly, the current findings indicate that chronic cannabis use weakens but does not eliminate the FAB. Based on the current findings, it is hypothesized that chronic cannabis use is less likely to be a causal agent in the development of depression, but

rather increases an individual's vulnerability to develop depression through the curtailment of negative affect fading associated with AM, in conjunction with other contributing factors. This hypothesis is consistent with past research that has found cannabis to be a risk factor for, but not necessarily the cause of, depression (see Hartman, Sreeram, & Wilson, 2017 for review).

Limitations. A number of limitations existed in the current study. The definition of chronic cannabis use was based on self-reported frequency of consumption on the CUDIT-R. While the reported use patterns were representative of the range of chronic cannabis use found in past studies (Nicholls et al., 2015; Papini et al., 2017), other research (Hindocha, Freeman, & Curran, 2017) has found that self-reported cannabis use may sometimes be overestimated. Yet, as Mercuri et al. (2018) note, this limitation is common in substance use research. Future studies may address this issue by conducting urine tests to measure the concordance between self-reported cannabis use and the associated participant biochemistry (Clark et al., 2016). Alternatively, the Timeline Follow Back Method (TLFB; Sobell et al., 1986) could be employed during participant recruitment to record participant cannabis use. The TLFB procedure involves the collection of detailed drug use information and involves a structured interview and the use of a calendar to allow participants to specify the occasions when drug use occurred over a particular time period. Growing literature suggests that this method of assessment can be reliable and valid in the assessment of recent cannabis use (Robinson et al., 2014).

Another common limitation in studies of cannabis is difficulty in measuring the quantity of cannabis consumption. Indeed, self-reported estimates of the quantity of cannabis-use were not collected in this study. Since these data were not collected, it is more difficult to be confident that frequency of use equates to higher quantities of cannabis consumption. The possibility exists that some cannabis users in our study smoke less frequently but tend to consume more cannabis

per smoking event. Relatedly, no instrument currently exists to validly quantify the amount of psychoactive substance (tetrahydrocannabinol; THC and cannabidiol; CBD) per unit of cannabis consumption (Lopez-Pelayo et al., 2015). Therefore, even if participants' cannabis smoking patterns were similar with regards to frequency and quantity, they may have been ingesting different strains of cannabis with varying levels of THC and CBD, the two cannabinoids presumed in preceding research to affect cognitive and emotional functioning (Curran et al., 2002; Martin-Santos et al., 2012; Niesink & Laar, 2013). Varying THC and CBD levels may be less of a limitation for future research once cannabis is legalized because commercially sold cannabis will be required to have labels that communicate THC and CBD levels to buyers (Siebert, 2018). These regulations will, at the very least, help research participants more accurately estimate their consumption of THC and CBD.

Though alcohol use is a prevalent demographic in cannabis users in previous research involving cannabis and memory (Mercuri et al., 2018; Hart et al., 2010; Fried, Watkinson, & Gray, 2005), a third limitation to the study was the potentially confounding relationship between alcohol use and the FAB. Follow up regression analysis revealed that alcohol use was associated with lower affect fading for unpleasant events. These findings are consistent with Gibbons et al. (2013), who found a similar effect when examining the impact of alcohol use on FAB. The possibility cannot be ruled out that alcohol use may have confounded the relationship between cannabis use and the FAB. Future research should seek to confirm the relationship between cannabis use and the FAB by using a non-drinking sample of participants.

A final limitation is the cross-sectional design of the present study. Due to collecting data at one specific time point, results may not be representative of the true impact (or lack of impact) that cannabis has on AM specificity and affect fading. The current results do not illuminate the

effects of cannabis use on AM over time; and cannot confirm if continued cannabis use creates lasting deficits in AM specificity and affect fading nor can it confirm whether disruptions in these AM phenomena abate if cannabis use is terminated. Some research suggests that cessation of cannabis use leads to improvement in verbal and working memory (Hanson et al., 2010; Tait, Mackinnon, & Christensen, 2011), which provides a potential basis for how AM specificity or FAB could be improved should a person abstain from the drug.

Future Directions for Research. Future investigation should seek to replicate these results as well as extend the cross-sectional design by conducting longitudinal research. As noted in the introduction, diary procedures for measuring the FAB (Ritchie et al., 2014; Ritchie & Skowronski, 2008; Ferguson, 2003) could be used to assess the FAB over time. A potentially fruitful extension of the current methods might be to have chronic cannabis users and non-users record one unique event per day in a diary, for a year. Participants would receive instructions that the unique event must be a pleasant or unpleasant experience. At the time of recording, participants will rate the pleasantness of the event. Diary recollections and mood ratings would be collected at the end of every week for the 52-week period. At the end of the recording period, participants would be prompted to read their diary entries in a random order and would give a current pleasantness rating of the event. To minimize the limitations of self-report and quantity of cannabis use, the TLFB procedure could be employed during participant recruitment to identify chronic cannabis users and at the end of each week to confirm participants' use habits.

Though previously discussed problems in measurement still apply, such as determining psychoactive ingredient per unit of consumption. Furthermore, participants would still be subject to retrospective bias when recalling their cannabis consumption. Nonetheless, in carrying out a longitudinal experiment, such as the one described above, the relationship between cannabis use

and the emotional profile associated with AM overtime would be observed and any influence cannabis may have in the development or maintenance of depression could be clarified.

Summary and Conclusion. In conclusion, the findings of the current study are consistent with previous research that has demonstrated an association between chronic cannabis use and overgeneralized autobiographical memory. This study is the first to establish this relationship using a free-recall procedure with a non-clinical sample of regular cannabis users. Additionally, results indicated that cannabis use is associated with a disruption in the fading affect bias in that cannabis users were less likely to show typical decreases in unpleasant affect associated with the retrieval of autobiographical memories, compared to non-users. Documenting the effects of cannabis on typical AM processes are especially important given the global trend toward the legalization of cannabis for recreational purposes.

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Appendix A

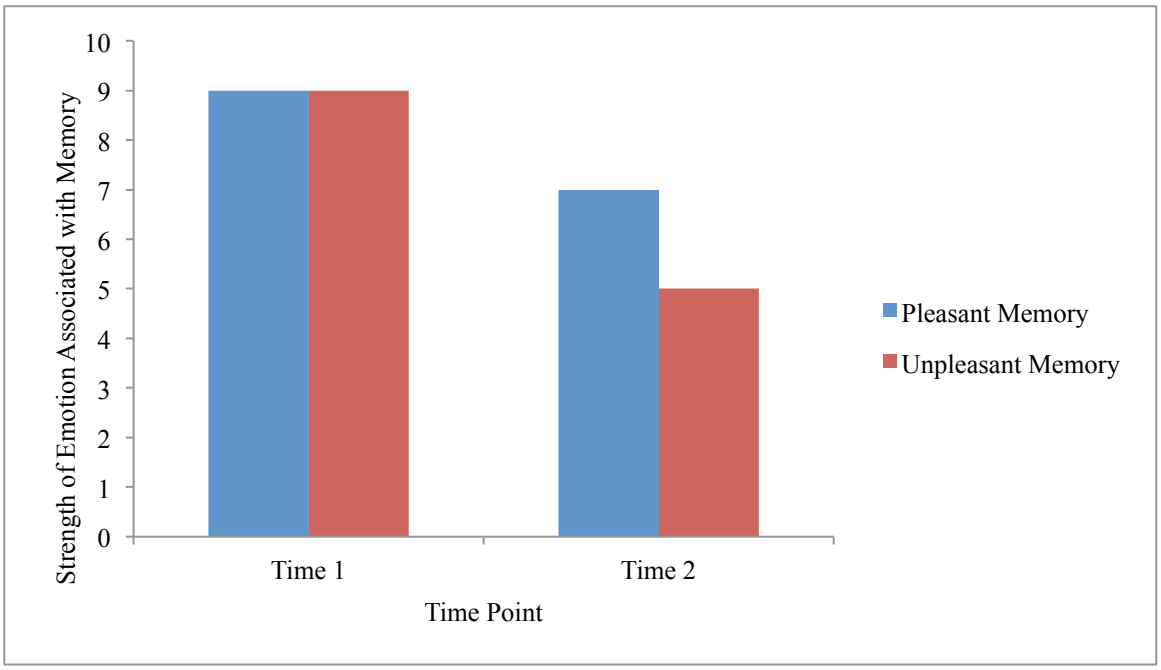

Figure 3. Graph values were created for explanation purposes and are not authentic rates of affect fading. The diagram depicts an average fading affect bias, similar to the FAB found by Walker et al. (1997).

Appendix B

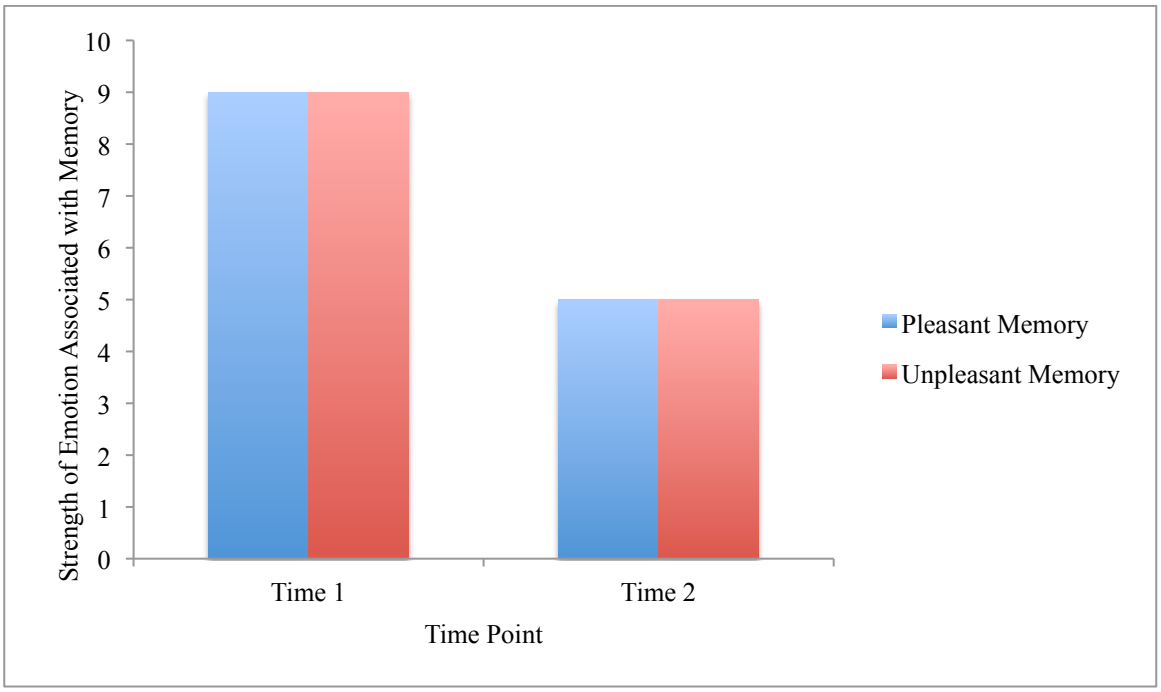

Figure 4. Graph values were created for explanation purposes and are not authentic rates of affect fading. The diagram depicts a fading affect bias that may be found in an individual with dysphoria, similar to the FAB pattern found by Walker et al. (2003).

Appendix C

Sentence Completion for Events from the Past Test (Raes et al., 2007)

Below you will find eleven sentences. Actually these are only parts of sentences, because only the beginning of each of the sentences is provided. The purpose of the task if for you to complete each of the sentences. You can complete the sentences any way you want, just as long as what you write corresponds to the provided stem. Also make sure that each of the sentences is on a different topic.

Sentences:

1. I still remember well how…
2. I still recall how/that I…
3. Last year…
4. In the past…
5. Last week I
6. I can still picture how…
7. When I think back to/of…
8. I will never forget…
9. The most important thing that I have ever
10. Last year I
11. At the time when I…

Appendix C (Continued)

Please rate each of your statements using the coding system below (write the appropriate number code next to each statement). Please read all codes before beginning this task.

1: What you wrote down refers to one specific moment or a particular time

2: What you wrote down refers to a repeated activity or a category of similar events without the specification of a particular time

3: What you wrote down refers to an extended period of time, which lasted longer than a day

4: You had something in mind, but did not want to write it down for whatever reason (e.g., too personal). What you had in mind refers to one specific moment or a particular time

5: You had something in mind, but did not want to write it down for whatever reason (e.g., too personal). What you had in mind refers to refers to a repeated activity or a category of similar events without the specification of a particular time

6: You had something in mind, but did not want to write it down for whatever reason (e.g., too personal). What you had in mind refers to refers to an extended period of time which lasted longer than a day

7: You seriously tried to complete the sentence, but could not come up with something

8: You did not seriously try to complete the sentence in a meaningful way

Appendix D

Cannabis Use Disorder Identification Test – Revised (Adamson et al., 2010)

Have you used cannabis over the past six months? YES/NO
If yes, please answer the following questions about your cannabis use. Circle the response that is most correct for you in relation to your cannabis use *over the past six months:*

1. How often do you use cannabis?

Never	Monthly or less	2-4 times a month	2-3 times a week	4 or more times a week
0	1	2	3	4

2. How many hours were you "stoned" on a typical day when you had been using cannabis?

Less than 1	1 or 2	3 or 4	5 or 6	7 or more
0	1	2	3	4

3. How often during the past 6 months did you find that you were not able to stop using cannabis once you started?

Never	Less than monthly	Monthly	Weekly	Daily or almost daily
0	1	2	3	4

4. How often during the past 6 months did you fail to do what was normally expected from you because of using cannabis?

Never	Less than monthly	Monthly	Weekly	Daily or almost daily
0	1	2	3	4

5. How often in the past 6 months have you devoted a great deal of your time to getting, using, or recovering from cannabis?

Never	Less than monthly	Monthly	Weekly	Daily or almost daily
0	1	2	3	4

6. How often in the past 6 months have you had a problem with your memory or concentration after using cannabis?

Never	Less than monthly	Monthly	Weekly	Daily or almost daily
0	1	2	3	4

7. How often do you use cannabis in situations that could be physically hazardous, such as driving, operating machinery, or caring for children?

Never	Less than monthly	Monthly	Weekly	Daily or almost daily
0	1	2	3	4

8. Have you ever thought about cutting down, or stopping, your use of cannabis?

Never	Yes, but not in the past 6 months	Yes, during the past 6 months
0	2	4

Appendix E

Alcohol Use Disorder Identification Test (Babor, De La Fuente, Saunders & Grant, 1992)

Because alcohol use can affect your health, it is important that we ask some questions about your alcohol use. Your answers will remain confidential so please be honest. Circle the number on the scales below that best describes your answer to each question.

1. How often do you have a drink containing alcohol?

Never	Monthly or less	2-4 times a month	2-3 times a week	4 or more times a week
0	1	2	3	4

2. How many drinks containing alcohol do you have on a typical day when you are drinking?

1 or 2	3 or 4	5 or 6	7 to 9	10 or more
0	1	2	3	4

3. How often do you have six or more drinks on one occasion?

Never	Less than monthly	Monthly	Weekly	Daily or almost daily
0	1	2	3	4

4. How often during the last year have you found that you were not able to stop drinking once you had started?

Never	Less than monthly	Monthly	Weekly	Daily or almost daily
0	1	2	3	4

5. How often during the last year have you failed to do what was normally expected of you because of drinking?

Never	Less than monthly	Monthly	Weekly	Daily or almost daily
0	1	2	3	4

6. How often during the last year have you needed a first drink in the morning to get yourself going after a heavy night of drinking?

Never	Less than monthly	Monthly	Weekly	Daily or almost daily
0	1	2	3	4

7. How often during the last year have you had a feeling of guilt or remorse after drinking?

Never	Less than monthly	Monthly	Weekly	Daily or almost daily
0	1	2	3	4

8. How often during the last year have you been unable to remember what happened the night before because of your drinking?

Never	Less than monthly	Monthly	Weekly	Daily or almost daily
0	1	2	3	4

9. Have you or someone else been injured because of your drinking?

No	Yes, but not in the last year	Yes, during the last year
0	2	4

10. Has a relative, friend, doctor, or other health care worker been concerned about your drinking or suggested you cut down?

No	Yes, but not in the last year	Yes, during the last year
0	2	4

Appendix F

Patient Health Questionnaire (Kroenke, Spitzer & Williams, 2001)

Over the past two weeks, how often have you been bothered by any of the following problems?

1. Little interest or pleasure in doing things

Not at all	Several days	More than half the days	Nearly every day
0	1	2	3

2. Feeling down, depressed, or hopeless

Not at all	Several days	More than half the days	Nearly every day
0	1	2	3

3. Trouble falling asleep, staying asleep, or sleeping too much

Not at all	Several days	More than half the days	Nearly every day
0	1	2	3

4. Feeling tired or having little energy

Not at all	Several days	More than half the days	Nearly every day
0	1	2	3

5. Poor appetite or overeating

Not at all	Several days	More than half the days	Nearly every day
0	1	2	3

6. Feeling bad about yourself – or that you're a failure or have let yourself or your family down

Not at all	Several days	More than half the days	Nearly every day
0	1	2	3

7. Trouble concentrating on things, such as reading the newspaper or watching television

Not at all	Several days	More than half the days	Nearly every day
0	1	2	3

8. Moving or speaking so slowly that other people could have noticed. Or, the opposite – being so fidgety or restless that you have been moving around a lot more than usual

Not at all	Several days	More than half the days	Nearly every day
0	1	2	3

9. Thoughts that you would be better off dead or of hurting yourself in some way

Not at all	Several days	More than half the days	Nearly every day
0	1	2	3

10. If you check off any problems, how difficult have those problems made it for you to do your work, take care of things at home, or get along with other people?

- □ Not difficult at all
- □ Somewhat difficult
- □ Very difficult
- □ Extremely difficult

Appendix G

Beck Anxiety Inventory (Beck, Epstein, Brown & Steer, 1988)

Below is a list of common symptoms of anxiety. Please carefully read each item in the list. Indicate how much you have been bothered by that symptom during the past month, including today, by circling the number in the corresponding column next to each symptom.

	Not At All	Mildly but it didn't bother me much.	Moderately - it wasn't pleasant at times	Severely – it bothered me a lot
Numbness or tingling	0	1	2	3
Feeling hot	0	1	2	3
Wobbliness in legs	0	1	2	3
Unable to relax	0	1	2	3
Fear of worst happening	0	1	2	3
Dizzy or lightheaded	0	1	2	3
Heart pounding/racing	0	1	2	3
Unsteady	0	1	2	3
Terrified or afraid	0	1	2	3
Nervous	0	1	2	3
Feeling of choking	0	1	2	3
Hands trembling	0	1	2	3
Shaky / unsteady	0	1	2	3
Fear of losing control	0	1	2	3
Difficulty in breathing	0	1	2	3
Fear of dying	0	1	2	3
Scared	0	1	2	3
Indigestion	0	1	2	3
Faint / lightheaded	0	1	2	3
Face flushed	0	1	2	3
Hot/cold sweats	0	1	2	3
Column Sum				

Appendix H

Demographic Form

Age:

Gender:

Ethnicity (please select)
__ Black/African/Caribbean
__ Chinese
__ Filipino
__ First Nations
__ Japanese
__ Latin American
__ Mixed
__ South Asian (e.g., East Indian, Pakistani, Sri Lankan, etc.)
__ Southeast Asian (e.g., Vietnamese, Cambodian, Malaysian, etc.)
__ White
__ Other: _____

Have you consumed cocaine in the past year? YES/NO/PREFER NOT TO ANSWER

If yes, when was the last time you used cocaine?_____

If yes, please circle the response that best estimates your frequency of cocaine use in the past year?
1 or 2 times 3 or 4 times 5 or 6 times 7 to 9 times 10 or more times

If yes, are you currently experiencing acute withdrawal symptoms from your cocaine consumption? Y/N

Have you consumed heroin in the past year? YES/NO/PREFER NOT TO ANSWER

If yes, when was the last time you used heroin?_____

If yes, please circle the response that best estimates your frequency of heroin use in the past year?
1 or 2 times 3 or 4 times 5 or 6 times 7 to 9 times 10 or more times

If yes, are you currently experiencing acute withdrawal symptoms from your heroin consumption? Y/N

Have you consumed ecstasy/MDMA in the past year? YES/NO/PREFER NOT TO ANSWER

If yes, when was the last time you used ecstasy/MDMA?_____

If yes, please circle the response that best estimates your frequency of ecstasy/MDMD use in the past year?
1 or 2 times 3 or 4 times 5 or 6 times 7 to 9 times 10 or more times

If yes, are you currently experiencing acute withdrawal symptoms from your ecstasy/MDMD consumption? Y/N

Appendix H (Continued)

Have you smoked cannabis in the past year? YES/NO/PREFER NOT TO ANSWER

If yes, when was the last time you used cannabis?_____

If yes, are you currently experiencing acute withdrawal symptoms from your cannabis consumption? Y/N

Have you had problems with work, school, or in your personal life due to substance use or addiction in the past year? Circle: YES/NO/PREFER NOT TO ANSWER

Have you experienced problems remembering past events in the past year? YES/NO/PREFER NOT TO ANSWER
Briefly explain:_____
_____
If not covered above, circle the cause of memory problems:
Traumatic Brain Injury Stroke Medication Other:_____ Prefer not to Answer

Appendix I

CONSENT TO PARTICIPATE IN RESEARCH

Title of the Study: Memory and Behavioural Health

You are asked to participate in a research study conducted by Daniel Pillersdorf under the supervision of Dr. Alan Scoboria from the Psychology Department at the University of Windsor.

If you have any questions or concerns about this research please feel free to contact Daniel Pillersdorf at pillersd@uwindsor.ca or Dr. Scoboria via email at scoboria@uwindsor.ca or by phone at (519) 253-3000 ext. 4090.

PURPOSE OF THE STUDY

To explore how specifically college students remember events from their past, and to investigate the relationship between memory for events and behavioural health (mental health and substance use).

PROCEDURES

If you volunteer to participate in this study, you will be asked to complete sentences with a description of a memory of your choosing. You will also be asked to identify a number of events from your past, provide a brief description of the events, and rate the events based on how you felt about the events when they occurred and how you feel about them when recalling them. You will also be asked to complete measures related to behavioural health. These measures relate to mood, anxiety, and current and past substance use. The study will take no longer than 1 hour to complete and will be completed in the lab space where you are reading this form.

POTENTIAL RISKS AND DISCOMFORTS

You may feel uncomfortable being asked questions about mental health or past or current personal illicit substance use. You may be concerned that the information you provide would not be held confidentially, and become public. Please note that your identity will never be associated with the information that you provide. You will be assigned a numerical ID and on the completion of the study, only this ID will be linked to your survey. No identifying information will be connected to any of the data. A separate record of our participants will be retained, to provide credit in the Psychology Participant Pool; this record will not be linked to your responses. It is also possible that some people may experience mild and temporary psychological or emotional discomfort when thinking about personal experiences. You are completely in control of which past events you choose to describe. You may end your participation in the study at any point.

Appendix I (Continued)

POTENTIAL BENEFITS TO PARTICIPANTS AND/OR TO SOCIETY

Although there are no foreseeable benefits of participation in this research, you might appreciate the experience of contributing to psychological research. Results of this research will add to our understanding of how people think about past events and how remembering events is related to aspects of behavioural health.

COMPENSATION FOR PARTICIPATION

You will be compensated one bonus credit for one hour of your participation in this research study, plus an additional .5 credit for attending a session in person; for a total of 1.5 points. Consistent with Participant Pool policy, if you choose to withdraw from the study before completion, you will receive .5 bonus credit for each half hour completed up to the point of withdrawal.

CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission. You will participate using your assigned numerical ID. Your name will be placed on an unconnected second document to confirm you completed the study, so that we can provide you with the compensation after the study is completed. No further identifying information will be collected about you. To ensure confidentiality of your identity, please do not include any personally identifying information about yourself or anybody else during the study. Data will be retained indefinitely and will be stored securely. Your data will be accessible to individuals associated with the study while the study is being conducted. In any resulting publications or presentations, participants will be referred to in groups so as to protect individual identity. If the event you provide is described in a presentation or publication, it will be altered or paraphrased, and any identifying information that you provide will be removed.

PARTICIPATION AND WITHDRAWAL

You can withdraw your participation from this study at any time. The investigator may withdraw you from this research if circumstances arise which warrant doing so. Once your data is submitted you will not be able to withdraw your data. You will receive credit equivalent to the time completed in the study if you choose to withdraw.

FEEDBACK OF THE RESULTS OF THIS STUDY TO THE PARTICIPANTS

A summary of the research findings will be available on completion of the project.
Web address: http://www1.uwindsor.ca/reb/study-results
Date when results are available: on or before August 31, 2019

Appendix I (Continued)

SUBSEQUENT USE OF DATA

These data may be used in subsequent studies, in publications and in presentations. The anonymized data may be published or shared with other researchers.

RIGHTS OF RESEARCH PARTICIPANTS

If you have questions regarding your rights as a research participant, contact: Research Ethics Coordinator, University of Windsor, Windsor, Ontario, N9B 3P4; Telephone: 519-253-3000, ext. 3948; e-mail: ethics@uwindsor.ca

SIGNATURE OF RESEARCH PARTICIPANT/LEGAL REPRESENTATIVE

I understand the information provided for the study **"**Memory and Behavioural Health" as described herein. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given an opportunity to print a copy of this form.

_____
Name of Participant

_____ _____
Signature of Participant Date

SIGNATURE OF INVESTIGATOR
These are the terms under which I will conduct research.

_____ _____
Daniel Pillersdorf Date

Appendix J

Provide a description of a pleasant memory that occurred over the past year. Try to include as many details a possible. For example, when did this event take place? Where did the event take place? What sensory details do you remember about the event (possible sights, sounds, smells, tastes, or physical feelings)?

or

Provide a description of an unpleasant memory that occurred over the past year. Try to include as many details a possible. For example, when did this event take place? Where did the event take place? What sensory details do you remember about the event (possible sights, sounds, smells, tastes, or physical feelings)?

Estimate how long ago this event occurred? _____Months + _____Weeks +_____Days ago

How well do you remember this event? Often, our ability to recall past events can vary, however remembering an event perfectly is unusual.

Not at all	Barely	Not so well	Fairly well	Very well	Almost perfectly	Perfectly
1	2	3	4	5	6	7

Appendix K

Rate how pleasant you found the event to be when it occurred.

Extremely Unpleasant Neutral Extremely Pleasant

-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10

Rate how pleasant you find the event to be as you recall it now. An event's pleasantness may change in several ways or it might not change at all.

Extremely Unpleasant Neutral Extremely Pleasant

-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10

Or

Rate how unpleasant you found the event to be when it occurred

Extremely Unpleasant Neutral Extremely Pleasant

-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10

Rate how unpleasant you find the event to be as you recall it now. An event's pleasantness may change in several ways or it might not change at all.

Extremely Unpleasant Neutral Extremely Pleasant

-10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10

Appendix L

Letter of Information/Debrief Form

In the study just completed, you were asked to continue sentence stems with personal remembered events. You were also asked to describe a series of pleasant and unpleasant remembered events and give pleasantness ratings for the event for when it occurred and also when it was presently recalled. All participants were asked to do these tasks. These tasks were in place to measure the specificity of your recalled memories (how detailed or specific you described your memories) and to measure the fading pattern of your affect associated with recalled memories over time (how your emotions associated with a memory strengthen or weaken).

Remembering past events in less detail and disruptions in healthy affect fading have been associated with negative outcomes such as impaired problem solving and dysphoric ideation. This project is being conducted to examine if an association exists between disruptions in the psychological mechanisms mentioned above and cannabis use. The connection between cannabis use and memory recall and cannabis use and affect fading is not well understood, yet other substances, such as alcohol, have been found to impair memory recall and disrupt affect fading. Exploring the impact of cannabis on memory and affect fading is merited due to its widespread use.

The study is comparing the memory recall of a large number of individuals who endorse using cannabis to the memory recall of a second large group of individuals who do not consume cannabis. Because students sign up randomly for study time slots, it would be unjustified to assume that any participant you may have seen while completing the study yourself is a user of cannabis.

If you have any further questions about the study, feel free to contact Daniel Pillersdorf, the principle researcher for the study (pillersd@uwindsor.ca). This email is also located on the consent form you were given at the beginning of the study. Thanks again for participating in the study. You will be credited on the Participant Pool shortly for your participation in the study.

Vita Auctoris

Daniel Pillersdorf was born in 1990 in Toronto, Ontario. He graduated from the Community Hebrew Academy of Toronto in 2008. From there he went on to McGill University where he obtained a B.A. in Psychology in 2012. In 2014, he obtained an M.A. in Counselling Psychology from Adler University. He is currently a candidate for the Doctoral degree in Clinical Psychology at the University of Windsor and hopes to graduate in Fall 2022.