THE AFFECT MISATTRIBUTION PROCEDURE AND CANNABIS COGNITIONS AMONG A SAMPLE OF CANADIAN ADOLESCENTS

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Abstract

Adolescence is a time when many adolescents begin using cannabis. Cognitions that adolescents hold are predictive of their initiation or increase in cannabis use. Research highlights implicit cognitions in early substance use initiation. The Affect Misattribution Procedure (AMP) measures the affective impact of implicit cognitions by examining their influence on neutral stimuli. The present study used the AMP to examine implicit factors that predict early cannabis use by examining affective reactions of youth to presentations of cannabis images. It was expected that affective misattributions would predict substance use over a 12-month period. This study drew from participants (n = 438) in Grade 8 at baseline (Time 1), 6 months (Time 2), and 12 months (Time 3). Results indicated that scores on the AMP were different for non-users compared to cannabis-users at each time point ($p < 0.05$). At baseline, the AMP independently predicted cannabis use, $\beta = 2.92$, Wald chi square = 11.96 (3.55 – 97.28), $p = .01$. An explicit cognitive measure (cannabis outcome expectancy liking; COEL) contributed significantly to the model at Time 1, $\beta = 1.09$, Wald chi square = 24.09 (1.93 – 4.62), $p = .01$, but did not eliminate the effect of the AMP. At Time 2, the AMP independently predicted cannabis use, $\beta = 1.25$, Wald chi square = 5.60 (1.24 – 9.85), $p = .02$. However, when COEL, $\beta = 1.02$, Wald chi square = 38.38 (2.01 – 3.85), $p = .01$, was added to the model, the AMP no longer predicted cannabis use. At Time 3, the AMP did not predict cannabis use independently. COEL predicted cannabis use in the full model, $\beta = 0.99$, Wald chi square = 40.33 (1.99 – 3.67), $p = .01$. Zero-inflated Poisson regressions showed the AMP also predicted the frequency of use at baseline, $\beta = 1.33$, SE = 2.35, $p = .01$, had moderate independent prediction at six months, $\beta = 0.66$, SE = 0.17, p = .01, and no predictive value at 12 months, $\beta = -0.11$, SE = 0.20, $p = .57$. These findings suggest that rapid affective reactions to cannabis images predict cannabis use in adolescents.

Lay Summary

Cannabis is the most common drug used by adolescents and adults in the world. Past research has suggested that the thoughts, ideas, and attitudes that adolescents have about substances influence their decision to experiment with and start using drugs and alcohol. Other research reports that unconsciously activated thoughts have the ability to influence substance use behaviour. The present study was the first to examine whether the Affect Misattribution Procedure was able to predict adolescent cannabis use currently, 6 months later, and 12 months later in a group of 438 Grade 8 students. Results suggest that this procedure is a good predictor of current cannabis use and cannabis use at 6 months. The procedure was not able to predict cannabis use 12 months later. This procedure can be incorporated into drug and alcohol screening and prevention programs to identify students who may be at an increased risk of harmful substance use.

Preface

The Behavioural Research Ethics Board of the University of British Columbia's Okanagan Campus granted ethics approval for this research. The certificate approval number for the project is H10-01582. To date, the results of this study have not been published.

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Dedication

To my Mom, who has supported my academic pursuits in endless ways and has taught me to be an independent, strong, and curious woman. Thank you for being my best friend.

1 Introduction

In 2015, the Government of Canada committed to legalizing and regulating cannabis consumption and production (Task Force on Marijuana Legalization and Regulation, 2016). Cannabis is the most common drug used by adolescents and adults in the world (Rehm & Fischer, 2015). Canadian adolescents have demonstrated higher cannabis use than the 29 most economically advanced countries of the world (UNICEF Office of Research, 2013) with estimates of past year usage range from 21% to 28% in the Canadian adolescent population (Statistics Canada, 2015). Further, Canadian youth use cannabis more often than any illicit substance (George & Vaccarino, 2015). A recent study found that cannabis usage increased from 7.5% of the adolescent population at age 15 to 29.8% at age 19 (Scholes-Balog, Hemphill, Patton, & Toumbourou, 2013).

Adolescence constitutes a time of rapid cognitive development, shifts in maturity, experiences of social and emotional stressors, and behavioural changes (Schmits, Maurage, Thirion, & Quertemont, 2015). Adolescents are also at an increased risk of experiencing more adverse events than adults including family conflict, anxiety, and intense moods (Miller Buchanan, Eccles, & Becker, 1992) and they often have difficulty coping with these stressors (Collins, 2001). Furthermore, adolescence is a critical period in which drug and alcohol experimentation often take place and this is also a precarious time in which the trajectory of cannabis use may be initiated (Schmits et al., 2015). A recent study of adolescents in British Columbia reported that those who abstained from or who reported being occasional cannabis users in adolescence started using cannabis on average after age 16 years of age (Thompson, Merrin, Ames, & Leadbeater, 2018). Those who went on to become chronic users (i.e., those who used cannabis in adolescence and continued use into adulthood) were those who started

using cannabis at an average age of 13 (Thompson et al., 2018). Age of onset is particularly important as early onset cannabis use has been reliably correlated with high-risk patterns of use as adolescents age (Thompson et al., 2018). As such, adolescent development lends itself to the exploration of early cannabis consumption and factors related to initiation or abstinence. Much research suggests that a relationship exists between early, heavy adolescent cannabis use and impairments in cognition and mental health (Lubman, Cheetham, & Yücel, 2015); however, definite conclusions about the direction and magnitude of this association are not apparent, mostly due to the paucity of research that has been conducted in these areas (Levine, Clemenza, Rynn, & Lieberman, 2016). Further, research examining the variability of cannabis use trajectories in youth is lacking (Thompson et al., 2018). Considering the high rates of cannabis use among the adolescent population in Canada, it is imperative that research examines the trajectories, predictors, and outcomes of adolescent cannabis use.

1.1 Cannabis-Related Harms in Adolescence

Recent research regarding cannabis use and adolescence has focused on the harms endured by youth who use cannabis. Debate exists in the literature as to whether cannabis creates harm, exacerbates existing issues, or whether the negative consequences of cannabis use can be partially or wholly accounted for by other variables (Levine et al., 2016). One longitudinal study found that those who used cannabis early in adolescence showed increases in rates of violence, antisocial behaviour, and cigarette and alcohol use relative to those who abstained (Scholes-Balog, Hemphill, Evans-Whipp, Toumbourou, & Patton, 2016). Analyses in this study controlled for gender and parental education but did not include other sociodemographic variables. No changes between groups were found regarding employment status, education, income, and alcohol problems at 5-year follow-up (Scholes-Balog et al., 2016). Another study reported that

trajectory of cannabis use was able to differentiate groups of behavioural problems (Thompson et al., 2018). Those who abstained from or who were occasional users of cannabis reported significantly less conduct problems (Thompson et al., 2018). Those who were classified as chronic users reported more symptoms of oppositional defiant disorder than others who reported lesser use patterns or abstained (Thompson et al., 2018).

Coffey and Patton (2016) suggest that consequences of early, heavy adolescent cannabis use have also been associated with advancement to other substance use. Even for late onset and occasional cannabis users, the risk of progressing to other substance use and abuse remained elevated compared to those who had never used cannabis (Coffey & Patton, 2016). This study accounted for possible confounds including social determinants of health, risk factors for mental health issues, location of school at study inception, parental divorce or separation, overseas birth, and parental smoking. Moreover, simultaneous cannabis and alcohol use was observed in 81.8% of incidents of cannabis use in a 14 to 20-year-old sample (Pape, Rossow, & Storvoll, 2009), precluding conclusions about the effects of cannabis use independently. One recent study found that youth who used cannabis were more likely to report heavy episodic drinking experiences than those who abstained from cannabis (Thompson et al., 2018). Similarly, those who reported higher levels of cannabis use (i.e., chronic users) also reported high levels of alcohol or illicit substance use and were at an increased risk of having an adulthood substance use disorder compared to those who abstained from cannabis use in adolescence (Ellickson, Martino, & Collins, 2004; Homel, Thompson, & Leadbeater, 2014; Nelson, Van Ryzin, & Dishion, 2015).

Research investigating cannabis use in adolescence and links to mood disturbances have produced inconsistent findings. Some studies suggest no association exists (Passarotti, Crane, Hedeker, & Mermelstein, 2015; Windle & Wiesner, 2004) while others have found that

increased use can lead to more mental health problems for adolescents. For instance, early onset cannabis use has been linked to an increased risk of developing a cannabis use disorder (Winters & Lee, 2008). Moreover, in one study, the most frequently reported cannabis-related harms were anxiety and depression, affecting between 20% to 30% of users between age 16 and 17 (Scholes-Balog et al., 2013). The authors did not separate analyses of each disorder nor did they allude to the direction of the relationship between cannabis use and mood disturbance. In addition to these findings, regular cannabis use in adolescence has been associated with a roughly two-fold increased risk of enduring an anxiety disorder at age 29 (Degenhardt et al., 2013). This risk remained even if cannabis use did not persist into adulthood. Additionally, cannabis use has been strongly linked to an increase in positive symptoms in adults with schizophrenia and psychosis (Caspi et al., 2005; Kuepper et al., 2011; Moore et al., 2007). This relationship has been posited to hold for adolescents as well (Bagot, Milin, & Kaminer, 2015). Evidence suggests that regular early cannabis use in boys may significantly increase the risk of exhibiting subclinical psychotic symptoms, paranoia, and hallucinations (Bechtold, Hipwell, Lewis, Loeber, & Pardini, 2016). This relationship persisted after controlling for current and past alcohol, tobacco, and other illicit substance use as well as internalizing and externalizing problems. Additionally, these effects remained even after participants had been abstinent from cannabis for one year. Similarly, a bidirectional association has been documented between vulnerability for psychosis in adolescence and cannabis use (Griffith-Lendering et al., 2013).

Cannabis use in adolescence has also been linked to cognitive impairments (Lubman et al., 2015). In adolescents who were at a high clinical risk of developing psychosis, those who initiated cannabis use before the age of 15 had lower intelligence quotient scores compared to those who initiated use after the age of 15 (Buchy et al., 2015). Working memory impairments in

cannabis-dependent adolescent users are suggested to be pronounced, though causal inferences are unclear due to small sample sizes, potential confounding effects of socio-economic status, and lack of working memory assessments prior to cannabis initiation (Vo, Schacht, Mintzer, & Fishman, 2014). Similarly, cannabis use in adolescence has been correlated with a cynical attitude towards high school education (Walburg, Moncla, & Mialhes, 2015) and poorer school satisfaction (Lynskey & Hall, 2000). In summary, cannabis use initiation at an early age, as well as heavy use throughout adolescence shows an association with several potential negative effects although the nature of these relationships is often not yet well understood.

1.2 Social Influences on Adolescent Cannabis Use

Canadian youth suggest that the decision to initiate cannabis use is influenced by social factors (Kobus, 2003; Porath-Waller, 2014). Adolescents who reported having friends who use cannabis were 27% more likely to have used cannabis themselves (Roditis, Delucchi, Chang, & Halpern-Felsher, 2016). In comparison to a group of adolescents who resisted cannabis offers, those who used cannabis displayed poorer relationships with their parents, had friends and romantic partners who use cannabis, and used tobacco and alcohol to intoxication regularly (Burdzovic Andreas, Pape, & Bretteville-Jensen, 2016). However, some evidence suggests that being strongly embedded in a highly cohesive peer group is a protective factor against initiation of cannabis use (Moriarty & Higgins, 2015). In addition, familial influences mediate the use of cannabis in adolescents. Children of fathers who were early onset cannabis users were more likely to initiate cannabis use early in life (Henry & Augustyn, 2017). Similarly, lack of parental support is associated with cannabis use in adolescence (de Looze et al., 2012). In contrast, concrete parental rules regarding smoking predicted a lower likelihood of adolescent cannabis use (de Looze et al., 2012).

1.3 Cognitions and Cannabis Use

Much research has established that changes in youths' cognitions about substances accompany and precede changes in substance use behaviour (Fulton, Krank, & Stewart, 2012; Van Der Vorst et al., 2013; Van Der Vorst, Vermulst, Meeus, Deković, & Engels, 2009). Some adolescents believe that cannabis is a substance associated with little harm, often citing the low cannabis-related mortality rate compared to that of alcohol or cigarettes (Hurd, Michaelides, Miller, & Jutras-Aswad, 2014). Adolescents who have used cannabis in the past report lower levels of perceived risk associated with the drug (Barrett & Bradley, 2016). Furthermore, those who use cannabis perceive it to be healthier and more socially acceptable than cigarettes (Roditis et al., 2016) and many strongly believe that all young people are daily users of cannabis (Porath-Waller, 2014).

Interestingly, cognitive expectancies have been related to frequency and quantity of substance use in several studies (Galen & Henderson, 1999; Hayaki, Hagerty, Herman, de Dios, & Anderson, 2010; Simons & Arens, 2007). For instance, adolescents who use cannabis report higher frequencies of relaxation expectancies and less frequent negative consequences than their non-using peers (Schmits et al., 2015). Positive outcome expectancies (e.g., stress reduction, euphoria) are associated with increased frequency of use (Alfonso & Dunn, 2007; Kristjansson, Agrawal, Lynskey, & Chassin, 2012; Willner, 2001). In contrast, negative outcome expectancies (e.g., harm to health) are related to decreased frequency of use (Simons & Arens, 2007). Research suggests that the most frequent reasons for using cannabis among adolescents include experimentation, relaxation, relief of boredom or anxiety, and fun (Bonn-Miller, Zvolensky, & Bernstein, 2007; Hathaway, 2003; Lee, Neighbors, & Woods, 2007). Similarly, youth suggest

that the negative effects of cannabis use should be associated with the individual using cannabis and not the substance itself (Porath-Waller, 2014).

1.4 Implicit and Explicit Influences on Cognition

Cannabis use initiation and frequent use in adolescence is complex and multi-faceted. Taken together, it is important that research examines the apparent consequences of adolescent cannabis use as well as the cognitions that precede and perpetuate use. Until recently, literature has focused most attention on explicit cognitions relating to substance use. Only in the past few decades have studies begun to explore the quick, automatic, associative cognitions that drive harmful substance use and addiction (MacKillop & De Wit, 2012; Stacy, 1995; Wiers & Stacy, 2006). This neglect, in part, has been spurred by the theory that most human behaviour can be characterized as the result of rational decision making in which individuals seek to maximize the pros and minimize the cons when selecting behaviours and evaluating outcomes (MacKillop & De Wit, 2012). Nevertheless, those who suffer from substance use problems and addiction often purposely engage in decision making and behaviour that causes significant harm to their health, relationships, and safety (MacKillop & De Wit, 2012). Perplexingly, the individual is often acutely aware of the detriment their substance use causes and they are frequently motivated to change this pattern (MacKillop & De Wit, 2012). As such, some have suggested that the rational decision-making process does not adequately characterize addiction and related phenomena. The relationship between implicit and explicit cognition has been proposed as an alternate explanation.

A significant amount of research suggests that it is likely that both implicit and explicit cognitions are influential in the initiation and development of substance use and related problems (Jajodia & Earleywine, 2003; Wiers & Stacy, 2006; Wiers, Van Woerden, Smulders, & De Jong,

2002). Implicit cognition has been characterized in addiction research as cognition that functions outside of awareness, spontaneously, and without the need to consciously deliberate (Stacy & Wiers, 2010). The general premise suggests that implicit cognitive processes can impact current cognition, interpretation of situations, and choice of behaviours (Ames et al., 2007). Explicit cognition by contrast is easy to report, purposeful, and operates at the conscious level of awareness (Stacy & Wiers, 2010). Researchers have adopted the notion that implicit cognitions are a product of associations in memory that can be quick, automatic, and preconsciously triggered in many circumstances, yet cannot be measured with self-report, introspection, or other common explicit measures (Stacy & Wiers, 2010). These implicit cognitions have the ability to alter and affect judgements, behaviour, and reasoning (Collins & Smith, 2009). A plethora of implicit tasks have been developed to capture these cognitions. For example, some tasks rely on the assumption that faster reaction times when responding to a substance-related stimulus relative to a neutral stimulus suggests that an underlying memory association is present and biased toward that stimuli (Collins & Smith, 2009). From this, researchers can infer an individual's implicit cognitions without explicitly asking about their ideas related to substance use.

1.5 Assessment of Implicit Cognition

The validity of assessing cognition with implicit measures is bolstered by the several hundred studies that have utilized implicit tasks (Fazio & Olson, 2003). Many benefits are associated with assessing substance use using implicit cognitive measures (Rooke, Hine, & Thorsteinsson, 2008), allowing researchers to observe tenants of substance use that may be left unexamined if research focuses exclusively on explicit cognitions that rely mainly on introspective methods (Wiers & Stacy, 2006). One study found that implicit measures predicted

cannabis and alcohol use better than cultural learning, ethnicity, socio-economic status, and gender variables (Stacy, Ames, Sussman, & Dent, 1996). Implicit measures are less sensitive to the effects of social desirability, thus providing an alternative measure of cognition. Explicit reports are more likely to be influenced by self-presentation biases (Wiers & Stacy, 2006) and by the context in which they are being collected (e.g., school or home). Similarly, implicit measures may also help explain circumstances where behaviour appears to be incongruent with explicitly held beliefs or attitudes such as when an individual expresses a desire to discontinue drinking alcohol yet continues a pattern of harmful alcohol use (Wiers & Stacy, 2006). In many cases, implicit and explicit measures of bias or attitude correlate well, however, there are instances where the correlation is low (Nosek, 2007). In these situations, researchers have suggested that the memory associates born out of implicit measures may be considerably different from explicit responses that participants report when they have enough time to reason with and use adequate cognitive control, such as when completing a self-report questionnaire (Nosek, 2007).

Implicit measures have been useful in examining opinions on sensitive subject matter such as race (Payne, Cheng, Govorun, & Stewart, 2005) and sexuality (Kiebel, McFadden, & Herbstrith, 2017). These measures also provide researchers with an alternative method of predicting initiation and increasing substance use (Ames et al., 2007). Substance use behaviour has also been predicted by implicit measures in community (Stacy & Newcomb, 1998), college (Stacy, Leigh, & Weingardt, 1994; Stacy, 1995), and criminal samples (Ames & Stacy, 1998; Ames, Zogg, & Stacy, 2002) as well as samples of at-risk youth (Ames, Sussman, Dent, & Stacy, 2005; Stacy et al., 1996).

Recent findings also highlight the role played by implicit cognitions in early substance use initiation (Cameron, Brown-Iannuzzi, & Payne, 2012; Payne, Lee, Giletta, & Prinstein, 2016;

Van Der Vorst et al., 2013). Research has found that the cognitions adolescents hold about substance use are predictive of their initiation or increase in use of the substance (Fulton et al., 2012). Youth who show positive associations to alcohol and cannabis are more likely to initiate use in the near future (Fulton et al., 2012). Further, associations between perceived parental alcohol use correlated positively with alcohol-related memories associations (Van Der Vorst et al., 2013). These memory associations also predicted alcohol use one year later (Van Der Vorst et al., 2013).

Additional research has examined attentional biases and action tendencies. This research has found significant relationships between substance use and cognitive processes (Roefs et al., 2011; Stacy & Wiers, 2010). Consistent with literature on implicit cognitions pertaining to alcohol (Field, Mogg, & Bradley, 2004; Wiers et al., 2002) and cigarettes (Swanson, Swanson, & Greenwald, 2001), research has found that positive implicit cannabis-related associations were consistently stronger among a group of cannabis-using participants (Field et al., 2004). Similarly, implicit measures predict alcohol use (Rooke et al., 2008; Wiers et al., 2007) and cannabis use (Field & Eastwood, 2005). These measures have also revealed that cannabis users display implicit cognitive biases in memory (Ames et al., 2005; Ames et al., 2002), attention (Field & Eastwood, 2005; Field et al., 2007), and approach (Cousijn, Goudriaan, & Wiers, 2011) when presented with implicit cannabis tasks. On the whole, the research suggests that implicit cognitive measures provide an important and unique window into the cognitive underpinnings of early substance use.

1.6 Affect Misattribution Procedure (AMP)

Though largely unrecognized, affect misattributions often influence emotions, thoughts, and behaviour (Payne, Hall, Cameron, & Bishara, 2010). These misattributions often occur when

an individual misattributes their affect surrounding a situation or event to something other than the true source. For instance, research has found that hikers reported greater attraction to a researcher after crossing a hazardous bridge (Beer, Knight, & D'Esposito, 2006; Dutton & Aron, 1974) and participants make more cautious decisions after undergoing a fearful experience (Beer et al., 2006). Examining these misattributions can provide insight into why people feel the way they do and how this subsequently influences their behaviours (Payne et al., 2010). Implicit measures are based on the premise that if a behaviour or cognition is strongly associated with the presentation of a stimulus (i.e., a cannabis photograph), then the underlying affect, attitude or bias towards that stimuli will be spontaneously triggered and be reflected in the participant's responses (Ames et al., 2007). As such, the field of affective misattributions has gained increasing attention to those who are interested in studying implicit attitudes and using this information to predict behaviour (Payne & Lundberg, 2014).

One method of studying implicit cognitions is by using the Affect Misattribution Procedure (AMP). The AMP measures implicit attitudes by eliciting affective responses of which the participant cannot accurately determine the source (Payne & Lundberg, 2014). In other words, the AMP replies on the premise that individuals are often unable to determine the source of their affect when two events occur closely together in space and time (Payne et al., 2010). To do so, the AMP briefly displays prime images on a computer screen. When used in substance use research, the prime image is typically presented for 75 to 125 milliseconds and consists of the substance in question (i.e., alcohol photographs; Payne et al., 2010; Payne et al., 2016). Following the prime, a neutral target image (i.e., a Chinese pictograph) is typically presented for a similar duration as the prime (Payne et al., 2016). Research has found that lengthier pictograph presentations (i.e., 1000ms) reduces the impact of the prime image and increases the impact of

the pictograph (Payne et al., 2010). The pictograph photos serve as neutral imagery to which the affective content of the prime photo is attributed. After the neutral image is presented, a black and white masking screen is presented to divide each trial and restrict perceptual processing in order to maximize the ambiguity of target images. Lastly, the participant is asked to rate the target image on a dichotomous scale. Participants are often asked to rate the pictograph as more or less pleasant than the average pictograph and are instructed to ignore the prime image (i.e., cannabis photograph) when making their judgement. However, a series of studies (Murphy & Zajonc, 1993; Payne et al., 2005) has shown that the prime image nonetheless influences the affective rating of the target image even after explicit instructions have been given to avoid this error. Therefore, the AMP allows researchers to examine implicit affective reactions to a substance use cue.

Initially used in a study of racial prejudice, the popularity of the AMP has grown within research that examines attitude and bias. Use of the AMP has been supported in various domains including consumption of alcohol (Payne, Govorun, & Arbuckle, 2008), moral mindsets (Hofmann & Baumert, 2010), and sexual prejudice (Kiebel et al., 2017). It has been used to assess attitudes related to smoking (Payne, McClernon, & Dobbins, 2007), adolescent and adult alcohol use (Payne et al., 2016; Payne et al., 2008), risky driving (Rusu, Sârbescu, Moza, & Stancu, 2017), and racial prejudices on electoral voting (Payne et al., 2005). The AMP has been successfully used to examine implicit attitudes held by children as young as 5 years old (Williams, Steele, & Lipman, 2016). Moreover, the AMP has successfully predicted future drinking behaviour in adolescents at one-year follow-up, regardless of alcohol experience (users versus abstainers) at baseline (Payne et al., 2016).

The AMP has previously been conceptualized as an implicit measure in that is it indirect (Payne et al., 2005). The AMP is implicit in the sense that participants are unable to control their affective reactions to the prime images (Payne et al., 2005). Furthermore, participants are never asked to directly describe their cognitions or biases. Instead, their biases are inferred from their behaviour. For example, a bias towards substance use is inferred from a higher proportion of pleasant affective ratings towards neutral images that precede substance-related photographs. The AMP contrasts many implicit measures in that it does not rely on reaction times such as in the IAT (Greenwald, McGhee, & Schwartz, 1998). A high degree of variability and error is introduced into methods that utilize a reaction time style of responding (Cameron et al., 2012).

Further evidence to the implicit nature of the AMP was provided in a study by Payne and Lundberg (2014) in which the influence of the prime was investigated. Half of the participants in the study were given the option to pass on any trial if they believed that the prime would influence their affective rating; the other half of the participants completed the AMP as usual with no option to pass on any trials. The researchers hypothesized that those who were aware of the influence of the primes would opt to pass more often on trials where affective primes were present compared to neutral primes. Conversely, results of those in the passing condition suggested that they were significantly more likely to pass on neutral trials. In addition, the effect of the prime images had an equally strong effect on those in the standard AMP condition relative to those in the passing condition. These results suggest that responses on the AMP are driven by uncontrolled, automatic influences of the primes instead of intentional affective ratings of the neutral pictograph.

The AMP offers several advantages over other implicit measures. The procedure can be conducted in less than 10 minutes on any modern computer, making it a quick and accessible

implicit measure that is easily administered in settings where time is limited. Administering the AMP does not require effortful labor or expertise, nor does it require specialized or expensive software. Unlike some implicit measures, the AMP does not require several sets of detailed directions or cover stories to conceal the purpose of the test. As such, participants are never purposefully deceived when being administered the AMP. Further, unlike explicit measures which ask the participant to consciously give responses, the AMP may reduce pressure to answer desirably by instead asking participants to rate the pleasantness of stimuli over many trials. Consequently, data gathered by implicit measures may generate more reliable responses about sensitive subjects as participants are not asked to explicitly report their cognitions.

The AMP has shown high predictive validity (Cameron et al., 2012; Gawronski & Ye, 2014). Further, a recent meta-analysis found that the AMP demonstrated higher predictive validity than other commonly used implicit measures (Cameron et al., 2012). Results of this analysis suggested that the AMP demonstrated an average effect ($r = 0.35$) when predicting behaviour. This compares to other priming tasks in the study including lexical decision-making tasks ($r = 0.29$) and reaction time evaluative priming tasks ($r = 0.25$). The AMP also performed better than the IAT ($r = 0.27$) in another meta-analysis in terms of predicting behaviour (Greenwald, Poehlman, Uhlmann, & Banaji, 2009).

Many other implicit measures suffer from low reliability estimates (Cunningham, Preacher, & Banaji, 2001; Fazio & Olson, 2003). The AMP in contrast has consistently demonstrated high reliability (average Cronbach's .81; Payne & Lundberg, 2014), particularly when measuring attitudes about alcohol (Goodall & Slater, 2010; Payne et al., 2008) and smoking habits (Haight, Dickter, & Forestell, 2012; Pokhrel et al., 2016). Further, the AMP does not rely on reaction times or relative measurements of two targets such as the IAT, and instead

relies on evaluative judgements (i.e., the pleasantness of a pictograph). The AMP measures effects of task-irrelevant primes (i.e., Chinese pictographs) on decisions about unrelated images (Payne et al., 2005) which may contribute to the high reliability found in the aforementioned studies. As such, little unintended effect is thought to influence the ratings made by participants. However, this may not be the case with the popular IAT, as the participant is asked to make an evaluative measurement between two categories (Cameron et al., 2012). Similarly, the AMP has demonstrated internal consistency estimates of 0.88 (Payne et al., 2005).

2 Current Study

2.1 Purpose

Considering rates of current use and potential harms, it is imperative to understand the factors that influence cannabis use among adolescents. Implicit measures have been increasingly used to study indirect cognitions or biases about substance use (Ames et al., 2007). Much work has been done on alcohol and cannabis use in adults. However, substantially less research has been conducted on the implicit cognitions that adolescents hold regarding cannabis. To date, no study has used the AMP to examine cannabis use and related cognitions in an adolescent population. This research is unique in looking at the implicit affective reactions of youth to brief presentations of substance-related pictures.

First, it was hypothesized that cannabis users would show significantly more positive ratings of the cannabis trials on the AMP than their non-using counterparts. Second, consistent with prior research using implicit measures (Ames & Stacy, 1998; Stacy, 1995; Stacy et al., 1996; Wiers et al., 2002), it was hypothesized that affective misattributions (i.e., positive affective ratings of neutral images preceding cannabis photographs) would predict substance use group membership over a 12-month period. It was also hypothesized that the AMP would continue to predict group membership while controlling for an explicit measure of cannabis cognitions. Third, it was hypothesized that the AMP would predict increases in days of cannabis use in the last 30 days over a 12-month period.

2.2 Method

2.2.1 Participants

This study drew participants from Grade 8 in the Vernon School District in British Columbia. All students in the Grade 8 cohort were invited to participate. Only those who were

physically unable to complete the measures were excluded. Data was collected at three time points: baseline (Time 1), 6 months (Time 2), and 12 months (Time 3). An a priori statistical power analysis was conducted using moderate effect sizes gleaned from past research (Alfonso & Dunn, 2007). The resulting power analysis suggested that a total sample of 180 participants was needed to detect meaningful results.

At Time 1, 438 Grade 8 students from Vernon School District were eligible to participate in the study. Of these, 378 (86%) students participated in the study. All participants completed that AMP and cannabis use questions at Time 1. Students who were eligible but did not participate in the present study were excluded because of incomplete data, lack of assent, or technical difficulties in linking data (e.g. missing identification codes for longitudinal linkages).

The sample consisted of 48.1% males and 51.9% females. At baseline, participants were between 12 and 15 years of age (*M*=13.24 years, *SD*=0.44). Participants reported their ethnicity as English Canadian (74.5%), French Canadian (10.2%), Western European (7.9%), Eastern European (5.1%), Status Indian (4.6%), Non-Status Indian (2.6%), Métis (2.3%), African (1.5%), East Asian (1.8%), Southeast Asian (1.3%), South Asian (1.5%), Latin American (1.3%), and Middle Eastern (0.8) and other (6.6%). Participants reported their primary caregiver(s) as: two primary parents (69.8%), single parent mother (13.4%), single parent father (1.7%), mother and step-father (9.9%), father and step-mother (2.0%), and another unspecified living situation (3.2%). Participants were asked to characterize their family's income as well below average (1.8%), below average (10.7%), average (56.1%), above average (26.4%), and well above average (5%). Maternal level of education was reported as follows: no high school (0.3%), some high school (2.6%), graduated high school (25.6%), college or diploma (28.2%), university degree (30.8%), and unsure (12.4%). Paternal level of education was reported as follows: no high

school (0.9%), some high school (5.2%), graduated high school (22.5%), college or diploma (22.5%), university degree (30.3%), and unsure (18.7%).

To calculate retention rates across the study, we examined the number of participants who completed the AMP at Time 1 and the number of who participated in subsequent time points. Of the 378 participants, 356 participants (94.2%) of participants participated in the second wave of data collection (Time 2); 321 participants (84.9%) completed the third wave of data collection (Time 3). Data was lost due to absenteeism, time constraints of the sessions, and incomplete answers.

Next, comparisons were conducted to examine differences between those who completed all timepoints and those who did not. No differences were found between males and females in those who completed and those who did not at Time 1, $\chi^2(1) = 0.02$, $p = 0.88$, Time 2, $\chi^2(1) = 2.21$, $p = 0.14$, and Time 3, $\chi^2(1) = 0.02$, $p = 0.89$. At Time 2, those who dropped out were more likely to report family income as being below average ($p < 0.05$). No other differences between family income were found at any time point.

2.2.2 Measures

2.2.2.1 Affect Misattribution Procedure (AMP; Payne, Hall, Cameron, & Bishara, 2010).

Implicit cognitions were measured using the AMP (Payne & Lundberg, 2014). Prime images were presented for 75ms and target images were presented for 150ms. A 175ms lag occurred between the two presentations. An intertrial interval of 500ms was included to deter the participants from randomly responding with the keyboard. Consistent with previous research on the reliability of the AMP (Payne & Lundberg, 2014), participants completed 133 trials. The reliability and validity of this procedure is well-established with other stimuli, including alcohol-

related images (Cameron et al., 2012). The task is completed in less than 10 minutes yet remains a powerful test of implicit cognitions (Cunningham et al., 2001). The AMP was presented before all other tasks querying drug and alcohol use so as to not contaminate spontaneous responses. The AMP was administered only during the Wave 1 assessment session. Photograph stimuli were drawn from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2008) and from online public domain sources. IAPS photo numbers and descriptions are contained in Appendix A.

2.2.2.2 Cannabis use.

To assess the frequency of cannabis use, participants were asked, "*When was the last time you smoked marijuana or used other THC products?*". Responses were given on a 5-point scale: *never, more than a year ago, in the past year, in the past month*, and *in the past week*. If participants indicated that they have used cannabis in the last 30 days, they were queried as to how many days out of the last 30 days did they use.

2.2.2.3 Drug use.

Using both formal and street names at Time 2 and 3, participants were asked how often they used each of the following nine drugs in the past year: psilocybin mushrooms, lysergic acid diethylamide (LSD), inhalants (glue, whiteout, nail polish remover, gasoline), ecstasy, gamma-hydroxybutyrate (GHB), rohypnol, methamphetamine, cocaine, and opiates. Responses were given on a 5-point scale: *never, more than a year ago, in the past year, in the past month*, and *in the past week*. Because of the low occurrence of affirmative ratings, responses were dichotomized to 0 (*none*) or 1 (*used at least one illicit drug in the past year*).

2.2.2.4 Cannabis Outcome Expectancy Liking (COEL; Fulton, Krank, & Stewart, 2012; See Appendix D).

Explicit measures of cannabis cognitions and attitudes were assessed using an open-ended question asking what participants anticipated would happen to them if they used cannabis (Fulton et al., 2012). Participants were asked to generate four expectancies. After completing this self-generated task, participants coded their responses according to how much they would like the respective outcome. This measure is used to capture the perceived hedonic quality of the outcome. COEL scores for cannabis outcomes were calculated at each wave. COEL scores ranged from 1 to 5 with higher scores indicating a greater liking score for that outcome. The mean was calculated for each set of outcomes at each time point. This score then reflected the mean liking score for cannabis outcomes. This procedure has been shown to have strong concurrent and prospective predictive validity and good test-retest reliability (Fulton et al., 2012).

2.2.3 Procedure

An information letter of negative consent was sent to all parents of children in the study prior to the study inception. According to school district policy, parents were given the option to have their child opt-out of participating on the days that their classes were participating in the surveys. Positive assent was obtained from participants on the day of the surveys and they were given the option at the end of each survey to have their data withdrawn.

All study procedures were approved by the Behavioural Research Ethics Board of the University of British Columbia Okanagan Campus (H10-01582). Students were provided with a confidential participant identification number. This number served as their password for each survey and allowed data to be linked through each wave of data collection. Each high school

maintained the list of students and their passwords. To ensure confidentiality, the lists were never provided to the researchers.

Students were seated at a computer for the duration of the study in their school computer labs or libraries. Approximately, 15 to 60 students completed the survey at a time and were supervised by the researcher or trained research assistants. The surveys were completed during class time and took approximately 30 to 60 minutes to complete. At Time 1, participants were tasked with the AMP first and were then asked to indicate whether they noticed anything about the Chinese pictographs and if they noticed anything about the images. Following this, the rest of the survey was completed. Each subsequent wave of data collection followed the same routine but excluded the AMP.

2.2.3.1 AMP procedure.

During each trial of the AMP, the prime appeared for 75ms in the middle of the computer screen. Prime images consisted of cannabis or neutral images. Following this, a 175ms lag occurred. Immediately after this lag, a Chinese pictograph appeared for 150ms followed by a black and white visual mask. The timing parameters were chosen based on past substance use research with the AMP (Payne et al., 2005). The mask remained on the screen until the participant responded to the trial by pressing one of two keys indicating a pleasant or unpleasant response. Participants were instructed to ignore the prime photograph and to make an affective judgement based on the Chinese pictograph instead. Participants rated each trial as pleasant or unpleasant.

To deter participants from responding without viewing the trials, a 500ms delay occurred before the next trial began. The task consisted of 133 trials of which the program selected randomly from each of the categories of prime photos without replacement. Images were chosen

from IAPS (Lang et al., 2008) and from open sources on the internet. Participants were given 10 practice trials prior to beginning the task to acquaint them with the procedure.

To calculate implicit attitudes towards cannabis from the AMP, the proportion of pleasant responses on control trials was subtracted from the proportion of cannabis trials respectively for each participant. Cannabis control trials included photos of people, plants, and objects that were matched to the proportion of cannabis photos including people, objects, and plants. This resulted in a score that indicated implicit attitudes, where a higher score indicated more positive attitudes towards cannabis (Payne et al., 2016).

2.3 Results

2.3.1 Analytical Procedure

The data analysis approach occurred in five stages. First, descriptive statistics including means and standard deviations were run on all study variables to characterize the study data. Second, a gamma distribution was used to examine differences at each time point between cannabis-users and non-users in regard to the cannabis-related AMP score. Third, Pearson correlations were computed between cannabis use at each timepoint, COEL scores, and AMP score to assess for associations between variables.

Fourth, a stepwise binomial logistic regression with robust methods was used to assess predictors of cannabis use group membership at each timepoint. This analysis was chosen because the data was characterized by a mix of continuous and categorical variables, some of which were not normally distributed. Cannabis user status (i.e., user or non-user) at each timepoint was input at the categorical dependent variable and implicit attitudes, COEL scores from each timepoint, and gender were input as covariates in the various models. Cannabis use was dichotomized into ever used and never used at each time point as the rates of use were less

than 20% in each wave. Several models were tested and are presented in the results section below.

Finally, a zero-inflated Poisson (ZIP) regression was used to measure the prediction of number of days used at each time point. ZIP regressions are used because most students had not used in past 30 days. The ZIP regression estimates the number of students who are users separately from the rate of use. A ZIP regression is an alternative procedure that allows for excessive zeros in count data by assuming two types of data exist within the outcome (i.e., individuals that fall into the zero-count group and individuals who fall into the count group) that can be predicted by a standard Poisson model. The ZIP regression uses probabilities from each group to allow for overdispersion in the count model (Poisson distribution) and excess zeros at the same time. The count variable in this analysis was the number of days a participant had used cannabis in the last 30 days. ZIP regressions estimate the probability of being a non-user (zero scores with a probability of 1) compared to the probability of being a current user (zero-inflation model assuming a binomial distribution). At the same time, the count model estimates the number of days using cannabis given that an individual is a current user. The count variable model fits a rate parameter to the number of days using cannabis while assuming a Poisson distribution.

2.3.2 Descriptive Statistics

Data for this study was collected as a part of an on-going research project. The target population included those who completed the AMP measure during Time 1. Demographic data was obtained from previous ongoing research with this population. During Time 2 and Time 3, information was missing from various participants due to time constraints or absenteeism and

loss of data from one school. As such, the following statistics represent those for whom data was available.

At Time 1, 94.5% of participants had never used cannabis (48.9% males; 51.1% females) and were classified as “cannabis non-users”; 5.5% had used cannabis in their lifetime (33.3% males; 66.7% females) and were classified as “cannabis users”. Of those who had used cannabis, 12.5% used more than a year ago, 33.3% used in the past year, 20.8% had used in the past month, and 33.3% had used in the last week.

At Time 2, 86.0% of participants had never used cannabis (45.8% males; 54.2% females) and were classified as “cannabis non-users”; 14.0% had used cannabis in their lifetime (44.7% males; 55.3% females) and were classified as “cannabis users”. Of those who had used cannabis, 19.6% used more than a year ago, 21.7% used in the past year, 23.9% had used in the past month, and 34.8% had used in the last week.

At Time 3, 82.9% of participants had never used cannabis (45.5% males; 54.5% females) and were classified as “cannabis non-users”; 17.1% had used cannabis in their lifetime (60.0% males; 40.0% females) and were classified as “cannabis users”. Of those who had used cannabis, 21.8% used more than a year ago, 18.2% used in the past year, 27.3% had used in the past month, and 32.7% had used in the last week.

2.3.2.1 Shapiro-Wilk Test

To test normality in the cannabis-related AMP scores, a visual inspection of the associated histogram and a Shapiro-Wilk test was conducted. Both indicated that the data was not normally distributed (W=0.97, $p < 0.01$).

2.3.3 Group Differences

To examine the differences between the cannabis user group and non-user group at Time 1, 2, and 3 on the continuous cannabis-related AMP variable, a gamma regression was estimated to account for the lack of normality in the variable. A constant (0.5) was added to the variable to account for negative numbers and was used to transform the data into an interpretable statistic. Group specific means and standard deviations are reported in Table 1. Reported means have been transformed back to reflect their original distribution. Results indicated that scores on the AMP at Time 1 were significantly different for non-users compared to cannabis-users at each time point ($p < 0.05$).

Table 1

Means and Standard Errors of AMP Score by Group

	Non-User Group		Cannabis-User Group	
	Mean	*Std. Error*	*Mean*	*Std. Error*
Time 1	-0.30_a	0.02	0.02_b	0.10
Time 2	-0.31_a	0.02	-0.12_b	0.06
Time 3	-0.32_a	0.02	-0.21_b	0.04

Note. Values in the same row not sharing the same subscript are significantly different at $p < 0.05$.

2.3.4 Pearson Correlations

Correlational analyses are reported in Table 2. Cannabis use at Time 1, 2 and 3 correlated significantly with COEL scores at each time point. AMP scores correlated significantly with cannabis use at each time point although the magnitude of correlation decreased over time. AMP scores also correlated significantly with COEL scores at each time point.

Table 2

Pearson Correlational Analyses

	Time 1 cannabis use	Time 2 cannabis use	Time 3 cannabis use	Time 1 COEL	Time 2 COEL	Time 3 COEL
Time 2 cannabis use	.39**	–				
Time 3 cannabis use	.32**	.71**	–			
Time 1 COEL	.38**	.32**	.28**	–		
Time 2 COEL	.23**	.43**	.33**	.51**	–	
Time 3 COEL	.22**	.43**	.42**	.47**	.59**	–
AMP score	.22**	.20**	.12*	.18**	.21**	.24**

Note: * $p < 0.05$; ** $p < 0.01$

2.3.5 Binomial Logistic Regression

The assumptions of a binomial regression were tested before conducting the procedure. No violations were found for independence of errors or multicollinearity. The Box-Tidwell test was conducted to determine if a linear relationship existed between the continuous predictor and the logit of the outcome variable. The test was non-significant ($p > 0.05$) suggesting this assumption was not violated.

2.3.5.1 Time 1 logistic regression.

At Time 1, a logistic regression analysis was conducted with AMP score, gender, and COEL variables as predictor variables and cannabis user status at Time 1 as the dependent variable. Variables were input in three stepwise blocks. Variables specific to the logistic regression analyses are reported in Table 3. The first model containing the AMP score only was statistically significant, $\chi^2(1) = 21.37$, $p < .01$, indicating that this variable was able to differentiate between those who did and did not use cannabis at Time 1. The model explained

between 7% (Cox and Snell R Square) and 19% (Nagelkerke R Square) of the variance in group membership, and correctly classified 93.6% of cases. In this model, the AMP score predicted group membership, $\beta = 3.40$, Wald chi square = 18.63 (6.41 – 141.16), $p = .01$.

The second model containing the AMP score and gender was statistically significant, $\chi^2(2) = 22.98$, $p < .01$. The model explained between 7.3% (Cox and Snell R Square) and 19.3% (Nagelkerke R Square) of the variance in group membership, and correctly classified 93.6% of cases. However, the addition of the gender variable, $\beta = 0.68$, Wald chi square = 1.53 (0.67 – 5.76), $p = .22$, in the second model at Time 1 did not make a unique statistically significant contribution to the overall model, indicating that gender did not predict whether an individual used cannabis at Time 1 or not.

The full model containing all predictors was statistically significant, $\chi^2(3) = 54.76$, $p < .01$, indicating that the model was able to differentiate between those with who were cannabis users at Time 1 and those who were not. The model explained between 17.6% (Cox and Snell R Square) and 46.6% (Nagelkerke R Square) of the variance in group membership, and correctly classified 95.4% of cases. The AMP score contributed significantly to this model, $\beta = 2.92$, Wald chi square = 11.96 (3.55 – 97.28), $p = .01$. COEL score at Time 1 also contributed significantly to the model, $\beta = 1.09$, Wald chi square = 24.09 (1.93 – 4.62), $p = .01$.

Table 3

Logistic Regression Analyses - Variables in the Equation for Time 1

	Exp(B)	*p*	95% CI		Wald	B(SE)
			Lower	Upper		
		Step 1				
AMP Score[a]	30.09	0.01	6.41	141.16	18.63	3.40(0.79)
		Step 2				
AMP Score[b]	30.06	0.01	6.49	144.73	18.66	3.42(0.79)
Gender	0.68	0.22	0.67	5.76	1.53	0.68(0.55)
		Step 3				
AMP Score[c]	18.57	0.01	3.55	97.28	11.96	2.92(0.85)
Gender	3.28	0.06	0.94	11.48	3.47	1.19(0.64)
COEL Time 1	2.99	0.01	1.93	4.62	24.09	1.09(0.22)

Note. CI = confidence interval; SE = standard error. [a] = R^2 = .07 (Cox & Snell), .19 (Nagelkerke). Model $\chi^2(1) = 21.37$, $p < .01$. [b] = R^2 = .08 (Cox & Snell), .21 (Nagelkerke). Model $\chi^2(2) = 22.98$, $p < .01$. [c] = R^2 = .18 (Cox & Snell), .47 (Nagelkerke). Model $\chi^2(3) = 54.76$, $p < .01$.

2.3.5.2 Time 2 logistic regression.

At Time 2, a logistic regression analysis was conducted with AMP score, gender, and COEL variables as predictors and cannabis user status at Time 2 as the dependent variable. Variables were input in three stepwise blocks. Variables specific to the logistic regression analyses are reported in Table 4. The first model containing the AMP score only was statistically significant, $\chi^2(1) = 5.64$, $p < .02$, indicating that this variable was able to

differentiate between those who did and did not use cannabis at Time 2. The model explained between 2.1% (Cox and Snell R Square) and 3.8% (Nagelkerke R Square) of the variance in group membership, and correctly classified 85.6% of cases. In this model, the AMP score predicted group membership, $\beta = 1.25$, Wald chi square = 5.60 (1.24 – 9.85), $p = .02$.

The second model containing the AMP score and gender was not statistically significant, $\chi^2(2) = 5.65$, $p = .06$. Prediction from this model did not improve at this step. The full model containing all predictors was statistically significant, $\chi^2(3) = 54.36$, $p < .01$, indicating that the model was able to differentiate between those with who were cannabis users at Time 2 and those who were not. The model explained between 18.7% (Cox and Snell R Square) and 33.2% (Nagelkerke R Square) of the variance in group membership, and correctly classified 85.2% of cases. The AMP score no longer contributed significantly to this model, $\beta = 0.76$, Wald chi square = 1.56 (0.65 – 7.01), $p = .21$. However, COEL score at Time 2 did contributed significantly, $\beta = 1.02$, Wald chi square = 38.38 (2.01 – 3.85), $p = .01$.

Table 4

Logistic Regression Analyses - Variables in the Equation for Time 2

	Exp(B)	*p*	95% CI		Wald	B(SE)
			Lower	Upper		
		Step 1				
AMP Score[a]	3.50	0.02	1.24	9.85	5.60	1.25(0.53)
		Step 2				
AMP Score[b]	3.49	0.02	1.24	9.85	5.59	1.25(0.53)
Gender	1.03	0.93	0.51	2.08	0.01	0.03(0.36)
		Step 3				
AMP Score[c]	2.13	0.21	0.65	7.01	1.56	0.76(0.61)
Gender	1.17	0.70	1.17	0.53	0.15	0.16(0.41)
COEL Time 2	2.79	0.01	2.01	3.85	38.38	1.02(0.17)

Note. CI = confidence interval; SE = standard error. [a] = R^2 = .02 (Cox & Snell), .04 (Nagelkerke). Model $\chi^2(1) = 5.64$, $p < .02$. [b] = R^2 = .02 (Cox & Snell), .04 (Nagelkerke). Model $\chi^2(2) = 5.65$, $p = .06$. [c] = R^2 = .19 (Cox & Snell), .33 (Nagelkerke). Model $\chi^2(3) = 54.36$, $p < .01$.

2.3.5.3 Time 3 logistic regression.

At Time 3, a logistic regression analysis was conducted with AMP score, gender, and COEL variables as predictor variables and cannabis user status at Time 3 as the dependent variable. Variables were input in three stepwise blocks. Variables specific to the logistic regression analyses are reported in Table 5. The first model containing the AMP score only was not statistically significant, $\chi^2(1) = 2.42$, $p = .12$, indicating that this variable was no

longer able to differentiate between those who did and did not use cannabis at Time 3. Similarly, the second model containing the AMP score and gender was not statistically significant, $\chi^2(2) = 5.75$, $p = .06$.

The full model containing all predictors was statistically significant, $\chi^2(3) = 57.16$, $p < .01$, indicating that the model was able to differentiate between those with who were cannabis users at Time 3 and those who were not. The model explained between 19.9% (Cox and Snell R Square) and 33.0% (Nagelkerke R Square) of the variance in group membership, and correctly classified 86.5% of cases. The only predictor that contributed significantly to this model was COEL at Time 3, $\beta = 0.99$, Wald chi square = 40.33 (1.99 – 3.67), $p = .01$.

Table 5

Logistic Regression Analyses - Variables in the Equation for Time 3

	Exp(B)	*p*	95% CI		Wald	B(SE)
			Lower	Upper		
		Step 1				
AMP Score[a]	2.22	0.12	0.82	6.02	2.44	0.80(0.51)
		Step 2				
AMP Score[b]	2.25	0.11	0.83	6.13	2.53	0.81(0.51)
Gender	0.55	0.07	0.28	1.05	3.27	-0.61(0.34)
		Step 3				
AMP Score[c]	0.76	0.64	0.24	2.42	0.22	-0.28(0.59)
Gender	0.62	0.22	0.30	1.32	1.53	-0.47(0.38)
COEL Time 3	2.70	0.01	1.99	3.67	40.33	0.99(0.16)

Note. CI = confidence interval; SE = standard error. [a] = R^2 = .01 (Cox & Snell), .02 (Nagelkerke). Model $\chi^2(1) = 2.42$, $p = .12$. [b] = R^2 = .02 (Cox & Snell), .04 (Nagelkerke). Model $\chi^2(2) = 5.75$, $p = .06$. [c] = R^2 = .20 (Cox & Snell), .33 (Nagelkerke). Model $\chi^2(3) = 57.16$, $p < .01$.

2.3.6 ZIP Regression

2.3.6.1 ZIP regression for AMP scores at Time 1.

At Time 1, a ZIP regression was conducted with AMP score and COEL ratings as the independent variables and number of days that cannabis was used in the last 30 as the dependent variable. Variables specific to the ZIP regression analyses at Time 1 are reported in Table 6 and 7. Results suggest that increased AMP scores, $\beta = 1.33$, SE = 2.35, $p = .01$,

predict higher rates of use (i.e., more days used) independent of COEL scores at Time 1 (see Table 6). Both increased AMP, β = -2.89, SE = 0.90, *p* = .01, and COEL scores, β = -0.77, SE = 0.24, *p* = .01, predict greater likelihood of being a current user at Time 1 (see Table 7).

Table 6

ZIP Regression Analyses – Count Model Coefficients

	Estimate	SE	z Score	*p*
AMP Score	1.33	2.35	5.64	0.01
COEL Time 1	-0.12	0.09	-1.40	0.63

Note. SE = standard error.

Table 7

ZIP Regression Analyses – Zero-Inflation Model Coefficients

	Estimate	SE	z Score	*p*
AMP Score	-2.89	0.90	-3.21	0.01
COEL Time 1	-0.77	0.24	-3.20	0.01

Note. SE = standard error.

2.3.6.2 ZIP regression for AMP scores at Time 2.

At Time 2, a ZIP regression was conducted with AMP score and COEL ratings as the independent variables and number of days that cannabis was used in the last 30 as the dependent variable. Variables specific to the ZIP regression analyses at Time 2 are reported in Table 8 and 9. Results suggest that increased AMP, β = 0.66, SE = 0.17, *p* = .01, and COEL scores, β = 0.36, SE = 0.07, *p* = .01, predict higher rates of use (i.e., more days used) at Time 2 (see Table 8). Both increased AMP, β = -2.35, SE = 0.70, *p* = .01, and COEL

scores, β = -0.97, SE = 0.21, *p* = .01, predict greater likelihood of being a current user at Time 2 (see Table 9).

Table 8

ZIP Regression Analyses – Count Model Coefficients

	Estimate	SE	z Score	*p*
AMP Score	0.66	0.17	3.91	0.01
COEL Time 2	0.36	0.07	5.50	0.01

Note. SE = standard error.

Table 9

ZIP Regression Analyses – Zero-Inflation Model Coefficients

	Estimate	SE	z Score	*p*
AMP Score	-2.35	0.70	-3.36	0.01
COEL Time 2	-0.97	0.21	-4.65	0.01

Note. SE = standard error.

2.3.6.3 ZIP regression for AMP scores at Time 3.

At Time 3, a ZIP regression was conducted with AMP score and COEL ratings as the independent variables and number of days that cannabis was used in the last 30 as the dependent variable. Variables specific to the ZIP regression analyses at Time 3 are reported in Table 10 and 11. Results suggest that increased AMP, β = -0.11, SE = 0.20, *p* = .57, and COEL scores, β = -0.07, SE = 0.06, *p* = .25, do not predict higher rates of use (i.e., more days used) at Time 3 (see Table 10). Increased AMP score, β = -0.89, SE = 0.81, *p* = .27, did not predict a greater likelihood of being a current user at Time 3 (see Table 11). COEL scores, β

= -1.20, SE = 0.24, *p* = .01, did independently predict greater likelihood of being a current user at Time 3 (see Table 11).

Table 10

ZIP Regression Analyses – Count Model Coefficients

	Estimate	SE	z Score	*p*
AMP Score	-0.11	0.20	-0.56	0.57
COEL Time 3	-0.07	0.06	-1.14	0.25

Note. SE = standard error.

Table 11

ZIP Regression Analyses – Zero-Inflation Model Coefficients

	Estimate	SE	z Score	*p*
AMP Score	-0.89	0.81	-1.10	0.27
COEL Time 3	-1.20	0.24	-4.93	0.01

Note. SE = standard error.

As would be expected, the statistical conclusions from the zero-inflation model for users versus non-users parallels the findings from the logistic regressions showing strong independent prediction of users by the AMP above outcome expectancies at baseline, moderate independent prediction at six months, and no significant predictive value at 12 months. The additional information provided by the ZIP analysis is such that frequency of cannabis use is independently predicted by the AMP at baseline and six months, but again not at 12 months.

3 Conclusion

3.1 Discussion

Assessing implicit cannabis cognitions among youth is valuable for informing public policy in Canada. Exploration of drugs and alcohol often occurs during adolescence, carrying the potential to shape a young person's future. The decision to experiment with substances is highly influenced by social factors which impact the cognitions and biases that are held by this age group. Several intervention and prevention strategies have been used to reduce adolescent engagement in harmful substance use. This study sought to contribute to the body of literature supporting prevention efforts to reduce harm to adolescents by using implicit measures to identify high risk adolescents.

The first hypothesis predicted that cannabis users would show significantly more positive ratings of the cannabis-related photos on the AMP than their non-using counterparts. Results indicated that scores on the AMP at Time 1 were significantly different for non-users compared to cannabis-users at each time point ($p < 0.05$). This suggests that cannabis users hold more positive cognitions that are automatically activated when they are presented with cannabis-related visual stimuli. This finding is consistent with previous cognitive research examining substance use (Cousijn et al., 2011; Field et al., 2004). This study adds to the literature by examining a large sample of adolescents, a group studied less often than emerging adults.

The second hypothesis suggested that AMP scores would predict substance use over a 12-month period. It was also hypothesized that the AMP would continue to predict group membership while controlling for an explicit measure of cannabis cognitions. These hypotheses were partially supported. Logistic regression analysis suggested that at baseline, the AMP score predicted group membership when controlling for the explicit measure of COEL. At 6 months,

the AMP independently predicted group membership, however, when COEL was included in the model, the AMP score was not significant, suggesting that COEL washes out the predictive effects of the AMP at 6 months post evaluation. At 12 months, the AMP score did not predict group membership independently anymore. COEL was significant in the full model at this time point, indicating that this measure is a strong longitudinal measure of substance use. Overall, the trend of prediction became weaker as time went on. The AMP appears to be an adequate predictor of current and future cannabis use but the predictive ability wanes over 12 months.

Third, it was hypothesized that the AMP would predict increases in days of cannabis use in the last 30 days over a 12-month period. ZIP regression analyses show that the AMP score has good concurrent predictive validity for cannabis use and frequency of use over and above a concurrent measure of explicit outcome expectancies at Time 1. Indeed, the prediction of frequency of use is only predicted by the AMP measure at Time 1. The AMP measure continues to predict frequency of use at 6-month follow-up, but the effects disappear by the 12-month follow-up. This finding was consistent across both logistic and ZIP regression analyses. This finding is in partial contrast to the study conducted by Payne and colleagues (2016). Results of this study suggest that implicit attitudes predicted alcohol use at 12-month follow-up in a similar aged group of adolescents. However, it is possible that the low rates of cannabis use in our sample accounted for the lack of significant results at the 12-month follow-up.

This study provides further evidence that both implicit and explicit cognitions significantly predict cannabis use in adolescents. Further, this effect exists even in those who have not tried cannabis previously, as our rates of use climbed at each time point. Consistent with prior drug research (Van Der Vorst et al., 2013), this suggests that implicit attitudes about cannabis use are formed prior to direct experience with the drug. Results such as this call for

prevention programs, as opposed to intervention programs, that are targeted at altering adolescents' cognitions regarding substance use before they enter into the experimentation stage. Lastly, this study bolsters evidence that the AMP is a valid procedure to detect and predict current and near future cannabis use and frequency in this population.

3.2 Limitations

This study utilizes data that was collected at three times points. Although we were able to examine adolescent substance use trajectories over a one-year period, we were unable to explore variation in trajectories over weeks or months. Further, data collection was limited to adolescents between the age of 12 and 15. Conclusions from this study are limited to adolescents transitioning from Grade 8 into Grade 9. Our findings must be interpreted with caution when extrapolating information to other adolescent age groups as generalizability may be low due to our sample characteristics. Further, analysis of adolescent substance use typically contains data from many adolescents who abstain from drug or alcohol use. As such, our measurements of substance use were skewed, with 82.4% reporting no cannabis use at any time point. To account for this zero-inflated data, we attempted to control for it statistically, as noted above.

This study is also limited by the self-report nature of the assessments that we conducted. With the exception of the AMP, the measures were solely self-report style measurements. The brief measures we used due to time constraints in the schools may have limited our reliability. Similarly, it is possible that this may have led to inaccurate reporting. Previous research has suggested that adolescent's reports of cannabis use may be underestimated using self-reported measures (Akinci, Tarter, & Kirisci, 2001). Moreover, because the assessments occurred in the school setting, it may be possible that students did not accurately respond to the self-report measures. Although the researchers took precautions to ensure all participants understood the

meaning of confidentiality and the limits in a research setting, some students may have feared their answers would be linked to their names and that they may face punitive actions or embarrassment.

Lastly, conducting research within a school district is often limited by time constraints on extracurricular activities as well as disruptions of various school routines. Although we would have preferred to include several more measures of substance use, mental health, and social variables, our allotted time was restricted to less than one hour during each wave of data collection. As such, our measurement of automatic cognitions was conducted during Time 1 only. We could not feasibly include another implicit measurement at the last time point. However, we determined that the research questions in this study could be adequately informed without a second implicit measurement. In the same vein, some research suggests that some participants will ignore the instructions to rate the Chinese pictograph and instead, will rate the prime photos (Payne et al., 2005). Future studies using the AMP should ask participants to state whether they intentionally rated the pictographs or the primes and determine if the data differ based on their intended ratings. However, one study suggested that those who stated that they rated the primes had stronger and more reliable priming effects (Bar-Anan & Nosek, 2012).

In contrast, our study had several strengths. For instance, we had a large sample size which increased our power to detect meaningful results. We also collected longitudinal data over the course of one year from our participants. We utilized 3 time points with 6 months in between the first and last wave of data collection. This allows us to examine individual variability in cannabis use trajectories and contrasts with the existing research that has often used cross-sectional or two-wave research designs. We were also provided with the opportunity to examine trajectories of substance use in those who did and did not use cannabis at baseline.

3.3 Implications

Despite the aforementioned limitations, this research contributes to the broader research base that examines the mediating role of implicit cognitions in adolescent cannabis use. This was the first study to examine implicit cognitions surrounding cannabis use with the AMP in a non-clinical sample of adolescents and was the first to use the AMP to predict the trajectory of cannabis use in adolescents. Results suggest evidence for the dual-processing theory of drug use in adolescents, as both implicit and explicit cognitions were independent and additive predictors of cannabis use.

The outcomes of this study suggest that the AMP holds value for assessing current and future cannabis use in adolescents in Canada. Although the levels of use in this sample were relatively low, we were able to model the data effectively. The simplicity and ease of implementations of the AMP procedure makes it a promising alternative to assessing adolescents who may be at increased risk of initiating or increasing their substance use.

3.4 Future Directions

With regards to future directions of this research, the AMP with cannabis use should be evaluated in older adolescents. As substance use experimentation and initiation typically increase as youth age, examining the utility of the AMP with an older adolescent population may provide further support for the predictive validity of this procedure. Furthermore, the AMP can be easily altered to include stimuli of other drugs. Comparative examinations between the AMP with cannabis and alcohol may provide insights into current substance use trends and further inform drug and alcohol prevention efforts.

References

Akinci, I. H., Tarter, R. E., & Kirisci, L. (2001). Concordance between verbal report and urine screen of recent marijuana use in adolescents. *Addictive Behaviors, 26*(4), 613-619. doi: 10.1016/S0306-4603(00)00146-5

Alfonso, J., & Dunn, M. E. (2007). Differences in the marijuana expectancies of adolescents in relation to marijuana use. *Substance Use & Misuse, 42*(6), 1009-1025. doi:10.1080/10826080701212386

Ames, S. L., Grenard, J. L., Thush, C., Sussman, S., Wiers, R. W., & Stacy, A. W. (2007). Comparison of indirect assessments of association as predictors of marijuana use among at-risk adolescents. *Experimental and Clinical Psychopharmacology, 15*(2), 204-218. doi:10.1037/1064-1297.15.2.204

Ames, S. L., & Stacy, A. W. (1998). Implicit cognition in the prediction of substance use among drug offenders. *Psychology of Addictive Behaviors, 12*(4), 272-281. doi:10.1037/0893-164X.12.4.272

Ames, S. L., Sussman, S., Dent, C. W., & Stacy, A. W. (2005). Implicit cognition and dissociative experiences as predictors of adolescent substance use. *The American Journal of Drug and Alcohol Abuse, 31*(1), 129-162. doi:10.1081/ADA-47908

Ames, S. L., Zogg, J. B., & Stacy, A. W. (2002). Implicit cognition, sensation seeking, marijuana use and driving behavior among drug offenders. *Personality and Individual Differences, 33*(7), 1055-1072. doi:10.1016/S0191-8869(01)00212-4

Bagot, K. S., Milin, R., & Kaminer, Y. (2015). Adolescent initiation of cannabis use and early-onset psychosis. *Substance Abuse, 36*(4), 524-533. doi:10.1080/08897077.2014.995332

Bar-Anan, Y., & Nosek, B. A. (2012). Reporting intentional rating of the primes predicts priming effects in the affective misattribution procedure. *Personality and Social Psychology Bulletin, 38*(9), 1194-1208. doi:10.1177/0146167212446835

Barrett, P., & Bradley, C. (2016). Attitudes and perceived risk of cannabis use in Irish adolescents. *Irish Journal of Medical Science, 185*(3), 643-647-647. doi:10.1007/s11845-015-1325-2

Bechtold, J., Hipwell, A., Lewis, D. A., Loeber, R., & Pardini, D. (2016). Concurrent and sustained cumulative effects of adolescent marijuana use on subclinical psychotic symptoms. *American Journal of Psychiatry, 173*(8), 781-789. doi:10.1176/appi.ajp.2016.15070878

Beer, J. S., Knight, R. T., & D'Esposito, M. (2006). Controlling the integration of emotion and cognition: The role of frontal cortex in distinguishing helpful from hurtful emotional information. *Psychological Science, 17*(5), 448-453. doi:10.1111/j.1467-9280.2006.01726.x

Bonn-Miller, M. O., Zvolensky, M. J., & Bernstein, A. (2007). Marijuana use motives: Concurrent relations to frequency of past 30-day use and anxiety sensitivity among young adult marijuana smokers. *Addictive Behaviors, 32*(1), 49-62. doi:10.1016/j.addbeh.2006.03.018

Buchy, L., Seidman, L. J., Cadenhead, K. S., Cannon, T. D., Cornblatt, B. A., McGlashan, T. H., . . . Addington, J. (2015). Evaluating the relationship between cannabis use and IQ in youth and young adults at clinical high risk of psychosis. *Psychiatry Research, 230*(3), 878-884. doi:10.1016/j.psychres.2015.11.033

Burdzovic Andreas, J., Pape, H., & Bretteville-Jensen, A. L. (2016). Who are the adolescents saying “no” to cannabis offers. *Drug and Alcohol Dependence, 163*, 64-70. doi:10.1016/j.drugalcdep.2016.03.025

Cameron, C. D., Brown-Iannuzzi, J. L., & Payne, B. K. (2012). Sequential priming measures of implicit social cognition: A meta-analysis of associations with behavior and explicit attitudes. *Personality and Social Psychology Review, 16*(4), 330-350. doi:10.1177/1088868312440047

Caspi, A., Moffitt, T. E., Cannon, M., McClay, J., Murray, R., Harrington, H., . . . Craig, I. W. (2005). Moderation of the effect of adolescent-onset cannabis use on adult psychosis by a functional polymorphism in the catechol-O-methyltransferase gene: Longitudinal evidence of a gene X environment interaction. *Biological Psychiatry, 57*(10), 1117-1127. doi:10.1016/j.biopsych.2005.01.026

Coffey, C., & Patton, G. C. (2016). Cannabis use in adolescence and young adulthood: A review of findings from the Victorian adolescent health cohort study. *Canadian Journal of Psychiatry, 61*(6), 318. doi:10.1177/0706743716645289

Collins, E. C., & Smith, E. R. (2009). Dual-process models: A social psychological perspective. In J. Evans & K. Frankish (Ed.), *In two minds: Dual processes and beyond* (pp. 197-216). Oxford Scholarship Online: Oxford Publishing. doi:10.1093/acprof:oso/9780199230167.003.0009

Collins, M. (2001). Transition to adulthood for vulnerable youths: A review of research and implications for policy. *Social Service Review, 75*(2), 271-291. doi:10.1086/322209

Cousijn, J., Goudriaan, A. E., & Wiers, R. W. (2011). Reaching out towards cannabis: approach-bias in heavy cannabis users predicts changes in cannabis use. *Addiction,* 106(9), 1667-1674. doi: 10.1111/j.1360-0443.2011.03475

Cunningham, W. A., Preacher, K. J., & Banaji, M. R. (2001). Implicit attitude measures: Consistency, stability, and convergent validity. *Psychological Science, 12*(2), 163-170. doi:10.1111/1467-9280.00328

de Looze, M., van den Eijnden, R., Verdurmen, J., Vermeulen-Smit, E., Schulten, I., Vollebergh, W., & ter Bogt, T. (2012). Parenting practices and adolescent risk behavior: Rules on smoking and drinking also predict cannabis use and early sexual debut. *Prevention Science, 13*(6), 594-604. doi:10.1007/s11121-012-0286-1

Degenhardt, L., Coffey, C., Romaniuk, H., Swift, W., Carlin, J. B., Hall, W. D., & Patton, G. C. (2013). The persistence of the association between adolescent cannabis use and common mental disorders into young adulthood. *Addiction, 108*(1), 124-133. doi:10.1111/j.1360-0443.2012.04015.x

Dutton, D. G., & Aron, A. P. (1974). Some evidence for heightened sexual attraction under conditions of high anxiety. *Journal of Personality and Social Psychology, 30*(4), 510-517. doi:10.1037/h0037031

Ellickson, P. L., Martino, S. C., & Collins, R. L. (2004). Marijuana use from adolescence to young adulthood: Multiple developmental trajectories and their associated outcomes. *Health Psychology, 23*(3), 299-307. doi:10.1037/0278-6133.23.3.299

Fazio, R. H., & Olson, M. A. (2003). Implicit measures in social cognition research: Their meaning and use. *Annual Review of Psychology, 54*(1), 297-327. doi:10.1146/annurev.psych.54.101601.145225

Field, M., Duka, T., Eastwood, B., Child, R., Santarcangelo, M., & Gayton, M. (2007). Experimental manipulation of attentional biases in heavy drinkers: Do the effects generalise? *Psychopharmacology, 192*(4), 593-608. doi:10.1007/s00213-007-0760-9

Field, M., & Eastwood, B. (2005). Experimental manipulation of attentional bias increases the motivation to drink alcohol. *Psychopharmacology, 183*(3), 350-357. doi:10.1007/s00213-005-0202-5

Field, M., Mogg, K., & Bradley, B. P. (2004). Cognitive bias and drug craving in recreational cannabis users. *Drug and Alcohol Dependence, 74*(1), 105-111. doi:10.1016/j.drugalcdep.2003.12.005

Fulton, H. G., Krank, M. D., & Stewart, S. H. (2012). Outcome expectancy liking: A self-generated, self-coded measure predicts adolescent substance use trajectories. *Psychology of Addictive Behaviors, 26*(4), 870-879. doi:10.1037/a0030354

Galen, L. W., & Henderson, M. J. (1999). Validation of cocaine and marijuana effect expectancies in a treatment setting. *Addictive Behaviors, 24*(5), 719-724. doi:10.1016/S0306-4603(98)00110-5

Gawronski, B., & Ye, Y. (2014). What drives priming effects in the affect misattribution procedure? *Personality and Social Psychology Bulletin, 40*(1), 3-15. doi:10.1177/0146167213502548

George, T., & Vaccarino, F. (2015). *Effects of cannabis use during adolescence*. Ottawa, ON: Canadian Centre on Substance Abuse.

Goodall, C. E., & Slater, M. D. (2010). Automatically activated attitudes as mechanisms for message effects: The case of alcohol advertisements. *Communication Research, 37*(5), 620-643. doi:10.1177/0093650210374011

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. K. (1998). Measuring individual differences in implicit cognition: The implicit association test. *Journal of Personality and Social Psychology, 74*(6), 1464-1480. doi:10.1037/0022-3514.74.6.1464

Greenwald, A. G., Poehlman, T. A., Uhlmann, E. L., & Banaji, M. R. (2009). Understanding and using the Implicit Association Test: III. Meta-analysis of predictive validity. *Journal of Personality and Social Psychology, 97*(1), 17-41. doi: 10.1037/a0015575

Griffith-Lendering, M. F. H., Wigman, J. T. W., Prince van Leeuwen, A., Huijbregts, S. C. J., Huizink, A. C., Ormel, J., . . . Vollebergh, W. A. M. (2013). Cannabis use and vulnerability for psychosis in early adolescence - A TRAILS study. *Addiction, 108*(4), 733-740. doi:10.1111/add.12050

Haight, J., Dickter, C. L., & Forestell, C. A. (2012). A comparison of daily and occasional smokers' implicit affective responses to smoking cues. *Addictive Behaviors, 37*(3), 234. doi:10.1016/j.addbeh.2011.10.006

Hathaway, A. D. (2003). Cannabis effects and dependency concerns in long-term frequent users: A missing piece of the public health puzzle. *Addiction Research & Theory, 11*(6), 441-458. doi:10.1080/1606635021000041807

Hayaki, J., Hagerty, C. E., Herman, D. S., de Dios, M. A., & Anderson, B. J. (2010). Expectancies and marijuana use frequency and severity among young females. *Addictive Behaviors, 35*(11), 995-1000. doi:10.1016/j.addbeh.2010.06.017

Henry, K. L., & Augustyn, M. B. (2017). Intergenerational continuity in cannabis use: The role of parent's early onset and lifetime disorder on child's early onset. *Journal of Adolescent Health, 60*(1), 87-92. doi:10.1016/j.jadohealth.2016.09.005

Hofmann, W., & Baumert, A. (2010). Immediate affect as a basis for intuitive moral judgement: An adaptation of the affect misattribution procedure. *Cognition & Emotion, 24*(3), 522-535. doi:10.1080/02699930902847193

Homel, J., Thompson, K., & Leadbeater, B. (2014). Trajectories of marijuana use in youth ages 15-25: Implications for postsecondary education experiences. *Journal of Studies on Alcohol and Drugs, 75*(4), 674-683. doi:10.15288/jsad.2014.75.674

Hurd, Y. L., Michaelides, M., Miller, M. L., & Jutras-Aswad, D. (2014). Trajectory of adolescent cannabis use on addiction vulnerability. *Neuropharmacology, 76*, 416. doi:10.1016/j.neuropharm.2013.07.028

Jajodia, A., & Earleywine, M. (2003). Measuring alcohol expectancies with the implicit association test. *Psychology of Addictive Behaviors, 17*(2), 126-133. doi:10.1037/0893-164X.17.2.126

Kiebel, E., McFadden, S., & Herbstrith, J. (2017). Disgusted but not afraid: Feelings toward same-sex kissing reveal subtle homonegativity. *The Journal of Social Psychology, 157*(3), 263-278. doi:10.1080/00224545.2016.1184127

Kobus, K. (2003). Peers and adolescent smoking. *Addiction, 98*(Suppl. 1), 37-55. doi:10.1046/j.1360-0443.98.s1.4.x

Kristjansson, S. D., Agrawal, A., Lynskey, M. T., & Chassin, L. A. (2012). Marijuana expectancies and relationships with adolescent and adult marijuana use. *Drug and Alcohol Dependence, 126*(1-2), 102-110. doi:10.1016/j.drugalcdep.2012.04.024

Kuepper, R., Os, J. v., Lieb, R., Wittchen, H., Höfler, M., & Henquet, C. (2011). Continued cannabis use and risk of incidence and persistence of psychotic symptoms: 10 year follow-up cohort study. *British Medical Journal, 342*(7796), 537-537. doi:10.1136/bmj.d738

Lang, P., Bradley, M., & Cuthbert, B. (2008). *International affective picture system (IAPS): Affective ratings of pictures and instruction manual.* (No. Technical Report A-8). University of Florida, Gainesville, FL: Oxford University Press.

Lee, C. M., Neighbors, C., & Woods, B. A. (2007). Marijuana motives: Young adults' reasons for using marijuana. *Addictive Behaviors, 32*(7), 1384-1394. doi:10.1016/j.addbeh.2006.09.010

Levine, A., Clemenza, K., Rynn, M., & Lieberman, J. (2016). Evidence for the risks and consequences of adolescent cannabis exposure. *Journal of the American Academy of Child & Adolescent Psychiatry 56*(3), 214-225, doi:10.1016/j.jaac.2016.12.014

Lubman, D. I., Cheetham, A., & Yücel, M. (2015). Cannabis and adolescent brain development. *Pharmacology & Therapeutics, 148*, 1-16. doi:10.1016/j.pharmthera.2014.11.009

Lynskey, M., & Hall, W. (2000). The effects of adolescent cannabis use on educational attainment: A review. *Addiction, 95*(11), 1621-1630. doi:10.1046/j.1360-0443.2000.951116213.x

MacKillop, J., & De Wit, H. (2012). *The Wiley-Blackwell handbook of addiction psychopharmacology* (3rd ed.). Chichester, West Sussex: Wiley-Blackwell.

Miller Buchanan, C., Eccles, J. S., & Becker, J. B. (1992). Are adolescents the victims of raging hormones: Evidence for activational effects of hormones on moods and behavior at adolescence. *Psychological Bulletin, 111*(1), 62-107. doi:10.1037/0033-2909.111.1.62

Moore, T. H., Zammit, S., Lingford-Hughes, A., Barnes, T. R., Jones, P. B., Burke, M., & Lewis, G. (2007). Cannabis use and risk of psychotic or affective mental health outcomes: A systematic review. *The Lancet, 370*(9584), 319-328. doi:10.1016/S0140-6736(07)61162-3

Moriarty, J., & Higgins, K. (2015). Effects of peer network interactions on adolescent cannabis use. *Journal of Criminal Psychology, 5*(2), 75.

Murphy, S. T., & Zajonc, R. B. (1993). Affect, cognition, and awareness: Affective priming with optimal and suboptimal stimulus exposures. *Journal of Personality and Social Psychology, 64*(5), 723-739.

Nelson, S. E., Van Ryzin, M. J., & Dishion, T. J. (2015). Alcohol, marijuana, and tobacco use trajectories from age 12 to 24 years: Demographic correlates and young adult substance use problems. *Development and Psychopathology, 27*(1), 253-277. doi:10.1017/S0954579414000650

Nosek, B. A. (2007). Implicit-explicit relations. *Current Directions in Psychological Science, 16*(2), 65-69. doi:10.1111/j.1467-8721.2007.00477.x

Pape, H., Rossow, I., & Storvoll, E. E. (2009). Under double influence: Assessment of simultaneous alcohol and cannabis use in general youth populations. *Drug and Alcohol Dependence, 101*(1), 69-73. doi:10.1016/j.drugalcdep.2008.11.002

Passarotti, A. M., Crane, N. A., Hedeker, D., & Mermelstein, R. J. (2015). Longitudinal trajectories of marijuana use from adolescence to young adulthood. *Addictive Behaviors, 45*, 301-308. doi:10.1016/j.addbeh.2015.02.008

Payne, B. K., Cheng, C., Govorun, O., & Stewart, B. (2005). An inkblot for attitudes: Affect misattribution as implicit measurement. *Journal of Personality and Social Psychology, 89*(3), 277-293. doi:10.1037/0022-3514.89.3.277

Payne, B. K., Lee, K., Giletta, M., & Prinstein, M. (2016). Implicit attitudes predict drinking onset in adolescents: Shaping by social norms. *Health Psychology, 35*(8), 829-836. doi:10.1037/hea0000353

Payne, B. K., & Lundberg, K. (2014). The affect misattribution procedure: Ten years of evidence on reliability, validity, and mechanisms. *Social and Personality Psychology Compass, 8*(12), 672-686. doi:10.1111/spc3.12148

Payne, B. K., Govorun, O., & Arbuckle, N. L. (2008). Automatic attitudes and alcohol: Does implicit liking predict drinking? *Cognition & Emotion, 22*(2), 238-271. doi:10.1080/02699930701357394

Payne, B. K., McClernon, F. J., & Dobbins, I. G. (2007). Automatic affective responses to smoking cues. *Experimental and Clinical Psychopharmacology, 15*(4), 400-409. doi:10.1037/1064-1297.15.4.400

Payne, B. K., Hall, D., Cameron, C., & Bishara, A. (2010). A process model of affect misattribution. *Personality and Social Psychology Bulletin, 36*(10), 1397-1408. doi:10.1177/0146167210383440

Pokhrel, P., Fagan, P., Herzog, T. A., Chen, Q., Muranaka, N., Kehl, L., & Unger, J. B. (2016). E-cigarette advertising exposure and implicit attitudes among young adult non-smokers. *Drug and Alcohol Dependence, 163*, 134-140. doi:10.1016/j.drugalcdep.2016.04.008

Porath-Waller, A. (2014). Clearing the smoke on Canadian youths' perceptions of cannabis. *Drug and Alcohol Dependence, 140*, e180. doi:10.1016/j.drugalcdep.2014.02.504

Rehm, J., & Fischer, B. (2015). Cannabis legalization with strict regulation, the overall superior policy option for public health. *Clinical Pharmacology & Therapeutics, 97*(6), 541-544. doi:10.1002/cpt.93

Roditis, M. L., Delucchi, K., Chang, A., & Halpern-Felsher, B. (2016). Perceptions of social norms and exposure to pro-marijuana messages are associated with adolescent marijuana use. *Preventive Medicine, 93*, 171-176. doi:10.1016/j.ypmed.2016.10.013

Roefs, A., Huijding, J., Smulders, F. T. Y., MacLeod, C. M., de Jong, P. J., Wiers, R. W., & Jansen, A. T. M. (2011). Implicit measures of association in psychopathology research. *Psychological Bulletin, 137*(1), 149-193. doi:10.1037/a0021729

Rooke, S. E., Hine, D. W., & Thorsteinsson, E. B. (2008). Implicit cognition and substance use: A meta-analysis. *Addictive Behaviors, 33*(10), 1314-1328. doi:10.1016/j.addbeh.2008.06.009

Rusu, A., Sârbescu, P., Moza, D., & Stancu, A. (2017). Implicit attitudes towards risky driving: Development and validation of an affect misattribution procedure for speeding. *Accident Analysis & Prevention, 100*, 15-22. doi:10.1016/j.aap.2016.12.022

Schmits, E., Maurage, P., Thirion, R., & Quertemont, E. (2015). Dissociation between implicit and explicit expectancies of cannabis use in adolescence. *Psychiatry Research, 230*(3), 783-791. doi:10.1016/j.psychres.2015.11.005

Scholes-Balog, K. E., Hemphill, S. A., Evans-Whipp, T. J., Toumbourou, J. W., & Patton, G. C. (2016). Developmental trajectories of adolescent cannabis use and their relationship to young adult social and behavioural adjustment: A longitudinal study of Australian youth. *Addictive Behaviors, 53*, 11-18. doi:10.1016/j.addbeh.2015.09.008

Scholes-Balog, K. E., Hemphill, S. A., Patton, G. C., & Toumbourou, J. W. (2013). Cannabis use and related harms in the transition to young adulthood: A longitudinal study of Australian secondary school students. *Journal of Adolescence, 36*(3), 519-527. doi:10.1016/j.adolescence.2013.03.001

Simons, J. S., & Arens, A. M. (2007). Moderating effects of sensitivity to punishment and sensitivity to reward on associations between marijuana effect expectancies and use. *Psychology of Addictive Behaviors, 21*(3), 409-414. doi:10.1037/0893-164X.21.3.409

Stacy, A. W., & Wiers, R. W. (2010). Implicit cognition and addiction: A tool for explaining paradoxical behavior. *Annual Review of Clinical Psychology, 6*(1), 551-575. doi:10.1146/annurev.clinpsy.121208.131444

Stacy, A. W. (1995). Memory association and ambiguous cues in models of alcohol and marijuana use. *Experimental and Clinical Psychopharmacology, 3*(2), 183-194. doi:10.1037/1064-1297.3.2.183

Stacy, A. W., Ames, S. L., Sussman, S., & Dent, C. W. (1996). Implicit cognition in adolescent drug use. *Psychology of Addictive Behaviors, 10*(3), 190-203. doi:10.1037/0893-164X.10.3.190

Stacy, A. W., Leigh, B. C., & Weingardt, K. R. (1994). Memory accessibility and association of alcohol use and its positive outcomes. *Experimental and Clinical Psychopharmacology, 2*(3), 269-282. doi:10.1037/1064-1297.2.3.269

Stacy, A. W., & Newcomb, M. D. (1998). Memory association and personality as predictors of alcohol use: Mediation and moderator effects. *Experimental and Clinical Psychopharmacology, 6*(3), 280-291. doi:10.1037/1064-1297.6.3.280

Statistics Canada. (2015). *Canadian tobacco, alcohol and drugs survey*. Ottawa, ON: Statistics Canada.

Swanson, J. E., Swanson, E., & Greenwald, A. G. (2001). Using the implicit association test to investigate attitude-behaviour consistency for stigmatised behaviour. *Cognition and Emotion, 15*(2), 207-230. doi:10.1080/0269993004200060

Task Force on Marijuana Legalization and Regulation. (2016). *Toward the legalization, regulation and restriction of access to marijuana: Discussion paper.* Ottawa: ON: Government of Canada.

Thompson, K., Merrin, G. J., Ames, M. E., & Leadbeater, B. (2018). Marijuana trajectories in Canadian youth: Associations with substance use and mental health. *Canadian Journal of Behavioural Science, 50*(1), 17-28. doi:10.1037/cbs0000090

UNICEF Office of Research. (2013). *Child well-being in rich countries: A comparative overview*. UNICEF Office of Research, Venice: Innocenti Report Card 11.

Van Der Vorst, H., Krank, M., Engels, R. C. M. E., Pieters, S., Burk, W. J., & Mares, S. H. W. (2013). The mediating role of alcohol-related memory associations on the relation between perceived parental drinking and the onset of adolescents' alcohol use. *Addiction, 108*(3), 526-533. doi:10.1111/add.12042

Van Der Vorst, H., Vermulst, A. A., Meeus, W. H. J., Deković, M., & Engels, R. C. M. E. (2009). Identification and prediction of drinking trajectories in early and mid-adolescence. *Journal of Clinical Child & Adolescent Psychology, 38*(3), 329-341. doi:10.1080/15374410902851648

Vo, H. T., Schacht, R., Mintzer, M., & Fishman, M. (2014). Working memory impairment in cannabis- and opioid-dependent adolescents. *Substance Abuse, 35*(4), 387-390. doi:10.1080/08897077.2014.954027

Walburg, V., Moncla, D., & Mialhes, A. (2015). Burnout among high-school students and cannabis use, consumption frequencies, abuse and dependence. *Child & Youth Care Forum, 44*(1), 33-42. doi:10.1007/s10566-014-9268-8

Wiers, R. W., Bartholow, B., Wildenberg, v. d., E., Thush, C., Engels, R., Sher, K. J., . . . Stacy, A. (2007). Automatic and controlled processes and the development of addictive behaviors in adolescents: A review and a model. *Pharmacology, Biochemistry and Behavior, 86*(2), 263-283. doi:10.1016/j.pbb.2006.09.021

Wiers, R. W., & Stacy, A. (2006). Implicit cognition and addiction: An introduction. In R. W. Wiers & A. W. Stacy. (Eds.), *Handbook of implicit cognition and addiction* (pp. 1-8). Thousand Oaks, CA: SAGE Publications Ltd. doi:10.4135/9781412976237.n1

Wiers, R. W., Van Woerden, N., Smulders, F. T. Y., & De Jong, P. J. (2002). Implicit and explicit alcohol-related cognitions in heavy and light drinkers. *Journal of Abnormal Psychology, 111*(4), 648-658. doi:10.1037//0021-843X.111.4.648

Williams, A., Steele, J. R., & Lipman, C. (2016). Assessing children's implicit attitudes using the affect misattribution procedure. *Journal of Cognition and Development, 17*(3), 505-525. doi:10.1080/15248372.2015.1061527

Willner, P. (2001). A view through the gateway: Expectancies as a possible pathway from alcohol to cannabis. *Addiction, 96*(5), 691-703. doi:10.1046/j.1360-0443.2001.9656915.x

Windle, M., & Wiesner, M. (2004). Trajectories of marijuana use from adolescence to young adulthood: Predictors and outcomes. *Development and Psychopathology, 16*(4), 1007-1027. doi:10.1017/S0954579404040118

Winters, K. C., & Lee, C. S. (2008). Likelihood of developing an alcohol and cannabis use disorder during youth: Association with recent use and age. *Drug and Alcohol Dependence, 92*(1), 239-247. doi:10.1016/j.drugalcdep.2007.08.005

Appendices

Appendix A: Picture Stimuli from the International Affective Picture System (IAPS)

IAPS number	IAPS name
2002	Man
2019	Attractive Female
2026	Woman
2036	Woman
2037	Woman
2038	Neutral Woman
2039	Woman
2102	Neutral Man
2104	Neutral Woman
2107	Male
2190	Man
2191	Farmer
2200	Neutral Face
2214	Neutral Man
2215	Neutral Man
2272	Lonely Boy
2305	Girl
2377	Reading
2383	Secretary
2390	Couple
2489	Musician
2491	Sick Man
2515	Harvest
5000	Flower
5001	Sunflower
5010	Flower
5020	Flower
5030	Flower
5040	Venus Fly Trap
5199	Garden
5200	Flowers
5726	Grain
5740	Plant
5750	Nature
5780	Nature
5800	Leaves
7000	Rolling Pin
7002	Towel
7009	Mug
7012	Rubber Bands
7014	Scissors

IAPS number	IAPS name
7021	Whistle
7025	Stool
7026	Picnic Table
7045	Zipper

Appendix B: Cannabis Outcome Expectancy Liking Task

What do you expect or anticipate to happen if you used marijuana?
Response 1: _____
Response 2: _____
Response 3: _____
Response 4:_____

How much would you like each outcome?

Like a lot	Like	Neither	Not like	Not like a lot