Addictive Behaviors Reports 15 (2022) 100425

Contents lists available at ScienceDirect

Addictive Behaviors Reports

journal homepage: www.elsevier.com/locate/abrep

Cognitions mediate the influence of personality on adolescent cannabis use initiation

Maya A. Pilin *, Jill M. Robinson, Katie Young, Marvin D. Krank

Psychology Department, University of British Columbia, 1147 Research Road, Kelowna, BC V1V 1V7, Canada

ARTICLE INFO

Keywords:
Adolescents
Substance use
Cannabis
Cognition
Personality, dual processing

ABSTRACT

Aims: Much research indicates that an individual's personality impacts the initiation and escalation of substance use and problems in youth. The acquired-preparedness model suggests that personality influences substance use by modifying learning about substances, which then affects substance use. The current study used longitudinal data to test whether automatic cannabis-related cognitions (memory associations and outcome expectancy liking) mediate the relationship between four personality traits with later cannabis use.

Methods: The study focused on initiation of use in a sample of adolescents who had not previously used ($n = 670$).

Results: A structural equation model supported a full mediation effect and the hypothesis that personality affects cannabis use in youth by influencing automatic memory associations and outcome expectancy liking. Further findings from the same model also indicated a mediation effect of these cognitions in the relationship between age and cannabis use.

Conclusion: The findings of the study support the acquired-preparedness model where personality influences automatic associations in the context of dual-processing theories of substance use.

1. Introduction

Adolescence is a time of vulnerability, experimentation, and susceptibility to drug and alcohol initiation, including cannabis use (Schmits et al., 2015; Smith & Anderson, 2001). Cannabis use can be detrimental to the development of young individuals when initiated at an early age and can increase the risk of substance-related problems later in life (Coffey & Patton, 2016). Therefore, further inquiry into the cognitive mechanisms that lead to cannabis use should be explored in order to prevent the onset of cannabis-related problems.

1.1. Personality and substance use

One area of research that shows promise in identifying those that may be vulnerable to problematic substance use is that of personality traits and automatic cognitions (Castellanos-Ryan et al., 2013; Krank et al., 2011; Sher et al., 2000; Teichman et al., 1989). A growing body of research with both adolescent and young adult samples suggests that certain specific personality traits, such as impulsivity, hopelessness, anxiety sensitivity, and sensation seeking, can lead to substance use (Krank et al., 2011; Woicik et al., 2009). The impulsivity personality trait is described as the inability to inhibit specific behaviours (Castellanos-Ryan et al., 2013). Impulsivity is associated with increased use and misuse of many substances (Krank et al., 2011) and is associated with poly-substance use problems in adults (Moody et al., 2016). Impulsivity has been shown to positively correlate with cannabis use, as well with severity of use and other substance use in a sample of adults within an inpatient substance abuse treatment program (Schlauch et al., 2015). Schlauch et al. (2015) posit that individuals high in impulsivity may have challenges inhibiting their behaviour when presented with cues offering immediate reinforcements.

Another personality trail that is related to substance use is negative thinking. Negative thinking is the tendency for one to experience increased feelings of despair (Castellanos-Ryan et al., 2013). Negative thinking is associated with a greater risk of substance use in numerous studies in adults, although Castellanos-Ryan and Conrod (2012) noted that less support has been found in adolescent samples.. However, some studies, notably Krank et al. (2011), have found that negative thinking predicts cannabis use, tobacco use, and other drug use in a study of young adults (grades 7 through 9) in Western Canada. Additionally, negative thinking has positive associations with alcohol use (Malmberg et al., 2012) and tobacco use in 11 to 15 year-olds (Malmberg et al.,

* Corresponding Author: Address: Psychology Department, University of British Columbia, 1147 Research Road, Kelowna, BC V1V 1V7, Canada.
E-mail address: mayapilin@alumni.ubc.ca (M.A. Pilin).

https://doi.org/10.1016/j.abrep.2022.100425
Received 9 January 2022; Received in revised form 22 March 2022; Accepted 5 April 2022
Available online 9 April 2022

2010), and sedative drug misuse in undergraduate students, specifically to cope with negative feelings (Woicik et al., 2009).

Anxiety sensitivity is the fear of anxiety-related physiological arousal and sensations and the potential loss of control over oneself (Castellanos-Ryan et al., 2013). The relationship between anxiety sensitivity and substance use has been explored in research but mixed results exist in the literature. For instance, Memetovic et al. (2016) discovered that all personality traits (i.e., sensation seeking, hopelessness, impulsivity) except for anxiety sensitivity were independently associated with an increased risk of smoking cigarettes in adolescents. Similarly, another study found that anxiety sensitivity was not a significant risk factor of substance misuse in early adolescence (Krank et al., 2011), and that anxiety sensitivity had significant negative associations with levels of substance use in incoming undergraduate students (Moser et al., 2014) and in adolescents (M. Krank et al., 2011). In contrast, a review by Stewart et al. (1999) suggested that anxiety sensitivity was positively associated with alcohol use and negatively associated with cannabis and stimulants. Similarly, Woicik et al. (2009) determined that anxiety sensitivity predicted drinking motives and alcohol use problems in a sample of undergraduate students. This may indicate that the developmental trajectory overtime has differential effects on substance use as it relates to anxiety sensitivity. For instance, it may be the case that in younger individuals, anxiety sensitivity is protective from substance use while in older adolescents, anxiety sensitivity begins to be predictive of alcohol and other sedative use when an adolescent begins to use sedative drugs to regulate anxiety (Conrod et al., 2000).

Finally, the personality trait sensation seeking is associated with a strong desire for stimulation and novel experiences (Castellanos-Ryan et al., 2013). Conrod et al. (2000) found that individuals high in sensation seeking were at an increased risk of alcohol-related problems. As well as being associated with alcohol use in both adolescents and young adults (Malmberg et al., 2010; Moser et al., 2014; Schlauch et al., 2015), Krank et al. (2011) found evidence that sensation-seeking as measured by the Substance Use Risk Profile Scale is also predictive of hallucinogen use in a longitudinal study of adolescents.

Despite significant support that certain personality traits are associated with alcohol use, there is less research examining the association of personality traits and cannabis use initiation. Furthermore, many studies examining the connection between personality traits and substance use do not comment on or postulate the mechanism through which personality impacts substance use.

1.2. Dual process theory

One theory relevant in determining the mechanisms of how personality affects substance use is the dual processes theory. Dual-processing theories illustrate that decisions are influenced by two distinct cognitive systems with different methods of information retrieval: System One and System Two (Kahneman, 2011). System One is described as spontaneous, fast, and operates without conscious awareness, whereas System Two operates at a conscious level of awareness, and is slower, reflective, and effortful (Kahneman, 2011). The automatic processes of System 1 influence decisions, judgements, and behaviours without the individual becoming conscious awareness of the influence System 1 is having on the present moment (Krank & Robinson, 2017). Strong evidence for a dual processing approach to cognition is born out in assessments of automatic cognition such as response time measures and approach-avoidance tasks (Kahneman, 2011).

Research also shows that these automatic cognitions can lead to cognitive biases, which may also have impacts on future substance use (van der Vorst et al., 2013). Specifically, memory association biases, attentional biases, and approach biases correlate with increased substance use (Stacy & Wiers, 2010). Attentional biases are the tendency to allocate attention to substance-related cues relative to non-substance-related cues when they are presented simultaneously or close in time (Lindgren et al., 2019). Automatic approach biases are demonstrated when an individual approaches substance related cues faster or more often than non-substance related cues (Lindgren et al., 2019). Finally, memory associations form when an individual is repeatedly exposed to substance use cues over time, creating an association between the environment, context, or experience and the substance (van der Vorst et al., 2013). Further, van der Vorst et al. (2013) suggest that these cognitive biases may begin to form before an individual initiates substance use. Substance-related memory associations have been reported in children and adolescents and are suggested to form through observations of parents, the internet, social media, and television (van der Vorst et al., 2013). Pilin et al. (2021) found that more cannabis use by parents was associated with more cannabis-related memory associations in adolescents, which led to a higher likelihood of cannabis use in the next year. These findings illustrate that cognitive processes have an indirect influence on later substance use in adolescents. This paper sought to demonstrate that these findings can be extended to include personality as a mediator of adolescent substance use.

1.2.1. Measuring automatic cognitions

Researchers have devised two theoretically different approaches to measuring System One and System Two cognition as it relates to substance use. To measure System One cognitive processes, researchers use indirect methods that do not ask the participant to consciously deliberate their response (e.g., reaction time tasks; Krank & Robinson, 2017). Indirect measures of substance use cognitions ask about the fundamental concept indirectly, yet responses related to substance use may be generated spontaneously and automatically (Krank & Robinson, 2017). Word association tasks are common indirect methods that use ambiguous single-word prompts or multi-word behavioral prompts that could be associated with substance-related cues (Krank et al., 2011; Krank & Robinson, 2017; Pilin et al., 2021; Stacy et al., 1994; Stacy, 1995). If the participant has strong automatic associations with the prompt and a substance, it is likely that these associations will be triggered automatically and will be reported on the measure spontaneously.

In many other measures, researchers ask participants directly about substance use via self-report measures such as substance use outcome expectancy scales. Although direct methods are more likely to be influenced by controlled processing (System two), dual processing theories acknowledge the important underlying influence of automatic associations (System one). That is, direct assessments, such as outcome expectancies, are strongly affected by automatic and unconscious influences (Ames et al., 2012; Krank & Robinson, 2017). Although some may view this influence as measurement error, the dual processing perspective views automatic influences from associative memory as the foundation of judgements and decision-making (Kahneman, 2011). In this study, we use the outcome expectancy liking measure (Fulton et al., 2012). This direct measure asks participants to rate how much they would like several self-generated outcomes of using a particular substance. The outcome expectancy liking emphasizes associative memory influences by encouraging top of mind responses. It also focuses on the overall positivity of these associations. Research findings demonstrate a strong prediction of the growth trajectories of both alcohol and cannabis use in adolescents (Fulton et al., 2012).

1.3. Acquired-Preparedness model

The Acquired-Preparedness Model (APM) describes how personality relates to substance use. The APM suggests that an individual's personality traits shape their learning experiences which then influence behaviour, potentially leading to substance use (Smith & Anderson, 2001). For instance, the impulsivity personality trait may predispose an individual to selectively focus on immediate rewards over the long-term consequences of their behaviour (Bolles et al., 2014). Further, in a situation with both positive and negative consequences, a person higher in impulsivity is more likely to attend to the rewards rather than the consequences (Smith & Anderson, 2001). Therefore, the impulsive individual will may learn over time that substance use will bring about positive reinforcements in the short-term and selectively ignore the long-term consequences of substance use (Smith & Anderson, 2001). The development of substance-related problems may then be acquired when the impulsive trait interacts with specific substance-related learning (Smith & Anderson, 2001). In more recent studies, the APM has been extended to examine the role of temperament (Marks et al., 2020) and sensation seeking (Gunn & Smith, 2010) in the alcohol use of young adolescents and young adults.

The APM also explains how personality traits may impact the outcome expectancies one has of substance use, which then influence substance use behaviour (Smith & Anderson, 2001). For example, if an individual scores high in anxiety sensitivity and they expect that drinking alcohol will help them relax, they are more likely to use alcohol when they experience high stress in their life (Woicik et al., 2009). The APM has accumulated considerable support across many studies, with many studies finding a mediating effect of cognitive processes in the relationship between personality traits and substance use outcomes, although the majority of studies have been based on young adult, not adolescent, samples (Anderson et al., 2003; Anthenien et al., 2017; Corbin et al., 2011; Fu et al., 2007; McCarthy et al., 2001).

In addition, research has also found that prior experiences influence later substance use through automatic cognitions (Pilin et al., 2021; van der Vorst et al., 2013). However, limited research in this has been conducted to fully examine relationship between personality traits and automatic cannabis cognitions. To best characterize the impact of cognition on cannabis use and use this research, it is essential to understand how personality traits can influence cognition. Therefore, the purpose of this study was to test the hypothesis that self-generated cannabis cognitions would mediate the association between personality and cannabis use in a large sample of young adolescents.

2. Methods

2.1. Participants and procedures

Participants were drawn from the Project on Adolescent Trajectories and Health (PATH) longitudinal study which included students in Grades 8 to 10 in a large school district in Western Canada. Parental consent and student assent was obtained as per the University of British Columbia Okanagan Behavioural Research Ethics Board procedures. At Time 1, the sample included 1142 participants. The attrition rate from Time 1 to Time 2 was 16.29%, with 956 participants remaining at T2. From the remaining 956 participants, and 265 participants were removed due to having used cannabis in the past year at T1. Additionally, two participants were removed due to being outliers on the age variable, 15 participants were removed for inconsistent response patterns on the cannabis use variables (see *Data Analysis* for more details), and 4 participants were removed for having missing data on the Cannabis Use at T1 variable. The final dataset thus included 670 participants. Parts of the data reported in this manuscript have been previously published and were collected as part of a larger data collection. Findings from the data collection have been reported in separate manuscripts. Fulton et al. (2012) focuses on the Outcome Expectancy Liking measure, Pilin et al. (2021) focuses on parental cannabis use and its effect on the OEL and word associate scores (WATs) and later cannabis use (years 1 through 3), while the current manuscript focuses on personality scores, cognitive variables, and adolescent cannabis use through years 2 and 3 of the study.

2.2. Measures

All participants responded to questions about the frequency of their cannabis use, cannabis associations, and their personality. These measures were repeated annually for two years. Data was linked by identification codes that preserved participant confidentiality. To test the mediation hypothesis, our analysis used personality scores measured at Time 1, the cannabis outcome expectancy liking (COEL) task and the cannabis word association task (CWAT) measured at Time 1and 2, age measured at Time 1, and cannabis use measured at Time 1 and 2. Time 1 represented baseline while Time 2 measures were taken 1 year later.

2.2.1. Personality measure

Personality scores were calculated using the Substance Use Risk Profile Scale (SURPS; Woicik et al., 2009). When completing the SURPS, participants responded to a series of 23 questions about their personality with answers given on a 1 to 5 Likert-scale (*Strongly Disagree* to *Strongly Agree*). To score the measure, several questions were reverse scored, as per the scoring guidelines. Scores were then summed for each subscale to create a separate score for Anxiety Sensitivity, Negative Thinking, Sensation-Seeking, and Impulsivity. The SURPS was developed specifically to identify traits associated with substance use and the scales allow calculation of separate scores to be calculated for each of these personality traits. Furthermore, the scale has strong psychometric properties, including in measures of internal consistency and test–retest reliability (see Conrod, 2016; Krank et al., 2011).

2.2.2. Cannabis use measures

Adolescent cannabis use at Time 1 and Time 2 was measured by asking participants when they last used marijuana, with responses coded on a 0 to 4 ordinal scale (e.g., never, more than a year ago, in the past year, in the past month, or in the past week). Categories were collapsed, such that responses were coded as 1 if they had used cannabis in the past year and 0 otherwise and any participants who had used cannabis in the past year at Time 1 were deleted from the dataset. This coding scheme captures more than 90% of the variance in the last time used response (Krank et al., 2010). We did not collapse the categories when measuring cannabis use at Time 2, retaining the ordinal structure of the scale, and included past cannabis use (i.e., past week, past month, past year, more than a year ago, never) at Time 2 as the outcome variable in our model.

2.2.3. Cannabis word associates task (CWAT)

Memory associations were measured using the CWAT at Time 1 and 2. Participants responded with the first word that came to mind in response to a target word that has dual meanings. Words were included based on previous research with alcohol and cannabis (Stacy, 1995). Participants were presented with 32 words that included several cannabis-related cue words (e.g., *weed, pot, pipe*). Responses were scored by two independent coders. Coders assigned a 1 to responses that were related to cannabis (e.g., smoke or get high) and a 0 to non-cannabis related responses. The final CWAT score was a sum of all the responses that were coded as cannabis-related by the coders, with higher scores indicating greater endorsement of cannabis-related cues. In the current sample, CWAT scores ranged from 0 to 6, with a mean score of 2.35, indicating that participants responded with approximately two cannabis-related associations in response to the six cues.

2.2.4. Cannabis outcome expectancy liking task (COEL)

Direct cannabis cognitions were measured with the COEL task at Time 1 and 2. Participants generated four outcomes they anticipated may occur if they used a moderate amount of cannabis. For each outcome, participants responded whether they would like the outcome or not, with responses that participants indicated as liking scored as 1, while non-liked responses were scored as 0. This procedure allows participants to clarify ambiguous responses by indicating whether they perceive the outcome positively or negatively; for instance, an adolescent may indicate that they expect to feel dizzy if they use cannabis, but that they enjoy this sensation. Sum outcome expectancy liking scores over the four responses were calculated for each participant, ranging from 0 to 4. Lower scores demonstrate less preference for the expected outcomes of cannabis use while higher scores demonstrate greater preference for the outcomes. In previous research, higher COEL scores were associated with earlier initiation of cannabis use and a faster rate of change (Fulton et al., 2012). In the current sample, scores ranged from 0 to 4, with a mean of 0.37, indicating overall low liking of expected outcomes of cannabis use.

2.3. Statistical analyses

Descriptive statistics and Pearson correlation analyses were conducted on all variables. In the structural equation model, CWAT Time 1 and 2 and COEL Time 1 and 2 scores were combined into a latent factor (Cognitions T1 and T2 respectively). Participants' age at Time 1 was included in the model to control for the potential effect on cannabis use. Next, a mediation model was constructed based on the hypothesis that personality traits influence cannabis use through cannabis cognitions. A full-information maximum-likelihood model was used for the structural equation. We ran our initial analyses with all possible direct paths included. We removed all non-significant paths from the full model using an iterative process, including direct paths from each of the personality variables to past use at T2. The final model described below is the trimmed model with only significant paths included (Fig. 1). To further test our hypotheses, we created a second model that included Cognitions at Time 1 and Cognitions at Time 2, allowing us to control for the influence of Time 1 Cognitions on past cannabis use and on Cognitions at Time 2 (see Fig. 2). We included all covariances that were significant in the original model and included covariances between the CWAT measures and COEL measures over the two assessment waves (CWAT at Time 1 to CWAT at Time 2 and COEL at Time 1 and COEL at Time 2) to account for measurement-specific variance. We tested direct paths from each of the personality variables and age to Time 1 Cognitions, along with direct paths from Cognitions at Time 1 to Time 2 and Cognitions at Times 1 and 2 to past use. We also included any direct paths that had been significant in the previous model (Model 1). We used an iterative process to remove any non-significant paths. We tested the significance of covariances between anxiety-sensitivity and each of the personality variables, along with anxiety-sensitivity with age. We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study. Materials and analysis code for this study are available by emailing the corresponding author. All structural equation modelling was run via the *lavaan* package in R (Rosseel, 2012).

3. Results

3.1. Descriptive statistics

The means and standard deviations of each variable are shown in Table 1, as well as the correlations among the variables used for modelling. On average, ambiguous cues elicited approximately two cannabis-related responses per participant at Time 1 and approximately two and a half cannabis-related response at Time 2. Moreover, participants generally did not rate cannabis-related outcomes as positive at either time point, although outcomes were rated as more positive at Time 2 than at Time 1. Correlation analyses showed a moderate association between the COEL and CWAT variables at each time point, lending further support to their inclusion in the latent cognition variable. At Time 2, 21.7% of the sample had used cannabis in the past year. Past cannabis use at Time 2 was moderately correlated with scores on the impulsivity, hopelessness, and sensation-seeking subscales of the SURPS, as well as with both cognitive variables at each time point, but not with age or anxiety-sensitivity.

3.2. Direct effects

In Model 1 (see Fig. 1), three out of the four personality traits (impulsivity, hopelessness, and sensation-seeking) measured in this study had direct effects on cannabis cognitions, such that participants who were higher in these traits were more likely to report more cannabis-related cognitions. with cognitions included, none of the personality traits had a significant direct effect on cannabis use at Time 2. In the model, age at Time 1 significantly predicted cannabis use at Time 2, with older adolescents *less* likely to use cannabis at Time 2 (b = -0.10, CI:

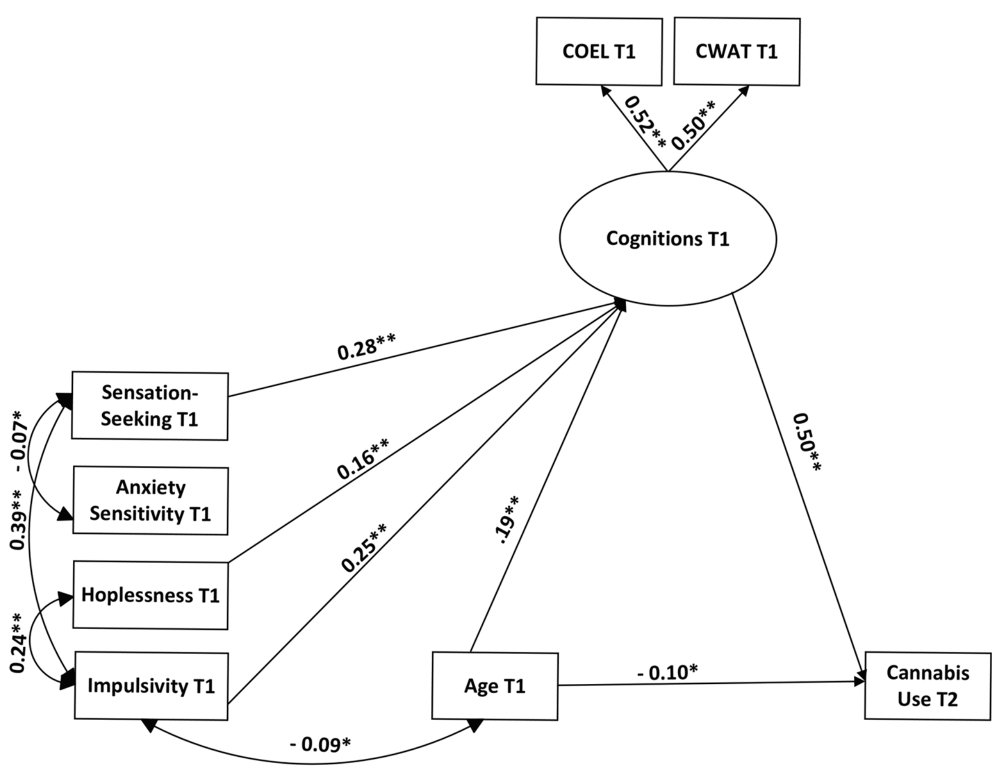

Fig. 1. Trimmed Model 1 (without Cognitions at T2).

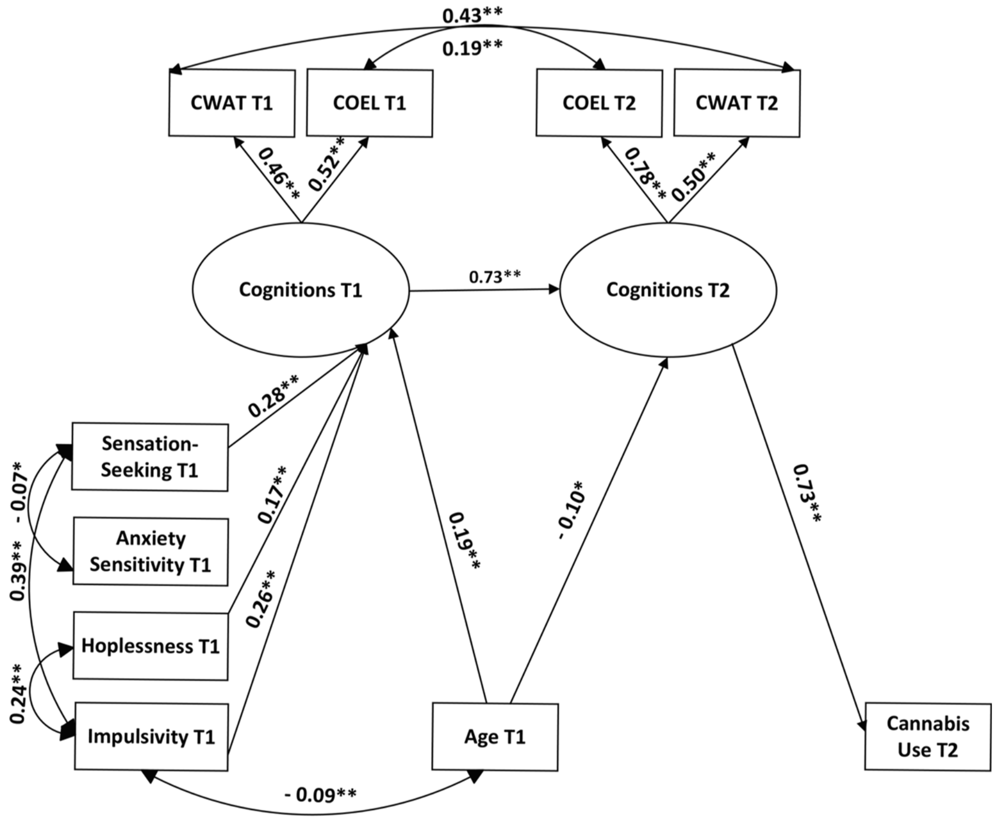

Fig. 2. Trimmed Model 2 (with Cognitions at T2).

Table 1
Means, standard deviations, and correlations with confidence intervals.

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9
1. COEL T2	0.69	1.06									
2. COEL T1	0.37	0.74	0.41**								
3. CWAT T2	2.51	1.82	0.39**	0.21**							
4. CWAT T2	2.29	1.69	0.25**	0.28**	0.51**						
5. Past Use T2	0.60	1.23	0.58**	0.25**	0.37**	0.24**					
6. SS T1	20.66	4.36	0.22**	0.17**	0.22**	0.18**	0.21**				
7. IMP T1	14.01	3.92	0.24**	0.20**	0.16**	0.20**	0.18**	0.39**			
8. AS T1	13.57	3.77	-0.09*	-0.10*	-0.01	0.00	-0.04	-0.05	0.04		
9. HOP T1	12.32	4.35	0.16**	0.12**	0.08*	0.09*	0.13**	-0.00	0.24**	0.01	
10. Age T1	14.71	0.85	0.04	0.09*	0.02	0.08*	-0.01	-0.01	-0.09*	0.01	0.02

Note. M and *SD* are used to represent mean and standard deviation, respectively. Values in square brackets indicate the 95% confidence interval for each correlation. The confidence interval is a plausible range of population correlations that could have caused the sample correlation (Cumming, 2014). * indicates $p < .05$. ** indicates $p < .01$. Dichotomous variable means presented as percentages for clarity. SS = sensation-seeking, IMP = impulsivity, HOP = hopelessness, AS = anxiety- sensitivity.

−0.18, −0.01, $p < .05$); however, this relationship was weaker relative to the other direct paths in the model. Furthermore, age at Time 1 also positively predicted cannabis cognitions, such that older participants were more likely to have more cannabis-related cognitions ($b = 0.19$, CI: 0.08, 0.31, $p < .01$). Both the CWAT ($b = 0.50$, CI: 0.41, 0.60, $p < .01$) and the COEL ($b = 0.52$, CI: 0.42, 0.63, $p < .01$) measures loaded significantly onto the cannabis cognitions variable. Finally, cannabis cognitions at Time 1 had a significant direct effect on cannabis use at Time 2 ($b = 0.50$, CI: 0.40, 0.60, $p < .01$). Notably, there was significant covariance between age and impulsivity, such that older participants were *less* likely to be impulsive ($b = -0.09$, CI: −0.16, −0.02, $p < .01$). Further details on the standardized regression weights are displayed in Table 2.

To further test our hypotheses, we constructed a second model. We included Time 2 Cognitions as a second mediator with a direct path from Time 1 Cognitions (Fig. 2). In this model, the direct paths from each personality trait and age to Cognitions at Time 1, but not Time 2, were significant. The direct and positive path from age to Cognitions at Time remained significant ($b = 0.19$, CI: 0.08, 0.31, $p < .01$). Additionally, the direct path from age at Time 1 to Cognitions at Time 2 was also significant albeit negative ($b = -0.10$, CI: −0.20, 0.00, $p < .05$). In this model controlling for Cognitions at Time 2, the direct path from Cognitions at Time 1 to use at Time 2 was nor longer significant. However, the direct paths from Cognitions at Time 1 to Cognitions at Time 2 ($b = 0.73$, CI: 0.63, 0.84, $p < .01$) and from Cognitions at Time 2 to use at Time 2 ($b = 0.73$, CI: 0.66, 0.79, $p < .01$) were significant. Further details on the standardized regression weights are displayed in Table 3.

3.3. Indirect effects

In Model 1, sensation-seeking, hopelessness, and impulsivity, along with age, had significant indirect effects on cannabis use at Time 2. Specifically, cannabis cognitions mediated the effects of the three

Table 2
Standardized regression weights for structural Model 1 (without Cognitions T2).

Parameter			Estimate	Lower	Upper	p
Cognitions T1	<—	Sensation-Seeking T1	0.28	0.17	0.39	< .01
Cognitions T1	<—	Impulsivity T1	0.25	0.14	0.37	< .01
Cognitions T1	<—	Hopelessness T1	0.16	0.06	0.27	< .01
Cognitions T1	<—	Age	0.19	. 08	. 31	< .01
COEL T1	<—	Cognitions T1	0.52	0.42	0.63	< .01
CWAT T1	<—	Cognitions T1	0.50	0.41	0.60	< .01
Use T2	<—	Cognitions T1	0.50	0.40	0.60	< .01
Use T2	<—	Age	-0.10	-0.18	-0.01	< .05
Impulsivity T1	⟨– – –⟩	Age	-0.09	-0.16	-0.02	< .01
Hopelessness T1	⟨– – –⟩	Impulsivity T1	0.24	0.17	0.31	< .01
Sensation-Seeking T1	⟨– – –⟩	Impulsivity T1	0.39	0.33	0.45	< .01
Sensation-Seeking T1	⟨– – –⟩	Anxiety-Sensitivity T1	-0.07	-0.14	0.00	.05

Notes. 95% confidence intervals are shown. Estimates are standardized. Double-sided arrows represent covariance.

Table 3
Standardized regression weights for structural Model 2 (with Cognitions T2).

Parameter			Estimate	Lower	Upper	p
Cognitions T1	<—	Sensation-Seeking T1	0.28	0.18	0.39	<.01
Cognitions T1	<—	Impulsivity T1	0.26	0.15	0.37	< .01
Cognitions T1	<—	Hopelessness T1	0.17	0.07	0.27	< .01
Cognitions T1	<—	Age	0.19	0.08	. 31	< .01
Cognitions T2	<—	Age	-0.10	-0.20	0.00	<.05
COEL T1	<—	Cognitions T1	0.52	0.42	0.62	< .01
CWAT T1	<—	Cognitions T1	0.46	0.38	0.55	< .01
COEL T2	<—	Cognitions T2	0.78	0.71	0.85	< .01
CWAT T2	<—	Cognitions T2	0.50	0.43	0.58	< .01
Cognitions T2	<—	Cognitions T1	0.73	0.63	0.84	< .01
Use T2	<—	Cognitions T2	0.73	0.66	0.79	< .01
Sensation-Seeking T1	⟨– – –⟩	Impulsivity T1	0.39	0.33	0.45	< .01
Impulsivity T1	⟨– – –⟩	Age	-0.09	-0.16	-0.02	< .01
Impulsivity T1	⟨– – –⟩	Hopelessness T1	0.24	0.17	0.31	< .01
CWAT T1	⟨– – –⟩	CWAT T2	0.43	0.36	0.50	< .01
COEL T1	⟨– – –⟩	COEL T2	0.19	0.06	0.32	< .01

Notes. 95% confidence intervals are shown. Estimates are standardized. Double-sided arrows represent covariance.

personality traits and age on later use. Further details on the standardized indirect effects are available in Table 4.

In Model 2, sensation-seeking, impulsivity, and hopelessness had significant indirect effects on cannabis use at Time 2. Cognitions at Time 1 also had a significant indirect effect on cannabis use at Time 2, with Cognitions at Time 2 acting as a mediator. Finally, age at T1 did not have significant indirect effects on cannabis use at Time 2. Further details on the standardized indirect effects are available in Table 5.

Table 4
Standardized indirect effects on T2 cannabis use through T1 cognitions (Model 1).

Source	Point estimate	Lower	Upper	p
Age	0.10	0.03	0.16	< .01
Impulsivity T1	0.13	0.01	0.19	< .01
Sensation-Seeking T1	0.14	0.08	0.20	< .01
Hopelessness T1	0.08	0.00	0.16	< .01

Notes. 95% confidence intervals are shown. Estimates are standardized.

3.4. Model fit indices

Overall model fit indices for both models resulted in non-significant chi-squares. As both models are trimmed (i.e., include only significant and marginally significant paths), their model fit indices are both CFI = 1.00 and RMSEA = 0.00.

4. Discussion

The current study explored the role automatic cognitions as mediators in the relationship between personality and cannabis use initiation in adolescents. The findings of this study support the acquired equivalence hypothesis (Smith & Anderson, 2001) and the role of automatic cognitions as antecedents of cannabis use in non-users (Krank et al., 2011; Pilin et al., 2021; van der Vorst et al., 2013). Specifically, we predicted that self-generated cannabis use outcome expectancies (Fulton et al., 2012) and cannabis memory associations (Stacy, 1995) would play a mediating role between personality at Time 1 and initiation of cannabis use at Time 2. Our study supported full cognitive mediation of the relationship between personality and initiation of cannabis use. Furthermore, our study found that the relationship between increasing age and cannabis use initiation was also mediated by these self-generated cognitions.

The present findings replicate previous findings with automatic cognitions and are consistent with dual processing theories. Dual processing theories posit that two cognitive systems operate simultaneously, with System One responsible for instantaneous, quick decision-making and evaluation and System Two responsible for slower processing operating at the level of awareness. Our study's measures emphasized automatic processing by asking for spontaneous and rapid responses. These measures, however, do not completely rule out contributions of controlled processing. Nevertheless, such influences are less likely for the memory association task, which only indirectly assess cannabis associations (Ames et al., 2007). Although the outcome expectancy task directly asks about cannabis outcomes, this expectancy measure also uses a quick-response, self-generated format and a rapid judgment rating. As Kahneman (2011) has argued, these features also favor automatic associations in both the generation of responses and in

Table 5
Standardized indirect effects on T2 cannabis use through T1 and T2 cognitions.

Source	Point estimate	Lower	Upper	p
Age	0.03	- 0.03	0.09	0.37
Impulsivity T1	0.14	0.08	0.20	< 0.01
Sensation-Seeking T1	0.15	0.09	0.21	< 0.01
Hopelessness T1	0.09	0.04	0.15	< 0.01
Cognitions T1	0.53	0.45	0.62	< 0.01

Notes. 95% confidence intervals are shown. Estimates are standardized. Final path listed (Cognitions T1 on Use) only mediates through Cognitions T2. See Fig. 2 for details.

their ratings. Together, these two measures significantly and strongly loaded onto a latent cognitions factor which was strongly related to adolescents' cannabis use.

Moreover, this study provides further support to Smith and Anderson's (2001) Acquired Preparedness Model. The APM posits that personality influences learning experiences, which then go on to influence substance use. The current study supports this notion, indicating that personality influences what individuals learn about substance use (i.e., the outcome expectancies they form) and that this relationship is associated with later substance use.

Another notable result in the current study was that cognitions mediated the positive relationship between age and cannabis use initiation. There were residual effects of age on use (Model 1) and Cognitions at Time 2, but the relationship was negative. The findings mirror previous results where age effects were fully (Pilin et al., 2021) or partially (van der Vorst et al., 2013) mediated by automatic cognitions on later substance use. In other words, older adolescents were significantly more likely to have stronger cannabis-related cognitions (i.e., more positive cannabis outcome expectancies, more word associates relating to cannabis use) and this relationship was associated with greater likelihood of cannabis use initiation at Time 2. To our knowledge, this is the third study to indicate that the association between age and consumption is mediated by cognitions. Such findings point to a mechanism behind why older adolescents are more likely to consume cannabis; while the act of aging is not inherently related to consumption, aging is associated with increases in cannabis-related cognitions, which are associated with increased risk of use.

Somewhat surprising was the finding that the addition of Time 2 cognitions as a control variable (Model 2) did not result in much change to the original model. When we included both Time 1 and Time 2 cognitions in the model, we found that only direct paths from each of the personality variables to Time 1 cognitions were significant. The updated model thus demonstrated that the influence of personality variables on cannabis use is driven by their influence on Time 1 cognition, which then influences Time 2 cognitions and use. This finding was further supported by the significant indirect effect of three of the personality traits on use via Time 1 and Time 2 cognitions. All of the effects on consumption were indirect thru Cognitions at Time 2 indicating that personality did not have a significant impact on the change in cognitions from Time 1 to Time 2. As such, this model provides additional supporting evidence for the importance of implementing substance use prevention programs early, and especially for the use of personality-focused prevention programs (i.e., Preventure; see Conrod et al., 2016).

Finally, the strength of cognitive mediation with alcohol (van der Vorst et al., 2013) and cannabis (present study; Pilin et al., 2021) may be due to the types of associations measured. The two cognitive measures in this study assess slightly different top-of-mind associations. Outcome expectancy liking is based on hedonic ratings of personally relevant and accessible anticipated consequences of use. This liking score is a measure of the overall positive association between use and its expected impacts (Fulton et al., 2012). The memory association score counts the frequency of associations with ambiguous words that have possible cannabis-related meanings and is a measure of the strength of cue-behavior (use) associations (Stacy, 1995). The strength of latent construct as a mediator suggests that this combination of these measures is especially useful in predicting the risk of substance use initiation in adolescents (Krank & Robinson, 2017). Moreover, the specific content of these associations focuses attention on associations that should be targets of cognitive behavioral prevention approaches (Krank & Goldstein, 2006).

4.1. Limitations

It is important to note several limitations in this study. First, while the study is longitudinal, we only drew upon two years of data. Thus, both personality and cognitions were measured at Time 1, while cannabis use was measured at Time 2. An additional year of data collection, with personality measured at Time 1, cognitions at Time 2, and cannabis use at Time 3, would provide more clarity in the interpretation of results, allowing us to determine whether personality impacts cannabis-related cognitions one year later, and then whether the mediating relationship is maintained after two years. Relatedly, it is important to note that this study is inherently non-experimental as personality traits cannot be randomized among participants. Thus, we cannot make causal conclusions using this model. Second, our measure of cannabis use asked participants about the last time that they had used cannabis. While this provides us with information about their initiation of cannabis use, it does not indicate whether these adolescents went on to consume cannabis regularly. Thus, we can draw limited conclusions given the use of this measure. Future studies should seek to explore adolescent cannabis use more widely to determine whether cognitions also act as a mediator between personality and cannabis use frequency or amount consumed. Additionally, the vast majority of our participants were aged 14 to 16. As noted in Pilin et al. (2021), which used the same sample, a limited age range only allows for the examination of a short developmental phase and does not allow our conclusions to be generalized to younger or older adolescents. Finally, the current study chose to examine cognitions as mediators of the relationship between personality and cannabis use initiation. This choice was based on the theory that cognitions are the mechanisms behind the relationship of personality and cannabis use. However, the choice of a moderator or mediator model is often unclear (see Kraemer et al., 2001, 2002), and we acknowledge that cognitions can also be tested as moderators of this relationship. Future studies should endeavour to explore this model.

4.2. Conclusion

In conclusion, the current study found that cognitions mediated the relationship between personality and cannabis use, as well as the relationship between age and cannabis use. Such findings support the AMP and dual-processing theories of substance use. However, the length of data collection, measures of cannabis use, and age range limit our conclusions. Thus, future studies should seek to replicate the current project and further explore the mediating role of substance-use related cognitions. Despite this, our findings contribute to the broader literature examining the important role of cognition and personality in substance use. We believe this study provides a theoretical foundation from which future research will flourish. Gaining further clarity as to the role of these cognitions will increase the applicability and individualization of substance use prevention programs and interventions for young people.

Role of funding sources

Funding for this study was provided through a Society Culture and Health grant from the Social Sciences and Humanities Research Council (SSHRC) of Canada and the Canadian Institutes of Health Research (CIHR; M.D. Krank).

CRediT authorship contribution statement

Maya A. Pilin: Writing – original draft, Writing – review & editing, Formal analysis. **Jill M. Robinson:** Writing – original draft, Writing – review & editing. **Katie Young:** Writing – original draft. **Marvin D. Krank:** Supervision, Writing – original draft, Formal analysis, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

We gratefully acknowledge participants in the longitudinal data collection that provided the data for this article: Anne-Marie Wall and Daniel Lai, who were coinvestigators; Peter Molloy, and Christine Wekerle, who were collaborators on the PATH study; and Tricia Johnson and Aarin Frigon, who served as project coordinators for the study. We thank Abby Goldstein, Jana Atkins, Jessica van Exan, Jonathan Brown, Tara Schoenfeld, Rob Callaway, Tabatha Freimuth, Adrienne Girling, and Pam Collins for their valued research assistance.

References

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. https://doi.org/10.1037/1064-1297.15.2.218

Ames, S. L., Krank, M., Grenard, J. L., Sussman, S., & Stacy, A. W. (2012). Prevention Education Effects on Fundamental Memory Processes. *Evaluation & the Health Professions, 35*(4), 416–439. https://doi.org/10.1177/0163278712444287

Anderson, K. G., Smith, G. T., & Fischer, S. F. (2003). Women and acquired preparedness: Personality and learning implications for alcohol use. *Journal of Studies on Alcohol, 64*(3), 384–392. https://doi.org/10.15288/jsa.2003.64.384.

Anthenien, A. M., Lembo, J., & Neighbors, C. (2017). Drinking motives and alcohol outcome expectancies as mediators of the association between negative urgency and alcohol consumption. *Addictive Behaviors, 66*, 101–107. https://doi.org/10.1016/j.addbeh.2016.11.009

Bolles, J. R., Earleywine, M., & Gordis, E. (2014). Acquired preparedness model and impulsivity moderated expectancies: Examining predictors of marijuana use. *Addiction Research & Theory, 22*(6), 490–497. https://doi.org/10.3109/16066359.2014.892929

Castellanos-Ryan, N., & Conrod, P. (2012). Personality and Substance Misuse: Evidence for a Four-Factor Model of Vulnerability. In J. C. Verster, K. Brady, M. Galanter, & P. Conrod (Eds.), *Drug Abuse and Addiction in Medical Illness: Causes, Consequences and Treatment* (pp. 47–62). Springer. https://doi.org/10.1007/978-1-4614-3375-0_4.

Castellanos-Ryan, N., O'Leary-Barrett, M., Sully, L., & Conrod, P. (2013). Sensitivity and Specificity of a Brief Personality Screening Instrument in Predicting Future Substance Use, Emotional, and Behavioral Problems: 18-Month Predictive Validity of the Substance Use Risk Profile Scale. *Alcoholism: Clinical and Experimental Research, 37*(s1), E281–E290. https://doi.org/10.1111/j.1530-0277.2012.01931.x

Coffey, C., & Patton, G. C. (2016). Cannabis Use in Adolescence and Young Adulthood: A Review of Findings from the Victorian Adolescent Health Cohort Study. *The Canadian Journal of Psychiatry, 61*(6), 318–327. https://doi.org/10.1177/0706743716645289

Conrod, P. J. (2016). Personality-Targeted Interventions for Substance Use and Misuse. *Current Addiction Reports, 3*(4), 426–436. https://doi.org/10.1007/s40429-016-0127-6

Conrod, P. J., Stewart, S. H., Pihl, R. O., Côté, S., Fontaine, V., & Dongier, M. (2000). Efficacy of brief coping skills interventions that match different personality profiles of female substance abusers. *Psychology of Addictive Behaviors, 14*(3), 231–242. https://doi.org/10.1037/0893-164X.14.3.231

Corbin, W. R., Iwamoto, D. K., & Fromme, K. (2011). A Comprehensive Longitudinal Test of the Acquired Preparedness Model for Alcohol Use and Related Problems. *Journal of Studies on Alcohol and Drugs, 72*(4), 602–610. https://doi.org/10.15288/jsad.2011.72.602

Cumming, Geoff (2014). The New Statistics: Why and How. *Psychological Science, 25*(1), 7–29. https://doi.org/10.1177/0956797613504966

Fu, A.-T., Ko, H.-C., Wu, J.-Y.-W., Cherng, B.-L., & Cheng, C.-P. (2007). Impulsivity and expectancy in risk for alcohol use: Comparing male and female college students in Taiwan. *Addictive Behaviors, 32*(9), 1887–1896. https://doi.org/10.1016/j.addbeh.2007.01.003

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.

Gunn, R. L., & Smith, G. T. (2010). Risk factors for elementary school drinking: Pubertal status, personality, and alcohol expectancies concurrently predict fifth grade alcohol consumption. *Psychology of Addictive Behaviors, 24*(4), 617–627. https://doi.org/10.1037/a0020334

Kahneman, D. (2011). *Thinking, fast and slow.* Macmillan.

Kraemer, H. C., Stice, E., Kazdin, A., Offord, D., & Kupfer, D. (2001). How Do Risk Factors Work Together? Mediators, Moderators, and Independent, Overlapping, and Proxy Risk Factors. *American Journal of Psychiatry, 158*(6), 848–856. https://doi.org/10.1176/appi.ajp.158.6.848

Kraemer, H. C., Wilson, G. T., Fairburn, C. G., & Agras, W. S. (2002). Mediators and Moderators of Treatment Effects in Randomized Clinical Trials. *Archives of General Psychiatry, 59*(10), 877–883. https://doi.org/10.1001/archpsyc.59.10.877

Krank, M. D., & Goldstein, A. L. (2006). Adolescent changes in implicit cognitions and prevention of substance abuse. *Handbook of Implicit Cognition and Addiction*, 439–453.

Krank, M. D., Schoenfeld, T., & Frigon, A. P. (2010). Self-coded indirect memory associations and. *Behavior Research Methods, 42*(3), 733–738. https://doi.org/10.3758/BRM.42.3.733

Krank, M., & Robinson, J. (2017). Automatic Cognitive Processes and Youth Substance Use: Risks and Prevention. *Current Addiction Reports, 4*(4), 386–396. https://doi.org/10.1007/s40429-017-0168-5

Krank, M., Stewart, S. H., O'Connor, R., Woicik, P. B., Wall, A.-M., & Conrod, P. J. (2011). Structural, concurrent, and predictive validity of the Substance Use Risk Profile Scale in early adolescence. *Addictive Behaviors, 36*(1), 37–46. https://doi.org/10.1016/j.addbeh.2010.08.010

Lindgren, K. P., Hendershot, C. S., Ramirez, J. J., Bernat, E., Rangel-Gomez, M., Peterson, K. P., & Murphy, J. G. (2019). A dual process perspective on advances in cognitive science and alcohol use disorder. *Clinical Psychology Review, 69*, 83–96. https://doi.org/10.1016/j.cpr.2018.04.002

Malmberg, M., Kleinjan, M., Vermulst, A. A., Overbeek, G., Monshouwer, K., Lammers, J., & Engels, R. C. M. E. (2012). Do Substance Use Risk Personality Dimensions Predict the Onset of Substance Use in Early Adolescence? A Variable- and Person-Centered Approach. *Journal of Youth and Adolescence, 41*(11), 1512–1525. https://doi.org/10.1007/s10964-012-9775-6

Malmberg, M., Overbeek, G., Monshouwer, K., Lammers, J., Vollebergh, W. A., & Engels, R. C. (2010). Substance use risk profiles and associations with early substance use in adolescence. *Journal of Behavioral Medicine, 33*(6), 474–485.

Marks, R. M., Simons, J. S., Simons, R. M., & Freeman, H. (2020). Temperament in the prediction of proximal versus distal expectancies: An acquired preparedness model. *Experimental and Clinical Psychopharmacology, 28*(1), 65–80. https://doi.org/10.1037/pha0000283

McCarthy, D. M., Kroll, L. S., & Smith, G. T. (2001). Integrating disinhibition and learning risk for alcohol use. *Experimental and Clinical Psychopharmacology, 9*(4), 389.

Memetovic, J., Ratner, P. A., Gotay, C., & Richardson, C. G. (2016). Examining the relationship between personality and affect-related attributes and adolescents' intentions to try smoking using the Substance Use Risk Profile Scale. *Addictive Behaviors, 56*, 36–40. https://doi.org/10.1016/j.addbeh.2016.01.002

Moody, L., Franck, C., Hatz, L., & Bickel, W. K. (2016). Impulsivity and polysubstance use: A systematic comparison of delay discounting in mono-, dual-, and trisubstance use. *Experimental and Clinical Psychopharmacology, 24*(1), 30.

Moser, K., Pearson, M. R., Hustad, J. T. P., & Borsari, B. (2014). Drinking games, tailgating, and pregaming: Precollege predictors of risky college drinking. *The American Journal of Drug and Alcohol Abuse, 40*(5), 367–373. https://doi.org/10.3109/00952990.2014.936443

Pilin, M. A., Robinson, J. M., Dow-Fleisner, S., Sanchez, T. A., & Krank, M. D. (2021). Automatic cognitions as mediators of parental influence on adolescent cannabis use. *Addictive Behaviors, 114*, Article 106728. https://doi.org/10.1016/j.addbeh.2020.106728

Rosseel, Y. (2012). lavaan: An R Package for Structural Equation Modeling. *Journal of Statistical Software, 48*(2), 1–36. https://doi.org/10.18637/jss.v048.i02

Schlauch, R. C., Crane, C. A., Houston, R. J., Molnar, D. S., Schlienz, N. J., & Lang, A. R. (2015). Psychometric Evaluation of the Substance Use Risk Profile Scale (SURPS) in an Inpatient Sample of Substance Users Using Cue-Reactivity Methodology. *Journal of Psychopathology and Behavioral Assessment, 37*(1), 231–246. https://doi.org/10.1007/s10862-014-9462-x

Schmits, E., Mathys, C., & Quertemont, E. (2015). A longitudinal study of cannabis use initiation among high school students: Effects of social anxiety, expectancies, peers and alcohol. *Journal of Adolescence, 41*, 43–52. https://doi.org/10.1016/j.adolescence.2015.02.009

Sher, K. J., Bartholow, B. D., & Wood, M. D. (2000). Personality and substance use disorders: A prospective study. *Journal of Consulting and Clinical Psychology, 68*(5), 818–829. https://doi.org/10.1037/0022-006X.68.5.818

Smith, G. T., & Anderson, K. G. (2001). Personality and learning factors combine to create risk for adolescent problem drinking: A model and suggestions for intervention. In P. M. Monti, S. M. Colby, & T. A. O'Leary (Eds.), *Adolescents, alcohol, and substance abuse: Reaching teens through brief interventions* (pp. 109–141). Guilford Press. https://doi.org/10.1176/appi.ajp.159.11.1958.

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

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.

Stacy, A. W., & Wiers, R. W. (2010). Implicit cognition and addiction: A tool for explaining paradoxical behavior. *Annual Review of Clinical Psychology, 6*, 551–575.

Stewart, S. H., Samoluk, S. B., & MacDonald, A. B. (1999). Anxiety sensitivity and substance use and abuse. In S. Taylor (Ed.), *Anxiety sensitivity: Theory, research, and treatment of the fear of anxiety* (pp. 287–319). Lawrence Erlbaum Associates Publishers.

Teichman, M., Barnea, Z., & Ravav, G. (1989). Personality and Substance Use Among Adolescents: A longitudinal study. *British Journal of Addiction, 84*(2), 181–190. https://doi.org/10.1111/j.1360-0443.1989.tb00567.x

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. https://doi.org/10.1111/add.12042

Woicik, P. A., Stewart, S. H., Pihl, R. O., & Conrod, P. J. (2009). The substance use risk profile scale: A scale measuring traits linked to reinforcement-specific substance use profiles. *Addictive Behaviors, 34*(12), 1042–1055. https://doi.org/10.1016/j.addbeh.2009.07.001