Cannabis
2024

researchmj.org
10.26828/cannabis/2024/000262
Volume 7, Special Issue 3

Expressive Writing About One's Trauma Increases Accessibility of Cannabis Information in Memory Among Trauma-Exposed Individuals

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ABSTRACT

Objective: Trauma survivors are more likely than others to use cannabis, and post-traumatic stress disorder (PTSD) commonly co-occurs with cannabis use disorder (CUD). Automatic memory associations between trauma reminders and cannabis use have been suggested as contributing mechanisms. These associations can be studied experimentally by manipulating trauma cue exposure in a cue-reactivity paradigm (CRP) and examining effects on the accessibility of cannabis information in memory in trauma survivors with and without PTSD. **Method:** Cannabis users with trauma histories (N= 202) completed a PTSD measure (PTSD Checklist-5) and were randomized to a trauma or neutral expressive writing task as an online CRP. Next, participants completed a cue-behavior word association task, which involved presentation of a series of ambiguous cue words to which participants provided the first word that came to mind. Some of these ambiguous cues pertained to cannabis (e.g., *weed, pot*) and some to other substances (e.g., *blow, shot*). This task was scored by two independent raters. Linear regression models tested the hypothesized main and interactive effects of CRP condition (trauma, neutral) and PTSD group (probable PTSD, no PTSD) on the number of cannabis and other substance responses generated. **Results:** Main effects of CRP condition were found for cannabis responses (b = 0.41, p = .048; trauma > neutral) but not other substance responses. Unexpectedly, no main effects or interactions of PTSD group were observed for either outcome. **Conclusions:** In cannabis users with trauma histories, writing about one's trauma specifically activates greater accessibility of cannabis-related information in memory, regardless of PTSD.

Key words: = PTSD; cue-reactivity paradigm; cannabis; automatic cognitions; word associations

Since cannabis was legalized for recreational use in 2018, Canada has seen an increase in the use of cannabis: past three-month use rose from 22% to 27% of those aged 16 and older from 2017 to 2022 (Government of Canada, 2023). Currently, 25% of Canadians aged 16 or older who use cannabisengage in daily or near daily use (Government of Canada, 2021). One risk factor for cannabis use is having experienced a traumatic event, defined in the DSM-5-TR (APA, 2022) as

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exposure to actual or threatened death, serious injury, or sexual violence. Indeed, those with trauma histories have a significantly increased odds of cannabis use (Kevorkian et al., 2016) and of regular cannabis use (Bassir Nai et al., 2023). Use of cannabis is in turn linked with increased risk of several physical and mental health conditions in the shorter- and longer-term such as high blood pressure, risks to lung health, cognitive impairments, CUD, psychosis, and anxiety (Connor et al., 2021; Cougle et al., 2016; Hasin et al., 2016) and expensive emergency department visits (Crocker et al., 2023).

One potential reason that those with trauma histories have an increased cannabis use risk is that they may use cannabis to cope with the negative affect resulting from exposure to reminders of their traumatic experience (see review by DeGrace et al., 2022). Some of this cannabis use may be deliberate, such as when an individual intentionally decides to use cannabis when they are feeling particularly hypervigilant. Other use may be reflexive; for example, someone may automatically reach for cannabis without forethought as soon as they encounter a trauma-related trigger, as a habitual response to their distress. Indeed, while specific, fully conscious, and deliberate coping motives may initially drive cannabis use in traumatized populations, automatic memory associations may form over time between the context in which substance use occurs (e.g., trauma-related contextual cues) and substance use behavior (van der Vorst et al., 2013). Thus, a person with a sexual assault history, for example, who uses cannabis to manage negative affect in response to trauma reminders (e.g., hearing about a sexual assault in the media) is thought to form strong memory associations over time between trauma cues, negative affect, cannabis use, and relief outcomes (Edalati & Krank, 2015; Romero-Sanchiz et al., 2022). These automatic cognitive associations are quick, spontaneous, and require little conscious awareness or reflection (Cousjin et al., 2011; Krank & Robinson, 2017; Stacy & Wiers, 2010). They can be tapped using tasks that capture automatic processes measured in various ways, including but not limited to reaction time (e.g., DeGrace et al., 2023b; Read et al., 2017) or word association tasks (Ames et al., 2007; Pilin et al., 2022). Performance on such automatic cognition measures have been positively associated with substance use behavior (e.g., Ames et al., 2007).

Theoretically, among trauma-exposed individuals who use cannabis, exposure to trauma reminders should activate the previously-formed memory associations between trauma cues and cannabis-related information (e.g., stimuli associated with cannabis use in the past like rolling papers). Because of this activation, trauma cue exposure should increase accessibility in memory of cannabis-related information which should, in turn, give rise to reflexive cannabis use behavior. This would be consistent with individuals who use substances' accounts of often finding themselves using their substance without deliberation (Stacy & Wiers, 2010). Researchers can study the effect of trauma (vs. neutral) cue exposure on these automatic cognitions experimentally using cue reactivity paradigms (CRPs; Sinha & Tuit, 2012): lab-based exposure to relevant stimuli to elicit *reactivity*, or a relevant change in state (e.g., emotional [affect], physiological [salivation], cognitive [craving]). In-lab exposure to a personalized trauma cue is intended to simulate the context of encountering a trauma reminder in everyday life. Findings from prior studies using trauma CRPs among individuals with trauma histories who use substances have consistently demonstrated heightened physiological and subjective responses to trauma cues compared to neutral cues including increased self-report craving and stress reactivity (see review by DeGrace et al., 2022). Additionally, studies have shown that trauma cue exposure can influence automatic cognitive processes. For example, participants with PTSD exposed to a personalized trauma cue showed a general response slowing on the Stroop task that was associated with self-reported urge to drink (Read et al., 2017).

A well-established CRP entails a two-session approach (Coffey et al., 2002). During the initial session, a semi-structured interview (Sinha & Tuit, 2012), developed to elicit emotional imagery (Lang et al., 1979), guides participants through describing their most traumatic experience. This material is later condensed into a brief, personalized audiovisual cue used in the second CRP session (Romero-Sanchiz et al., 2022). An equivalent procedure is followed in developing and presenting the neutral control cue. Attrition rates are high between the initial semi-structured

interview session and the second CRP exposure session within this two-session protocol (e.g., Coffey et al., 2006). We addressed this issue in a prior study, where we used the semi-structured interview alone, expecting it would itself elicit similar emotional and cognitive responses seen with the two-session protocol. However, while some controlled processes (e.g., cannabis craving) were successfully elicited by the single-session CRP (DeGrace et al., 2023a), the semi-structured interview alone did not evoke increased automatic cannabis-related cognitions using a reaction time task (DeGrace et al., 2023b). This points to a need to explore alternative CRPs that not only mitigate study attrition, but also demonstrate sensitivity to the effects of trauma cue exposure on cannabis-relevant automatic cognitive processes.

Thus, the present study utilized a novel stand-alone expressive writing task (trauma vs. neutral) as a single-session method of administering a CRP remotely. Prior work in our lab has found this task to be efficacious in eliciting negative affect and positive cannabis outcome expectancies (including relief expectancies) in a sample of recent trauma-exposed individuals who use cannabis (DeGrace et al., 2024). The expressive writing task was developed in accordance with two-session CRPs that incorporate brief expressive writing tasks into the protocol (Read et al., 2017; Rodrigeuz & Read, 2020) and in accordance with the work of Pennebaker (1997) on the therapeutic benefits of expressive writing about one's trauma. However, our prior work (DeGrace et al., 2024) and the present study are novel in using the expressive writing task as a stand-alone CRP in eliciting cognitions relevant to understanding cannabis use among trauma-exposed individuals who use cannabis. We studied trauma cue-elicited controlled cognitive processes (i.e., self-reported craving) in our prior expressive writing study (DeGrace et al., 2024) and trauma cue-elicited automatic cognitive processes (i.e., cue-behavior memory associations) in the present expressive writing study.

Theoretically, for those with PTSD, the effects of trauma cue exposure in activating automatic accessibility of cannabis-related information in memory should be particularly strong. This is because those with PTSD show greater coping motivated cannabis use (Atasoy et al., 2023) providing greater opportunity for strong memory associations to develop between trauma cues and cannabis use. Indeed, PTSD co-occurs at high rates with cannabis use and CUD (Cougle et al., 2011; Kevorkian et al., 2016; Metrik et al., 2022; Walsh et al., 2014). For example, in a study of trauma-exposed individuals who use cannabis, lifetime PTSD was associated with increased odds of lifetime CUD even after controlling potential confounds (e.g., depression, anxiety, alcohol dependence; Kevorkian et al., 2016). Importantly, longitudinal work shows that continued cannabis use is associated with worse PTSD outcomes (Wilkinson et al., 2015).

Trauma cue-elicited increases in automatic accessibility of cannabis information in memory might be an underlying mechanism to help explain this high co-occurrence of PTSD with cannabis use and CUD. Specifically, cue condition (trauma vs. neutral) effects on relevant automatic association measures should be strongest among those with PTSD (i.e., an interaction). We tested this possibility in a recent study using a reaction time task – specifically, a cannabis approach-avoidance task (DeGrace et al., 2023b). However, we showed only that those with greater PTSD symptoms displayed a greater cannabis approach bias than those with lesser PTSD symptoms; we failed to show that this automatic cognitive bias was enhanced among those exposed to a trauma (vs. neutral) CRP in an $N = 50$ lab study. This suggested that automatic cannabis approach bias may be chronically activated among those with higher PTSD symptom severity. However, cue condition x PTSD symptoms interactions have been detected in other studies of deliberative, controlled cognitive processes, such as self-reported craving (e.g., Romero-Sanchiz et al., 2022). This suggests that such interactions may be observable for automatic cognition measures as well, provided a study is adequately powered to detect an (often smaller magnitude) interaction effect. Thus, we utilized our expressive writing task remotely in an online study to acquire a sufficiently large sample to detect such theorized cue condition x PTSD interactions in a single session.[a]

[a] Using R (R v. 4.2.1; pwr package; Champely, 2020), we calculated the number of participants needed to detect a small to medium ($d = .3$) effect for a 2x2 design, with power set at .80 and 12 total targets (i.e., cannabis and substance-primed CWAT items). This analysis determined that we would need $n = 44$ participants per cell to detect this effect size (i.e., a minimum of $N = 176$). Thus, we aimed to recruit ~200 participants to allow for some potential incomplete responding.

We hypothesized those trauma-exposed individuals who use cannabis randomly assigned to the trauma (vs. neutral) expressive writing task would display greater accessibility of cannabis-related information in memory (H1). We also expected that individuals with (vs. without) probable PTSD would show increased accessibility of cannabis-related information in memory (H2). Further, we hypothesized a cue condition by PTSD group interaction, with the trauma (vs. neutral) cue-elicited accessibility of cannabis-related information in memory being greater among those with (vs. without) probable PTSD (H3). Finally, we hypothesized specificity of the above expected effects to the ambiguous cannabis items on the Cannabis Word Association Task (CWAT; Pilin et al., 2022) that would not generalize to the other substance items on the CWAT (H4).

METHODS

Participants

Qualtrics Survey Panels were used to recruit trauma-exposed individuals who use cannabis. To participate, participants must have been residing in Canada; aged 19-65 years old; exposed to 1 or more lifetime traumatic event(s) (Gray et al., 2004); and have used at least one gram[b] of cannabis in the past month.[c] Our final sample, after data scrubbing,[d] was N = 202 participants (43.6% male; M age = 42.94 years, SD = 14.71). This is the same sample used in our prior expressive writing study (DeGrace et al., 2024).

Tasks and Measures

Demographics. Participants reported their sex and age.

Trauma exposure. The Life Events Checklist (LEC-5; Gray et al., 2004) was used to assess exposure to one or more DSM-5 (APA, 2013) PTSD Criterion A traumatic event(s) (e.g., sexual assault, environmental disater) to ensure study eligibility. If respondents indicated more than one lifetime traumatic event exposure, they answered all further questions about trauma (e.g., PTSD assessment; expressive writing task) in relation to the trauma that had affected them the most profoundly (i.e., index event).

Cannabis use. Past month cannabis use (frequency and quantity) was assessed with an online version of the Cannabis Timeline Followback (C-TLFB; Sobell & Sobell, 1992). Scores were used to ensure eligibility and were analyzed as potential covariates for use in sensitivity analyses. The C-TLFB has excellent inter-rater reliability and test-retest reliability (Norberg et al., 2012) and self-reported online versions of the TLFB have been shown to be psychometrically sound (Rueger et al., 2012).

CUD symptom severity. To assess CUD symptom severity, we used the 8-item Cannabis Use Disorder Identification Test-Revised (CUDIT-r; Adamson et al., 2010). Participants rated the frequency of experiencing various cannabis-related problems over the past six months on a scale from 0 to 4 (ranging from never to daily or almost daily). The scores were then totaled. Our sample demonstrated satisfactory internal consistency with an alpha coefficient of .75, indicating the CUDIT-r's robust psychometric properties.

PTSD group. The PTSD Checklist for DSM-5 (PCL-5; Bovin et al., 2016) was used to describe sample PTSD symptom severity and to categorize[e]

[b] Participants could consume cannabis using any method, but were provided with conversion rates to ensure the amount they used was equivalent to at least one gram of cannabis (flower).

[c] This minimum cannabis use threshold was set lower than that used in DeGrace et al. (2023a,b) (i.e., at least 1 gram per week over last month; see Gabrys & Porath, 2019) in order to feasibly recruit a sufficiently large sample to detect PTSD group x cue condition interactions if they were present.

[d] In order to ensure data quality, 597 respondents were excluded for failure to follow writing task instructions (e.g., did not write about the assigned topic; wrote the same word repeatedly), 98 respondents were removed for duplicate IP addresses, and 47 respondents were excluded due to failed speeder checks (performed by Qualtrics) and/or failed attention checks (e.g., "Select '3' for this item").

[e] We chose a categorical (vs. dimensional) measure of PTSD in order to best establish clinical relevance.

[f] While a number of cut-offs on the PCL-5 have been suggested for identifying probable PTSD (e.g., 31-33; Bovin et al., 2016) we chose a relatively high categorical cut-off for probable (i.e., 38; Cohen et al., 2015) as our predictor to minimize false positives which are more likely when using a self-report questionnaire vs. clinical interview for case identification. Additionally, this cut-off has undergone validation in evaluating probable PTSD in civilian samples, distinguishing it from other commonly used thresholds (e.g., Bovin et al., 2016) which have been validated in military, clinical, and mostly male populations (Cohen et al., 2015).

participants into two PTSD groups: probable PTSD (≥38[f]; Cohen et al., 2015) or probable no PTSD (<38). The PCL-5 has good reliability and validity and good sensitivity and specificity in detecting clinically-diagnosed PTSD (Blevins et al., 2015). In our sample, internal consistency was excellent (α = .95).

Expressive writing task. Participants were randomly assigned to complete a trauma-related (i.e., describing their worst lifetime trauma) or a neutral expressive writing task (i.e., describing their morning routine). Programmed prompts queried for details on what happened, and bodily sensations, thoughts, and feelings that occurred during the event (Sinha & Tuit, 2012). Participants were required to write for two minutes minimum and then to continue imagining the event as if it were happening now (Read et al., 2017; Rodriguez & Read, 2020) for another two minutes. These were enforced through task-programming, meaning participants were not able to continue the survey until the 2-minute minima had elapsed. Length of the written passage was recorded (total word count) and later analyzed.

Cannabis-related automatic cognitions. The Cannabis Word Association Task (CWAT; Pilin et al., 2022), a cue-behavior association test (Ames et al., 2007), assessed degree of accessibility of cannabis-related information in memory. This was estimated by the likelihood of generating a cannabis-related word associate to an ambiguous cannabis word. Participants were shown a list of 35 ambiguous words, five of which could be associated with cannabis use (e.g., *pipe, joint*). To examine specificity to cannabis associations in memory, an additional seven items on the CWAT were ambiguous words which could be associated with other substance use (e.g., *blow, shot*). Participants filled in a blank next to each word in the list with the first word that came to mind. Two independent raters, both blind to PTSD group and cue condition, coded each response as cannabis-related, other substance-related, or neither.[g] Summed totals to each category were calculated (e.g., if a participant responded with 4 cannabis-related responses to the 5 ambigous cannabis words, their CWAT cannabis score was a 4). These coded responses to the CWAT's ambiguous cannabis (possible range = 0-5; κ = 0.84) and other substance-related words (possible range=0-7; κ = 0.86) were used as CWAT outcomes in analyses.

Procedure

If trauma exposure (LEC-5; Gray et al., 2004), and cannabis use (C-TLFB; Sobell & Sobell, 1992) eligibility requirements were met, participants were redirected to complete other measures (see DeGrace et al, 2024) including assessment of PTSD symptoms (PCL-5; Boivin et al., 2016). Participants were then automatically randomized to complete either the trauma (n = 96) or neutral (n = 106) expressive writing task, which served as our remote CRP. Following expressive writing, participants completed the CWAT (Pilin et al., 2022).

Analysis strategy. We ran two separate linear regression models (R v. 4.2.1; lme4 package) with cue condition, PTSD group, and the condition by PTSD interaction term, predicting accessibility of cannabis and other substance-related information in memory (i.e., count of cannabis-related and other substance-related words generated to the appropriate ambiguous prompts on the CWAT, respectively). We also tested for potential covariates (i.e., age, sex, cannabis use quantity and frequency, self-reported cannabis use problems, expressive writing word count) that were theoretically and empirically related to both the predictors and CWAT outcomes that might need to be controlled in our main analyses.

RESULTS

Sample characteristics. Demographic and clinical characteristics are reported in Table 1 for the overall sample and by cue condition. Over one-third of the sample (36%; n = 73) scored 38 or higher on the PCL-5 indicating probable PTSD (Cohen et al., 2015). This sample average CUDIT-R score was just below the cutoff of 12 (43.6% scored 12 or greater) for probable CUD and above the cutoff of 8 (61.8% scored 8 or more) for hazardous use (Adamson et al., 2010). Sample demographic and clinical characteristics are reported elsewhere further broken down by cue condition x PTSD group (DeGrace et al., 2024).

[g] The coding of the first rater (SJT), who was naïve to study hypotheses and objectives, was used in analyses, as we reasoned this rater would be less prone to biases.

Table 1. *Descriptive Statistics*

				N (%)/ Mean (SD)
Cue Condition		Trauma *n* = 96	Neutral *n* = 106	Overall Sample *N* = 202
Age (in years)		43.25 (14.89)	42.55 (14.61)	42.94 (14.71)
Sex	Male	43 (44.8%)	45 (42.5%)	88 (43.6%)
	Female	53 (55.2%)	61 (57.5%)	114 (56.4%)
CUDIT-R score		11.80 (6.62)	10.97 (5.89)	11.37 (6.25)
TLFB past month cannabis use (days used)		14.24 (10.68)	13.84 (10.18)	14.03 (10.40)
PCL-5 score		32.02 (18.44)	31.05 (19.03)	31.51 (18.71)
% with probable PTSD		36 (37.5%)	37 (34.9%)	73 (36.1%)
Expressive writing task word count		93.86 (95.94)	58.06 (50.39)	75.08 (77.45)

Note. CUDIT-R score: Cannabis Use Disorder Identification Test-Revised (Adamson et al., 2010). TLFB = Timeline Follow-back (Sobell & Sobell, 1992). PCL-5 = PTSD Checklist for DSM-5 (Bovin et al., 2016).

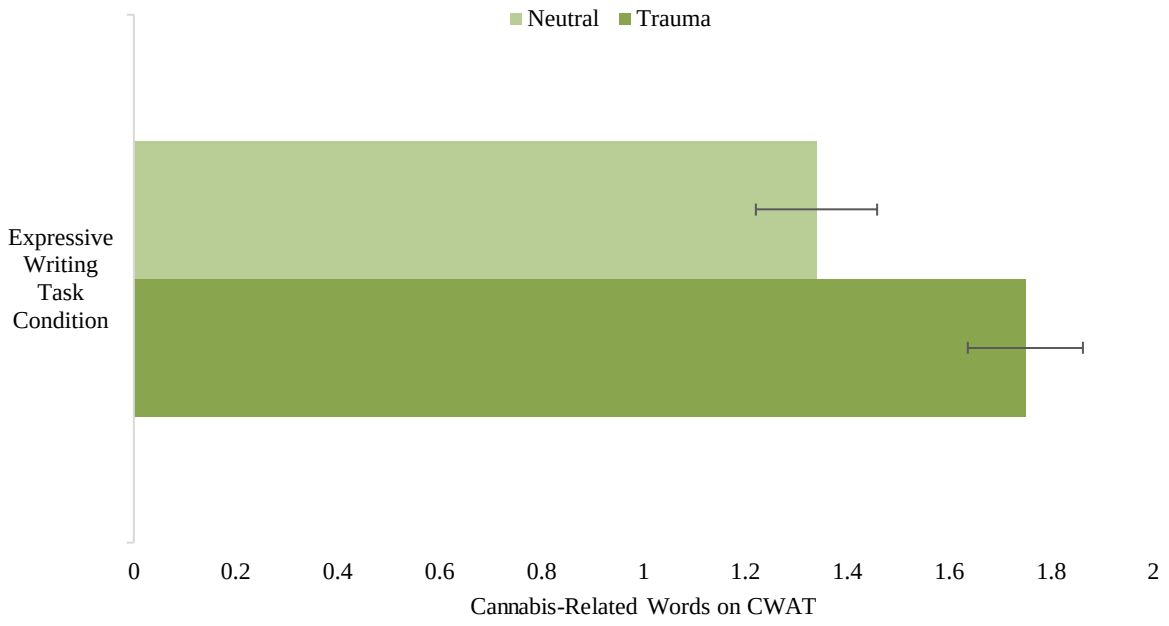
Cannabis accessibility. Consistent with H1, a significant main effect of cue condition emerged for CWAT cannabis responses (t[198] = 1.99, 95%CI [0.00-0.81], p = .048), with more cannabis responses generated to the ambiguous cannabis-related words in the trauma than the neutral condition (see Figure 1, Table 2). Contrary to H2 and H3, there was no PTSD group main effect or interaction with cue condition for CWAT cannabis responses (see Table 2). Consistent with H4, the significant main effect of cue condition seen for CWAT cannabis responses (see H1 above) did not extend to a significant main effect of cue condition for other substance-related responses (t[198] = 0.17, 95%CI [-0.25-0.59], p = .424) on the CWAT, and neither PTSD group nor its interaction with cue condition predicted other substance-related responses on the CWAT.

Table 2. *Linear Mixed Models' Omnibus Results for Cannabis and Substance-Related Automatic Cognitions*

	Estimate (*b*)	CI (95%)	*p*
Cannabis Words Generated		Marginal R^2 = 0.034 / Conditional R^2 = 0.019	
Condition (Neutral = 0)	0.41	0.00 – 0.81	.048*
PTSD Status (PTSD- = 0)	-0.15	-0.62 – 0.32	.534
Condition*PTSD Status	0.01	-0.66 – 0.69	.966
Substance Words Generated		Marginal R^2 = 0.018 / Conditional R^2 = 0.003	
Condition (Neutral = 0)	0.17	-0.25 – 0.59	.424
PTSD Status (PTSD- = 0)	-0.28	-0.77 – 0.20	.251
Condition*PTSD Status	0.25	-0.44 – 0.95	.472

Note. * $p < .05$, ** $p < .01$, *** $p < .001$.

Figure 1. *Mean Number of Cannabis-Related Responses on the Cannabis Word Assocation Task (CWAT) by Cue Type (Trauma Vs. Neutral Expressive Writing Task).*



Tests for potential covariates. To identify potential covariates possibly needing to be controlled for in sensitivity analyses, we used a set of 2 (PTSD group) x 2 (writing condition) linear mixed models to examine if any writing condition effects emerged that might need to be controlled as covariates in the hypothesis tests. A separate analysis was run for each potential covariate: age, sex, cannabis use quantity and frequency, self-reported cannabis use problems, number of past traumatic events experienced, and writing task word count. Results indicated a statistically significant effect of cue condition only on writing task word count (t[198] = 30.16, 95%CI [3.77-56.55], p = .025) with more words written by those randomized to the trauma expressive writing than those randomized to the neutral expressive writing condition. We then assessed if writing task word count was related to our outcome (cannabis-related responses on the CWAT) by running a correlational analysis. Writing task word count and cannabis related CWAT responses were not significantly correlated (r = .10, p = .149). Thus, with no potential covariates differing by cue condition influencing our outcome, we did not conduct sensitivity analyses including covariates.

DISCUSSION

The present study served two primary purposes. First, our single session online trauma expressive writing CRP had a methodological purpose, as it could help mitigate the attrition common to CRP studies conducted in person across two sessions (Coffey et al., 2006) and permitted acquisition of a larger sample to increase power to detect potential interactions. Second, our trauma expressive writing task allowed us to examine trauma cue-elicited activation of relevant automatic cognitions that might help us understand why individuals with trauma histories are more likely than others to use cannabis (Kevorkian et al., 2016; Bassir Nia et al., 2023). Specifically, this study provided preliminary evidence for the stand-alone trauma expressive writing CRP to successfully elicit greater accessibility to cannabis-related information in memory relative to the neutral expressive writing CRP, consistent with H1. This finding is partially consistent with prior work: a study on automatic attention allocation found a slowing of automatic responses among drinkers with PTSD assigned to the trauma relative to the neutral CRP condition, with the CRP including (but not specific to) an expressive writing task (Read et al., 2017).

While cue condition was a significant predictor of the accessibility of cannabis related information

in memory, the CRP manipulation had no impact on responses to other substance-related ambiguous cues on the CWAT, consistent with our cannabis-specificity hypothesis (H4). At first glance, this pattern of findings suggests that among a broad sample of recent trauma-exposed individuals who use cannabis, the activation of substance-related information in memory in response to personalized trauma cue exposure (via expressive writing) may be specific to cannabis rather than generalizable to a variety of other substances (i.e., substance-related responses on the CWAT to other substance-related ambiguous prompts [e.g., *blow, shot*]). In a previous study using a semi-structured interview (Sinha & Tuit, 2012) as the CRP, in a sample of regular trauma-exposed individuals who use cannabis, trauma (vs. neutral) cue exposure elicited not only increased cannabis craving but also increased craving for alcohol (DeGrace et al., 2024). This difference may indicate cannabis specificity for automatic cognitive processes and generalizability to other substances for more controlled, deliberative cognitive processes like craving (Tiffany, 1999). Alternatively, the discrepancy may be due to methodological differences: in DeGrace et al. (2023a), we only examined alcohol craving in the subset of individuals who use cannabis who also reported drinking alcohol while we did not obtain information on other substance use in the present study. Thus, it remains possible that expressive writing about a personal traumatic experience may indeed activate increased accessibility to other substance-related information in memory for those who use cannabis and other substances.

Contrary to expectations and prior work, probable PTSD status did not predict greater cannabis-related cognitions (H2; cf., DeGrace et al., 2023b), nor did probable PTSD status interact with the trauma cue to predict such cognitions (H3; cf., Romero-Sanchiz et al., 2022). While we had a larger sample than our previous study using the single session CRP interview (DeGrace et al., 2023a), like that previous study, we were unable to detect an interaction between PTSD and randomly assigned cue condition (trauma vs neutral) on cannabis cue-behavior associations. This absence of a PTSD by cue condition interaction is also consistent with our recent study using the same expressive writing task in this same sample (see DeGrace et al., 2024) showing a main effect of cue condition on negative affect and expectancy craving (a controlled cognitive process; Tiffany, 1999) but no interaction with PTSD. Other work from our group has, however, shown a significant interaction between PTSD and CRP cue condition for compulsivity cannabis craving – a controlled cognitive process (Romero-Sanchiz et al., 2022). Since these prior studies have not systematically varied CRP (single- vs. two-session; audiovisual cue vs. structured interview vs. expressive writing), cognitive outcome (automatic vs. controlled process; word association vs. reaction time task), or PTSD conceptualization (categorical vs. continuous; self-reported vs. clinical interview), more work is needed in identifying the conditions under which cue condition and PTSD interact in predicting cognitive outcomes relevant to understanding PTSD-CUD comorbidity (e.g., Cougle et al., 2011; Kevorkian et al., 2016).

Another possible explanation for the lack of PTSD effects in the present study could be that the automatic substance-related cognitions tapped by the CWAT may be relevant for all trauma-exposed individuals who use cannabis rather than being particularly relevant to those with PTSD. Indeed, the type of automatic cognitions assessed may be worth noting in interpreting the results of this study. For example, we found an effect of PTSD status, but no cue condition effects, on cannabis approach bias in DeGrace et al. (2023b), whereas we found an effect of trauma cue assignment, but no effect of PTSD, on the accessibility of cannabis information in memory in the present study. This suggests we cannot assume results with one automatic cannabis-related cognitive bias will extend to another measure tapping another type of cognitive bias. Future work may aim to directly compare, in a single study, trauma CRP and PTSD main and interactive effects on different automatic cognition outcomes using word association (e.g., cue-behavior; behavior-outcome; Ames et al., 2007) and reaction time tasks (e.g., selective attention to cannabis; automatic cannabis approach bias; e.g., Read et al., 2017; DeGrace et al., 2023b) in this population.

Our study presents limitations which should be considered when interpreting our results. Firstly, while steps were taken to ensure data quality in this online study (e.g., attention and speeder checks; replacement of participants who

clearly did not follow expressive writing instructions), the lack of experimenter presence in the online environment may have enabled participants to escape from the CRP (e.g., stopping writing about trauma if anxiety became too intense), potentially minimizing the magnitude of cue condition effects. Given that avoidance of trauma reminders is a symptom of PTSD (APA, 2013), escape from the writing task specifically among those with probable PTSD may have worked against the PTSD group x cue condition interaction hypothesized in H3. Second, while we coded PTSD categorically for greater clinical relevance to understanding PTSD-CUD comorbidity, and for consistency with the results of latent class analysis studies suggesting PTSD is better conceptualized as categorical than as dimensional (Ayer et al., 2011; Breslau et al., 2005; Steenkamp et al., 2012), this choice may have reduced power to detect PTSD main or interactive effects relative to studies that have examined PTSD symptoms continuously (e.g., Romero-Sanchiz et al., 2022). Third, our categorizing participants into probable PTSD and probable no PTSD groups based on a cutoff on a self-report measure (although a high cutpoint relative to other suggested cutoffs; e.g., Bovin et al., 2016) likely resulted in some misclassification relative to if we had used a diagnostic interview like the Clinician Administered PTSD Scale (CAPS-5; Weathers et al., 2018) – the gold standard for officially diagnosing PTSD. Use of a self-report measure may result in a participant scoring above the 'clinical' cutoff for PTSD without aligning with the full DSM-5 diagnostic criteria by scoring high on intrusion and hyperarousal items, for example, without meeting the avoidance or negative alterations in cognitions and mood criteria. In contrast, the CAPS-5 ensures a comprehensive assessment aligned with the DSM-5 criteria. The resultant potential misclassification could explain the absence of the hypothesized main and interactive PTSD group effects, highlighting a limitation in our study and emphasizing the importance of using the CAPS-5 in future research when possible.

Despite limitations, the present study provided preliminary evidence for the use of a remote, self-administered expressive writing task as a CRP, in eliciting specific automatic cannabis-related cognitions – namely increased accessibility of cannabis-related information in memory. However, the presence of likely PTSD did not intensify this trauma vs. neutral CRP effect on cannabis accessibility in memory. Thus, in-person CRP administration (with an in-person experimenter to monitor participant engagement) may be needed to successfully intensify these automatic cannabis-related cognitions in individuals with PTSD, given their tendency to avoid trauma reminders (APA, 2013). While the absence of PTSD group effects or an interaction of PTSD group with cue condition suggests cue-behavior associations are an unlikely candidate for an automatic cognitive process to explain the high comorbidity of PTSD and CUD (Cougle et al., 2011), the main effects of cue condition may well be useful in understanding why those with trauma histories are at increased risk of cannabis use (Bassir Nia et al., 2023; Kevorkian et al., 2015). Indeed, the tendency of trauma cue exposure to increase accessibility of cannabis information in memory among trauma-exposed individuals who use cannabis may promote increased cannabis use, even without the individual's conscious awareness or reflection (Ames et al., 2007). This trauma cue-elicited reflexive cannabis use among those with trauma histories may be particularly likely in an environment where cannabis is readily accessible, such as in Canada's legalized context.

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Funding and Acknowledgements: This work was supported through a Cannabis and Mental Health Catalyst Grant (Application #442109; Principal Investigator: SHS) from the Mental Health Commission of Canada and by a grant (Grant #893728; Principal Investigator: SD) from the Nova Scotia Health Authority Research Fund. SD is supported by graduate studentships from the Chronic Pain Centre of Excellence for Canadian Veterans' Capacity Building Initiative, the L'Oréal-UNESCO & France-Canada Research Fund for Women in Science Scholarship, and the Dalhousie Medical Research Foundation's MacQuarrie Neuroscience Research Graduate Studentship. PT is supported through the Dr Paul Janssen Chair in Psychotic Disorders, Dalhousie University. SHS is supported through a Tier 1 Canada Research Chair in Addictions and Mental Health.

Citation: DeGrace, S., Tibbo, P. G., Pilin, M. A., Krank, M. D., O'Connor, R. M., Wardell, J., Keough, M. T., Snooks, T., Trottier, S-J., & Stewart, S. H. (2024). Expressive writing about one's trauma increases accessibility of cannabis information in memory among trauma-exposed individuals who use cannabis. *Cannabis, 7*(3), 61–73. https://doi.org/10.26828/cannabis/2024/000262

Issue Date: December 12, 2024