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Development of Brief Alcohol and Cannabis Motives Measures: Psychometric Evaluation Using Expert Feedback and Longitudinal Methods

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ABSTRACT

Objective: Alcohol and cannabis use motives are often studied as contributors to risky substance use patterns. While various measures for capturing such motives exist, most contain 20+ items, which render their inclusion in certain research designs (e.g., daily diary) or with certain populations (e.g., polysubstance users) unfeasible. We sought to generate and validate six-item measures of cannabis and alcohol motives from existing measures, the Marijuana Motives Measure (MMM) and the Modified Drinking Motives Questionnaire-Revised (MDMQ-R). **Methods:** In Study 1, items were generated, feedback from 33 content-domain experts was obtained, and item revisions were made. In Study 2, the finalized brief cannabis and alcohol motives measures, along with the MMM, MDMQ-R, and substance-related measures, were administered to 176 emerging adult cannabis and alcohol users (71.6% female) at two timepoints, two months apart. Participants were recruited through a participant pool. **Results:** Study 1 experts indicated satisfactory ratings of face and content validity. Expert feedback was used to revise three items. Study 2 results suggest test-retest reliabilities for the single-item forms (r = .34 to .60) were similar to those obtained with full motives measures (r = .39 to .67). Validity was acceptable-to-excellent in that brief and full-length measures were significantly intercorrelated (r = .40 to .83). The brief and full-length measures had similar concurrent and predictive relationships for cannabis and alcohol quantity x frequency (coping-with-anxiety for cannabis and enhancement for alcohol) and problems (coping-with-depression), respectively. **Conclusions**: The brief measures represent psychometrically-sound measures of cannabis and alcohol use motives with substantially less participant burden than the MMM and MDMQ-R.

Key words: = cannabis motives; alcohol motives; test development; young adults

Individuals are motivated to engage in cannabis and alcohol use to achieve a variety of effects (i.e., substance use motives). Theory suggests motivations for cannabis and alcohol use exist on positive vs negative reinforcement and internal vs external dimensions (Cooper et al., 2016). These two dimensions interact to create four categories of motives for cannabis and alcohol use (Cooper et al., 2016): 1) internal positive reinforcement motives, involving substance use to increase positive emotions (i.e., enhancement motives); 2) internal negative reinforcement motives, involving substance use to reduce negative emotions (i.e., coping motives); 3) external positive reinforcement motives, involving substance use to enhance or improve social events or relationships (i.e., social motives); and 4) external negative reinforcement motives, involving substance use to avoid ostracism (i.e., conformity motives).

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Research supports the validity of the above model for both cannabis and alcohol (see Cooper et al., 2016 for review). As a result, various measures of cannabis and alcohol motives were based on this theory, beginning with Cooper's foundational measures (Cooper, 1992; Cooper, 1994). In recent years, iterations of Cooper's scales were developed and expanded upon. Currently, two commonly used and well-validated iterations are the Marijuana Motives Measure (MMM; Simons et al. 1998) and the Modified Drinking Motives Questionnaire-Revised (MDMQ-R; Grant, et al. 2007). Both include Cooper's (1994) items assessing enhancement, social, coping and conformity motives. Each also adds items either allowing for the separation of the internal, negative reinforcement motive into separate coping-with-anxiety and coping-with-depression scales (MDMQ-R) or the separation of the internal, positive reinforcement motive into separate enhancement and expansion motives scales (expansion motives include using to enhance experience and creativity; MMM).

In line with motivational theory, the motives measured by the MMM and the MDMQ-R are linked to cannabis- and alcohol-related outcomes. Coping, enhancement, and expansion motives have been shown to predict frequency and/or quantity of cannabis and alcohol use (Bonar et al., 2017; Cooper et al., 2016). Coping motives have also been found to predict cannabis- and alcohol-related problems cross-sectionally and longitudinally (Cooper et al., 2016; Patrick et al., 2016). With respect to alcohol coping motive subtypes, coping-with-depression appears to be particularly predictive of alcohol-related problems (e.g., Loose & Acier, 2017). Other motives such as conformity and enhancement motives have also demonstrated weak positive (conformity) or indirect (enhancement – via consumption) relationships with cannabis- and alcohol-related problems (Cooper et al., 2016; Simons et al., 1998). Notably, social motives appear to be less of a risk factor, as they are related to typical patterns of consumption, but not consistently related to problematic use (Cooper et al., 2016; Kuntsche et al., 2005).

Limitations of Current Measures

While both the MMM and the MDMQ-R have strong psychometric properties (e.g., Grant et al., 2007; Simons et al., 1998), their use in certain study designs is not feasible due to their length (25+ items each). For example, the length of the MMM and the MDMQ-R can pose a problem for polysubstance use studies or egocentric social network studies, as asking participants to complete these scales for multiple substances or multiple network members is burdensome. Longer measures are also unsuitable for ecological momentary assessment studies where people may complete measures several times per day for multiple weeks. Given research suggests questionnaire length and participant burden may be associated with careless participant responding, the length of the existing motives questionnaires may impact data validity (e.g., Gibson & Bowling, 2019). While a 12-item short form of Cooper's (1994) measure has been developed and validated for alcohol (Kuntsche & Kuntsche, 2009), it remains too long for research using the designs outlined above and does not separate the coping motive into coping-with-depression and coping-with-anxiety, distinguishable motives which are associated with different alcohol outcomes (e.g., Grant et al., 2007; Loose & Acier, 2017). A short form of the MMM has yet to be developed.

Considering the above measurement issues, many researchers are forced to take non-ideal approaches when studying cannabis and alcohol motives. Some researchers select and use a subset of items from existing subscales, which introduces limitations, as it cannot be assumed the chosen items represent each motive in a reliable and valid fashion (e.g., Bonar et al., 2017; Joyce et al. 2018; Joyce et al., 2021; O'Donnell et al., 2019; O'Hara et al., 2015; Pearson et al., 2020; Stevenson et al., 2019). To overcome limitations of this approach, other researchers have been forced to choose to study only certain motives that are of highest interest (i.e., include only certain subscales), rather than study all possible relevant motives (e.g., Dvorak et al., 2014). Our goal was to develop and validate brief versions of the MMM and the MDMQ-R so researchers no longer need sacrifice reliability or validity when studying substance motives.

METHODS

To develop and validate our measures, we conducted two studies. Study 1 was a measure development study, consisting of item generation, expert feedback, and item revision. Study 2 was a

validation study where the psychometric properties of the revised versions of our brief measures were tested in a longitudinal design in comparison with the original long forms.

Study 1: Item Development

Item generation. We followed the short-form test development methods employed by Breslin et al. (2000) and Smith et al. (2011). For both cannabis and alcohol, we created one item for each of the following six motives: enhancement, expansion, social, coping-with-anxiety, coping-with-depression, and conformity. Each item consisted of a general statement representing the general concept of the motive, followed by two items from the MMM or the MDMQ-R in brackets (e.g., "In the past 30 days, I've used cannabis because it's a good way to socialize with others [e.g., because it makes social gatherings more enjoyable, or to be sociable]."). Items were generated using the following guidelines: the general statement must be face-valid and reflect the main aspects of the motive, and the two examples that follow must, if possible 1) have high factor loadings onto the construct; 2) be face-valid; and 3) cover core aspects of the motive, as well as the breadth of content included in the motive items. When developing preliminary versions of these measures, we aimed to balance these guidelines; however, because we wanted to make uniform cannabis and alcohol scales to enable cross-substance comparisons, this was not always possible. For example, while the expansion motive items on the MMM have been studied in relation to alcohol[1], factor loadings for these items are not published, and expansion motives are not included in the MDMQ-R. As such, the developed expansion item relied upon factor loadings of the expansion items in the MMM.

As we sought to measure each motive with one item, capturing variation in participant response was essential. As such, we chose a visual analog scale (VAS) response format, which offers more nuanced response options than traditional Likert-type scales (Kuhlmann et al., 2017). VAS response formats also have several advantages, including being quick, avoiding systematic bias from limited scale responses, and providing interval-scaled data (Aguinis et al., 2009; Klimek et al., 2017). Item responses range from "never" (0) to "always" (100).

Expert opinion. We identified 72 experts from whom we sought feedback on our developed items[2], consistent with best-practice recommendations for test development (Boateng et al., 2018). While typically 5-7 experts are used, we wanted to receive as much expert feedback as possible (Boeateng et al., 2018). An expert was defined as first or senior authors of at least one publication about cannabis or alcohol motives in the past 15 years and was identified through a PsychInfo search on "cannabis motives" or "alcohol motives". The experts were e-mailed a copy of our measures and an online questionnaire which asked them to provide feedback on our approach to test construction, and on the validity and wording of our draft items (See Supplemental Materials C for copy of this questionnaire). Responses were anonymous. Prior to reviewing expert feedback, we decided to change an item for both substances (see above) if $\geq$10% of experts disagreed on one of the questions related to that item or if $\geq$10% raised the same criticism regarding an item.

Expert responses. We received 33 responses to our survey (45.8% response rate). 95.2% and 92.3% of experts reported they would use the brief cannabis and alcohol motives measures, respectively; and 87.5% agreed we had taken an acceptable approach to brief-form test development; the remaining 12.5% neither agreed nor disagreed. The vast majority agreed the items had face- and content-validity (i.e., were fully representative; see Table 1). Given our $\geq$10% rule mentioned above, enhancement, coping-with-depression, and conformity items were altered for both substances. See Supplementary Materials A for a list of specific alterations to these three items. See Supplementary Materials B for the final versions of the Brief Cannabis Motives Measure (BCAMM) and the Brief Alcohol Motives Measure (BAMM).

[1]Despite not being commonly mentioned in relation to alcohol, alcohol expansion motives have been shown to be endorsed more highly than alcohol conformity motives (Simons, et al., 2000). Thus, the expansion motive is likely relevant to alcohol and warranted inclusion in our alcohol measure.

[2]Based on publication history, 27 experts were considered to have expertise in both alcohol and cannabis motives; 21 were considered to have expertise in cannabis motives only; and 25 were considered to have expertise in alcohol motives only.

Table 1. *Results from Experts Regarding Face and Content Validity*

Motive	Substance	Face Validity	Core Aspects	All Aspects (i.e., Breadth)
Enhancement	Alcohol	90.62% (6.25%)	96.67% (3.33%)	80.64% (6.45%)
	Cannabis	95.24% (4.76%)	95.24% (4.76%)	90.47% (9.52%)
Social	Alcohol	96.55% (3.45%)	100.00% (0.00%)	82.73% (10.34%)
	Cannabis	100.00% (0.00%)	100.00% (0.00%)	85.71% (9.52%)
Coping-with-anxiety	Alcohol	100.00% (0.00%)	96.55% (3.45%)	86.21% (3.45%)
	Cannabis	100.00% (0.00%)	100.00% (0.00%)	90.48% (4.76%)
Coping-with-depression	Alcohol	83.71% (3.57%)	92.85% (3.57%)	81.12% (3.57%)
	Cannabis	95.00% (5.00%)	100.00% (0.00%)	80.95% (14.29%)
Conformity	Alcohol	92.00% (0.00%)	96.00% (0.00%)	82.61% (17.39%)
	Cannabis	95.00% (5.00%)	90.00% (10.00%)	82.61% (17.39%)
Expansion	Alcohol	83.34% (16.67%)	80.00% (20.00%)	72.00% (20.00%)
	Cannabis	100.00% (0.00%)	100.00% (0.00%)	95.24% (4.76%)

Note. The percentage before the brackets indicates the percentage of experts that agreed or strongly agreed that the item either was face-valid, represented all aspects of the motive (i.e., full coverage of the motive concept), and reflected the core aspects of the motive, respectively. The number within brackets represents the percentage of experts that neither agreed nor disagreed.

Study 2: Measure Evaluation

We then sought to evaluate the reliability and further evaluate the validity of the BCAMM and BAMM. Given many motives studies are conducted with emerging adults, a high substance using population (Canadian Centre on Substance use and Addiction, 2017), we chose to conduct the initial validation of the BCAMM and BAMM in this population. Moreover, we chose to conduct Study 2 in a sample of individuals who use both cannabis and alcohol, as research suggests 54% of young adults in Canada use both alcohol and cannabis (13% concurrently and 41% simultaneously) and only 1% of young adult cannabis users use cannabis, but not alcohol (Thompson et al., 2021). We hypothesized: H1) brief and full-length measures would have similar reliability, as indicated by relative consistency; H2) brief and full-length subscales would be at least moderately concurrently correlated; H3) brief and full-length subscales would remain significantly concurrently correlated after removing shared items between the brief and full-length measures; H4) given theoretical links of internal motives with substance use quantity/frequency (Cooper et al., 2016), for both substances, enhancement, coping-with-anxiety, and coping-with-depression (plus expansion for cannabis) would predict substance use quantity x frequency (QxF) concurrently for brief and full-length scales; H5) given theoretical links of negative reinforcement motives with problems (Cooper et al., 2016), for both substances, baseline quantity, conformity motives, and coping-with-depression motives would prospectively predict follow-up substance-related problems for the brief and full-length scales.[3]

Participants. One hundred and seventy-six university students between 17-30 years old (M=20.15, SD = 3.15) were recruited (Male = 50, Female =126)[4]. On average, participants began

[3]While developing the MMM and the MDMQ-R, the authors included all motives in regression analyses for exploratory purposes. As established relationships between the MMM and the MDMQ-R with substance use outcomes now exist, that are consistent with theory (Cooper et al., 2016), we only included specific theoretically derived motives in our hypotheses/analyses.

using alcohol at age 15.70 (*SD* = 1.97) and cannabis at age 16.88 (*SD* = 1.62) and had completed 1.6 full years of university (*SD* = 1.29; range 0-6). Eighteen participants were lost to attrition at wave two (89.8% retention). To ensure participants could be considered "users", they had to have used alcohol ≥four times, and cannabis recreationally ≥two times, in the past month at baseline (see Cougle et al., 2015). An a-priori power analysis was conducted with G*Power (Faul et al., 2007), which allows for estimation of F^2 through the imputation of predictor correlations. This analysis indicated a sample size of 166 to reach a power of .8. This analysis was based on Grant et al. (2007) and Simons et al. (1998), accounting for the slightly lower variance in outcomes predicted by single-item measures.

Measures

BCAMM and BAAMM. The BAMM and BCAMM each include an item to assess enhancement, expansion, social, coping-with-anxiety, coping-with-depression, and conformity motives. Instructions for measures are in Supplementary Materials B. A time frame of 30 days was used[5]. Each item was answered using a VAS from never (0) to always (100). Items are scored individually (i.e., there is no total BCAMM or BAMM score).

Marijuana Motives Measure + (MMM+). The MMM (Simons, et al., 1998) is a 25-item measure assessing enhancement, expansion, social, coping, and conformity motives for cannabis use. The MMM+ includes the following instructions: "Listed below are 33 reasons people might be inclined to use cannabis. Using the five-point scale below, decide how frequently your own cannabis use is motivated by each of the reasons listed." A time frame of 30 days was used. Response options ranged from almost "never/never" (1) to "almost always/always" (5). The original measure has good internal consistency (subscale α's=.86 to .92), concurrent, and predictive validity (e.g., cannabis-related problems; Simons et al., 1998). To compare the coping-with-anxiety and coping-with-depression items on the BCAMM to full-length subscales, the coping-with-anxiety and coping-with-depression items from the MDMQ-R were added to the MMM substituting "cannabis" for "alcohol". The items replaced the original four MMM coping items. This modified version of the MMM had similar internal consistency to the MMM (α = .76-.94) on all comparable subscales other than social, which was lower than the MMM+.

Modified Drinking Motives Questionnaire – Revised + (MDMQ-R+). The MDMQ-R (Grant et al., 2007) is a 28-item measure assessing enhancement, social, coping-with-anxiety, coping-with-depression, and conformity motives. The instructions for the MDMQ-R+ were identical to the MMM+, substituting "cannabis" with "alcohol." Response options and time frame match that of the MMM+. This measure has good test-retest reliability (ICC = .65 to 78), concurrent validity for drinking quantity, and predictive validity for alcohol-related problems (Grant et al., 2007). As previously done by Simons et al. (1998), we added the expansion items from the MMM, substituting "alcohol" for "marijuana" to compare the expansion item on the BAMM to a full-length subscale. Each subscale of the MDMQ-R+ had similar internal consistency (α = .67 to .93) to the corresponding subscale of the MDMQ-R reported in Grant et al. (2007). The expansion subscale had similar internal consistency to the alcohol expansion subscale reported by Simons et al. (1998; α = .79).

Substance Use Questionnaire. This measure assessed alcohol and cannabis quantity and frequency using items recommended by the National Institute of Health (2003) for alcohol, and items from the Daily Sessions, Frequency, Age of Onset, and Quantity of Cannabis Use Inventory (DFAQ-CU; Cuttler & Spradlin, 2017) for cannabis. Each question referred to the past 30 days. Alcohol questions included a depiction and description of a typical drink. Ten response options were given for alcohol quantity within a typical drinking day, ranging from 0-25+ drinks. Seven response options were given for past month alcohol frequency ranging from "once" to "every day". An image with a Canadian 5-dollar bill (as size referent) and various amounts of cannabis (1/8th -1 gram), adapted from the DFAQ-CU was

[4]Note that one additional participant aged 52 participated; however, as we sought to study emerging adults, this participant was excluded from the analysis.

[5]Suggested instructions for daily, ecological momentary assessment and weekly time frames can also be found in Supplementary Materials B.

given to assist in reporting on cannabis quantity. Participants were asked to indicate number of grams used in a single session of use. Responses were entered into a textbox and could include up to three decimal places. The DFAQ-CU frequency question was altered to reflect the past 30 days (i.e., only response options referencing past 30 days use were included) and additional responses options were added to capture the nuance of high frequency use more accurately; sixteen response options were given for past month cannabis frequency ranging from "I did not use cannabis" to "15+ times a day." Similar approaches to measuring cannabis frequency were taken by other researchers (Sofis et al., 2021). A QxF variable was created for both alcohol and cannabis by multiplying responses to quantity and frequency items (Grant et al., 2007). We chose to combine quantity and frequency, as their combination together is arguably a more meaningful estimate of use than either alone (e.g., Fischer et al., 2017; Prince et al., 2019).

Rutgers Alcohol Problem Index. The RAPI (White & Labouvie, 1989) is a 23-item measure assessing alcohol-related problems. The time frame was 30 days and items were scored dichotomously (i.e., "never" = 0; "1-2" - "10+" times = 1) and then summed (Martens et al., 2007). This method of scoring has been shown to have adequate convergent validity (e.g., r = .44 with drinking frequency; Martens et al., 2007) and had excellent internal consistency in our sample [α = .91 (baseline) to .94 (follow-up)].

Rutgers Marijuana Problem Index (RMPI). The RMPI (Simons et al., 2000) is a 23-item measure assessing common cannabis-related problems. The RMPI modifies RAPI items to assess cannabis. The time frame was 30 days and items were scored dichotomously and then summed for consistency with the RAPI scoring (i.e., "never" = 0; "1-2" - "10+" times = 1). The RMPI demonstrates expected relationships with cannabis use (Simons et al., 2005) and had good-to-excellent internal consistency in our sample [α = .87 (baseline) to .95 (follow-up)].

Procedure. Participants were recruited through a psychology participant pool at an Eastern Canadian university[6]. Participants completed measures online in the lab at baseline and again two months later online at home. Questionnaire order was randomized. Participants were compensated with psychology credits or a $10 CDN Amazon gift card after each wave.

RESULTS

Analytic strategy. We planned to use Pearson correlation coefficients to test H1-3, and multiple regression to test H4-5. Assumptions of multivariate normality for Pearson correlation coefficients were violated, so Spearman's rank-order correlations were used. Assumptions of multivariate normality were also violated for the planned regressions to test H4 with cannabis variables and H5 with both alcohol and cannabis variables. As recommended (Neal & Simons, 2007), generalized linear modelling (Glim) was chosen. Robust estimates of standard errors were used to handle heterogenous variance. For each analysis, we ran models with various distributions and links, comparing averaged BIC across 40 imputations to determine best fit. See Supplementary Materials E for model comparisons. We calculated McFadden's pseudo-R^2 (McFadden, 1973) to compare the predictive ability of brief and full measures. Sex and age were examined as covariates, and sex was found to have a significant relationship with cannabis-related problems (i.e., greater in males). As a result, sex was included as a covariate in our predictive validity analyses for the BCAMM.

Descriptive Statistics

Eighteen participants demonstrated monotone missing data. There was no statistically significant difference in those who dropped out from those who were retained on baseline alcohol (t = -.45, p = .66) or cannabis quantity (t = .185, p = .85), or alcohol (t = -.18, p = .86) or cannabis frequency (t = .98, p = .33). Little's MCAR test was non-significant (X^2 = 1121.96; df = 1072; p = .14). Multiple imputation in SPSS was used to handle missing data (40 imputations as recommended by Graham et al.,

[6]Regarding ineligibility: The psychology participant pool indicates the inclusion criteria for the study on the study sign up page (i.e., potential participants read these criteria before signing up for a study participation timeslot). It is unclear how many people clicked on the study advertisement, but later realized they were ineligible. Screening was formally done with participants that signed up for the study and attended the baseline assessment. Only one participant was turned away due to not meeting the substance use criteria. All participants who consented participated.

2007). All variables in the analyses were used as potential predictors and imputed variables. No auxiliary variables were added.

Means, standard deviations and bivariate Spearman's rank-order correlations for brief and full measures appear in Supplementary Tables 2 and 3. At time 1 (T1), the mean numb er of drinks per occasion was 3.60 (*SD* = 1.4) and frequency of use was 3.59 (*SD* = 1.02; corresponds to "once per week"). The mean grams of cannabis used per occasion of use was .59 (*SD* = .75)[7] and frequency of cannabis use was 4.01 (*SD* = 1.02; corresponds to "twice per week"). At time 2 (T2), the mean dichotomized and summed RAPI score was 6.60 (*SD* = 5.80) and mean dichotomized and summed RMPI score was 4.89 (*SD* = 4.30), meaning participants experienced an average of seven alcohol-related problems and five cannabis-related problems in the past month.

Test-retest Reliability

To test H1, test-retest reliability was examined using Spearman's rank correlations (Lexell & Downham, 2005). As shown in Table 2, brief measures were significantly correlated at T1 to T2 (cannabis, *r*=.33 to .60; alcohol, *r*=.34-.59). The MMM+ (*r*=.46-.67) and the MDMQ-R+ (*r*=.39 to .63) were significantly correlated at T1 to T2. The strength of test-retest correlations between each item of the brief measures and the corresponding full-length subscale (e.g., BAMM social item vs. MDMQ-R+ social subscale) were compared (Lee & Preacher, 2013) and were not statistically different (See Table 2 for specific *p*-values).

Convergent Validity

Spearman's rank correlations were run to test H2 and H3. Convergent validity correlations were interpreted as moderate (*r* = .40 to .59), strong (*r* = .60 to .79), and very strong (*r* = .80 to 1.00; Evans, 1996). Convergent validity between the BCAMM and MMM+ subscales at T1 and T2 ranged from moderate (*r* = .56) to very strong (*r* = .83), with the majority (5/6) of subscales demonstrating strong or very strong convergent validity at T1 and T2. Convergent validity between the BAMM and MDMQ-R+ subscales at T1 and T2 ranged from moderate (*r* = .40) to strong (*r* = .73), with the majority (4/6) of subscales demonstrating strong convergent validity at T1 and moderate convergent validity at T2 (4/6). See Table 3 for convergent validity results.

To examine whether correlations between brief and full measures were primarily due to the two shared items between the brief and full-length measures (i.e., two items within brackets in the BCAMM and BAMM), subscale scores of the MMM+ and the MDMQ-R+ were re-calculated without shared items (see Table 4). Convergent validity remained moderate to very strong for all motives, except social motives for alcohol. Further examination indicated the BAMM social item was significantly correlated with the MDMQ-R+ social motive items that have high face validity (e.g., "to be sociable"), but not with items with lower face validity (i.e., "as a way to celebrate", "because it is customary on special occasions"). This pattern also existed for the BCAMM and the MMM+, although correlations were stronger. See Supplementary Materials D Tables 3-14 for correlations between the BCAMM and BAMM and individual subscale items from the MMM+ and MDMQ-R+.

Concurrent and Predictive Validity

Our first set of concurrent validity analyses included alcohol QxF at T1 as predicted by T1 BAMM or MDMQ-R+ coping-with-anxiety, coping-with-depression, and enhancement motives (see Table 5). Partially consistent with H4, there was a significant effect of T1 BAMM and MDMQ-R+ enhancement. There were no significant effects of BAMM or MDMQ-R+ coping-with-anxiety or coping-with-depression. VIF (BAMM = 1.13 to 1.83; MDMQ-R+ = .48 to 2.29) and tolerance values (BAMM = .55 to .89; MDMQ-R+ = .44 to .87) were acceptable.

Our second set of concurrent validity analyses included T1 cannabis QxF predicted by T1 BCAMM or MMM+ enhancement, coping-with-anxiety, coping-with-depression, and expansion motives (see Table 6). Partially consistent with H4, there was a significant effect of BCAMM coping-with-anxiety and MMM+ coping-with-anxiety, coping-with-depression, and expansion (inverse relationship) motives. No significant effects of BCAMM or MMM+

[7]An examination of the cannabis quantity variable indicated some participants had entered unrealistic values in answer to the question, "In a typical session of use (i.e., one sitting) over the last 30 days, how many grams of cannabis did you personally use?" (e.g., 100 grams). As such, 8 participants who entered >5 grams were removed from the analyses.

Table 2. *Test-Retest Correlations Between T1 and T2*

Motive	BAMM	MDMQ-R+	Difference between BAMM & MDMQ-R+ subscale	BCAMM	MMM+	Difference between BCAMM & MMM+ subscale
Enhancement	.53**	.63**	$p = .10$	.49**	.61**	$p = .07$
Social	.43**	.49**	$p = .60$	.47**	.57**	$p = .11$
Coping with Anxiety	.54**	.54**	$p = .91$	.60**	.67**	$p = .16$
Coping with Depression	.52**	.59**	$p = .30$	.60**	.64**	$p = .32$
Conformity	.55**	.48**	$p = .37$	.33**	.46**	$p = .08$
Expansion	.34**	.39**	$p = .54$	.50**	.56**	$p = .29$

Note. Correlations represent pooled Spearman's Rank Order Correlations. Correlations reflect items/subscales at T1 correlated with same items/subscales at T2. BAMM = Brief Alcohol Motives Measure; MDMQ-R+ = Modified Drinking Motives Questionnaire Revised +; BCAMM = Brief Cannabis Motives Measure; MMM+ = Marijuana Motives Measure. * $p < .05$; ** $p < .01$.

Table 3. *Convergent Validity Between the BAMM/MDMQ-R and BCAMM/MMM+ at T1 and T2*

Motive	T1 Alcohol	T2 Alcohol	T1 Cannabis	T2 Cannabis
Enhancement	.63**	.60**	.62**	.62**
Social	.47**	.40**	.65**	.62**
Coping with Anxiety	.70**	.58**	.81**	.75**
Coping with Depression	.73**	.62**	.83**	.74**
Conformity	.61**	.60**	.59**	.56**
Expansion	.49**	.57**	.79**	.73**

Note. Correlations represent pooled Spearman's Rank Order Correlations. T1 Alcohol = correlations between T1 Brief Alcohol Motives Measure item and corresponding T1 Modified Drinking Motives Questionnaire Revised + subscale; T2 Alcohol = correlations between T2 Brief Alcohol Motives Measure item and corresponding T2 Modified Drinking Motives Questionnaire Revised + subscale; T1 Cannabis = correlations between T1 Brief Cannabis Motives Measures item and corresponding T1 Marijuana Motives Measure + subscale; T2 Cannabis = correlations between T2 Brief Cannabis Motives Measure item and corresponding T2 Marijuana Motives Measure + subscale.
* $p < .05$; ** $p < .01$.

Table 4. *T1 Concurrent Correlation between the BAMM/MDMQ-R+ and BCAMM/MMM+ Excluding Shared Items*

Motive	Alcohol	Cannabis
Enhancement	.61**	.63**
Social	.19**	.45**
Coping-with-anxiety	.51**	.70**
Coping-with-depression	.70**	.83**
Conformity	.56**	.61**
Expansion	.45**	.76**

Note. Correlations represent Spearman's Rank Order Correlations. Due to shared items between the BAMM and BCAMM items and the MDMQ-R+ and the MMM+ subscales, the subscale scores of the MDMQ-R+ and the MMM+ were re-calculated without the shared items and correlated with the relevant BAMM and BCAMM items. ** $p < .01$.

Table 5. *Regression Coefficients in Multiple Regressions for Alcohol QxF Predicted by the BAMM and the MDMQ-R+ Coping-with-Anxiety, Coping-with-Depression, and Enhancement Motives*

	T1 Alcohol QxF									
Measure	BAMM					MDMQ-R+				
Variables	B	*SE B*	T	*P*	R^2	B	*SE B*	t	*p*	R^2
Intercept	10.64	1.08	9.84	.00		6.46	1.87	3.47	.00	
Coping-with-anxiety T1	.01	.02	.27	.79		.09	.22	.42	.68	
Coping-with-depression T1	.00	.03	-.08	.94	.04	.00	.10	.03	.97	.08
Enhancement T1	.04	.02	2.38	.02		.39	.12	3.26	.00	

Note. BAMM = Brief Alcohol Motive Measures; MDMQ-R+ = Modified Drinking Motives Questionnaire Revised +. R^2 represents average of R^2 values across 40 imputations. B = Unstandardized betas.

Table 6. *Generalized Linear Model for Cannabis QxF Predicted by BCAMM and MMM+ Coping-with-Anxiety, Coping-with-Depression, Enhancement, and Expansion Motives*

	T1 Cannabis QxF											
Measure	BCAMM						MMM+					
Variable	*B*	*SE*	Wald χ^2 95% CI lower	Wald χ^2 95% CI higher	*P*	R^2	*B*	*SE*	Wald χ^2 95% CI lower	Wald χ^2 95% CI higher	*P*	R^2
Intercept	.80	.28	.24	1.35	.01	.14	1.01	.71	-.38	2.40	.15	.02
Coping-with-anxiety T1	.03	.01	.01	.04	.00		.14	.07	.01	.27	.04	
Coping-with-depression T1	.01	.01	-.01	.03	.40		.08	.03	.02	.14	.01	
Enhancement T1	.00	.01	-.01	.01	.93		-.05	.05	-.14	.05	.35	
Expansion T1	.00	.01	-.02	.01	.57		-.08	.03	-.15	-.01	.02	

Note. Statistics represent pooled effects. Generalized linear models utilized the gamma distribution with log link. BCAMM = Brief Cannabis Motives Measure; MMM+ = Marijuana Motives Measure+. R^2 = McFadden's Pseudo R^2.

enhancement motives were found. VIF and tolerance statics are not available in Glim models. See the Supplementary Materials F for an additional comparison of the effect sizes for the BCAMM and the MMM+.

Our first set of predictive validity analyses included alcohol-related problems at T2 as predicted by T1 alcohol quantity, and BAMM or MDMQ-R+ conformity and coping-with-depression motives (see Table 7). Partially consistent with H5, there were significant effects of T1 BAMM and MDMQ-R+ coping-with-depression. There was no significant effect of T1 alcohol quantity or T1 BAMM or MDMQ-R conformity. See Supplementary Materials F for an additional comparison of the effect sizes for the BAMM and the MDMQ-R+.

We then ran the same predictive validity models, substituting cannabis variables for alcohol variables and adding in sex as a covariate. Partially consistent with H5, there was a significant effect of T1 cannabis quantity and T1 BCAMM and MMM+ coping-with-depression in predicting T2 cannabis-related problems. There was a significant effect of sex for the BCAMM (greater in males), with the effect of sex for the MMM+ marginal at p = .05. There were no significant effects of T1 BCAMM or MMM+ conformity items (see Table 8). See Supplementary Materials F for an additional comparison of the effect sizes for the BCAMM and the MMM+.

Table 7. *Generalized Linear Model for Time 2 Alcohol-related Problems Predicted by Time 1 Alcohol Quantity and Enhancement and Coping-with-Depression Motives*

	T2 Alcohol-related problems											
Measure	BAMM						MDMQ-R+					
Variables	*B*	*SE*	Wald χ^2 95% CI lower	Wald χ^2 95% CI higher	*P*	R^2	*B*	*SE*	Wald χ^2 95% CI lower	Wald χ^2 95% CI higher	*P*	R^2
Intercept	1.02	.29	.46	1.58	.00	.02	.42	.28	-.33	1.16	.27	.03
Alcohol quantity T1	.12	.06	-.00	2.48	.05		.11	.06	-.01	.24	.08	
Conformity T1	.01	.00	-.00	.01	.10		.05	.03	-.01	.11	.09	
Coping-with-depression T1	.01	.00	.00	.01	.00		.04	.01	.02	.06	.00	

Note. Statistics represent pooled effects. Generalized linear models utilized the negative binomial distribution with log link. BAMM = Brief Alcohol Motive Measures; MDMQ-R+ = Modified Drinking Motives Questionnaire Revised+. R^2 = McFadden's Pseudo R^2.

Table 8. *Generalized Linear Model for Time 2 Cannabis-related Problems Predicted by Time 1 Cannabis Quantity and Conformity and Coping-with-Depression Motives*

	T2 Cannabis-related problems											
Measure	BCAMM						MMM+					
Variables	*B*	*SE*	Wald χ^2 95% CI lower	Wald χ^2 95% CI higher	*P*	R^2	*B*	*SE*	Wald χ^2 95% CI lower	Wald χ^2 95% CI higher	*P*	R^2
Intercept	1.85	.19	1.48	2.22	.00	.02	1.26	.38	.53	2.00	.00	.03
Sex	-.42	.19	-.78	.06	.02		-.38	.19	-.76	-.01	.05	
Cannabis quantity T1	.01	.00	.00	.02	.00		.01	.00	.00	.02	.01	
Conformity T1	-.01	.00	-.01	.00	.27		.00	.40	-.08	.08	1.00	
Coping-with-depression T1	.01	.00	.00	.01	.00		.04	.01	.02	.06	.00	

Note. Statistics represent pooled effects. Generalized linear models utilized the negative binomial distribution with log link. Sex is coded as 0 = male and 1 = female. BCAMM = Brief Cannabis Motives Measure; MMM+ = Marijuana Motives Measure+. R^2 = McFadden's Pseudo R^2.

DISCUSSION

We developed and examined the psychometrics of the BCAMM and the BAMM, brief cannabis and alcohol motive measures based on the MMM and the MDMQ-R, respectively. We began by creating two six-item measures and incorporating feedback from 33 experts in cannabis and/or alcohol motives. Expert responses in Study 1 suggest the BCAMM and BAMM have excellent face- and content-validity.

Results from Study 2 suggest the brief and full-length measures have similar test-retest reliability, supporting H1. Note the reliability ranged from r = .34 to .67. This does not reflect poor psychometric properties, but rather the nature of motives, which are thought to be trait-states (i.e., demonstrating general stability, while also indicating some occasion-specific variability; Windle & Windle, 2018). While further research examining the use of our scales in daily diary contexts is needed, our test-retest reliability results suggest our measures, like the full measures, may capture sufficient change for such a design.

In terms of convergent validity, the majority of concurrent correlations between the brief and full-length measures were strong, supporting H2 and suggesting good convergent validity between the BAMM, BCAMM, and corresponding full measures. After removing shared items from the MMM+ and the MDMQ-R+, the revised correlations remained similar, with the single exception of the social motive for alcohol. This may be explained by the facts that two of the three unshared items of the MDMQ-R+ and the MMM+ social subscales do not include the word "social" and the social subscale of the MDMQ-R+ has lower internal consistency than other motives (α = .58; Grant et al., 2007). Given this, our BAMM social item appears to capture the core components of the social motive well and may represent a more face valid social motive than that of the MDMQ-R given the BAMM's focus on sample items that include the term "social". Of note, an examination of the relationship between BCAMM and BAMM items with corresponding MMM+ and MDMQ-R+ subscales, respectively, suggests the BCAMM and BAMM appear to capture the breadth and depth of all other motives. Thus, our results suggest the good convergent validity between brief and full-length measures is not simply due to shared items and largely support H3.

Study 2 also suggests our brief measures predict substance use outcomes in a similar fashion to the MMM+ and MDMQ-R+. In line with H4 and research with the MDMQ-R (e.g., Grant et al., 2007), enhancement motives on both brief and full-length measures predicted concurrent alcohol QxF. Similarly, coping-with-depression motives on both brief and full-length measures prospectively predicted both alcohol- and cannabis-related problems, after controlling T1 quantity. This result aligns with research with the MDMQ-R, as well as research indicating that MMM coping motives predict cannabis dependence (Benschop et al., 2015), despite slight changes to the original measures in our study. Thus, brief measures generally demonstrated the same concurrent and predictive relationships as the full measures. There were two notable exceptions to this, however. First, while MMM+ coping-with-anxiety, coping-with-depression, and expansion motives were significant predictors of cannabis QxF[8], only BCAMM coping-with-anxiety was significant. This difference may be a result of power. In the MMM+ model, coping-with-anxiety was the strongest effect (B = .14), while the effects of coping-with-depression and expansion were weaker (B = -.08); it is possible the BCAMM model did not have enough power to detect these smaller effects due to the increased error associated with single-item measures and/or the highly correlated coping items (note, while VIF and tolerance statistics are not available for BCAMM analyses, BAMM analyses suggested acceptable levels of multicollinearity). While our power analysis suggested we had a sufficient sample size, we may have underestimated the effect of increased error and including highly correlated predictors within the same model. Despite this, it appears that coping-with-anxiety motives may have a stronger relationship with cannabis QxF than coping-with-depression for both the MMM+ and the BCAMM, suggesting there may be utility in separating the two subscales. The BAMM and the BCAMM offer researchers the choice to study these two distinct coping motives or to combine them together into a global factor, as was done with the BAMM elsewhere (e.g., Deacon et al., 2021). Second, BIC comparisons often suggested models including full measures were a better fit. Given the full scales have higher content validity simply by virtue of having more items (Baumgartner & Homburg, 1996), this was to be expected regardless of the

[8]Note expansion motives had an inverse relationship with cannabis QxF.

quality of our brief items. Despite this, R^2 and McFadden's R^2 values for brief and full measures were similar, suggesting only a slight loss of predictive power when using the brief scales. In situations where the full-length measures cannot be used without significant participant burden, this slightly lower predictive power is likely worth the trade-off in increased feasibility.

It is worth noting that Study 2 results deviated from aspects of H4 and H5. First, despite hypothesizing enhancement, coping-with-anxiety, and coping-with-depression motives would predict alcohol QxF, only enhancement was a significant predictor for the BAMM and MDMQ-R+. This aligns with research indicating enhancement is a notably stronger predictor of both alcohol quantity and frequency than coping motives (e.g., Cooper et al., 2016). Additionally, with respect to coping motives not predicting alcohol QxF, this result may be expected given our non-clinical emerging adult sample; coping motives tend to be more prevalent in clinical populations (Molnar et al., 2010) and were not endorsed highly by our participants. Second, conformity motives were not a significant predictor of alcohol- or cannabis-related problems for the brief or full measures. Extant research suggests the relationship between conformity motives and alcohol-related problems is not always present (ß = -.02 to .12; Cooper et al., 2016), and the relationship between conformity motives and cannabis-related problems is inconsistent (e.g., Buckner et al., 2007; Buckner et al., 2016; Fox et al., 2011). Thus, our lack of findings between conformity motives and substance-related problems may also reflect this complicated relationship.

Limitations and Future Directions

Our results are limited by our sample, which was predominantly female and recruited from a participant pool at a single university. It is not clear whether these measures are appropriate for other samples. Relatedly, our sample was composed of emerging adults; while motives measures are often found to be valid in age groups other than those of the initial validation sample (e.g., Crutzen & Kuntsche, 2013; Gilson et al., 2013; Martens et al., 2008), this should be confirmed for the BCAMM and BAMM. Moreover, our sample was composed of dual-alcohol and cannabis users. While we consider this to be a strength of our study, given the common co-occurrence of cannabis and alcohol use (Thompson et al., 2021), the BCAMM and BAMM should be validated in single use samples. Additionally, while we examined the BAMM and the BCAMM in a dual-use sample, the utility of the BAMM and BCAMM for predicting simultaneous cannabis and alcohol use relative to measures designed to tap specific motives for simultaneous use of these substances (e.g., Patrick et al., 2018) remains to be determined. Should researchers be interested in creating a version of the SAM motives questionnaire developed by Patrick et al. (2018) that includes one item per subscale, the BAMM and the BCAMM may provide a blueprint for the shortening of this measure.

Our results are also limited by our methodological decisions; as we sought to create brief versions of the established MMM and the MDMQ-R, we did not add any additional motives that might be relevant for cannabis (e.g., sleep). While this allowed for comparison between the BCAMM and the MMM, the BCAMM might be limited by the exclusion of additional motives. Moreover, as we sought to include expansion motives for alcohol, and coping-with-anxiety and coping-with depression motives for cannabis, we modified the MMM and the MDMQ-R, creating the MMM+ and the MDMQ-R+. While all original items of the MDMQ-R+ were included, some original items of the MMM were changed (i.e., coping items were added or altered), limiting validity comparisons. Furthermore, we did not have a second round of feedback with experts after changing the wording of three items. While our changes were carefully considered, an additional round of expert feedback would have provided further confirmation of face and content validity. Finally, we chose to study the reliability and validity of the BCAMM and the BAMM in a longitudinal design. The validity of these measures in a daily diary/ecological momentary assessment context should be ascertained as a next step.

Conclusions

Our findings support the reliability and the validity of the BCAMM and the BAMM. In situations where the MMM or the MDMQ-R cannot be feasibly used due to excessive participant burden, the BCAMM and the BAMM offer a psychometrically sound alternative. Our measures open the door for motives to be included in various research designs where their use was previously considered impractical, thereby solving a problem in our research field.

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All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Research ethics board approval was obtained prior to data collection by the Dalhousie Health Sciences Research Ethics Board. Informed consent was obtained from all patients for being included in the study.

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