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The influence of cannabis motives on alcohol, cannabis, and tobacco use among treatment-seeking cigarette smokers

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Abstract

Objectives—The present study evaluated the effects of cannabis motives on multi-substance use in an effort to examine the incremental validity of cannabis motives with respect to substance use outcomes.

Methods—Participants were 167 treatment-seeking smokers (41.92% female; M_{age} = 28.74; *SD* = 11.88) who reported smoking an average of 10 or more cigarettes daily for at least one year.

Results—Structural equation modeling was used to examine the association between cannabis motives and two dependent variables each for alcohol (drinking frequency and alcohol problems), cannabis (cannabis use frequency and cannabis problems), and tobacco (average cigarettes per day and nicotine dependence). Findings indicated that conformity motives were linked with increases in alcohol problems and cannabis problems. Enhancement motives were associated with increased cannabis use and cannabis problems. Coping motives were linked with increased cannabis use and cannabis problems. Contrary to expectations, expansion motives were associated with reductions in the number of cigarettes smoked per day. Also, results supported expectations that the observed effects due to cannabis motives were unique from shared variance with theoretically relevant covariates.

Conclusions—The present findings supported predictions that cannabis motives would evince effects on the use of multiple substances over and above theoretically relevant variables. However,

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Contributors

Dawn Foster drafted the manuscript. Nicholas Allan conducted statistical analysis. Drs. Zvolensky and Schmidt conceptualized theoretical bases of the grant, oversaw data collection, and provided guidance and feedback to manuscript drafts. All authors contributed to and have approved the final manuscript.

Conflict of Interest

All authors declare that they have no conflicts of interest.

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results indicate that the relationship between cannabis motives and multi-substance use is complex, and therefore, additional research is warranted to better understand substance use intervention.

Keywords

cannabis; marijuana; alcohol; drinking; tobacco; cigarettes; smoking; motives

1. INTRODUCTION

1.1. Multiple substance use

Alcohol, cannabis, and tobacco are the most widely used substances and they frequently co-occur and interplay with one another in clinically significant ways (Kessler et al., 1997; Redonnet et al., 2012; Roxburgh et al., 2013). For example, cigarette smoking is a key precursor to cannabis relapse (Haney et al., 2013). Further, strong associations between tobacco and alcohol consumption have been documented (Palfai et al., 2000). Relative to abstainers, drinkers are 75% more likely to use tobacco, and 85% of smokers also drink (Harrison et al., 2009; Howell et al., 2010; Krukowski et al., 2005; Reed et al., 2007). Moreover, cannabis is related to a myriad of negative outcomes, including psychological symptoms and disorders (Patton et al., 2002; Zvolensky et al., 2006), and tobacco smokers are more likely to use cannabis (Ford et al., 2002). Coupled with tobacco and alcohol use, cannabis use has adverse effects on fetal growth and development (Cornelius et al., 2002; Richardson et al., 1995), increases risk for harder drugs (Golub and Johnson, 2001), and negatively impacts educational achievements (Centers for Disease, 1991; Martin et al., 1992). Interventions for co-occuring substance use have demonstrated favorable effects (Chariot et al., 2014; Gmel et al., 2013; Laporte et al., 2014). However, recent work has shown differential effects on health risk behavior when comparing the influence of cognitive processes related to one substance versus a different substance. Specifically, alcohol-related cognitive processes have been shown to impact smoking outcomes more strongly than smoking processes impact alcohol consumption (Piasecki et al., 2011). Additionally, cognitive factors important in the process of quitting substance use may not have a straightforward relationship with reducing poly substance use (Foster et al., under review, 2014). Foster and colleagues (under review) found that although co-use of tobacco and alcohol decreased among individuals with more cognitive processes related to quitting smoking, a subset of individuals were at greater risk for heavier alcohol use, despite also having greater smoking quit processes. These findings suggest that among multiple substance users, cognitive factors that may facilitate quitting or protect against problem use of substance (e.g., tobacco) might pose difficulties to quitting other substances (e.g., alcohol or cannabis).

1.2. Motives for cannabis use

One avenue of research that has facilitated development of effective interventions relates to motivational bases of cannabis use. Extensions of its utility to better understanding tobacco and alcohol use have provided important and clinically-relevant insights into patterns related to multiple substance use (Cooper, 1994; Piper et al., 2004). There are five established motives for cannabis use; social, coping, enhancement, conformity, and expansion (Bonn-

Miller et al., 2007; Chabrol et al., 2005; Zvolensky et al., 2007). Endorsement of specific motives has been linked with cannabis use frequency in varying populations (Chabrol et al., 2005; Simons et al., 2000) and cannabis motives are shown to be incrementally and uniquely associated with cannabis use over and above the variance explained by alcohol and cigarette use (Bonn-Miller et al., 2007; Zvolensky et al., 2007). Recent work has demonstrated associations between cannabis motives related to coping and gender (Bujarski et al., 2012), conformity, coping, and expansion motives and personality risk factors (Hecimovic et al., 2014), coping motives and social anxiety (Buckner et al., 2014), and enhancement, social, and coping motives and the experience of cannabis-related problems (Buckner, 2013).

Although previous work has evaluated cannabis motives and other substance use (Norberg et al., 2014; Zvolensky et al., 2007), comparatively little is known about the influence of cannabis motives on concurrent substance use (i.e., tobacco, alcohol, and cannabis). Cross-substance motives literature has evaluated why tobacco users may use cannabis (Agrawal et al., 2012), and has also examined associations between alcohol and cannabis motives and alcohol-cannabis co-use (Simons et al., 2005). However, research exploring links between cannabis use motives and multi-substance use is scarce, and as a result, relatively little is known about whether specific motives uniquely contribute to the prediction of co-use and other clinically relevant phenomena over and above theoretically related variables (e.g., gender). Thus, it is necessary to better understand potential antecedents to concurrent use in order to further elucidate critical junctures for altering substance use behavior.

1.3. Current study

The present study was designed to address this gap in knowledge by examining relationships among cannabis motives and the use of alcohol, tobacco, and cannabis in a sample of daily cigarette smokers who consume alcohol and cannabis using structural equation modeling (SEM) to account for measurement errors of the observed variables by modeling them as latent constructs (Kline, 2011a). This effort will facilitate further advances in understanding how motives for one substance (i.e., cannabis) can relate to co-occurrence of alcohol, tobacco, and cannabis in a treatment seeking population. We examined the incremental validity of cannabis motives in regard to drinking frequency, drinking level, cannabis use, cannabis problems, nicotine dependence, and the number of cigarettes smoked per day. Additionally, we evaluated the unique effects above and beyond theoretically relevant covariates including gender, education, and race (Goncy and Mrug, 2013; Westmaas and Langsam, 2005). Based on previous work indicating positive associations between motives and use (Chabrol et al., 2005), we expected that cannabis motives would be significantly linked with increases in alcohol consumption, tobacco use, and cannabis use. Further, we expected that any observed effects would be unique from shared variance with covariates. These expectations are based on theoretically relevant motivational models and empirical evidence, which suggests that among multiple substance users, factors including motives or reasons for use are linked with substance use.

2. METHOD

2.1. Participants

The present sample consisted of 167 treatment-seeking daily smokers (41.92% female; M_{age} = 28.74; *SD* = 11.88). The racial and ethnic distribution of this sample was as follows: 83.23% identified as White/Caucasian; 7.78% identified as Black/Non-Hispanic; 0.60% identified as Black/Hispanic; 3.59% identified as Hispanic; 1.20% identified as Asian; and 3.59% identified as 'Other.' 21.56 % of participants completed high school as their highest form of education, 48.50% completed some college, 11.98% obtained a 4-year college degree, 7.19% obtained a 2-year college degree, 3.59% obtained a graduate degree, 3.59% completed some graduate school, and 3.59% completed less than a high school degree. Of the sample, 52.73% met criteria for at least one current (past month) Axis I diagnosis including social phobia (9.70%), alcohol abuse (5.45%), alcohol dependence (4.24%), cannabis abuse (4.24%), cannabis dependence (3.03%), and generalized anxiety disorder (3.64%).

Participants for the present study were recruited for participation in a larger longitudinal trial, for which inclusion criteria included: (1) 18 years or older; (2) reporting smoking an average of 10 or more cigarettes per day for at least one year; and, (3) providing a carbon monoxide breath sample of 10 ppm or higher during the baseline session. Participants were excluded based on the following criteria: (1) current homicidality or suicidality; (2) endorsement of past or current psychotic-spectrum symptoms via structured interview screening; and (3) limited mental competency and inability to provide informed, voluntary, written consent. Participants were included in the present analyses, if they reported having used cannabis in their lifetime, and alcohol within the previous month.

2.2. Measures

2.2.1. Demographics—Participants provided demographic information including gender, age, racial background, ethnicity, and highest education level.

2.2.2. The Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I)—The SCID-I-NP (Non-Patient Version) was used for diagnostic assessments in order to assess DSM-IV-TR diagnoses for past and current Axis I Disorders (First et al., 2002). All SCID-I interviews were administered by trained research personnel including research assistants and doctoral level staff, and were supervised by independent doctoral-level professionals. Interviews were audio-taped, and the reliability of a random selection of 12.5% of interviews was reviewed (MJZ) for accuracy; no cases of diagnostic coding disagreement were noted.

2.2.3. Alcohol use and problems—Alcohol use was assessed using one item from the Alcohol History Questionnaire (AHQ). The 42-item AHQ (Filbey et al., 2008) assesses quantity and frequency of use. Example items include "How many years have you been drinking regularly?" and "How old were you when you first had an alcoholic drink?" Item 4, "In the last year, how many days per week did you drink alcohol on average was used to assess drinking frequency. The Alcohol Use Disorders Identification Test (AUDIT), used to

measure alcohol problems, is a 10-item measure that screens for hazardous or harmful drinking (Saunders et al., 1993). Items assess heavy drinking, quantity and frequency of use, dependence, tolerance, and problems. The AUDIT's internal consistency alpha was .83 in the present sample, and in past work it has reliably distinguished between hazardous, harmful, and no drinking histories (Fleming et al., 1991). An AUDIT score of 8 produces 85% sensitivity and 89% specificity for harmful or hazardous drinking (Cherpitel, 1995).

2.2.4. Cannabis use and problems—Cannabis use was assessed using one item from the 40-item Marijuana Smoking History Questionnaire (MSHQ). The MSHQ assesses history and patterns of cannabis use (Bonn-Miller and Zvolensky, 2009). Example items include "How many years have you smoked marijuana?" and "Think about your smoking during the last week, how much marijuana did you smoke per occasion in an average day?" Participants rated the latter item on an eight-point Likert scale. Scores correspond to pictures depicting increasing sizes of cannabis joints, with 1 indicating the smallest cannabis joint and 8 indicating the largest cannabis joint. Previous research has used the MSHQ as a successful indicator of cannabis use (Buckner et al., 2012). Item 2, "Please rate your marijuana use in the past 30 days" was used to assess cannabis use frequency. Cannabis problems were assessed using 19-item Marijuana Problems Scale (MPS). The MPS is a 19-item list of negative social, occupational, physical, and personal consequences associated with cannabis use in the previous 90 days (Stephens et al., 2000). Cronbach's alpha (.83) indicates that the measure was internally consistent in the present sample, with scores ranged from 0 to 28.

2.2.5. Tobacco use—Tobacco use was assessed using two measures; the Smoking History Questionnaire (SHQ) and the Fagerström Test for Nicotine Dependence (FTND). Smoking rate, years of being a daily smoker, age of onset of initiation, and other characteristics are assessed using the SHQ (Brown et al., 2002). Items included, for example, "Since you started regular daily smoking, what is the average number of cigarettes you smoked per day?" which assessed smoking rate. Individuals indicated their quit methods by endorsing items (0 = *No* or 1 = *Yes*) including "Cold turkey," "Behavior modification," "Nicotine patch," "Gradual reduction," and "Telephone counseling." Item 5, "In the last week, average number of cigarettes smoked per day" was used to assess tobacco use in the current study. The FTND (Heatherton et al., 1991) was used to assess nicotine dependence. The measure includes six items that assess gradations in tobacco dependence and this measure exhibits positive relations with key smoking variables, adequate internal consistency, and high test-retest reliability (Heatherton et al., 1991; Pomerleau et al., 1994). FTND scores range from 0 to 10, with higher scores indicating greater dependence on nicotine (Fagerstrom et al., 1990). Cronbach's α was .59 in the present sample.

2.2.6. Motives for cannabis use—The Marijuana Motives Questionnaire (MMQ) was used to assess motives or reasons for using cannabis (Simons et al., 2000, 1998). The MMQ is comprised of 25 items and assesses motives for using cannabis, and has shown high levels of internal consistency for each of the five factors (Zvolensky et al., 2007). Participants rated items on a 5-point scale ranging from 1 (*Never/Almost Never*) to 5 (*Almost Always/Always*). The measure yields five subscales that reflect cannabis motives, including social motives

(six items; e.g., “Because it helps me enjoy a party”; α = .90), coping motives (four items; e.g., “To forget my worries”; α = .92), enhancement motives (five items; e.g., “Because I like the feeling”; α = .84), conformity motives (five items; e.g., “Because my friends pressure me to use marijuana”; α = .85), and expansion motives (five items; e.g., “Because it helps me be more creative and original”; α = .84). Scores for each subscale were computed by summing relevant items.

2.3. Procedure

Participants were adult daily smokers who reporting consuming alcohol and using cannabis. Participants were recruited from the community via radio announcements, flyers, and newspaper ads to participate in a large dual-site randomized controlled clinical trial evaluating the efficacy of two interventions for smoking cessation. Individuals responding to advertisements related to the study were scheduled for an in-person baseline assessment to evaluate eligibility for inclusion in the study. Written informed consent was obtained during the baseline assessment and participants were interviewed using the SCID-I/NP. Participants also completed a computer-based battery of self-report measures. All study procedures and treatment of human subjects were conducted in compliance with ethical standards of the American Psychological Association. The study protocol was approved by the Institutional Review Board at each study site. The present study is based on analyses of baseline (pre-treatment) data for a sub-set of the sample, which was on the basis of available data on all studied variables.

2.4. Statistical analyses

Zero-order correlations (Table 1) and univariate statistics (Table 2) were computed for relevant variables. All participants completed all survey items in the present study, and as such, there was no missing data. Structural equation modeling (SEM) was used to examine the association between cannabis motives and two dependent variables each for alcohol (drinking frequency and alcohol problems), cannabis (cannabis use frequency and cannabis problems), and tobacco (average cigarettes per day and nicotine dependence). Latent variables were constructed for the measurement scales. Only the covariates (i.e., gender, race, and education level) and the items used to measure frequency (i.e., item 4 of the AHQ to measure drinking frequency, item 2 of the MSHQ to measure cannabis use frequency, and item 5 of the SHQ to measure tobacco use) were treated as observed variables. Confirmatory factor analysis (CFA) models were first fit to the MMQ subscales (i.e., social, coping, enhancement, conformity, and expansion) and to the AUDIT, the MPS, and the FTND scales, separately. Models using items treated as continuous (e.g., MMQ, AUDIT) were conducted using full information maximum likelihood and the Satorra-Bentler scaled chi-square (S-B χ^2) to provide standard errors robust to nonnormality. Models using only items treated as categorical (i.e., MPS, FTND items 3 through 6) were conducted using the robust weighted least squares estimator. For SEM models that contained continuous and categorical scales, full information maximum likelihood was used for consistency. Overall model fit was assessed using the χ^2 value, with a nonsignificant χ^2 indicative of good model fit. Model fit was also assessed using the comparative fit index (CFI) with CFI values greater than .90 indicative of adequate fit and values greater than .95 indicative of good fit. Finally, overall model fit was assessed using the root mean square error of approximation (RMSEA) and the

90% confidence interval (CI). An RMSEA less than .05 indicates good fit and an RMSEA less than .10 indicates adequate fit. Good fit cannot be ruled out if the 90% CI contains a value less than .05 and poor fit cannot be ruled out if the 90% CI contains a value greater than .10 (Brown, 2006; Browne and Cudeck, 1992; Hu and Bentler, 1999; Kline, 2011a, 2011b; Yu, 2002).

3. RESULTS

3.1. Descriptive Data and Correlations among Variables

Means, standard deviations, and bivariate correlations for all of the study variables are presented in Table 1. Drinking frequency and alcohol problems were positively correlated ($r = 0.42$, $p < .001$). Cannabis problems were positively correlated with alcohol problems ($r = 0.39$, $p < .001$) and with cannabis use ($r = 0.30$, $p < .001$). The number of cigarettes smoked per day was negatively correlated with cannabis use ($r = -0.16$, $p < .05$) and positively correlated with nicotine dependence ($r = 0.64$, $p < .001$). All cannabis motives subscales were positively correlated with each other (all p's < .01) with the exception of conformity motives, which were not significantly correlated with enhancement motives ($p > .05$). Social motives were positively correlated with cannabis use ($r = 0.38$, $p < .001$) and problems ($r = 0.41$, $p < .001$). Coping motives were positively correlated with cannabis use ($r = 0.41$, $p < .001$). Enhancement motives were positively correlated with cannabis use ($r = 0.56$, $p < .001$), and cannabis problems ($r = 0.29$, $p < .001$), and were marginally correlated with alcohol problems ($r = .15$, $p < .10$) and marginally negatively correlated with the number of cigarettes smoked per day ($r = -0.15$, $p < .10$). Conformity motives were positively correlated with alcohol problems ($r = 0.22$, $p < .001$) and cannabis problems ($r = 0.40$, $p < .001$). Expansion motives were positively correlated with alcohol problems ($r = 0.21$, $p < .01$), cannabis use ($r = 0.33$, $p < .001$), and cannabis problems ($r = 0.32$, $p < .001$), and were negatively correlated with the number of cigarettes smoked per day ($r = -0.18$, $p < .05$). Gender (dummy coded such that females received a 0 and males a 1) was positively correlated with conformity motives ($r = 0.24$, $p < .01$) and marginally correlated with cannabis problems ($r = 0.13$, $p < .10$) and expansion motives ($r = 0.14$, $p < .10$). Education level was negatively correlated with cannabis use ($r = -0.22$, $p < .01$) and problems ($r = -0.16$, $p < .05$), and was marginally and correlated with drinking frequency ($r = 0.13$, $p < .10$).

3.2. Measurement model of Independent and Dependent Latent Factors

Prior to conducting the full structural equation model with all variables, measurement models for all the latent variables were examined. The measurement model for the cannabis motives factors provided adequate fit to the data ($\chi^2 = 464.15$, $p < .05$, CFI = .93, RMSEA = .07, 95% CI [.06, .08]). Correlated residuals between MMQ item 7 (e.g., "because I like the feeling") and MMQ item 13 (e.g., "Because it gives me a pleasant feeling") and between MMQ item 11 (e.g., "because it makes social gatherings more fun") and MMQ item 14 (e.g., "because it improves parties and celebrations") were allowed to improve model fit given the similarity across these items. The model for the Alcohol Problems factor also provided adequate fit to the data ($\chi^2 = 68.98$, $p < .05$, CFI = .91, RMSEA = .08, 95% CI [.05, .11]). A correlated residual between AUDIT item 1 (e.g., "how often do you have a drink containing

alcohol?") and AUDIT item 3 (e.g., "how often do you have 6 (if man)/4 (if woman) or more drinks on one occasion?") was allowed to improve model fit given the similarity across these items. The Marijuana Problems factor model provided only modest fit to the data ($\chi^2 = 294.56$, $p < .05$, CFI = .88, RMSEA = .08, 95% CI [.07, .10]), and only after item 10 (e.g., "blackouts or flashbacks") was omitted due to empty cells with other items as a function of 162 of 167 participants reporting no problems on this item. Although this factor provided poor fit to the data, all items did load on the Marijuana Problems factor. Therefore, this factor was retained for further analysis. Finally, the Nicotine Dependence factor (treating items 3 through 6 as categorical) provided excellent fit to the data ($\chi^2 = 8.17$, $p = .51$, CFI = 1.00, RMSEA = .00, 95% CI [.00, .08]).

3.3. Structural Equation Models Examining the Associations between Cannabis Motives and Alcohol, Cannabis, and Tobacco Use

3.3.1. Alcohol use—Two models were tested with regard to alcohol use (see top panel of Table 3). The first included the observed drinking frequency variable as the dependent variable (DV) and the cannabis motives factors included with the covariates (e.g., gender, race, and education) as independent variables (IVs). This model provided adequate fit to the data ($\chi^2 = 617.73$, $p < .05$, CFI = .91, RMSEA = .07, 95% CI [.06, .08]). No significant effects emerged with respect to drinking frequency. This model accounted for 5% of the variance in drinking frequency. The model including the Alcohol Problems factor provided adequate fit to the data ($\chi^2 = 1016.10$, $p < .05$, CFI = .90, RMSEA = .06, 95% CI [.05, .07]). Of the control variables, race was negatively associated with significantly greater drinking levels ($\beta = -.19$, $p = .02$). The Conformity Motives factor was associated with significantly greater drinking levels ($\beta = .21$, $p = .02$). This model accounted for 17% of the variance in Alcohol Problems.

3.3.2. Cannabis use—Two models were tested with respect to cannabis use; both models were similar to alcohol models described above, except that they included cannabis use (treated as an observed variable) and the Cannabis Problems factor as DV's (see middle panel of Table 3). The model including frequency of cannabis use provided adequate fit to the data ($\chi^2 = 618.88$, $p < .05$, CFI = .91, RMSEA = .07, 95% CI [.06, .08]). However, a significant, negative relation between the Conformity Motives factor and cannabis use ($\beta = -.16$, $p = .04$) was found. This effect is likely a suppression effect, given the nonsignificant bivariate relation between the conformity motives scale and cannabis use and the significant positive relations between all the cannabis motives scales (see Table 1; Maassen and Bakker, 2001). Indeed, when an SEM model was conducted examining the relations between the Conformity Motives factor and cannabis use, controlling only for gender, race, and education, the association between the Conformity Motives factor and cannabis use was not significant ($\beta = -.01$, $p = .92$). Therefore, the model including frequency of cannabis use was reanalyzed without the Conformity Motives factor included. This model provided adequate fit to the data ($\chi^2 = 428.76$, $p < .05$, CFI = .92, RMSEA = .07, 95% CI [.06, .08]). Of the control variables, gender was negatively associated with frequency of cannabis use ($\beta = -.14$, $p = .02$) as was education ($\beta = -.17$, $p = .02$). The Coping Motives ($\beta = .16$, $p = .01$) and Enhancement Motives factors ($\beta = .54$, $p < .001$) were associated with significantly greater cannabis use. This model accounted for 42% of the variance in cannabis use.

Model fit for the SEM including Cannabis Problems as the DV was not provided because robust maximum likelihood was used with categorical data and therefore model fit statistics were unavailable. Of the control variables in this model, education was negatively, marginally associated with the Cannabis Problems factor ($\beta = -.17$, $p = .02$). The Coping factor ($\beta = .31$, $p = .03$), Enhancement factor ($\beta = .41$, $p = .02$), and the Conformity factor ($\beta = .27$, $p = .04$) were all significantly associated with frequency of cannabis use. This model accounted for 42% of the variance in the Cannabis Problems factor.

3.3.3. Tobacco use—We tested two tobacco use SEMs, and both were constructed in similar fashion to the alcohol and cannabis models described above. The first model, including average cigarettes per day (treated as an observed variable) as the DV provided adequate overall model fit $\chi^2 = 634.02$, $p < .05$, CFI = .91, RMSEA = .07, 95% CI [.06, .08]). Of the control variables, race was negatively, significantly associated with cigarettes per day ($\beta = -.21$, $p < .001$). The Expansion factor was negatively, significantly associated with cigarettes per day also ($\beta = -.21$, $p = .03$). This model accounted for 12% of the variance in average cigarettes per day. Model fit for the SEM including the Nicotine Dependence factor as the DV was not provided because robust maximum likelihood was used with categorical data and therefore model fit statistics were unavailable. There were no significant effects in this model and the model accounted for 9% of the variance in the Nicotine Dependence factor.

3.4. Structural Equation Models Examining the Associations between Cannabis Motives and Alcohol, Cannabis, and Tobacco Use Accounting for Comorbid Use

To examine whether the effects of the results were robust to cross-substance use SEMs were also examined including cannabis use and average cigarettes smoked per day as covariates in the alcohol outcomes models, drinking frequency and average cigarettes smoked per day as covariates in the cannabis outcomes models, and frequency of cannabis use and drinking frequency as covariates in the tobacco outcomes. There were no substantive differences in parameter estimates in these models, compared to the parameter estimates reported in Table 3, although model fit was generally worse in the models including cros-substance use as covariates as compared to models not including these covariates. In addition, in the alcohol outcomes models, neither cannabis use nor cigarettes smoked per day were significant, in the cannabis outcomes models, neither drinking frequency nor cigarettes smoked per day were significant, and in the tobacco outcomes models, neither drinking frequency nor cannabis use were unique predictors.

4. DISCUSSION

The present study evaluated the unique effects of cannabis motives on multi-substance use in an effort to examine the incremental validity of cannabis motives with respect to substance use outcomes. Findings generally indicated that alcohol, tobacco, and cannabis use correlate with cannabis motives (Zvolensky et al., 2007). Results also largely supported expectations that the observed effects due to cannabis motives were unique from shared variance with theoretically relevant covariates. As such, findings demonstrated that cannabis motives contributed unique variance to non-cannabis substance use including alcohol

consumption, nicotine dependence, and the number of cigarettes smoked per day. Individuals reporting many reasons for using cannabis not only tend to exhibit increased cannabis use behaviors, they are also at risk for using substances other than cannabis. These findings are consistent with previous cross-substance work which has demonstrated that motives for alcohol consumption are related to smoking processes (Foster et al., 2014) and problem behaviors other than alcohol use (Bradley et al., 1992). Further, it is worth noting that present findings demonstrated that cannabis motives only accounted for a modest amount of variance with respect to substance use outcomes. It is likely that beyond cannabis motives, there are other variables at play as risk factors for multi-substance use, including self-efficacy related to resisting alcohol (Foster et al., 2014), smoking expectancies (Foster et al., 2014), and drink-related implicit associations (Foster et al., 2014). Previous work finding associations between cognitively-based smoking processes (e.g., reasons for quitting, barriers to cessation) and alcohol consumption has suggested the possibility that individuals attempting to quit one substance might utilize other substances during change efforts (Foster et al., 2014). This finding, in conjunction with present results, further support the perspective that among poly substance users, motives for using one substance (e.g., cannabis) may pose difficulties to quitting or refraining from other substances (e.g., alcohol and tobacco). Moreover, these findings emphasize the importance of tailoring multi-substance interventions to the specific needs of poly users, for whom single-substance treatments may be less effective (Holt et al., 2012; Joseph et al., 2004).

It is worth noting that in certain cases, cannabis motives were associated with *reductions* in substance use outcomes, which is contrary to what was expected. Specifically, expansion motives were linked with reductions in the number of cigarettes smoked per day. This finding suggests while cannabis motives have generally adverse effects on multi-substance use, the relationships among these constructs are not straightforward. A cross-substance alcohol and tobacco users, research indicates that a parallel recognition of the need to change problem behaviors might exist (Foster et al., 2014). Thus, individuals who use multiple substances might also simultaneously be aware that they are putting their health at risk, and as such, might be more eager or ready to make efforts to reduce use. Alternatively, it is possible multi-substance using individuals might be less likely to use substances for certain reasons (e.g., expansion motives) and more likely to use substances as a function of motives related to coping. Extant literature indicates that, with respect to alcohol use, coping motives may relate to regulatory mechanisms for using psychoactive substances to relieve stress, and this may in turn reinforce the continued use of multiple substances (Conrod et al., 2000). This perspective is consistent with basic and applied research related to neuroregulatory functions of substance use for reward sensitivity and mood-related sequalae (Robinson and Berridge, 1993). As such theoretically-driven models and clinically applied activies that focus on reduction of multi-substance use might benefit from considering the roles of coping, enhancement, and conformity cannabis motives. It might be useful to assess cannabis motives in addition to other motives for using substances among multi users in efforts to facilitate harm reduction and eventual abstinence.

It bears emphasizing that multi-substance using individuals are at increased risk for multiplicative adverse health effects (Jarvis et al., 2007; Taylor and Rehm, 2006), and these

individuals may represent a population in great need of targeted intervention strategies. Present findings supported predictions that cannabis motives would evince effects on the use of multiple substances over and above theoretically relevant variables. However, results indicate that the relationship between cannabis motives and multi-substance use is complex. Further, results indicate that cannabis motives accounted, and therefore, additional research is warranted to better understand best points to intervene against substance use.

4.1. Limitations

The strengths of the study must be considered in light of its limitations. The present sample was relatively homogenous (e.g., primarily Caucasian) and composed largely of a group of adult smokers who volunteered to participate in treatment for smoking cessation. Therefore, it will be important for future studies to draw from populations other than those included in the present research to address potential self-selection bias among individuals with these characteristics and to increase the generalizability. Further, the present data were cross-sectional, and thus, findings cannot shed light on processes over time or isolate causal relations between variables. Additionally, the FTND exhibited relatively low internal consistency, which is an issue that can emerge with this measure (Korte et al., 2013).

4.2. Conclusions

In sum, the present research evaluated the effects of cannabis motives on multi-substance use, and examined the incremental validity of cannabis motives with respect to substance use outcomes. Findings generally indicated that cannabis motives contributed unique variance to non-cannabis substance use including alcohol consumption, nicotine dependence, and the number of cigarettes smoked per day, and may be an important factor for consideration in development of substance use interventions. The present work contributes to present knowledge by examining incremental validity of cannabis motives with respect to multi-substance use among cigarette smokers who also use both cannabis and alcohol, and indicate that additional research is needed to better elucidate associations to inform development and implementation of multi-substance usse interventions.

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Highlights

- We evaluated effects of cannabis motives on multi-substance use.
- Structural equation modeling was utilized to examine associations.
- Cannabis motives have complex relationships with multi-substance use.

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Table 1

Means, Standard Deviations, and Correlations among Variables

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. Drinking frequency	-													
2. Alcohol problems	0.42***	-												
3. Cannabis use	0.02	0.07	-											
4. Cannabis problems	0.02	0.39***	0.30***	-										
5. Cigarettes per day	0.09	0.03	−0.16*	−0.10	-									
6. Nicotine dependence	−0.06	−0.04	−0.07	−0.003	0.64***	-								
7. Social motives	−0.03	0.13	0.39***	0.31***	−0.07	−0.02	-							
8. Coping motives	0.01	0.12	0.38***	0.41***	−0.07	0.06	0.44**	-						
9. Enhancement motives	0.02	0.15†	0.56***	0.29***	−0.13†	−0.09	0.62***	0.33***	-					
10. Conformity motives	−0.06	0.22**	−0.07	0.40***	0.01	0.08	0.33***	0.23**	0.11	-				
11. Expansion motives	0.07	0.21**	0.33***	0.32***	−0.18*	−0.12*	0.55***	0.38***	0.48***	0.24**	-			
12. Gender	−0.02	0.07	−0.09	0.13†	0.10	0.10	0.06	−0.11	0.12	0.24**	0.14†	-		
13. Race	−0.14†	−0.23**	−0.003	−0.13†	−0.17*	0.03	−0.12	0.06	−0.15†	−0.06	−0.19*	−0.11	-	
14. Education	0.13†	−0.04	−0.22**	−0.16*	−0.02	−0.02	−0.06	−0.12	−0.12	0.03	0.07	−0.06	−0.01	-
Mean	2.59	9.15	4.84	3.77	14.69	4.72	14.22	9.20	17.07	6.49	11.21			
Standard Deviation	2.37	5.98	2.46	3.85	8.72	2.34	6.41	4.89	5.35	2.84	6.35			

Note. N=167

*** $p < .001$.

** $p < .01$.

* $p < .05$.

† $p < .10$

Gender was dummy coded such that females received a 0 and males a 1. Race was dummy coded such that Caucasians/Whites received a 0 and all other ethnicities a 1.

Table 2

Respondent Characteristics: Demographics, Substance Use, and Axis I Disorders (N = 167)

DEMOGRAPHICS	***n***	**%**
Gender		
Female	70	41.92
Male	97	58.08
Race/Ethnicity		
Caucasian/White	139	83.23
Black/non-Hispanic	13	7.78
Black Hispanic	1	0.60
Hispanic	6	3.59
Asian	2	1.20
Other	6	3.59
Marital Status		
Married	35	20.96
Widowed	1	0.60
Separated	3	1.80
Divorced	15	8.98
Never Married	113	67.66
Highest Level of Education		
Some High School	6	3.59
High School	36	21.56
Some College	81	48.50
2 year College	12	7.19
4 year College	20	11.98
Some Graduate School	6	3.59
Graduate School	6	3.59

SUBSTANCE USE	***Age***	***n***	**%**
Age of first alcoholic beverage	0–10	17	10.18
	11–20	146	87.43
	21–30	3	1.80
	31+	0	0
Age of first cigarette	0–10	10	6
	11–20	151	90
	21+	6	4
Age of first cannabis	0–10	3	2
	11–20	157	94
	21+	7	4
	Mean	*SD*	
Cigarettes smoked per day	14.62	8.69	
Years as a daily smoker	11.34	11.63	
Level of nicotine dependence	7.08	2.20	

SUBSTANCE USE	*Age*	*n*	%
Drinks per occasion	4.61	2.32	
Years as a regular cannabis user	7.82	8.90	

AXIS-I DISORDERS	*n*	%
Social phobia	16	9.70
Generalized anxiety disorder	6	3.64
Alcohol abuse	9	5.45
Alcohol dependence	7	4.24
Cannabis abuse	7	4.24
Cannabis dependence	5	3.03

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Table 3

Structural Equation Models Examining the Associations between Cannabis Motives and Alcohol, Cannabis, and Tobacco Use

	Criterion		Predictor	*B*	*SE*	*p*	β	R^2
Alcohol Outcomes	Drinking Frequency	Covariates	Gender	−0.08	0.40	0.84	−0.02	0.05
			Race	−0.87	0.49	0.08	−0.14	
			Education	0.23	0.13	0.08	0.13	
		Cannabis Motives	Social	−0.30	0.29	0.29	−0.14	
			Coping	0.11	0.15	0.48	0.05	
			Enhancement	0.12	0.29	0.67	0.06	
			Conformity	−0.24	0.33	0.48	−0.05	
			Expansion	0.22	0.24	0.37	0.09	
	Alcohol Problems	Covariates	Gender	−0.04	0.07	0.60	−0.04	0.17
			Race	**−0.21**	**0.09**	**0.02**	**−0.19**	
			Education	−0.02	0.03	0.38	−0.08	
		Cannabis Motives	Social	−0.07	0.06	0.28	−0.18	
			Coping	0.03	0.03	0.27	0.10	
			Enhancement	0.02	0.11	0.75	0.05	
			Conformity	**0.21**	**0.09**	**0.01**	**0.29**	
			Expansion	0.07	0.05	0.12	0.18	
Cannabis Outcomes	Cannabis Use	Covariates	Gender	**−0.69**	**0.33**	**0.04**	**−0.14**	0.42
			Race	0.41	0.42	0.33	0.06	
			Education	**−0.32**	**0.10**	**0.002**	**−0.17**	
		Cannabis Motives	Social	−0.16	0.25	0.52	−0.07	
			Coping	**0.34**	**0.17**	**0.04**	**0.16**	
			Enhancement	**1.20**	**0.26**	**<0.001**	**0.54**	
			Conformity[a]					
			Expansion	0.20	0.21	0.34	0.08	
	Cannabis Problems	Covariates	Gender	0.30	0.26	0.25	0.10	0.42

	Criterion		Predictor	*B*	*SE*	*p*	β	R^2
			Race	−0.43	0.34	0.20	−0.11	
			Education	−0.19	0.11	0.10	−0.17[†]	
		Cannabis Motives	Social	−0.30	0.22	0.16	−0.22	
			Coping	**0.40**	**0.18**	**0.03**	**0.31**	
			Enhancement	**0.55**	**0.24**	**0.02**	**0.41**	
			Conformity	**0.73**	**0.35**	**0.04**	**0.27**	
			Expansion	0.14	0.17	0.39	0.09	
Tobacco Outcomes	Average Cigarettes per Day	Covariates	Gender	1.84	1.30	0.16	0.10	0.12
			Race	**−4.86**	**1.37**	**< 0.001**	**−0.21**	
			Education	−0.03	0.51	0.95	−0.01	
		Cannabis Motives	Social	0.43	1.07	0.69	0.05	
			Coping	0.22	0.65	0.73	0.03	
			Enhancement	−0.97	1.03	0.35	−0.12	
			Conformity	0.69	1.57	0.44	0.04	
			Expansion	**−1.91**	**0.92**	**0.03**	**−0.21**	
	Nicotine Dependence	Covariates	Gender	0.17	0.12	0.14	0.15	0.09
			Race	−0.05	0.15	0.75	−0.03	
			Education	0.001	0.05	0.98	0.003	
		Covariates and Cannabis Motives	Social	0.002	0.09	0.99	0.003	
			Coping	0.06	0.06	0.36	0.11	
			Enhancement	−0.07	0.08	0.41	−0.13	
			Conformity	0.06	0.12	0.62	0.06	
			Expansion	−0.11	0.08	0.15	−0.19	

Note.

[a]Conformity was not included in this model due to issues with suppression effects. Significant effects are in bold.