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Cathy Lau-Barraco
Old Dominion University

Robert J. Milletich
Old Dominion University

Ashley N. Linden
Old Dominion University

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Caffeinated Alcohol Consumption Profiles and Associations with Use Severity and Outcome Expectancies

Cathy Lau-Barraco[a], **Robert J. Milletich**[a], and **Ashley N. Linden**[a]

Cathy Lau-Barraco: cbarraco@odu.edu; Robert J. Milletich: rmill040@odu.edu; Ashley N. Linden: alind016@odu.edu

[a]Old Dominion University, Department of Psychology, 244D Mills Godwin Building, Norfolk, VA, USA 23529-0267

Abstract

Growing evidence suggests that the consumption of caffeinated alcoholic beverages (CAB) may be riskier than alcohol alone. Efforts to identify patterns of CAB use and the correlates of such drinking patterns could further our conceptualization of and intervention for this health issue. Consequently, the current study aimed to (1) identify distinct classes of CAB users, (2) examine differences between classes on measures of alcohol and caffeine problems, and (3) compare distinct classes of CAB users on caffeine and alcohol outcome expectancies. Participants were 583 (31% men) undergraduate students from a psychology research pool. Latent profile analysis models were derived using four indicators: CAB use quantity, CAB use frequency, alcohol use quantity, and alcohol use frequency. Finding revealed four classes of drinkers: High Alcohol/High CAB (6.00%), High Alcohol/Moderate CAB (5.15%), High Alcohol/Low CAB (22.99%), and Low Alcohol/Low CAB (65.87%). The Low Alcohol/Low CAB class reported the lowest relative levels of caffeine dependence symptoms, caffeine withdrawal, alcohol use problems, and heavy episodic drinking frequency. Further, results indicated differential expectancy endorsement based on use profiles. CAB users in the High Alcohol/Low CAB class endorsed more positive alcohol expectancies than the Low Alcohol/Low CAB group. Those in the High Alcohol/High CAB class endorsed stronger withdrawal symptoms caffeine expectancies than all other classes. Inclusion of substance-specific expectancies into larger theoretical frameworks in future work of CAB use may be beneficial. Findings may inform intervention efforts for those at greatest risk related to CAB consumption.

Keywords

Caffeinated alcohol; expectancies; latent profile analysis; emerging adults

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The consumption of alcohol mixed with caffeine, or caffeinated alcoholic beverages (CAB), is prevalent among emerging adults (e.g., Berger, Fendrich, & Fuhrmann, 2013). These beverages may be either pre-mixed with alcohol and caffeine, such as original versions of Four Loko and Sparks, or mixed by the user (e.g., vodka or Jagermeister mixed with Red Bull). It has been estimated that approximately one fourth to one half of college drinkers

Correspondence concerning this article should be addressed to: Cathy Lau-Barraco, Ph.D., Department of Psychology, Old Dominion University, Norfolk, VA 23529-0267. Phone: 757-683-4445. Fax: 757-683-5087. cbarraco@odu.edu.

report consuming CAB in the previous 30 days (Brache & Stockwell, 2011; MacKillop et al., 2012; Miller, 2008; O'Brien, McCoy, Rhodes, Wagoner, & Wolfson, 2008). Additionally, past year prevalence rate is 65% while lifetime use rate is 75% (Berger et al., 2013). Emerging adults cite a number of reasons for using CAB that include pleasurable taste, ability to socialize longer, alertness, and greater intoxication (Jones, Barrie, & Berry, 2012; Peacock, Bruno, & Martin, 2012).

While users perceive benefits to drinking CAB, growing research suggests that the co-consumption of alcohol with caffeine may be riskier and result in more severe behavioral consequences than alcohol use alone. Compared to alcohol-only drinkers, college students who consume CAB tend to drink alcohol in greater quantities and drink more frequently (MacKillop et al., 2012; O'Brien et al., 2008; Price, Hilchey, Darredeau, Fulton, & Barrett, 2010; Thombs et al., 2010). They also are more likely to experience negative alcohol-related harms including being taken advantage of sexually, physically hurt or injured, riding with an intoxicated driver, and requiring medical attention (O'Brien et al., 2008). The odds of engaging in risky behaviors or experiencing negative outcomes appear to increase as the frequency of CAB use increases, even after controlling for individual differences like age, sex, and risk taking tendency (Brache & Stockwell, 2011). A field study of college student bar patrons found that those who consumed CAB are at increased risk for leaving the bar with a blood alcohol concentration (BAC) above .08 and intending to drive under the influence (Thombs et al., 2010). When users are asked about adverse consequences that were unique to CAB over alcohol-only beverages, college drinkers noted experiencing heart palpations, blackouts, and consuming greater amounts of alcohol than intended (Jones et al., 2012).

Beyond alcohol consequences, the co-consumption of alcohol and caffeine may be associated with caffeine-related harms. One study found a greater likelihood of experiencing both physiological (e.g., sleep difficulties, tremors, heart palpations, rapid speech) and psychological (e.g., irritability, tension) caffeine-related outcomes on days in which CAB were consumed versus alcohol-only days (Peacock et al., 2012). Similar findings with regard to physiological effects from CAB consumption have been found in other studies (Jones et al., 2012; Pennay & Lubman, 2012; Woolsey, Waigandt, & Beck, 2010). Overall, evidence supports that the use of CAB may increase the likelihood that young adults will engage in risky behaviors and experience undesirable consequences.

Of the growing studies that address CAB consumption and associated risks, few have explored outcome expectancies for drug effects. Outcome expectancies are our beliefs regarding the behavioral effects of a particular substance and may be acquired through both direct and indirect experience (see Jones, Corbin, & Fromme, 2001). Expectancies have been shown to be a consistent predictor of substance use behavior including tobacco, marijuana, and cocaine (e.g., Ashare, Weinberger, McKee, & Sullivan, 2011; Heinz, Kassel, & Smith, 2009; Smith, Goldman, Greenbaum, & Christiansen, 1995). The largest body of work supporting expectancy effects on substance use has come from alcohol research. Alcohol expectancies are well established as an important determinant of alcohol use outcomes (see Goldman, Darkes, & Del Boca, 1999). They predict alcohol use both concurrently and longitudinally (Christiansen & Goldman, 1983; Stacy, Newcomb, &

Bentler, 1991) as well as drinking initiation and development of problem drinking (Christiansen, Smith, Roehling, & Goldman, 1989). Alcohol expectancies partially mediate the influence of other antecedents on alcohol use (Sher, Walitzer, Wood, & Brent, 1991) and have been shown to be modifiable with corresponding changes in drinking (Dunn, Lau, & Cruz, 2000; Lau-Barraco & Dunn, 2008).

Efforts to extend the expectancy framework to caffeine research have revealed that expected outcomes of caffeine correlate with caffeine-related behavior. In general, expectations of the positive effects of caffeine predict consumption quantity and frequency of caffeine as well as caffeine problems (Bradley & Petree, 1990; Heinz et al., 2009; Huntley & Juliano, 2012). More specifically, expectations that caffeine will result in withdrawal/dependence effects, energy/work enhancement, appetite suppression, social/mood enhancement, and physical performance enhancement positively predict caffeine consumption (Huntley & Juliano, 2012). Generally, low expectation of negative caffeine outcomes, such as anxiety/negative physical effects and sleep disturbance, predicts greater caffeine use and lower desire to cut down or stop caffeine consumption. Caffeine expectancies also have been shown to relate to greater severity of caffeine use. Heinz and colleagues (2009) found that stronger endorsement of the expected effects of caffeine, be it positive or negative, was positively related to greater reports of caffeine withdrawal symptoms, dependence symptoms, cessation difficulty, and perceived dependence.

There has been a paucity of research investigating expectancies as it relates to CAB consumption specifically. Given that CAB contain both caffeine and alcohol, it is likely that expectancies for each substance would play an important role. To explore this idea, one preliminary study examined the incremental and relative contributions of caffeine and alcohol expectancies in predicting CAB use outcomes (Lau-Barraco & Linden, under review). Findings revealed that both alcohol and caffeine expectancies uniquely predict CAB use quantity, frequency and related problems. However, alcohol expectancies appeared to be a stronger predictor than caffeine expectancies. Other researchers have examined caffeine expectancies and found a positive relationship between CAB use and withdrawal expectancies for caffeine (Heinz et al., 2009) and that consumers as compared to nonconsumers of CAB endorsed stronger social/mood enhancement caffeine expectancies (Huntley & Juliano, 2012). Several recent investigations specifically focused on CAB-specific expectancies. MacKillop and colleagues (2012) developed a measure of CAB expectancies with two factors: “intoxication enhancement” and “avoid negative consequences.” Only endorsement of intoxication enhancement expectancies predicted CAB use frequency, suggesting that college students’ decision to consume CAB is driven more by a desire to achieve intoxication (e.g., get high or “drunk” quicker) rather than by the avoidance of negative harms (e.g., drive safer) by consuming CAB. Two other investigations compared empirically derived profiles of CAB users on CAB-specific expectancies. One study found that profiles characterized by higher proportion of CAB use to alcohol-only use were associated with greater endorsement of CAB expectancies (Mallett, Marzell, Scaglione, Hultgren, & Turrisi, in press). Another study found that CAB risk profiles based on CAB expectancies and other CAB-related attitudes are associated with CAB use and negative consequences longitudinally (Varvil-Weld, Marzell, Turrisi, Mallett, & Cleveland, in press). In general, while previous research applying the expectancy paradigm to CAB have been limited, initial findings support additional efforts to understand outcome expectancies and their role in the CAB consumption of young adults.

Considering the heightened risks associated with CAB, research into identifying patterns of CAB use and the correlates of specific CAB drinking patterns could further our conceptualization of this increasingly pervasive health issue. Latent profile analysis (LPA), a person-centered analytical strategy that groups individuals into categories based on shared characteristics, would allow us to identify classes of CAB users. These classes then can be compared on relevant key dimensions as to identify potential risk factors associated with CAB use. Previous research has not examined CAB profiles as they relate to caffeine and alcohol use problems or to cognitions related to caffeine and alcohol separately. Consequently, the aims of the present study were to (1) identify distinct subtypes or classes of CAB consumers based on relevant indicators while taking into consideration typical alcohol use, (2) examine differences between classes on measures of alcohol and caffeine use severity (i.e., alcohol use problems, heavy drinking status, caffeine dependence and withdrawal), and (3) examine differences between classes on caffeine and alcohol expectancies. We hypothesized that CAB use could be characterized by distinct patterns based on quantity and frequency of CAB consumption, as well as typical alcohol consumption. We expected to find a relatively larger group of low frequency and quantity users of CAB and a smaller group of high frequency and quantity of CAB users. We expected the heavier and more frequent group of CAB consumers to report greater alcohol and caffeine use severity, as well as stronger endorsement of alcohol and caffeine expectancies.

Method

2.1. Participants and Procedure

Participants were 583 (402 female) college student drinkers recruited from an undergraduate psychology research pool at a mid-size east coast university. To be eligible, participants must have (1) been between the ages of 18–25, (2) reported consuming alcohol at least once in the previous 12 months, and (3) have reported consuming CAB at least once during a typical week. Mean age of the sample was 19.84 (*SD* = 1.69) years old. Approximately 56.09% of participants identified their racial group as Caucasian, 28.64% as African American, 6.00% as Asian, 3.43% as Hispanic, 0.17% as Native American, 5.49% as ‘other’, and 0.17% of participants had missing data. Of those who reported their academic status, the highest grade of school completed by participants was: 24.64% high school, 26.43% freshmen, 22.69% sophomore, 19.70% junior, and 6.48% senior. The average age of alcohol use onset (i.e., age when first alcoholic beverage was consumed) for the sample was 15.59 (*SD* = 2.51) years.

Data collection was administrated in small groups. Following informed consent, participants were provided with a battery of self-report questionnaires that took approximately one hour to complete. Participants received course credit as compensation for their participation. The present study was approved by the university’s college committee on human subjects research and followed APA guidelines (APA, 2002).

2.2. Measures

2.2.1. Alcohol expectancies—The Alcohol Expectancy Questionnaire (AEQ; Brown, Goldman, Inn, & Anderson, 1980) was used to assess alcohol expectancies. This 69-item self-report measure consists of statements regarding the positive effects of alcohol with *true* or *false* response options. The AEQ consists of six subscale domains: positive global changes in experience (e.g., "Alcohol enables me to have a good time at parties"; α = .86), sexual enhancement (e.g., "I'm a better lover after a few drinks"; α = .76), social and physical pleasure (e.g., "I like the taste of some alcoholic beverages"; α = .66), assertiveness (e.g., "When I'm drinking, it is easier to open up and express my feelings"; α = .85), relaxation/tension reduction (e.g., "Alcohol enables me to fall asleep more easily"; α = .74), and arousal/interpersonal power (e.g., "At times, drinking is like permission to forget problems"; α = .67). Subscale scores were calculated by summing positively endorsed items corresponding to each domain, with higher scores indicating greater salience of the particular expectancy.

2.2.2. Caffeine expectancies—Caffeine expectancies were measured using the Caffeine Expectancy Questionnaire (CEQ; Heinz et al., 2009). The CEQ is a 37-item self-report measure assessing beliefs regarding the effects of caffeine use. The CEQ provides four subscales: positive effects (e.g., "Drinking a caffeinated beverage helps me think more clearly"; α = .87), acute negative effects (e.g., "Caffeinated beverages make my heart race"; α = .87), withdrawal symptoms (e.g., "I have less motivation to get work done if I don't drink caffeine regularly"; α = .91), and mood effects (e.g., "I drink caffeinated beverages to help me relax"; α = .84).

2.2.3. Alcohol and CAB use—Alcohol and CAB consumption was measured using the Daily Drinking Questionnaire (DDQ; Collins, Parks, & Marlatt, 1985). Participants reported the typical consumption of (1) non-caffeinated alcoholic drinks and (2) caffeinated alcoholic drinks. They reported the number of drinks they typically consume for each day of the week averaged over the past three months. For both alcohol and CAB use, we used typical weekly drinking quantity, frequency, and heavy episodic drinking frequency (4/5 drinks in one sitting for women/men).

2.2.4. Alcohol use problems—The Alcohol Use Disorders Identification Test (AUDIT; Babor, de la Fuente, Saunders, & Grant, 1992) was used to measure alcohol use problems. The AUDIT consists of 10 self-report items on recent alcohol use, alcohol dependence symptoms and alcohol related problems. Higher scores reflect greater risk related to alcohol, with a score of eight or higher indicating harmful drinking (Babor et al., 1992). Internal consistency was α = .82.

2.2.5. Caffeine use dependence and withdrawal—Caffeine use dependence and withdrawal were assessed using the Caffeine Dependence and Withdrawal Checklist (CDWC; Heinz et al., 2009; Hughes, Oliveto, Liguori, Carpenter, & Howard, 1998). The checklist is based on the generic DSM-IV-TR (APA, 2000) criteria for psychoactive substance dependence but modified for caffeine use. Participants rated the presence of each criterion with *yes* or *no* response options. A criteria is considered present if the dependence (e.g., "Tried to cut down or quit drinking caffeine but couldn't") or withdrawal symptoms (e.g., "Headache", "Anxiety", "Nausea") have occurred at least once a month in the past 12 months. Caffeine dependence symptoms were measured continuously with higher scores reflecting greater dependence, although previous research suggest that endorsing three or more criteria may be considered "caffeine dependent" (Hughes et al., 1998). Caffeine withdrawal was measured continuously, with higher scores indicating greater likelihood of experiencing caffeine withdrawal in the past year. For caffeine dependence, $\alpha = .83$. For caffeine withdrawal, $\alpha = .82$.

Results

3.1. Data Analytic Strategy

Missing data ranged from 0% on several variables to approximately 8.75% on the quantity of CAB consumed in a typical week. All missing values were imputed via the expectation maximization algorithm (Schafer & Graham, 2002). Typologies of drinking based on alcohol use frequency, alcohol use quantity, CAB use frequency, and CAB use quantity were identified using latent profile analysis (LPA) in Mplus 5.2 with robust maximum likelihood estimation (Muthén & Muthén, 2008). LPA is a type of latent variable mixture model, where in this case, the latent variable is categorical and the observed indicator variables are continuous. The categorical latent variable has *k* number of categories and an individual's value on the latent variable is thought to cause his or her levels on the observed continuous indicators (Pastor, Barron, Miller, & Davis, 2007). As compared to traditional cluster analysis, LPA is a model-based procedure that allows for more flexible model specification (Marsh, Lüdtke, Trautwein, & Morin, 2009).

The Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), and sample size adjusted BIC (SSA-BIC) were used to assess model fit, where lower values indicate better model fit (Nylund, Asparouhov, & Muthén, 2008). Moreover, the Lo-Mendell-Rubin likelihood ratio test (LMR) was used to empirically test the null hypothesis that the k–1 class solution is acceptable compared to the *k*-class solution. For this test, a *p*-value less than .05 indicates that the *k*-class model has a superior fit compared to the k–1 class model (Wang & Wang, 2012). Relative entropy criteria were used to evaluate classification accuracy. These values range from 0.0 to 1.0, where a higher value indicates better classification. Clark (2010) suggests a value of 0.80 is high, 0.60 is medium, and 0.40 is low entropy.

To identify the most optimal and parsimonious latent class solution, first, latent classes were fit iteratively to obtain model fit statistics. For each model, means were freely estimated across classes; however, variances were constrained to equality across latent classes (e.g., see parameterization of covariance matrix "Model A" in Pastor et al., 2007). Then, a multinomial logistic regression was used to model the effects of the demographic covariates with the "AUXILIARY" statement in Mplus. Specifically, the "AUXILIARY" statement allows variables to be specified that are not part of the LPA model to predict class membership in the categorical latent variable using posterior probability-based multiple imputations (i.e., pseudo-class draws) (Marsh et al., 2009; Wang & Wang, 2012). In other words, a multinomial logistic regression model is estimated independently after latent class classification; therefore, the specification of covariates does not affect latent class classification.

After the optimal number of latent classes was established, three one-way multivariate analysis of variance (MANOVA) models were estimated in SAS 9.3 (SAS Institute, 2012) to determine if these latent classes differed on alcohol and caffeine use problems, alcohol-related cognitions, or caffeine-related cognitions. Pillai's Trace (*V*) was used to test each multivariate hypothesis since it is the statistic that is most robust to lack of normality and homogeneity of covariance matrices (Timm, 2002). A Shaffer-Holm alpha correction (e.g., see Shaffer, 1986 for details) was used to adjust for multiple comparisons. Please see Table 1 for zero-order correlations among the key study variables for the full sample.

3.2. Latent Profile Models

Fit statistics for the unconditional 1 – 6 LPA models are presented in Table 2. As can been seen, the information indexes (i.e., AIC, BIC, and the SSA-BIC) continued to decrease across the range of models considered. However, this can be expected with large sample sizes and the sample size dependency of these measures. The 5- and 6-class solutions resulted in the smallest class with less than 5% of cases. In mixture modeling, the number of individuals in each class represents the prevalence of the corresponding subpopulation in the target population, so in order to have a meaningful group classification, the relative size of each latent class should not be too small (Wang & Wang, 2012). The 2-class solution was not interpretable. Although 3-, 4-, and 5-class solutions were examined, based on interpretability and the LMR likelihood ratio test, a 4-class solution was deemed optimal. The entropy statistic for this model was .989, indicating a superior level of classification accuracy into the four latent classes (Clark, 2010). To ensure that the parameter estimates from the 4-latent class model were not estimated from local solutions, the model was re-estimated twice with different seeds. Across models, parameter estimates were identical suggesting that a global solution was used.

As can be seen in Figure 1 and Table 3[1], Class 1 is characterized by the greatest weekly quantity of alcohol and CAB consumption relative to all other classes and comprised 6.00% (n = 35) of the sample. As such, Class 1 was labeled the "High Alcohol/High CAB" class. Class 2 is characterized by similar mean scores on alcohol use frequency and quantity and CAB frequency as Class 1; however, Class 2 had a lower mean score on CAB quantity than Class 1. Therefore, Class 2 was labeled the "High Alcohol/Moderate CAB" class and comprised 5.15% (n = 30) of the sample. Class 3 is characterized by even lower quantity of CAB use as compared with Classes 1 and 2, as well as relatively lower frequency of CAB use but similar alcohol use quantity as Class 1 and 2. Class 3 was labeled the "High alcohol/Low CAB" class and comprised 22.99% (n = 134) of the sample. Lastly, Class 4 is characterized by the lowest use level across all four indicator variables, including quantity and frequency of both alcohol and CAB use. As such, Class 4 was labeled the "Low alcohol/Low CAB" class and comprised 65.87% (n = 384) of the sample.

[1]Standard deviation estimates are presented in Table 3 (obtained by using the TECH7 option in Mplus) only to provide the reader with desciptive information about the variability of the indicators across the latent classes. It should be noted that the variances were constrained to equality across latent classes in the LPA models.

After determining the optimal latent class solution, the demographic covariates (i.e., age, gender, age of drinking onset) were specified as predictors in the LPA model using the "AUXILIARY" statement. Results of the multinomial logistic regression revealed that aside from gender, none of the demographic covariates significantly predicted latent class membership. In particular, compared to females, males had significantly lower odds of being in Class 4 (i.e., Low alcohol/Low CAB class) than Class 2 (i.e., High Alcohol/Moderate CAB class), ($B = -0.85$, $SE = 0.39$, odds ratio = 0.43, $p = .027$).

3.3. Multivariate Analysis of Variance Models

The first MANOVA model tested to see if latent classes significantly differed on mean scores of alcohol use problems (as measured by the AUDIT), heavy episodic drinking frequency, caffeine dependence, or caffeine withdrawal. The multivariate effect was significant, Pillai's Trace (V) = 0.16, $F(12, 1734) = 8.02$, $p < .001$, partial $\eta^2 = .053$. Likewise, follow-up analysis of variance (ANOVA) models demonstrated that latent class had a significant univariate effect across all dependent variables. As shown in Table 4, pairwise comparisons revealed that the means for alcohol use problems, heavy episodic drinking frequency, and caffeine withdrawal scores were significantly lower for the Low Alcohol/Low CAB class than compared to the High Alcohol/Low CAB and High Alcohol/High CAB class. Moreover, the mean caffeine dependence score of the High Alcohol/High CAB class was significantly higher than all other latent classes.

The second MANOVA model tested if latent classes significantly differed on mean scores of alcohol-related cognitions. The dependent variables were the six subscales of the AEQ. The multivariate effect was significant, $V = 0.06$, $F(18, 1728) = 2.04$, $p = .006$, partial $\eta^2 = .021$. Follow-up ANOVA models demonstrated that latent class had a significant univariate effect across all dependent variables except social assertiveness. As can be seen in Table 4, pairwise comparisons revealed that the mean global positive change, enhanced sexual performance, physical and social pleasure, relaxation and tension reduction, and arousal and power scores were significantly lower for the Low Alcohol/Low CAB class compared to the High Alcohol/Low CAB class.

The third MANOVA model tested to see if latent classes significantly differed on mean scores of caffeine-related cognitions. The dependent variables were the four subscales of the CEQ (Heinz et al., 2009). The multivariate effect was significant, $V = 0.09$, $F(12, 1734) = 4.34$, $p < .001$, partial $\eta^2 = .029$. Follow-up ANOVA models revealed that latent class had a significant univariate effect across all dependent variables except acute negative effects. As shown in Table 4, the mean positive effects and withdrawal symptom scores for the Low Alcohol/Low CAB class were significantly lower than the High Alcohol/Low CAB class. In addition, the mean mood effect and withdrawal symptom scores were significantly lower for the Low Alcohol/Low CAB class than the High Alcohol/High CAB class. Moreover, the mean withdrawal symptom scores were significantly lower for the Low Alcohol/Low CAB, High Alcohol/Low CAB, and High Alcohol/Moderate CAB classes compared to the High Alcohol/High CAB class.

Discussion

The present study aimed to shed light on the nature of CAB consumption among college drinkers by modeling patterns of CAB use. Specifically, we sought to identify empirically derived profiles or classes of CAB users while considering their typical alcohol use. We also investigated whether classes differed on key constructs, including alcohol and caffeine use problems, and substance-related cognitions. As hypothesized, CAB consumption could be characterized into distinct subtypes based on the quantity and frequency of the drinkers' CAB and alcohol use. We found evidence for four unique classes of CAB users. These classes were labeled: High Alcohol/High CAB, High Alcohol/Moderate CAB, High Alcohol/Low CAB, and Low Alcohol/Low CAB. The majority of our sample of moderate to heavy college drinkers was classified into the Low Alcohol/Low CAB group (65.87%) while 6.00% were classified into the High Alcohol/High CAB group. Although the High Alcohol/High CAB, High Alcohol/Moderate CAB, and High Alcohol/Low CAB groups all shared relatively similar levels of typical alcohol-only consumption (range between 12.98 to 14.10 standard drinks weekly), they diverged on the quantity of CAB use. Specifically, the High Alcohol/High CAB group is characterized by the greatest quantity of CAB use of approximately 16 drinks weekly, while the High Alcohol/Moderate CAB and High Alcohol/Low CAB groups consumed approximately 8 and 4 drinks, respectively. The Low Alcohol/Low CAB group is characterized by less than one CAB drink weekly.

We tested whether latent classes differed on measures of caffeine-related and alcohol-related outcomes. As could be expected, when compared with the High Alcohol/High CAB class, the Low Alcohol/Low CAB class reported significantly lower levels of caffeine withdrawal, caffeine dependence, frequency of heavy episodic drinking, and alcohol use problems. An interesting finding emerged when evaluating caffeine dependence as the outcome variable. When compared to *all* other classes, the High Alcohol/High CAB class reported experiencing significantly more caffeine dependence symptoms (e.g., drank caffeine despite negative consequences, used caffeine to avoid withdrawal) than all other classes. These results are particularly concerning given that lifetime caffeine intake and caffeine dependence are positively associated with a variety of psychological disorders including depression, anxiety, panic disorder, and antisocial personality disorder (Kendler, Myers, & Gardner, 2006). The severity of caffeine use and dependence also is associated with various substance use disorders including alcohol dependence, as well as cocaine and cannabis use disorders (Kendler et al., 2006).

Latent profiles were compared on caffeine-related as well as alcohol-related outcome expectancies to determine their salience in caffeinated alcohol use. With regard to caffeine expectancies, results indicated a significant effect of class on three of the four subscales of the CEQ – positive effects, mood effects, and withdrawal symptoms effects. The most notable finding was that the High Alcohol/High CAB class endorsed significantly stronger withdrawal symptoms effects than all other classes. In other words, these individuals are more likely to believe that *not* consuming caffeine will result in consequences associated with caffeine withdrawal, such as nausea, headaches, drowsiness, fatigue, amotivation and irritability. The High Alcohol/High CAB group also is relatively more likely to report general positive caffeine expectancies, such as feeling more energized, alert, talkative, and thinking clearly, as well as improved mood, but differences were not statistically significant. These findings suggest that CAB users have a wide range of expectancies about the effects of caffeine and that the more CAB an individual consumes or the greater their use profile in general, the more they endorsed certain effects of caffeine consisting of both positive and negative reinforcement outcomes.

Our results on caffeine expectancies with CAB users are consistent largely with findings derived from other work with caffeine users. Previous research found that positive caffeine expectancies were associated with caffeine use and severity (e.g., caffeine dependence, caffeine withdrawal, cessation difficulty and perceived dependence; Heinz et al., 2009; Huntley & Juliano, 2012). With regard to the role of negative caffeine expectancies, it has been found to have a positive (Heinz et al., 2009) or no relationship (Huntley & Juliano, 2012) with caffeine dependence features. Our findings indicate that the High Alcohol/High CAB class did not report more negative caffeine expectancies as measured by the acute negative effects subscale of the CEQ. However, it appears that the riskiest drinkers in our sample with the most experience with CAB use have the strongest negative reinforcement caffeine expectations (i.e., withdrawal symptoms expectancy effects). Further, we found that the High Alcohol/High CAB class reported greater caffeine mood expectancies than the Low Alcohol/Low CAB class. These results are consistent with those found in previous research (Heinz et al., 2009; Huntley & Juliano, 2012). Consequently, it may be possible that the strength of these expectancies may serve as an underlying mechanism driving greater future consumption.

In examining alcohol expectancies, results indicated some differential endorsement based on use profiles. In particular, CAB users in the High Alcohol/Low CAB class endorsed more positive alcohol expectancies than the Low Alcohol/Low CAB group. The expected effects include alcohol's ability to produce global positive changes, enhance sexual performance, reduce tension, facilitate social and physical pleasure, and increase arousal and power. These results are consistent with the relatively larger body of work on alcohol users that has shown heavy drinkers to report greater and stronger positive expected alcohol effects (Brown et al., 1980; Southwick, Steele, Marlatt, & Lindell, 1981).

Generally, our findings suggest that both caffeine and alcohol expectancies may play a role in governing CAB consumption. This also is supported by research that has shown caffeine and alcohol expectancies each to exert incremental influence in the prediction of CAB outcomes, although alcohol expectancies appear to be a stronger predictor overall (Lau-Barraco et al., 2013). Beyond looking at the additive or interactive nature of separate caffeine and alcohol expectancies, however, others have examined CAB-specific expectancies. Researchers found that CAB users may hold a unique expectancy for CAB over other substances (i.e., quicker intoxication; MacKillop et al., 2012) and that greater CAB use is associated with greater CAB expectancy endorsement (Mallett et al., in press; Varvil-Weld et al., in press). Overall, previous studies' and our support for the role of outcome expectancies provide sufficient basis for more in-depth investigations in to substance specific expectancies and CAB use. In addition, given the associations between CAB use and expectancy endorsement, the inclusion of expectancies into larger theoretical frameworks in future work of CAB may provide a more comprehensive understanding of the factors contributing to use patterns.

There are several implications of our study findings. Potential practice-related implications may be warranted given the heightened risk connected with the use of caffeinated alcohol as compared with consuming alcohol only. First, identifying subtypes of CAB use patterns could improve intervention efforts by targeting those profiles associated with the greatest risk. Also, in the present study, findings suggest differential endorsement of caffeine and alcohol expectancy based on use profiles. Thus, prevention programs may be most effective if they are designed to accommodate differences in patterns of CAB consumption and the outcome expectancies associated with these various patterns or profiles. Expectancies could be targeted in intervention work for CAB use like those developed for college alcohol drinkers (e.g., Darkes & Goldman, 1993, 1998; Lau-Barraco & Dunn, 2008). An “expectancy challenge” procedure may be used to modify beliefs regarding the positive effects of alcohol and caffeine consumption. Further, education about CAB and their related risks may be useful to incorporate into existing health promotion programs or other primary prevention efforts. This may be particularly helpful given research findings that CAB users report lower subjective intoxication with no improvements in task performance (Ferreira, de Mello, Pompéia, Souza-Formigoni, 2006; Marczinski & Fillmore, 2006). Their lowered ability to detect impairment or intoxication level accurately may result in engaging in high risk behaviors such as driving under the influence, being injured, or being in a risky sexual situation.

The current findings should be interpreted in light of the study limitations. First, our target sample consisted of college student drinkers. This limits our ability to generalize findings to other populations including non-young adults and nonstudents. Relatedly, participants in our study were mostly Caucasian (56%) and African American (29%), thus generalizability to a more ethnically diverse sample is unknown. Second, while our overall sample size was adequate for conducting latent profile analyses, the lower sample size of some latent classes may have lacked enough power to detect differences between groups in the MANOVA models. Another limitation involves the cross-sectional nature of our data. To firmly establish the relationship between CAB use and its associated risks, studies involving experimental manipulation or prospective designs are warranted. Additionally, our data relied on participants’ retrospective self-reports, and hence, may be susceptible to recall bias. A final limitation is that our study did not assess CAB-specific expectancies or CAB-specific problems. A measure of CAB expectancies (MacKillop et al., 2012) only became available following the completion of data collection for the present study. Future research may focus on examining differences between latent classes on expectancies specific to CAB. Further, future research may benefit from the development of an alcohol problems measure related to CAB use in particular.

Despite these limitations, our findings contribute to the limited body of research on caffeinated alcohol use and provide background for further research into profiles of CAB consumption among young adult drinkers. Future research may consider other relevant general risk factors previously identified for alcohol use, such as impulsivity, sensation seeking, peer network, and other substance use, that may be examined in relation to CAB risk profiles. Further, our findings suggest that only a relatively small percentage of students consume CAB frequently. Consequently, future research should account for frequency of CAB consumption rather than limiting to only quantity of CAB use or grouping individuals into dichotomous groups (e.g., CAB use vs. no-use) as has been done in some epidemiological studies. Finally, this study provides support for the association between CAB use and substance-related cognitions. This could suggest outcome expectancies as a potential risk factor for future use. As such, our results set the stage for prospective studies or daily diary assessments that can probe more specifically into the cognitive and contextual factors associated with problematic CAB use and ultimately could provide insight into intervention planning.

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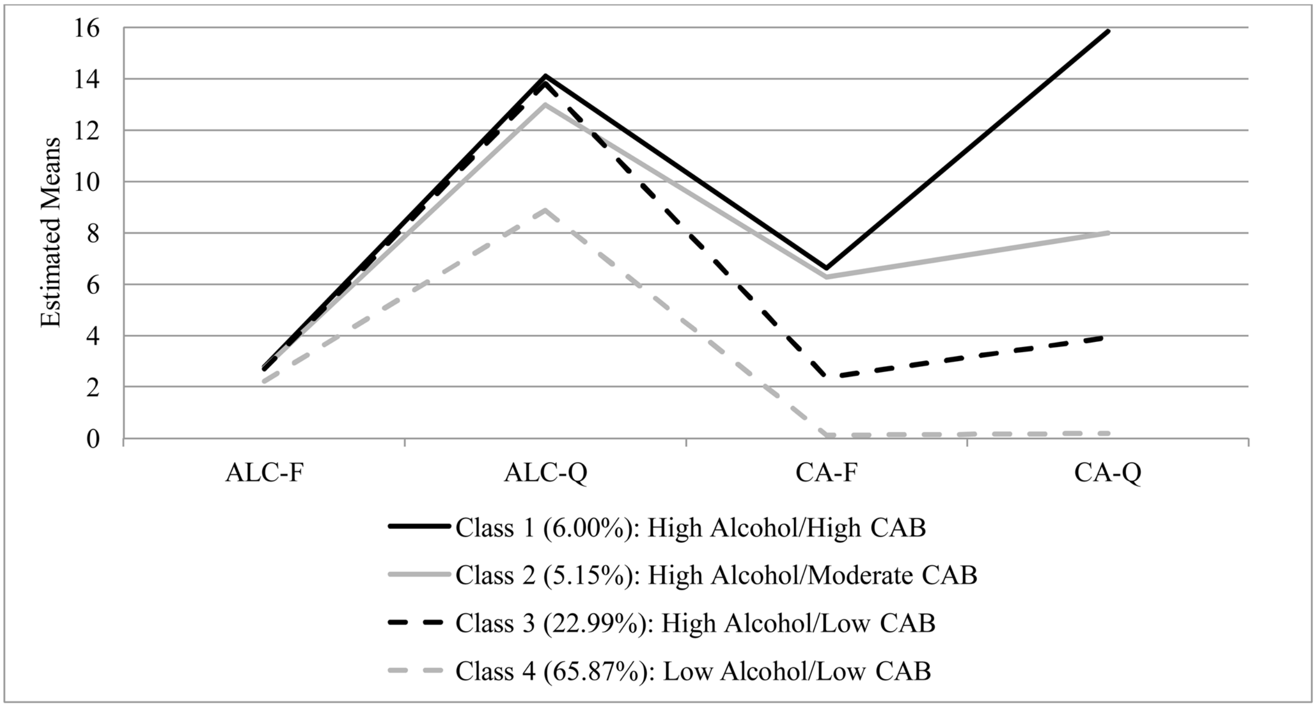

Figure 1.

Estimated mean plot for unconditional 4-class latent profile model. CAB = caffeinated alcoholic beverage; ALC-F = alcohol use frequency weekly; ALC-Q = alcohol-only drinks per week; CA-F = caffeinated alcohol use frequency weekly; CA-Q = caffeinated alcohol drinks per week.

Table 1

Correlations Among Study Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. AGE	-																				
2. GENDER	.09*	-																			
3. AGE DRNK	.19***	−.09*	-																		
4. ALC-F	.12**	.07	−.09*	-																	
5. ALC-Q	−.04	.17***	−.14**	.64***	-																
6. CA-F	.03	.06	−.08	.16***	.19***	-															
7. CA-Q	.03	.06	−.08	.14**	.19***	.90***	-														
8. ALC PROBS	−.11*	.19***	−.20***	.43***	.74***	.20***	.20***	-													
9. HED-F	−.07	.02	−.14**	.51***	.85***	.19***	.18***	.67***	-												
10. C-DEP	.01	−.10*	.01	.11**	.03	.20***	.27***	−.01	.03	-											
11. C-WIT	.02	−.03	−.02	.07	.01	.17***	.19***	.03	.03	.51***	-										
12. AEQ - GPC	−.17***	.12**	−.01	.26***	.29***	.14**	.15***	.38***	.29***	.09*	.09*	-									
13. AEQ - SEX	−.14**	.01	−.05	.19***	.22***	.11**	.13**	.31***	.22***	.13**	.07	.58***	-								
14. AEQ - PSP	−.10*	.02	−.09*	.34***	.34***	.06	.04	.37***	.32***	.05	.10*	.56***	.42***	-							
15. AEQ - A	−.13**	.07	−.03	.23***	.28***	.05	.07	.38***	.27***	.08	.10*	.66***	.52***	.54***	-						
16. AEQ - RTR	−.14**	.08*	−.06	.29***	.29***	.08	.06	.34***	.28***	.10*	.13*	.67***	.43***	.63***	.54***	-					
17. AEQ - AP	−.15***	−.07	−.05	.23***	.25***	.12**	.13**	.36***	.26***	.12*	.07	.66***	.57***	.48***	.62***	.55***	-				
18. CEQ - P	.01	−.01	.01	.10*	−.01	.13**	.13**	.04	.02	.32***	.27***	.15***	.07	.13**	.19***	.20***	.15***	-			
19. CEQ - N	−.02	.07	.00	.10*	.05	.00	−.00	.11*	.03	.09*	.13**	.21***	.14**	.09*	.16***	.18***	.17***	.43***	-		
20. CEQ - M	−.04	.05	−.01	.12**	.02	.15***	.17***	.02	.03	.41***	.32***	.26***	.16***	.16***	.18***	.22***	.22***	.63***	.30***	-	
21. CEQ - W	.02	−.03	−.01	.12**	.04	.24***	.26***	.04	.04	.62***	.55***	.17***	.12**	.10*	.14**	.15***	.18***	.47***	.24***	.62***	-

Note. AGE = participant age in years; GENDER = gender of participant; AGE DRNK = age in years of drinking onset; ALC-F = alcohol use frequency; ALC-Q = alcohol use quantity; CA-F = caffeinated alcohol use frequency; CA-Q = caffeinated alcohol use quantity; ALC PROBS = alcohol use problems; HED-F = heavy episodic drinking frequency; C-DEP = Caffeine dependence; C-WIT = caffeine withdrawal; AEQ = Alcohol Expectancies Questionnaire; GPC = global positive change; SEX = enhanced sexual performance; A = assertiveness; PSP = physical and social pleasure; CEQ = Caffeine Expectancy Questionnaire; P = positive effects; M = mood effects; W = withdrawal symptoms.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

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Table 2

Summary of Model Fit for Unconditional Latent Profile Models (N = 583)

Model tested	−2*LL*	*df*	AIC	BIC	SSA-BIC	*p*-value for LMR LRT	Entropy	% of individuals in smallest class
1-class	−6034.016	8	12084.032	12118.978	12093.581	-	-	-
2-classes	−5494.685	13	11015.371	11072.157	11030.887	< .0001	.982	12.521
3-classes	−5211.895	18	10459.790	10538.418	10481.274	.0007	.986	11.149
4-classes	−5081.848	23	10209.696	10310.164	10237.148	.0212	.989	5.146
5-classes	−4982.670	28	10021.341	10143.650	10054.760	.1976	.988	3.431
6-classes*	−4876.198	33	9818.397	9962.547	9857.784	.1663	.984	1.372

Note. −2*LL* = −2 log likelihood; AIC = Akaike information criteria; BIC = Bayesian information criteria; SSA-BIC = sample size adjusted BIC; LMR LRT = Lo-Mendell-Rubin Likelihood Ratio Test.

*standard errors for model parameters not trustworthy due to a non-positive definite first-order product matrix.

Table 3

Descriptive Statistics of Indicator Variables for 4-Class Latent Profile Model

Latent class	Indicator variables			
	ALC-F	**ALC-Q**	**CA-F**	**CA-Q**
Low Alcohol/Low CAB	2.21 (1.26)	8.87 (8.02)	0.13 (0.34)	0.20 (0.55)
High Alcohol/Low CAB	2.71 (1.24)	13.80 (9.99)	2.37 (0.61)	3.93 (2.30)
High Alcohol/Moderate CAB	2.75 (1.66)	12.98 (11.05)	6.27 (0.86)	7.99 (1.96)
High Alcohol/High CAB	2.78 (1.38)	14.10 (10.63)	6.62 (0.91)	15.84 (2.94)

Note. CAB = caffeinated alcoholic beverage; ALC-F = alcohol use frequency weekly; ALC-Q = alcohol-only drinks per week; CA-F = caffeinated alcohol use frequency weekly; CA-Q = caffeinated alcohol drinks per week. Numbers represent mean estimates; standard deviation estimates are enclosed in parentheses. Estimates obtained by weighting observations by posterior probabilities.

Table 4

Summary of Multiple Comparisons among Latent Classes for Alcohol and Caffeine Use Problems, Alcohol-Related Cognitions, and Caffeine-Related Cognitions

Dependent variable	Latent class			
	Class 1 High Alcohol/High CAB	Class 2 High Alcohol/Moderate CAB	Class 3 High Alcohol/Low CAB	Class 4 Low Alcohol/Low CAB
Alcohol use problems	7.91 (5.95)[a]	7.78 (5.95)	8.44 (5.16)[d]	5.52 (4.07)
HED frequency	1.57 (1.38)[a]	1.27 (1.14)	1.61 (1.16)[d]	0.89 (1.09)
Caffeine dependence	2.72 (2.52)[a, b, c]	1.20 (1.58)	1.49 (2.02)	0.97 (1.66)
Caffeine withdrawal	1.35 (1.76)[a]	0.83 (1.42)	1.07 (1.66)[d]	0.55 (1.26)
AEQ - Global positive change	32.72 (5.90)	34.06 (5.46)	33.20 (5.31)[d]	31.24 (5.00)
AEQ - Enhanced sexual performance	9.57 (2.46)	10.02 (2.08)	9.77 (2.14)[d]	9.06 (2.00)
AEQ - Physical and social pleasure	15.63 (2.06)	16.42 (1.50)	16.40 (1.61)[d]	15.80 (1.86)
AEQ - Relaxation and tension reduction	14.20 (2.18)	15.25 (2.50)	15.07 (2.30)[d]	14.28 (2.43)
AEQ - Arousal and power	13.50 (1.96)	14.13 (2.27)	13.95 (2.34)[d]	13.10 (2.19)
CEQ - Positive effects	30.73 (7.97)	28.99 (6.91)	29.65 (6.54)[d]	27.62 (7.27)
CEQ - Mood effects	14.40 (5.30)[a]	12.63 (4.25)	12.83 (4.59)	11.77 (4.09)
CEQ - Withdrawal symptoms	23.84 (7.72)[a, b, c]	18.80 (6.49)	20.03 (7.88)[d]	16.98 (6.36)

Note. Numbers represent mean and standard deviation is in parentheses. HED = heavy episodic drinking. AEQ = Alcohol Expectancy Questionnaire. CEQ = Caffeine Expectancy Questionnaire. CAB = caffeinated alcoholic beverage.

[a]Significant mean difference between Class 1 and Class 4;

[b]Significant mean difference between Class 1 and Class 3;

[c]Significant mean difference between Class 1 and Class 2;

[d]Significant mean between Class 3 and Class 4. Means are significantly different from each other at the .05 probability level using a Shaffer-Holm alpha correction.