A Latent Class Analysis of DSM-IV Alcohol Use Disorder Criteria and Binge Drinking in Undergraduates

Cheryl L. Beseler, Ph.D.,
Department of Psychology, Colorado State University New York State Psychiatric Institute, Columbia University

Laura A. Taylor, B.A.,
George Washington University School of Medicine

Deborah Tebes Kraemer, Ph.D., and
Psychology Department, Southern Connecticut State University

Robert F. Leeman, Ph.D.
Psychiatry Department, Yale University School of Medicine Institutions of origin: Colorado State University and Yale University School of Medicine

Abstract

Background—Adolescent and adult samples have shown that DSM-IV abuse and dependence criteria lie on a continuum of alcohol problem severity, but information on criteria functioning in college students is lacking. Prior factor analyses in a college sample (Beseler et al., 2010) indicated that a two-factor solution fit the data better than a single-factor solution after a binge drinking criterion was included. The second dimension may indicate a clustering of criteria related to excessive alcohol use in this college sample.

Methods—The present study was an analysis of data from an anonymous, online survey of undergraduates ($N = 361$) that included items pertaining to the DSM-IV alcohol use disorder (AUD) diagnostic criteria and binge drinking. Latent class analysis (LCA) was used to determine whether the criteria best fit a categorical model, with and without a binge drinking criterion.

Results—In a LCA including the AUD criteria only, a 3-class solution was the best fit. Binge drinking worsened the fit of the models. The largest class (class 1, $n = 217$) primarily endorsed tolerance (18.4%); none were alcohol dependent. The middle class (class 2, $n = 114$) endorsed primarily tolerance (81.6%) and drinking more than intended (74.6%); 34.2% met criteria for dependence. The smallest class (class 3, $n = 30$) endorsed all criteria with high probabilities (30% to 100%); all met criteria for dependence. Alcohol consumption patterns did not differ significantly between classes 2 and 3. Class 3 was characterized by higher levels on several variables thought to predict risk of alcohol-related problems (e.g., enhancement motives for drinking, impulsivity and aggression).

Conclusions—Two classes of heavy drinking college students were identified, one of which appeared to be at higher risk than the other. The highest risk group may be less likely to "mature out" of high-risk drinking after college.

Keywords

alcohol use disorders; latent class analysis; college students; impulsivity; alcohol typology

Corresponding author: Cheryl Beseler, Ph.D. Department of Psychology 1879 Campus Delivery Colorado State University Fort Collins, CO 80523-1879 Telephone: 970-491-2680, fax: 970-491-0527, cheryl.beseler@colostate.edu.

Introduction

Heavy alcohol consumption in the college population is a public health concern and it is not surprising that alcohol use disorder (AUD) diagnoses (i.e., diagnoses of alcohol abuse or dependence) are prevalent among young adults. According to findings from the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC), college students ages 18-29 were almost twice as likely as adults 30 years of age or older to meet criteria for current alcohol abuse and more than four times as likely to meet criteria for current alcohol dependence (Dawson et al., 2004; Grant et al., 2004). In a national survey of undergraduates, about 6% of students met criteria for current alcohol dependence and about 31% met criteria for current alcohol abuse. Also, just over 44% had experienced at least one symptom of an AUD within the last year (Knight et al., 2002).

Heavy episodic drinking is closely associated with AUD diagnoses. Approximately 44% of undergraduates in the United States reported at least one heavy episodic drinking occasion (i.e., five or more drinks in a single occasion for men and four or more for women) in the prior two weeks (Wechsler et al., 2000). In the same national survey, Knight et al. (2002) found that frequent heavy episodic drinkers (i.e., three or more heavy drinking occasions in the prior two weeks) were 13 times more likely to meet criteria for current abuse and 19 times more likely to meet criteria for current dependence than non-heavy drinkers. Occasional heavy episodic drinkers were four times as likely to meet criteria for either abuse or dependence compared with non-heavy drinkers.

While many undergraduates "mature out" of heavy use after graduation, a considerable minority will continue heavy use and be at risk for clinically significant problems (Jackson et al., 2001). Thus, research is needed to predict which undergraduates may be likely to engage in high-risk drinking and potentially fail to "mature out" of heavy use in later years.

Traits associated with behavioral undercontrol/disinhibition (e.g., types of impulsivity, sensation seeking, aggression) have been found to predict high-risk patterns of alcohol use. Changes in self-reported impulsivity in a college student cohort from the ages of 18-35 were significantly and positively correlated with changes in self-reported alcohol-related problems during the same time period (Littlefield et al., 2010). Sensation seeking has been found to be a prospective predictor of heavy drinking in undergraduates (Katz et al., 2000), however, associations between sensation seeking and alcohol-related problems have not been as strong (Zuckerman, 1994). Scores on a self-report measure of aggression were significantly and positively correlated with scores on the AUDIT in a national survey of young adult twin and non-twin siblings in Finland (von der Pahlen et al., 2008). The strong relationships that have been observed between behavioral undercontrol/disinhibition and high-risk alcohol use may reflect shared genetic risk among these attributes (Iacono et al., 2008; Slutske et al., 2002; von der Pahlen et al., 2008).

In addition to these relationships with externalizing tendencies in young adults, alcohol use and problems have been related to variables indicative of internalizing tendencies. Both alcohol use (Leeman and Wapner, 2001) and alcohol-related problems (Camatta and Nagoshi, 1995) have been positively correlated with the experience of life stressors. Alcohol-related problems have been related to poorer life satisfaction among undergraduates and alcohol use was inversely related to life satisfaction among female students (Murphy et al., 2005). Both perceived stress (Cohen et al., 1983) and poorer life satisfaction (Pavot and Diener, 1993) have been correlated significantly with depression, suggesting relationships between these variables and internalizing tendencies.

Motives for drinking are also of interest, both as predictors of high risk drinking in their own right and due to their associations with behavioral undercontrol/disinhibition. Coping

motives (i.e., drinking to reduce negative affect) have been related to alcohol dependence diagnoses cross-sectionally and one year later in a community sample of adult drinkers (Carpenter and Hasin, 1999). In the above-mentioned prospective study examining a cohort of college students from ages 18-35 (Littlefield et al., 2010), changes in coping motives were found to mediate the aforementioned relationship between changes in impulsivity and changes in alcohol-related problems.

Literature on latent class and related analyses

Latent Class Analysis (LCA) is a classification method that produces a categorical latent factor rather than a continuous one, as in analytic techniques such as factor analysis and Item Response Theory (IRT) (Hagenaars and McCutcheon, 2002). LCA calculates the probability of being in a particular group or class conditional on a pattern of item responses. Each class has a specific profile of item endorsement unique to that class and classes are independent of each other. LCA can be a valuable tool in addressing the fundamental issue facing DSM-V concerning whether subtypes of alcohol abuse and dependence exist and whether these subtypes can be superimposed upon a continuous underlying dimension.

Several reports have been published in which LCAs and related analyses have been conducted on DSM alcohol use disorder criteria. Studies in adult samples have shown that DSM-IV alcohol dependence and abuse criteria can be explained by a single factor that accounts for a majority of the variance in the criteria (Kahler et al., 2006; Krueger et al., 2004; Proudfoot et al., 2006; Saha et al., 2006). The criteria constitute a linear continuum of severity in Rasch (Kahler et al., 2006); IRT (Krueger et al., 2004) and a method testing for discontinuities in the criteria (Hasin and Beseler, 2009). However, in two studies, unidimensionality was not obtained initially. In an adult clinical sample, unidimensionality was reached only after removing tolerance and legal problems (Langenbucher et al., 2004) and in the NESARC, only after removing legal problems (Saha et al., 2006). In an adolescent treatment sample, LCA identified three classes (asymptomatic, mild and severe) representing a continuum of severity (Chung and Martin, 2001). To our knowledge, there are no published studies using LCA to identify homogeneous groups of college drinkers based on DSM-IV criteria.

Rationale for conducting LCA in an undergraduate sample

The DSM-IV criteria have not been widely used in the college population. Instead, instruments such as the Young Adult Alcohol Problems Screening Test (YAAPST; Hurlbut and Sher, 1992) and the Rutgers Alcohol Problems Index (RAPI; White and Labouvie, 1989) have been utilized more frequently in the college drinking literature (Devos-Comby and Lange, 2008). Further, college students have been underrepresented in studies of the DSM-IV abuse and dependence criteria, although they are an ideal group in which to explore the role of binge drinking on the diagnostic criteria, given that students engage in heavy drinking frequently.

Using exploratory factor analysis, we previously (Beseler et al., 2010) showed that the eigenvalues for a two-factor model that included binge drinking with seven alcohol dependence and three abuse criteria were 6.47 and 1.14, respectively. Binge drinking loaded more strongly on a second factor with drinking more than intended. The fit statistics showed that the two-factor model fit the data somewhat better than a one-factor model. After removing weekly binge drinking as a criterion, the eigenvalues were 6.22 and 0.89 with an excellent fit to the data using CFI, TLI and RMSEA.

The purpose of this paper is to explore the role of binge drinking in forming a second dimension of undergraduate drinkers when considered alongside the DSM-IV criteria. We

hypothesized that the existence of a second dimension was due to a subpopulation of college students who drink heavily and experience a lack of control over their drinking. We believed that a data analytic approach to differentiate classes of participants according to their DSM-IV criteria endorsement was an effective way to address this hypothesis. We also thought analyses to identify *classes of participants* would provide a nice complement to our prior factor analysis, the goal of which was to identify *groupings of items*. A class of young adult drinkers with difficulty controlling their drinking may have a particularly strong risk profile compared to other classes. To address this possibility, we conducted subsequent analyses to compare classes on measures of alcohol consumption and other indicators of alcohol problem risk (e.g., drinking motives and key personality traits).

Thus, the goal of the present study was to test whether distinct classes of undergraduate drinkers would emerge, based on a pattern indicative of difficulty controlling alcohol use or according to other patterns of criteria endorsement. To justify this approach, we first needed to establish evidence of measurement invariance or population heterogeneity with regard to one or more variables that may be indicative of particularly strong alcohol-related risk. We utilized a Multiple Indicator Multiple Causes or MIMIC model for this purpose. A MIMIC model with categorical variables is equivalent to an item response model where the latent factor variable is regressed on covariates to assess evidence of measurement invariance or population heterogeneity. We selected gender and age at initiation of drinking to be the covariates in this model. Gender (e.g., Harford et al., 2010) and age at initiation (e.g., Clark et al., 2005; Iacono et al., 2008) are important predictors of at-risk drinking in their own right, but are also important given their possible relationships to other predictors of at-risk drinking, such as personality traits reflecting behavioral undercontrol/disinhibition (Iacono et al., 2008; von der Pahlen et al., 2008). In MIMIC models, we tested a direct effect of age at initiation of drinking and gender on the latent factor representing binge drinking and drinking more than intended. We hypothesized that evidence of differences between latent factors in age at initiation or gender in the presence of binge drinking could indicate a subgroup of at-risk drinkers whose class membership could be related to endorsement of other risk factors such as behavioral undercontrol/disinhibition and motives for drinking. With population heterogeneity established, we planned to proceed to conduct LCA to identify distinct classes of drinkers, followed by subsequent analyses to assess the extent to which these classes differed according to alcohol consumption variables and other risk factors.

The present study was conducted to test the following hypotheses: (1) Distinct classes of college students will be identified based on patterns of DSM-IV criteria endorsement; (2) Classes will be distinguished by frequency of binge drinking; (3) Known risk factors such as impulsivity and drinking motives will differ significantly among classes of drinkers, holding constant sex, age of alcohol use initiation and binge drinking.

Methods

Sample and procedures

The survey was conducted at a state university located in the Northeast United States, with an enrollment of 8,515 undergraduates as of the Fall 2007 semester when data collection began. Of these students, 7,114 were full-time. Over 70% of the student body is Caucasian with 28% of students housed on campus.

The survey was advertised via flyers posted on campus, brief announcements during psychology classes and through a website maintained by the psychology department. Participants completed the survey in exchange for credit toward completion of a research participation requirement for introductory psychology courses. Participants were at least 18

years of age and volunteered to participate. Both men and women were enrolled in the study and a history of alcohol use was not required. Surveys were completed online through a secure website. Before beginning the survey, participants were directed to a page containing an informed consent form. Only participants providing consent were directed subsequently to the survey itself. No personally identifying information was required as part of the survey. Participants' responses could not be linked with their identities and thus, the survey was anonymous.

Measures

AUD criteria—Past-year alcohol abuse and dependence were assessed using a self-report measure comprised of 11 yes/no items corresponding to the DSM-IV criteria (American Psychiatric Association, 2000). Examples were given to illustrate each criterion. There were two main differences between the DSM criteria and the items in this measure. Two items concerning withdrawal were posed: one concerning the experience of withdrawal and the other concerning the consumption of alcohol to avoid withdrawal. These two items were combined for the purposes of analysis, such that endorsement of either was indicative of withdrawal. Also, the abuse criteria concerning legal and social/interpersonal problems were combined to form a single item. This combination was done to address a concern that some students may consider recently enacted penalties for drinking at this university to be legal problems, whereas others may consider them social/interpersonal consequences—potentially threatening the validity of each item if kept separate.

Binge drinking—Participants were asked to report the number of times in the past three months that they have consumed five or more alcoholic beverages (four or more for females) in a two-hour period. This question adheres to the definition of "binge drinking" put forth by the National Institute on Alcohol Abuse and Alcoholism (NIAAA, 2004). To create a dichotomous version for inclusion in the LCA analyses, participants reporting binge drinking at least once per week were considered to be binge drinkers. Weekly frequency of binge drinking was analyzed as a continuous variable for purposes of comparison across classes generated by the LCA.

Quantity of current alcohol use—The *Daily Drinking Questionnaire-Revised (DDQ-R)* was used to obtain estimates of drinks per drinking day and drinks per week. The DDQ-R, adapted from the original DDQ (Collins et al., 1985), assesses typical drinking behavior in the prior three months through the use of two questions: 1) for each day of the week, participants were asked to report the number of times in the prior 13 weeks they had consumed any alcohol and 2) on a typical day of the week in which drinking took place, they reported the number of standard drinks they typically consumed. Drinks per drinking day was calculated by taking the mean number of drinks per day for each day of the week, weighted according to how many of these days out of the prior 13 the participant reported consuming alcohol.

Drinking motives—On the Cooper et al. (1992) measure, participants report on a five-point scale the extent to which they drink for each of 15 reasons. The measure contains three subscales, each a mean of five items, which capture endorsement of coping ($\alpha = 0.92$), social ($\alpha = 0.86$) and enhancement ($\alpha = 0.92$) of pleasurable affect motives for drinking.

Two items related to alcohol history were included. Participants were asked to report the *age at which they started drinking*, excluding small tastes or sips of alcohol. To assess *family history of alcohol problems*, participants were asked whether any of their relatives ever "had a significant problem with alcohol or drugs, one that either led to treatment or should have led to treatment." The same definition of alcohol/drug problem was utilized in the Addiction

Severity Index (McLellan et al., 1992). Participants reported on alcohol and drug problems separately and only alcohol problems are reported here. Those reporting an alcohol history for at least one parent were classified as family history positive.

Three aspects of *disinhibition/behavioral undercontrol* were assessed: types of *impulsivity, sensation seeking* and *aggression*. The *Barratt Impulsiveness Scale, Version 11* (*BIS-11*; Patton et al., 1995) is a 30-item self-report questionnaire with items rated on a four-point scale, including three second-order factors: attentional (α = .80), motor (α = .69) and nonplanning impulsiveness (α = .76). In the disinhibition subscale of the *Sensation Seeking Scale, Form V* (Zuckerman, 1994) participants are presented two descriptions and are asked to report which pertains most closely to them (e.g., "I like wild, uninhibited parties" or "I prefer quiet parties with good conversation"). Each response indicating sensation seeking was scored "1" and the sum was taken. To prevent criterion contamination (Darkes et al., 1998), two items directly pertaining to alcohol were removed, leaving an 8-item measure (α = .67). The *Buss-Perry Aggression Questionnaire* (1992) contains 29 items on a five-point scale, including four subscales: hostility (α = .84), anger (α = .78), verbal (α = .77) and physical aggression (α = .82).

Two variables related to internalizing tendencies were assessed. The *Perceived Stress Scale* (Cohen et al., 1983) is comprised of 14 statements rated on a five-point scale as to the degree to which life situations are appraised as being stressful (α = .79). The Satisfaction with Life Scale (Diener et al., 1985) is made up of five global statements that participants rate as to their agreement on a seven-point scale (α = .90). Both measures were validated initially in samples of college students.

The survey also included demographic items, including gender, age, race/ethnicity and class standing. The race/ethnicity and class standing items were omitted during one semester of data collection and thus, this information was not available for a portion of the sample.

Analyses

The MIMIC analysis with the covariates gender and age at initiation was used to assess whether these covariates might explain why a two-factor model fit the data better when binge drinking was included as a criterion in our prior report (Beseler et al., 2010). The likelihood ratio test (LRT), Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC) and sample size adjusted BIC were used to assess model fit. We followed the MIMIC analysis with LCA to test whether the model best fit a two, three or four class structure and whether adding binge drinking as a criterion improved the model fit. Estimated model parameters included the prevalence of each latent class and the prior probability that an individual fell into a specific class given a specific item endorsement profile. Class assignment was based on having the highest posterior probability of membership conditional on their individual item profiles. Lastly, we tested a factor mixture model, which allows for a continuous latent factor within each of the classes, indicating that alcohol use severity varies by class due to some common factor within a particular class. These analyses were done in MPlus Version 5 (Muthen & Muthen, 2008).

We utilized latent class assignment to form the groups used in a series of *ANCOVA*s to assess differences among the three classes in age at initiation of drinking, alcohol use variables, impulsiveness, sensation seeking, aggression, perceived stress, life satisfaction and drinking motive scores. This step in the analysis was used to test hypotheses two and three, that classes could be distinguished by binge drinking and personality traits and/or drinking motives. Age at initiation of drinking was adjusted for sex, alcohol use variables were adjusted for sex and age at initiation, drinking motives and personality traits were further adjusted by frequency of weekly binge drinking. The purpose of holding these

variables constant was to attempt to isolate differences due to class membership and partial out effects of sex, duration of drinking history and heaviness of drinking. The distributions of all continuous variables were examined prior to conducting the main analyses in order to gauge normality. Drinks per week, drinks per drinking day, number of binge drinking events per week, the aggression subscale variables, coping motives for drinking and the motor impulsiveness subscale of the BIS-11 were log transformed. The attentional impulsiveness subscale of the BIS-11 was square root transformed. These analyses were done in SAS, v 9.2 (SAS Institute, Cary, North Carolina). Results were considered significant at $p < 0.02$, after applying a Bonferroni correction for multiple comparisons.

Results

Participants

A total of 425 participants completed at least half of the survey and were considered to be the valid sample for the larger study. The sample for the present study ($N = 361$) was limited to those who reported lifetime exposure to alcohol and who responded to all of the items in the self-report measure concerning the AUD criteria ($N = 353$ also completed the binge drinking item and were included in analyses involving this variable). The ($N = 361$) sample was 73.3% female and 26.7% male with one participant declining to report gender. The mean age was 19.07 ($SD = 2.31$). Race/ethnicity and class standing were available for about half of the sample ($n = 191$ and 194, respectively). This portion of the sample was 84.8% Caucasian, 7.3% African-American, 4.7% Hispanic, 1% Asian and 2.1% "other." Freshman was the most common class standing (80.4%), followed by sophomore (15.5%), junior (2.6%), senior (1%) and "other" (.5%). The mean frequency of binge drinking episodes per week was 1.19 ($SD = 1.27$), with a range of 0 to 5.5 episodes per week. A total of 127 of 352 (36.1%) had at least one parent with alcohol problems and were considered family history positive. Average age of initiation of alcohol consumption in the sample was 15.6 (SD = 1.64). Age at initiation of drinking was younger in males (M=15.3 SD=1.79) than in females (M=15.8 SD=1.56); the difference was significant (p=0.03).

Prevalence of criteria, MIMIC and LCA results

Criteria for past 12-month alcohol dependence was met by 19.1% ($n = 69$) of the sample. Tolerance (45.2%) and drinking more than intended (34.6%) were the most frequently endorsed criteria in this college sample; 44.8% endorsed binge drinking (Table 1).

After adjusting for sex and age at initiation, the MIMIC model showed that a single factor best fit the data after excluding binge drinking (Table 2). Although sex was not a statistically significant covariate in the model, the model fit the data marginally better when it was included. After adding binge drinking, drinking more than intended and binge drinking loaded separately on a single factor, but the correlation between the two factors was very high ($r = 0.90$). Age at initiation was significantly associated with both factors and the odds of binge drinking were higher for males than for females ($OR = 1.96$, 95% confidence interval 1.06-3.62). Nonetheless, the best fitting MIMIC model did not include binge drinking as a criterion after controlling for sex and age at initiation. LCA results showed that a 3-class solution without binge drinking significantly fit the data better than a 2-class solution (Table 2). Furthermore, a 2-class solution without binge drinking fit the data significantly better than a 2- or 3-class model that included binge drinking (Table 2). A 4-class solution identified a class with only 4 individuals, which was too small for further analyses and did not fit as well as a 3-class model. The factor mixture model with two classes and a dimensional latent factor did not fit the data as well as the LCA with two classes (Table 2). Therefore, we concluded that the 3 classes were distinct and pursued the 3-class LCA solution of 10 criteria without binge drinking in further analyses because

models without binge drinking were significantly better than any model that included binge drinking. The probability of being assigned to class 1 given a class 1 profile was 0.92, for class 2 it was 0.90 and for class 3, 0.91. The probability of being assigned to class 1 given a class 3 profile or vice versa was 0, indicating that perfect classification occurred between classes 1 and 3 with no overlap whatsoever. The probability of error between class 1 and 2 was 0.08 and between class 2 and 3 was 0.07.

The MIMIC model without binge drinking showed the best fit to the data, however, the MIMIC model results were not appropriate to test our hypotheses based on factor analyses in our prior report (Beseler et al., 2010). Tests of these hypotheses required an analytic approach such as LCA, which could divide the sample into classes or groups for comparisons regarding drinking patterns--specifically frequency of binge drinking--and assessment of whether any differences in drinking patterns could be explained by personality traits and drinking motives.

The largest class (class 1, n = 217) was characterized by tolerance (18.4%), drinking more than intended (6.9%), neglecting responsibilities (5.1%) and hazardous use (3.7%). No one in this class met the diagnostic threshold for dependence. The second largest class (class 2, n = 114) endorsed primarily tolerance (81.6%) and drinking more than intended (74.6%) and 34.2% of these individuals met the criteria for dependence. The remaining 65.8% were "diagnostic orphans" who endorsed one (14%) or two (51.8%) dependence criteria. The smallest class (class 3, n = 30) endorsed all criteria with high probabilities (30% to 100%) and all met the threshold for a dependence diagnosis.

The mean number ± standard deviation of dependence criteria endorsed (1.30±1.60 in the entire sample) increased in each successive class (class 1: 0.27±0.45, class 2: 2.29±0.83 and class 3: 5.03±1.27) and differed significantly by class, K (2, N = 361) = 282.24, $p < .001$. Endorsement of withdrawal was relatively low in all three classes. There were similarities and differences in criterion endorsement between classes 2 and 3. Similar class probabilities were observed for tolerance and drinking more than intended (Figure 1). However, in contrast to class 2, class 3 endorsed spending a great deal of time drinking and continued use despite problems at the same frequency as drinking more than intended. Although classes 2 and 3 tended to be heavy episodic drinkers, these classes did not contain a significantly higher percentage of males than class 1 (class 1=25.4%, class 2=28.1%, class 3=31.0%), nor did they differ significantly by age (class 1: M = 19.15 [SD = 2.57], class 2: M =18.79 [SD = 1.07], class 3: M =18.93 [SD = 0.94]) or likelihood of having a positive family history of alcohol-related problems (class 1=36.6%, class 2=30.6%, class 3=53.6%). The family history difference was a non-significant trend as just over half of class 3 was family history positive X^2 (N = 352) = 5.17, p = .075.

Analysis of Covariance Results

Class 1 differed significantly from classes 2 and 3 on all alcohol consumption variables, drinking motives, perceived stress, life satisfaction, impulsiveness subscales, sensation seeking and aggression subscales (Table 3). Classes 2 and 3 did not differ significantly in the number of drinks per week, drinks per drinking day or frequency of binge drinking (Table 3). These negative findings corresponded to their similar rates of endorsement of the tolerance and drinking more than intended criteria. Although they showed similar patterns of alcohol consumption, class 2 was significantly different from class 3 in its endorsement of enhancement motives, non-planning and motor impulsiveness and all subscales of the aggression measure (Table 3).

Discussion

In this report, we identified a small, high risk group of college students who endorsed significantly more AUD criteria and reported more severe alcohol-related problems than the other classes, though members of this class did not drink significantly more than the moderately severe class. Every member of this high risk class met criteria for alcohol dependence. In a recent paper by Moss et al. (2007), similar classes of young adults were identified in the NESARC. A class similar to our class 2 was identified with early onset alcohol dependence but very little psychiatric comorbidity, low rates of antisocial personality disorder, and little family history of alcohol problems. Another class of young antisocial drinkers was identified who tended toward high rates of comorbidity, elevated rates of familial alcohol dependence, an early onset of drinking and early onset of alcohol dependence. This latter class resembles class 3 in our study. A suggestion of elevated familial alcohol problems was observed in our class 3, but results did not reach statistical significance.

There was strong evidence that class 3 was the most severe. Compared to the other classes, class 3 endorsed significantly more DSM-IV criteria overall, stronger drinking motives, higher perceived stress, poorer life satisfaction and more behavioral undercontrol/ disinhibition. There were, however, some exceptions to this tendency. The two higher severity classes both exhibited elevated levels of endorsement of tolerance and drinking more than intended compared to the lowest severity group. These two classes also did not differ significantly with regard to level of alcohol use. Not unlike the present study, in an LCA of relatives of alcoholic patients from the Collaborative Study on the Genetics of Alcoholism (COGA), classes generally showed a continuum of severity with the exception of withdrawal where the most severe class showed substantial endorsement compared to the other classes (Bucholz et al., 1996).

Binge drinking did not improve the model fit either in the MIMIC or LCA, and this may be due to the fact that the two most severe classes did not differ by endorsement of weekly binge drinking. Our previous report suggested the presence of a second dimension after adding binge drinking as a criterion to the AUD criteria in a factor analysis, although the second factor was highly correlated with the first (Beseler et al., 2010). The MIMIC analysis suggested measurement invariance or population heterogeneity due to age of initiation. Early age at initiation has been associated with behavioral undercontrol/disinhibition longitudinally (Iacono et al., 2008). The second factor uncovered in our prior report could possibly be explained by a clear separation between problem and non-problem drinkers. As no overlap occurred between class 1 and class 3, this finding argues against binge drinking falling on a continuum of severity with other criteria. This result supports previous findings of non-dimensionality of binge drinking, which may serve better as a risk factor for an AUD in the presence of other risk factors (e.g., personality traits and drinking motives), and may not add linearly to the DSM-IV criteria as a severity indicator.

The prevalence of students meeting criteria for current alcohol dependence was high, however, this sample excluded lifetime abstainers and was a heavy drinking sample overall (43.8% binge drinking at least once per week), making the high prevalence of alcohol dependence not entirely surprising. It has been suggested recently that the high prevalence of alcohol dependence in college samples might be due to error in the measurement of withdrawal, tolerance and drinking more than intended in young adults who have limited drinking experience (Caetano et al., 2006). Possibly, young adults are confusing the after-effects of intoxication with withdrawal and are mistaking tolerance for how well they maintain control over their drinking while juggling college life (Babor, 2007). In this college sample, class probabilities for withdrawal were low in all three classes (0.10 to 0.30).

Tolerance and drinking more than intended were endorsed at high rates in the two groups with high alcohol consumption, but were particularly high in the class 2 "diagnostic orphans" where 81% of those endorsing one criterion endorsed tolerance or drinking more than intended. Of the "diagnostic orphans" who endorsed two criteria, 59% endorsed both tolerance and drinking more than intended. The validity of these two criteria in young adult populations should be explored further. Drinking more than intended is one aspect of impaired control over alcohol use (Heather et al., 1993). Leeman et al. (2009b) found that self-reported impaired control predicted alcohol-related problems cross-sectionally and prospectively in an undergraduate sample, suggesting the possibility that drinking more than intended and other aspects of impaired control are indicative of problem drinking risk in young adults.

Endorsement of spending a great deal of time drinking and continuing to drink despite problems indicates that alcohol seeking, an aspect of the alcohol dependence syndrome articulated by Edwards and Gross (1976), may be highly salient to some members of class 3. In the presence of disinhibited personality traits and drinking motives, these individuals are at a much higher risk of a serious alcohol problem in the future. A previous prospective study of undergraduates found that behavioral undercontrol strongly predicts the number of alcohol dependence criteria endorsed (Grekin and Sher, 2006) and this result supports earlier cross-sectional studies as reviewed in Baer (2002). Although class 2 members were either alcohol dependent or considered "diagnostic orphans", they tended not to endorse as many of the disinhibited personality traits and drinking motives as those in class 3, suggesting this group may be at lower risk. Members of class 2 are likely at some risk though. Results from a national sample of young adults indicate that diagnostic orphan status is predictive of meeting AUD criteria subsequently (Harford et al., 2010).

We have interpreted the present findings to suggest that the risk profile of class 3 may make it less likely that they will mature out of high risk drinking after graduation. Along similar lines, prospective and longitudinal studies have suggested that aspects of behavioral undercontrol/disinhibition predict subsequent substance use problem severity (Littlefield et al., 2010; Mezzich et al., 2007). The cross-sectional nature of this study prevents us from making unequivocal explanations for the observed relationships between behavioral undercontrol/disinhibition and alcohol problem severity. Heavy substance use has also been found to increase disinhibited behavior (Bechara, 2005; Redish et al., 2008; see Leeman et al., 2009a for a discussion of these issues). It is also possible that the significantly earlier age of alcohol use initiation among those in class 3 is critical to their increased level of risk and with additional time, those in class 2 will also see their level of alcohol problem severity rise. Further prospective research is needed to address the merits of these possible interpretations of the present findings.

Other limitations should be noted. Social and legal problems were combined into a single criterion due to concerns specific to the university where the data were collected. To keep alcohol-related self-reports other than the AUD items to the well-validated three-month time frame often used in undergraduate alcohol research, the binge drinking item was reported in a different time frame (past three months) than the self-report items on the DSM-IV AUD criteria (past 12 months). In addition, this was a convenience sample from introductory-level psychology courses. Samples derived from introductory psychology courses are commonly used in alcohol research though (e.g., Leeman et al., 2009b). Women were disproportionately represented. We reported previously (Beseler et al., 2010) that in this sample, fewer women than men met the weekly binge drinking criterion, however women in this sample tended to drink heavily (41.1% met the weekly binge drinking criterion). We also pointed out in a prior report that men and women in this sample differed on only 1 of the 10 DSM-IV AUD items (Beseler et al. 2010).

In this study we identified a small group of heavy-drinking, alcohol-dependent college students whose behavioral undercontrol traits (impulsivity and aggressiveness) might put them at increased risk of alcohol problems after graduation (i.e., they may not "mature out" of drinking). A second group of heavy drinking students was identified who will likely face some level of risk, but at the same time seem more likely to "mature out" of heavy drinking. The similarity in alcohol consumption patterns between the two highest severity classes may be the reason that binge drinking did not improve the model fit when added as an additional criterion to the DSM-IV AUD criteria.

Acknowledgments

References

American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 4th edition. American Psychiatric Association; Washington, DC: 2000. text revision

Babor TF. We shape our tools, and thereafter our tools shape us: Psychiatric epidemiology and the alcohol dependence syndrome concept. Addiction. 2007; 102:1534–1535. [PubMed: 17854330]

Baer JS. Student factors: Understanding individual variation in college drinking. J Stud Alcohol. 2002; 14:40–53.

Bechara A. Decision making, impulse control and loss of willpower to resist drugs: A neurocognitive perspective. Nature Neurosci. 2005; 8:1458–1463. [PubMed: 16251988]

Beseler CL, Taylor LA, Leeman RF. An Item-Response Theory analysis of DSM-IV alcohol use disorder criteria and "binge" drinking in undergraduates. J Stud Alcohol Drugs. 2010; 71:418–423. [PubMed: 20409436]

Bucholz KK, Heath AC, Reich T, Hesselbrock VM, Kramer JR, Nurnberger JI Jr. Schuckit MA. Can we subtype alcoholism? A latent class analysis of data from relatives of alcoholics in a multicenter family study of alcoholism. Alcohol Clin Exp Res. 1996; 20:1462–1471. [PubMed: 8947326]

Caetano R, Babor T. Diagnosis of alcohol dependence in epidemiological surveys: an epidemic of youthful alcohol dependence or a case of measurement error? Addiction. 2006; 101:111–114. [PubMed: 16930167]

Camatta CD, Nagoshi CT. Stress, depression, irrational beliefs, and alcohol use and problems in a college student sample. Alcohol Clin Exp Res. 1995; 19:142–146. [PubMed: 7771640]

Carpenter KM, Hasin DS. Drinking to cope with negative affect and DSM–IV alcohol use disorders: A test of three alternative explanations. J Stud Alcohol. 1999; 60:694–704. [PubMed: 10487740]

Chung T, Martin CS. Classification and course of alcohol problems among adolescents in addictions treatment programs. Alcohol Clin Exp Res. 2001; 25:1734–1742. [PubMed: 11781506]

Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. J Health Soc Behav. 1983; 24:385–396. [PubMed: 6668417]

Collins RL, Parks GA, Marlatt GA. Social determinants of alcohol consumption: The effects of social interaction and model status on the self-administration of alcohol. J Consult Clin Psychol. 1985; 53:189–200. [PubMed: 3998247]

Cooper ML, Russell M, Skinner JB, Windle M. Development and validation of a three-dimensional measure of drinking motives. Psychol Assess. 1992; 4:123–132.

Darkes J, Greenbaum PE, Goldman MS. Sensation seeking-disinhibition and alcohol use: Exploring issues of criterion contamination. Psychol Assess. 1998; 10:71–76.

Dawson DA, Grant BF, Stinson FS, Chou PS. Another look at heavy episodic drinking and alcohol use disorders among college and noncollege youth. J Stud Alcohol. 2004; 65:477–488. [PubMed: 15378804]

Devos-Comby L, Lange JE. Standardized measures of alcohol-related problems: A review of their use among college students. Psychol Addict Behav. 2008; 22:349–361. [PubMed: 18778128]

Diener E, Emmons RA, Larsen RJ, Griffin S. The Satisfaction with Life Scale. J Pers Assess. 1985; 49:71–75. [PubMed: 16367493]

Edwards G, Gross MM. Alcohol dependence: provisional description of a clinical syndrome. Br Med J. 1976; 1:1058–1061. [PubMed: 773501]

Grant BF, Dawson DA, Stinson FS, Chou PS, Dufour MC, Pickering RP. The 12-Month Prevalence and Trends in DSM–IV Alcohol Abuse and Dependence: United States, 1991–1992 and 2001–2001. Drug Alcohol Depend. 2004; 74:223–34. [PubMed: 15194200]

Grekin ER, Sher KJ. Alcohol dependence symptoms among college freshmen: Prevalence, stability, and person-environment interactions. Exp Clin Psychopharmacol. 2006; 14:329–338. [PubMed: 16893276]

Hagenaars, JA.; McCutcheon, AL. Applied Latent Class Analysis. Cambridge University Press; 2002.

Harford TC, Yi HY, Grant BF. The five-year diagnostic utility of "diagnostic orphans" for alcohol use disorders in a national sample of young adults. J Stud Alcohol Drugs. 2010; 71:410–417. [PubMed: 20409435]

Hasin DS, Beseler CL. Dimensionality of lifetime alcohol abuse, dependence and binge drinking. Drug Alcohol Depend. 2009; 101:53–61. [PubMed: 19095379]

Heather N, Tebbutt JS, Mattick RP, Zamir R. Development of a scale for measuring impaired control over alcohol consumption: a preliminary report. J Stud Alcohol. 1993; 54:700–709. [PubMed: 8271806]

Hurlbut SC, Sher KJ. Assessing alcohol problems in college students. J Am Coll Health. 1992; 41:49–58. [PubMed: 1460173]

Iacono WG, Malone SM, McGue M. Behavioral disinhibition and the development of early-onset addiction: Common and specific influences. Ann Rev Clin Psychol. 2008; 4:325–348. [PubMed: 18370620]

Jackson KM, Sher KJ, Gotham HJ, Wood PK. Transitioning into and out of large-effect drinking in young adulthood. J Abnorm Psychol. 2001; 110:378–391. [PubMed: 11502081]

Kahler CW, Strong DR. A Rasch Model analysis of DSM-IV alcohol abuse and dependence items in the National Epidemiological Survey on Alcohol and Related Conditions. Alcohol Clin Exp Res. 2006; 30:1165–1175. [PubMed: 16792564]

Katz EC, Fromme K, D'Amico EJ. Effects of outcome expectancies and personality on young adults' illicit drug use, heavy drinking, and risky sexual behavior. Cognitive Ther Res. 2000; 24:1–22.

Knight JR, Wechsler H, Kuo M, Seibring M, Weitzman ER, Schuckit MA. Alcohol abuse and dependence among U.S. college students. J Stud Alcohol. 2002; 63:263–270. [PubMed: 12086126]

Krueger RF, Nichol PE, Hicks BM, Markon KE, Patrick CJ, Iacono WG, McGue M. Using latent trait modeling to conceptualize an alcohol problems continuum. Psychol Assess. 2004; 16:107–119. [PubMed: 15222807]

Langenbucher JW, Labouvie E, Martin CS, Sanjuan PM, Bavly L, Kirisci L, Chung T. An application of item response theory analysis to alcohol, cannabis, and cocaine criteria in DSM-IV. J Abnorm Psychol. 2004; 113:72–80. [PubMed: 14992659]

Leeman RF, Grant JE, Potenza MN. Behavioral and neurological foundations for the moral and legal implications of intoxication, addictive behaviors and disinhibition. Behav Sci Law. 2009a; 27:237–259. [PubMed: 19241397]

Leeman RF, Toll BA, Taylor LA, Volpicelli JR. Alcohol-induced disinhibition expectancies and impaired control as prospective predictors of problem drinking in undergraduates. Psychol Addict Behav. 2009b; 23:553–563. [PubMed: 20025361]

Leeman RF, Wapner S. Some factors involved in alcohol consumption of first-year undergraduates. J Drug Educ. 2001; 31:249–262. [PubMed: 11696962]

Littlefield AK, Sher KJ, Wood PK. Do changes in drinking motives mediate the relation between personality change and the "maturing out" of problem drinking? J Abnorm Psychol. 2010; 119:93–105. [PubMed: 20141246]

McLellan AT, Kushner H, Metzger D, Peters R, Smith I, Grissom G, Pettinati H, Argeriou M. The fifth edition of the Addiction Severity Index. J Subst Abuse Treat. 1992; 9:199–213. [PubMed: 1334156]

Mezzich AC, Tarter RE, Feske U, Kirisci L, McNamee RL, Day BS. Assessment of risk for substance use disorder consequent to consumption of illegal drugs: Psychometric validation of the neurobehavior disinhibition trait. Psychol Addict Behav. 2007; 21:508–515. [PubMed: 18072833]

Moss HB, Chen CM, Yi HY. Subtypes of alcohol dependence in a nationally representative sample. Drug Alcohol Depend. 2007; 91:149–158. [PubMed: 17597309]

Murphy JG, McDevitt-Murphy ME, Barnett NP. Drink and be merry? Gender, life satisfaction, and alcohol consumption among college students. Psychol Addict Behav. 2005; 19:184–191. [PubMed: 16011389]

Muthén, BO.; Muthén, LK. Mplus: Statistical analysis with latent variables. version 5.1. Muthén & Muthén Inc.; Los Angeles, CA: 2008.

National Institute on Alcohol Abuse and Alcoholism. NIAAA council approves definition of binge drinking. NIAAA Newsletter. 2004 Winter. http://pubs.niaaa.nih.gov/publications/Newsletter/winter2004/Newsletter_Number3.pdf

Patton JH, Stanford MS, Barratt ES. Factor structure of the Barratt impulsiveness scale. J Clin Psychol. 1995; 51:768–774. [PubMed: 8778124]

Pavot W, Diener E. Review of the Satisfaction with Life Scale. Psychol Assess. 1993; 5:164–172.

Proudfoot H, Baillie AJ, Tesson M. The structure of alcohol dependence in the community. Drug Alcohol Depend. 2006; 81:21–26. [PubMed: 16005578]

Redish AD, Jensen S, Johnson A. A unified framework for addiction: Vulnerabilities in the decision process. Behav Brain Sci. 2008; 31:415–437. [PubMed: 18662461]

Saha TD, Chou SP, Grant BF. Toward an alcohol use disorder continuum using item response theory: Results from the National Epidemiologic Survey on Alcohol and Related Conditions. Psychol Med. 2006; 36:931–941. [PubMed: 16563205]

Slutske WS, Heath AC, Madden PAF, Bucholz KK, Statham D, Martin NG. Personality and the genetic risk for alcohol dependence. J Abnorm Psychol. 2002; 111:124–133. [PubMed: 11871377]

von der Pahlen B, Santtila P, Johansson A, Varjonen M, Jern P, Witting K, Sandnabba N. Do the same genetic and environmental effects underlie the covariation of alcohol dependence, smoking, and aggressive behaviour? Biol Psychol. 2008; 78:269–277. [PubMed: 18456382]

Wechsler H, Lee JE, Kuo M, Lee H. College binge drinking in the 1990s: A continuing problem. Results from the Harvard School of Public Health 1999 College Alcohol Study. J Am Coll Health. 2000; 48:199–210. [PubMed: 10778020]

White HR, Labouvie EW. Towards the assessment of adolescent problem drinking. J Stud Alcohol. 1989; 50:30–37. [PubMed: 2927120]

Zuckerman, M. Behavioral expressions and biosocial bases of sensation seeking. Cambridge University Press; New York: 1994.
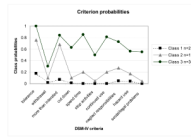
Figure 1.
Probability of college students (n=361) endorsing a DSM-IV criterion conditional on belonging to a particular class.

Table 1

Prevalence of DSM-IV dependence and abuse criteria (N =361) and binge drinking (N =353) college students.

Criteria	Number	Percent
Tolerance	163	45.2
Withdrawal	25	6.9
Drank more than intended	125	34.6
Made efforts to quit or cut down	34	9.4
A great deal of time spent drinking	51	14.1
Social/recreational activities reduced	22	6.1
Continued use despite problems	51	14.1
Neglect responsibilities in order to drink	68	18.8
Drinking in hazardous situations	48	13.3
Social or legal problems	22	6.1
Binge drinking	158	44.8

Table 2

Model fit statistics showing a confirmatory factor analysis with covariates (MIMIC) model, latent class analysis (LCA) 2-class and 3-class models with and without binge drinking and a factor mixture model in 361 college drinkers.

	log likelihood	df	AIC	BIC	Adjusted BIC
MIMIC [*] 10 criteria, no binge drinking (1 factor model)	−1132.4	22	2308.9	2393.4	2323.6
MIMIC [*] 10 criteria plus binge drinking (2 factor model)	−1328.5	26	2709.0	2809.0	2726.4
LCA (10 criteria no binge drinking)					
2 classes (290, 71)	−1227.2	21	2496.3	2578.0	2511.4
3 classes (217, 114, 30)	−1186.4[a]	32	2436.7	2561.2	2459.7
LCA (10 criteria plus binge drinking)					
2 classes (268, 93)	−1444.8	22	2935.7	3025.1	2952.2
3 classes (221, 112, 28)	−1393.5[a]	35	2857.0	2993.1	2882.1
Factor Mixture Model (10 criteria, no binge drinking)					
2 classes (376, 12), 1 factor	−1209.5	32	2482.9	2609.7	2508.1

[*] Adjusted for age at initiation of alcohol drinking and sex.

[a] p<0.001 comparing 3-class solution to 2-class solution

Table 3

Means and standard deviations for 361 college drinkers and by latent class membership; ANCOVA p-values for class comparisons on selected variables using adjusted least squares means.

Risk Factor	Entire sample (N = 361) mean (sd)	Class 1 (n=217) mean (sd)	Class 2 (n=114) mean (sd)	Class 3 (n=30) mean (sd)	2 vs.3 p-value	1 vs. 3 p-value	1 vs. 2 p-value
Age of initiation[a]	15.6 (1.64)	15.9 (1.56)	15.4 (1.62)	14.3 (1.63)	0.003	<0.0001	0.008
Drinks per week[b]	10.7 (13.30)	5.89 (9.00)	16.2 (13.8)	24.6 (19.2)	0.172	<0.0001	<0.0001
Drinks per drinking day[b]	5.44 (4.11)	4.09 (3.61)	7.28 (3.86)	8.36 (4.40)	0.372	<0.0001	<0.0001
Weekly frequency of binge drinking[b]	1.19 (1.27)	0.74 (1.06)	1.75 (1.24)	2.21 (1.39)	0.303	<0.0001	<0.0001
MOTIVES [c]							
Social	3.02 (1.00)	2.73 (0.97)	3.40 (0.86)	3.65 (0.88)	0.669	0.019	0.001
Coping	2.10 (1.12)	1.74 (0.92)	2.48 (1.15)	3.22 (1.19)	0.023	<0.0001	<0.0001
Enhancement	2.73 (1.17)	2.28 (1.05)	3.25 (0.96)	3.94 (0.98)	0.014	<0.0001	<0.0001
IMPULSIVENESS [c]							
Attentional	17.2 (4.54)	16.2 (4.30)	18.2 (4.46)	20.9 (3.97)	0.025	0.0002	0.008
Non-planning	24.6 (5.46)	23.3 (5.28)	25.9 (5.07)	28.8 (5.06)	0.006	<0.0001	0.0008
Motor	21.6 (4.33)	20.7 (4.34)	22.4 (3.42)	25.3 (4.94)	0.008	<0.0001	0.004
SENSATION SEEKING [c]	3.68 (1.99)	3.10 (1.95)	4.44 (1.67)	4.83 (2.01)	0.772	0.016	0.0004
AGGRESSION [c]							
Physical	19.7 (7.45)	17.8 (6.45)	21.3 (7.38)	26.9 (8.85)	0.007	<0.0001	0.0004
Verbal	10.9 (4.14)	9.90 (3.59)	11.8 (4.10)	14.9 (4.92)	0.007	<0.0001	0.0004
Anger	15.3 (5.79)	13.9 (5.02)	16.5 (5.74)	20.9 (6.88)	0.007	<0.0001	0.0004
Hostility	17.5 (6.62)	15.8 (5.74)	18.9 (6.56)	23.9 (7.86)	0.007	<0.0001	0.0004
INTERNALIZING TRAITS							
Perceived stress	19.9 (6.03)	18.7 (5.69)	20.6 (5.71)	25.8 (5.93)	0.0001	<0.0001	0.0008
Satisfaction with Life	23.4 (6.65)	24.1 (6.70)	23.1 (5.83)	19.0 (7.60)	0.012	<0.0001	0.014

[a] Adjusted for sex (% males: class 1=25.4%, class 2=28.1%, class 3=31.0%; p-value > 0.05)

[b] Adjusted for sex and age at initiation of alcohol use

[c] Adjusted for sex, age at initiation of alcohol use and binge drinking