

# Pre-college Matriculation Risk Profiles and Alcohol Consumption Patterns During the First Semesters of College

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**Abstract** Excessive alcohol consumption represents a significant concern on U.S. college campuses, and there is a need to identify students who may be at risk for engaging in risky alcohol use. The current study examined how variables measured prior to college matriculation, specifically alcohol-related decision-making variables drawn from the Theory of Reasoned Action (i.e., alcohol expectancies, attitudes, and normative beliefs), were associated with patterns of alcohol use prior to and throughout the first semesters of college. Participants were 392 undergraduate students (56 % female) from a large Northeastern U.S. university. Decision-making variables were assessed prior to college matriculation, and alcohol use was measured with five assessments before and throughout freshman and sophomore semesters. Latent profile analysis was used to identify types of students with distinct patterns of decision-making variables. These decision-making profiles were subsequently linked to distinct patterns of alcohol use using latent transition analysis. Four distinct decision-making profiles were found and were labeled “Anti-Drinking,” “Unfavorable,” “Mixed,” and “Risky.” Five drinking patterns were observed and included participants who reported consistently low, moderate, or high rates of alcohol use. Two patterns described low or non-drinking at the pre-college baseline with drinking escalation during the measurement period. Students’ likelihood of following the various drinking patterns varied according to their decision-making. Findings

suggest the early identification of at-risk students may be improved by assessing decision-making variables in addition to alcohol use. The findings also have implications for the design of early identification assessments to identify at-risk college students and for the targeting of alcohol prevention efforts to students based on their alcohol-related attitudes and beliefs.

**Keywords** College students · Alcohol · Early identification

Excessive alcohol consumption and related problems represent significant concerns on U.S. college campuses (National Institute for Alcohol Abuse and Alcoholism 2012). A large number of college students are affected by alcohol-related consequences, including unplanned sexual activity, injuries, physical and sexual assaults, and criminal activities (Hingson et al. 2009), and nearly 1/3 meet diagnostic criteria for alcohol abuse (Knight et al. 2002). Several promising alcohol prevention and intervention programs have been developed to reduce alcohol use among college students (Cronce and Larimer 2011). Universal programs, such as e-interventions (Walters et al. 2007), parent-based interventions (Turrisi et al. 2009), or social marketing campaigns (DeJong et al. 2006), are designed to be relatively cheap and easily disseminated to a wide range of students. Indicated programs, such as brief motivational interviews (Cronce and Larimer 2011), are often delivered by a professional or trained counselor and have shown efficacy in reducing drinking in students with a history of alcohol problems.

As the amount and variety of these programs increases, it is important to consider strategies for identifying students at various levels of alcohol use related risk. Identifying students at various levels of risk as an aspect of a targeted intervention approach may greatly increase efficacy and reduce costs associated with indiscriminant intervention distribution (King et al. 2008). Although some early identification procedures

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exist for students, most are adapted from assessments of alcohol-related problems in adult populations with an emphasis on chronic alcohol abuse (Larimer and Cronce 2002) or measure alcohol use only (Reinert and Allen 2002). The current research will examine measures that may be useful in identifying students who are not drinking excessively or experiencing alcohol problems prior to college but are at risk for initiating excessive consumption based on pre-college alcohol-related attitudes and beliefs. Specifically, we examined how students' pre-college attitudes, beliefs, and other decision-making constructs influence their patterns of alcohol use during the first 2 years of college.

### Alcohol-Related Decision-Making Variables

An extensive body of literature has demonstrated associations between decision-making variables, derived from theories such as the Theory of Reasoned Action (TRA) (Fishbein and Ajzen 1975), and alcohol-related outcomes. Specifically, research has demonstrated the importance of alcohol-related expectancies (i.e., beliefs about the effects of alcohol) (Greenbaum et al. 2005), attitudes toward drinking (i.e., how favorably one feels about drinking) (Collins and Carey 2007), descriptive normative beliefs (i.e., one's perceptions about others' drinking behavior), and injunctive normative beliefs (i.e., one's perceptions of others' approval or disapproval of drinking behavior) (Larimer et al. 2004). In addition to alcohol-specific variables, we also considered attitudes toward non-drinking alternative behaviors (Turrisi 1999; Turrisi et al. 2009). Decision-making variables from the TRA were chosen as the risk variables of interest because they are strongly associated with alcohol use and often form prior to college matriculation and, accordingly, college-related increases in alcohol use (Larimer et al. 2004; Read et al. 2002).

Decision-making is a theoretically complex process. This study is unique in the use of a person-centered technique, latent profile analysis (LPA), in an attempt to better capture such complexity by examining how decision-making variables cluster to form distinct and complex patterns (Muthén and Muthén 2000). LPA allows for the analysis of such variable clusters by fitting latent subgroups of individuals, called profiles, characterized by common patterns of decision-making variables. Individuals in each profile respond similarly to the decision-making variables as others within their profile but have distinctly different decision making compared with those in other profiles. In the context of early identification, understanding risk factors at the individual level may aid in the identification of types of students who may be at future risk for alcohol consumption. Thus, the first aim of this research was to identify types of students based on established alcohol risk factors related to decision-making.

### Alcohol Use Patterns

The second aim was to identify distinct patterns of alcohol use based on measures of weekly alcohol use assessed during the summer prior to college in addition to several occasions throughout the first and second years of college. Given that alcohol use often increases during the first year of college for some students (Borsari et al. 2007), early identification of students would likely be most effective prior to college matriculation. Thus, the current study focused on incoming, first-time freshman students. Alcohol use reported at each assessment point was then modeled and linked to the decision-making profiles using a latent transition analysis (LTA) framework. This person-centered technique allows for the identification of latent subgroups of individuals with distinct patterns of alcohol use across the measurement period. A subgroup approach is well suited for modeling alcohol use given the large variability in college student alcohol use (Greenbaum et al. 2005).

### Linking Decision-Making Profiles with Alcohol Use Patterns

The final aim was to examine the likelihood of following various drinking patterns in college, given students' pre-college decision-making profiles. The LTA analysis provides probability estimates of following each college alcohol use pattern given membership in a given pre-college decision-making profile. These probabilities describe the likelihood of progressing into high rates of alcohol use during college based on variables measured prior to college.

Although the current analyses are by nature model-driven approaches intended to explore the latent structure of the data, we made specific hypotheses. We expected the analyses to identify individuals who would report unfavorable alcohol-related decision-making profiles prior to college and who, as a result, would not engage in risky drinking during college. We also expected to find individuals who would report favorable alcohol-related decision-making patterns and would drink in a risky manner. However, the greatest potential strength of this approach is in the identification of those individuals who exhibit both risky and protective alcohol decision-making variables. Given these students' ambiguity in their decision making, the alcohol consumption of these individuals is difficult to predict. These are the students that may not be in obvious need of prevention efforts when first arriving to campus given their low levels of alcohol use but may begin risky drinking during college. A finding that decision-making profiles are related to increased alcohol consumption once students begin college would suggest decision-making variables are suitable for use as early identification tools.

In sum, the aims were to (1) identify distinct decision-making profiles measured prior to college, (2) identify distinct patterns of alcohol use during college, and (3) identify the probability of belonging to a particular alcohol use pattern given one’s decision-making profiles.

**Method**

**Participants**

Participants were incoming first-year students from a large, Northeastern United States university who were randomly selected from lists generated by the university’s registrar office. We generated a series of random numbers, assigned a number to each student, and invited students into the study who had random numbers within a pre-determined range. Study invitation E-mails were sent to 2,950 students in two cohorts. Of the 2,950 recruited students, 1,893 consented to participate in the study and completed the web-based, pre-college survey. Participants provided telephone and E-mail contact information for the purpose of tracking and invitation into future assessments following the baseline assessment. The response rate (64 %) is consistent with other online college intervention studies (Larimer et al. 2007; Turrisi et al. 2009). This study is a secondary analysis of data from participants who served as the non-intervention control group for a parent-based alcohol intervention efficacy study (Turrisi et al. 2013). Random assignment to condition was conducted prior to being invited into the study.

Participants were 392 students (mean age=17.92, SD=0.35). Approximately half of the participants were female ( $n=220$  (56 %)), and racial characteristics of the sample were similar to those of the campus population: 86.7 % White/Caucasian, 4.4 % Asian, 3.1 % Black or African American, 0.5 % American India/Alaskan Native, 1.3 % Multiracial, and 4.0 % other. Six percent ( $n=25$ ) identified as Hispanic or Latino(a). Participants selected one of the following categories to describe their alcohol use at baseline: never tried alcohol (16.4 %); have tried alcohol but do not currently drink (32.0 %); light, social, non-problem drinker (29.4 %); moderate, social, non-problem drinker (21.5 %); heavy, non-problem drinking (3 participants). All participants gave informed consent, and procedures were approved by the university’s institutional review board.

**Procedures**

In addition to a baseline, pre-college assessment, data were collected with four additional online surveys at the following time points: approximately 1 month into the first semester of the first college year (Fall Freshman); the end of the first semester, first year (Winter Freshman); the end of second

semester, first year (Spring Freshman); and the beginning of first semester, second year (Fall Sophomore). Prior to each follow-up assessment, participants were sent an invitation via E-mail to access the assessment, and multiple reminder E-mails were sent to those who did not complete surveys. Response rates for the follow-up surveys were as follows: Fall Freshman, 86 %; Winter Freshman, 87 %; Spring Freshman, 82 %; and Fall Sophomore, 80 %. Participants received \$20–30 for completing each survey depending on survey length and timing.

**Measures**

The decision-making variables were based on the TRA and measured at baseline. Alcohol use was assessed in each survey. All items have been used in our previous work (e.g., Turrisi et al. 2001; Turrisi et al. 2010) and have demonstrated sound psychometric properties. Descriptive statistics for the following composite variables are presented in Table 1.

*Alcohol-Related Decision-Making Variables*

*Alcohol Expectancies* Five expectancies were measured based on our previous work (Turrisi et al. 2010) to capture the following beliefs: alcohol can lead to positive transformations, alcohol can facilitate social behavior, alcohol can increase negative affect (reverse coded), everyone experiences a

**Table 1** Means and standard deviations for all composite variable scores

	M	SD	Minimum	Maximum	Rescored maximum
Time 1 decision-making variables					
Expectancies	-0.30	0.82	-2.00	1.40	n/a
Drinking attitude	-0.36	0.96	-2.00	1.75	n/a
Non-drinking attitude	0.91	0.92	-2.00	2.00	n/a
Descriptive norm	1.80	1.17	0.00	6.79	n/a
Injunctive norm	-1.82	0.89	-3.00	1.00	n/a
Weekly alcohol use					
Time 1: summer prior to college	3.31	5.53	0.00	22.95	15.00
Time 2: fall freshman year	6.90	7.95	0.00	33.92	23.00
Time 3: winter freshman year	7.55	8.53	0.00	36.29	25.00
Time 4: spring freshman year	8.20	8.70	0.00	38.97	26.00
Time 5: fall sophomore year	9.30	9.23	0.00	42.44	30.00

Rescored maximum represents the maximum scores on the weekly alcohol use measures after trimming of extreme outlier scores based on recommendations of Tabachnick and Fidell (2001) (see section on measures)

“drinking phase”, and commitment to a healthy lifestyle without alcohol (reverse coded). Items were measured with five-point Likert-type scales anchored with  $-2$  (*strongly disagree*) and  $2$  (*strongly agree*) with  $0$  representing *neither agree nor disagree*. Items were averaged to create a single index ( $\alpha=0.69$ ).

**Attitudes Toward Drinking** Participants were presented a list of activities (going to a school-sponsored sporting event on a weekend; going to a party on a weekend night; going to a campus special event on a weekend night; “hanging out” with friends on a weekend night) and indicated whether they felt favorable about “having a few drinks” and “getting drunk” during these activities. Items used five-point Likert-type scales anchored with  $-2$  (*strongly disagree*) and  $2$  (*strongly agree*) with  $0$  representing *neither agree nor disagree*. These eight items (4 activities  $\times$  2 drinking options) were averaged to create a single attitude toward drinking index ( $\alpha=0.92$ ).

**Attitudes Toward Non-drinking Alternatives** Participants were presented with the previous list of activities and scale responses and asked to indicate whether they felt favorable about “not drinking” while engaging in the activities ( $\alpha=0.86$ ).

**Descriptive Peer Norms** Descriptive norms were measured with the Drinking Norms Rating Form (Baer et al. 1991). Participants wrote the number of drinks they thought their close friends and college peers typically consumed on each day of the week. The responses to these 14 items (7 days a week for both close friends and peers) were averaged to create a composite score ( $\alpha=0.83$ ).

**Injunctive Peer Norms Toward Risky Alcohol Use** Items assessed participants’ perceptions of their friends’ approval of their personal risky alcohol use: “How would your friends respond if they knew: (1) you drank alcohol every weekend, (2) you drank alcohol daily, (3) you drove a car after drinking, and (4) you drank enough alcohol to pass out?” (Baer 1994). Response options were a seven-point scale anchored with  $-3$  (*strong disapproval*) and  $3$  (*strong approval*) ( $\alpha=0.74$ ) with  $0$  representing *wouldn’t care*.

#### *Drinking Outcome Measure*

**Weekly Alcohol Use** Weekly alcohol use was measured using the Daily Drinking Questionnaire (Collins et al. 1985). The item read “Given that it is a typical week, please write the number of drinks you probably would have each day (if none, then write in 0; If you are not exactly sure then write in your best estimate).” A response scale is provided for each day of the week (e.g., Monday\_\_\_\_, etc.). The number of drinks for each day of the week were summed to create the composite

weekly drinking variable. Although there are multiple validated alcohol use measures, including assessing heavy episodic drinking episodes, we chose to use weekly alcohol use based on research that has directly compared these measures (Borsari et al. 2001). Borsari and colleagues found that measures of weekly alcohol use had a stronger association with alcohol-related problems compared with measures of heavy drinking episodes. Furthermore, heavy drinking episodes did not consistently add predictive value of problems beyond the weekly drinking measure. Based on the recommendations of Tabachnick and Fidell (2001), extreme outliers on the weekly alcohol use measure (less than 4 %) were rescored to 3.29 standard deviations above the mean (values shown in Table 1).

#### **Statistical Analyses**

**Decision-Making Profiles** LPA was used to identify latent subgroups, or profiles, of participants who had response patterns to the decision-making variables that were similar to others within their profile and distinct from participants in other profiles. LPA models provide information about the proportion of participants in the sample who fit each latent profile, the pattern of means of the decision-making variables within each profile, and the probabilities of each individual belonging to each of the observed profiles (posterior probability).

The LPA model was tested using Mplus Version 6.1 and procedures recommended in the mixture modeling literature (Muthén 2004; Muthén and Muthén 2012). The first step in determining the best-fitting LPA model is to test a model with a two-profile solution to the data. The fit indices of the two-profile model are then compared with the fit indices of a three-profile model to test for an improvement in model fit by allowing an extra profile. This process of fitting a  $k+1$ -profile model and comparing model fit to a  $k$ -profile model continues until the best-fitting model is found. The fit indices we used were the Bayesian Information Criteria (BIC) and the sample adjusted BIC (SABIC) (Lanza and Collins 2006; Muthén and Muthén 2000). A decrease in absolute size of these indices is indicative of better model fit. LPA models must also contain practically interpretable, theoretically sound, and adequately sized profiles. A model entropy value above 0.80 suggests well-separated and distinct latent profiles and good predictive value of the profiles by the decision-making variables (Celeux and Soromenho 1996). The default LPA model in Mplus assumes equal indicator–item variances across the latent profiles.

We examined gender as a covariate in the LPA model. Covariate variables in LPA are linked to the profiles through a series of multinomial logistic regression analyses (Muthén and Muthén 2012). The significance of the covariate was

tested by comparing the difference in the log-likelihood (LL) value of the model with the covariate to the model without the covariate (Coffman et al. 2007). The LL difference was compared with the chi-square distribution with degrees of freedom equal to the difference in degrees of freedom between the two models.

#### Linking Decision-Making Profiles with Alcohol Use Patterns

The second aspect of the analysis was to determine how the decision-making profiles were related to patterns of alcohol use throughout early college using a latent transition analysis framework (LTA). LTA analyses allows for the linking of the LPA decision-making profiles to latent variables that represent subgroups of individuals with distinct patterns or trajectories of weekly alcohol use. The LTA model uses a series of multinomial logistic regressions of the categorical latent drinking patterns on the categorical latent alcohol-related decision-making profiles. The LTA analysis also provides latent transition probabilities that represent the average probability of an individual to be a member of a given drinking pattern given their membership in a decision-making profile at baseline. When fitting the LTA model, we modeled two categorical latent factors. The first factor included the decision-making variables with a number of profiles equal to the findings of the LPA. The second latent factor represented the alcohol use patterns and was regressed onto the first factor. We first tested an LPA model with four decision-making profiles (based on the LPA findings, see below) and two drinking patterns. We tested a series of subsequent models by allowing one additional drinking pattern to be estimated. The criteria used for determining model-fitting procedures were the same as described for the LPA model (e.g., BIC values, interpretability, entropy values).

**Data Considerations** Missing data in the analyses were handled in Mplus via the full information maximum likelihood utility. The amount of missing data on the decision-making variables was less than 0.01 %. The percentage of missing data on the weekly drinking outcome at each survey measurement was as follows—0.3 % (Summer prior to college), 14.5 % (Fall Freshman), 12.8 % (Winter Freshman), 18.4 % (Spring Freshman), 19.6 % (Fall Sophomore). We compared those who provided data to non-completers and found little evidence of differences in attrition rates based on alcohol use. Specifically, we created dichotomous variables for each drinking outcome to represent whether or not the data was missing (Graham et al. 2003). This variable was compared with the weekly drinking variable in the previous assessment. Those who did not complete the second assessment (Fall Freshman) reported, on average, nearly two additional drinks a week on the first assessment compared to those who did complete the second assessment ( $t(389)=-2.42, p<0.05$ ). However, there were non-significant differences when comparing previous

assessment weekly alcohol use and missing data on the subsequent assessment for the final three assessments (all  $p$ 's<0.05).

## Results

### Decision-Making Profiles: Latent Profile Analysis

**Model Fit** Fit indices for the three-profile model indicated an improvement in model fit over the two-profile model: a decrease in the BIC and SABIC indices (Table 2). The process of testing models by adding profiles and comparing to the previous best-fitting model was continued until the model fit indices indicated that the tested model did not have better fit than the preceding model. The fit indices for the five-profile solution did show a relatively small improvement over the four-profile solution. However, the fifth profile contained only two individuals, and the model produced a non-positive definite first-order derivative product matrix. These model problems are typically evidence of over extraction of profiles (O'Connor and Colder 2005) and were not resolved after increasing the number of random starting values. Finally, the Lo-Mendell-Rubin Likelihood Ratio Test (LMR-LRT; Lo et al. 2001) comparing the five-profile solution to the four-profile solution was non-significant ( $p=0.19$ ). Thus, the four-profile model was retained as the best model (entropy value=0.83).

**Decision-Making Profiles** The means for decision-making indicator items within the profiles are presented in Table 3. Each column represents one of the four profiles and contains both the number of individuals described by each profile and the mean value for each of the indicator decision-making variables within each profile. Profile 1 described 91 participants (23 % of the sample) who reported, on average, strongly unfavorable alcohol expectancies ( $M=-1.40, SE=0.06$ ) and

**Table 2** Fit indices for latent profile analysis models

Latent profile analysis, decision-making variables			
Number of profiles	BIC	SABIC	LMR-LRT
2	4,858.53	4,807.77	–
3	4,700.73	4,630.92	188.38 ( $p<0.01$ )
4	4,641.56	4,552.72	92.41 ( $p=0.08$ )
5	4,630.56	4,522.68	45.56 ( $p=0.19$ )

Smaller values on these indices indicate better model fit. The LMR-LRT presented in each row represents the comparison of the LPA solution with  $k$  profiles to a solution with  $k-1$  profiles

*BIC* Bayesian Information Criteria, *SABIC* sample-size adjusted BIC, *LMR-LRT* Lo-Mendell-Rubin likelihood ratio test

**Table 3** Standardized means (standard errors) of the drinking-related decision-making variables within each profile

	Profile 1, anti-drinking, ( <i>n</i> =91; 23 %)	Profile 2, unfavorable, ( <i>n</i> =134; 34 %)	Profile 3, mixed ( <i>n</i> =138; 35 %)	Profile 4, risky ( <i>n</i> =29; 7 %)
Expectancies	-1.40 (0.06)	-0.30 (0.08)	0.32 (0.05)	0.40 (0.12)
Drinking attitude	-1.62 (0.08)	-0.51 (0.08)	0.47 (0.06)	0.53 (0.15)
Non-drinking attitude	1.83 (0.06)	1.07 (0.08)	0.27 (0.09)	0.16 (0.19)
Descriptive norm	1.22 (0.08)	1.36 (0.07)	2.00 (0.11)	4.64 (0.32)
Injunctive norm	-2.33 (0.10)	-2.03 (0.08)	-1.49 (0.09)	-0.72 (0.17)

attitudes toward drinking ( $M=-1.62$ ,  $SE=0.08$ ), strongly favorable attitudes toward non-drinking alternatives ( $M=1.83$ ,  $SE=0.06$ ), low levels of descriptive peer norms ( $M=1.22$ ,  $SE=0.08$ ), and perceived their friends as strongly disapproving of risky alcohol use ( $M=-2.33$ ,  $SE=0.10$ ). This profile was labeled “Anti-drinking.”

Profile 2 ( $n=134$ , 34 %) described participants who reported, on average, slightly unfavorable expectancies ( $M=-0.30$ ,  $SE=0.08$ ) and attitudes toward drinking ( $M=-0.51$ ,  $SE=0.08$ ), favorable attitudes toward non-drinking ( $M=1.07$ ,  $SE=0.08$ ), low levels of drinking in their friends and peers ( $M=1.36$ ,  $SE=0.07$ ), and strong disapproval of their risky drinking from their friends ( $M=-2.03$ ,  $SE=0.08$ ). This profile was labeled “Unfavorable.”

Profile 3 described 35 % ( $n=138$ ) of the participants. On average, these participants reported slightly favorable expectancies ( $M=0.32$ ,  $SE=0.05$ ), attitudes toward drinking ( $M=0.47$ ,  $SE=0.06$ ), and attitudes toward non-drinking ( $M=0.27$ ,  $SE=0.09$ ). Those in profile 3 perceived their friends and peers as drinking approximately two drinks per night ( $M=2.00$ ,  $SE=0.11$ ) and disapproving of risky drinking ( $M=-1.49$ ,  $SE=0.09$ ). This profile was labeled “Mixed” to reflect the generally drinking-favorable alcohol expectancies and attitudes and their drinking-unfavorable descriptive and injunctive peer norms.

Profile 4 ( $n=29$ , 7 %) described participants with slightly favorable expectancies ( $M=0.40$ ,  $SE=0.12$ ), attitudes toward drinking ( $M=0.53$ ,  $SE=0.15$ ), and attitudes toward non-drinking alternatives ( $M=0.16$ ,  $SE=0.19$ ). Participants also reported high rates of drinking ( $M=4.64$ ,  $SE=0.32$ ) and slight disapproval of risky drinking in their friends ( $M=-0.72$ ,  $SE=0.17$ ). This profile was labeled “Risky” as this subgroup was the most favorable toward alcohol.

**Decision-Making Profiles and Gender** There was a marginally significant difference in LL values for the covariate and baseline LPA model ( $LL_{diff}(3)=7.61$ ,  $p=0.055$ ). This suggests the decision-making profile probabilities differed for males and females. We examined these differences by converting the logistic odds ratios from the multinomial logistic regressions to probabilities as recommended by Muthèn

and Muthèn (2012). Females were more likely to be assigned to the Unfavorable profile (41 %) compared with males (25.3 %), and males were more likely to be assigned to the Risky profile (12 %) compared with females (6 %).

### Drinking Patterns: Latent Transition Analysis

**Model Fit** LTA was used to examine the relationship between the decision-making profiles and the drinking patterns. A series of LTA models was fit in order to determine the appropriate number of drinking patterns using previously described model-fitting criteria. The first LTA model allowed two drinking patterns to be regressed on the four decision-making profiles, and subsequent models estimated additional drinking patterns. Model fit statistics are presented in Table 4. The LTA model with five drinking patterns was retained as the best-fitting model as the improvement in BIC and SABIC for the six-pattern model was small relative to the improvement in previous models, and the additional pattern from the six-pattern model was not conceptually distinct from the five-pattern solution. In addition, each pattern for the five-pattern solution was theoretically plausible and distinct, and the observed patterns are fairly consistent in college samples with similar alcohol use measures repeated across the freshman semester (e.g., Greenbaum et al. 2005). Finally, the entropy value of the five-pattern model was high (0.90) which is indicative of well-separated and distinct latent profiles (Celeux and Soromenho 1996).

**Table 4** Fit indices for latent transition analysis models

		Latent transition analysis, weekly alcohol use		
		Number of drinking patterns		
		BIC	SABIC	
		2	15,517.58	15,368.45
		3	15,071.72	14,894.03
		4	14,945.82	14,739.58
		5	14,826.86	14,592.06
		6	14,786.13	14,522.78
		7	14,757.79	14,465.88

Smaller values on these indices indicate better model fit

BIC Bayesian Information Criteria, SABIC sample-size adjusted BIC

**Table 5** Standardized means (standard errors) of the alcohol use measures within each drinking pattern

	Pattern 1, low (n=190; 49 %)	Pattern 2, low to moderate (n=111; 28 %)	Pattern 3, low to high (n=20; 5 %)	Pattern 4, moderate (n=52; 13 %)	Pattern 5, high (n=19; 5 %)
Summer prior	0.26 (0.11)	1.80 (0.35)	5.98 (1.08)	10.35 (0.90)	20.56 (0.57)
Fall freshman	1.16 (0.19)	9.38 (0.64)	21.84 (2.72)	12.48 (1.37)	25.84 (1.58)
Winter freshman	1.23 (0.20)	10.36 (0.66)	24.58 (2.12)	12.80 (1.43)	27.63 (1.73)
Spring freshman	1.99 (0.35)	10.58 (0.77)	25.54 (2.37)	14.78 (1.65)	24.41 (2.12)
Fall sophomore	2.19 (0.30)	12.05 (0.91)	23.87 (2.73)	16.11 (1.81)	29.03 (3.10)

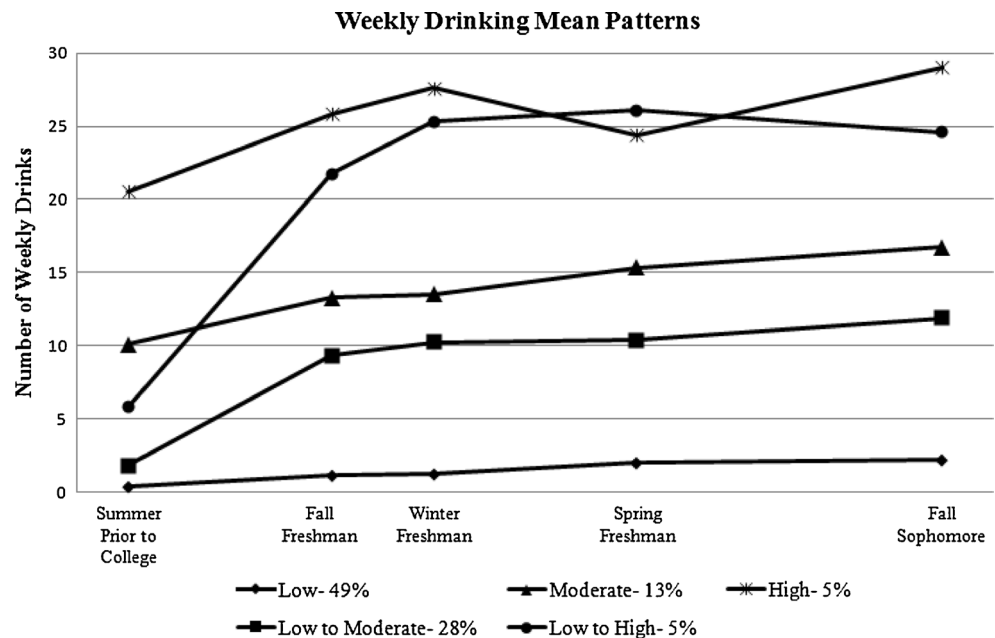
*Drinking Patterns Means* The weekly drinking means at each survey for each of the five drinking patterns are presented in Table 5 and Fig. 1. The drinking patterns were named to reflect the relationships relative to each other in order to highlight the differences between the latent patterns produced by the model. Drinking pattern 1, labeled “Low,” represented the largest latent subgroup of participants (49 % of the sample). These participants consumed little alcohol prior to college matriculation and continued very low levels of consumption throughout the assessment period. Drinking pattern 2, labeled “Low to Moderate,” represented the second largest subgroup of participants (28 %) who consumed low levels prior to college and increased to moderate levels. Participants in drinking pattern 3, “Low to High” (5 %), consumed low levels prior to college, increased their consumption dramatically by the end of their first freshman semester and maintained a moderately high level of drinking during the final two measurement periods. Participants in drinking pattern 4, “Moderate” (13 %), consumed moderate amounts of alcohol prior to college, had a small increase in drinking the

freshman year, and maintained the moderate drinking levels. Finally, participants in drinking pattern 5, “High” (5 %) consumed high levels of alcohol prior to college, and maintained these high levels.

Linking the Drinking Patterns and Decision-Making Profiles

LTA provides transition probabilities that represent the likelihood of belonging to each of the latent drinking patterns given membership in the latent decision-making profiles. It is important to consider the null hypothesis that there is no significant difference in the probability of belonging to a given drinking pattern across the decision-making profiles. Put another way, the null hypothesis is that the likelihood of following the various drinking patterns is the same regardless of one’s decision-making profile. The null hypothesis was formally tested by comparing the unconditional LTA model to a null LTA model in which the transitional probabilities for each of the drinking patterns were constraining to be equal across

**Fig. 1** Patterns of alcohol use based on mean weekly drinking at five measurement intervals



the decision-making profiles. The factor variances that corresponded to the zeros in the LTA transitional probabilities matrix were fixed in the model. These analyses utilized the probability parameterization and model test features of Mplus version 7 (Muthén and Muthén 2012). The model test of the null model converged properly and resulted in a significant Wald test when compared to the unconditional model (Wald=495.42 (7),  $p<0.001$ ). This finding suggests the unconditional model, which allows variation in the drinking patterns probabilities across the decision-making profiles, is a significantly better fitting model compared with the null model that constrains these probabilities to be equal.

Transitional probabilities are presented in Table 6. Participants described by the Anti-drinkers profile had a probability of 1.00 of being assigned to the low consumption drinking pattern. Those in the Unfavorable profile were likely to belong in either the low (0.66) or the low to moderate (0.34) drinking pattern. Drinking pattern probabilities were the most varied for the Mixed profile—0.07 (Low), 0.46 (Low to Moderate), 0.13 (Low to High), 0.33 (Moderate), and 0.01 (High). Finally, for the Risky drinking profile, 8 % were assigned to the Low drinking pattern, 8 % to the Low to Moderate, 8 % to the Low to High, and 21 % to the Moderate. Most Risky participants (55 %) followed the High drinking pattern.

We conducted a series of post hoc comparisons to test for differences in the drinking pattern transition probabilities within the decision-making profiles using Wald's test of parameter restrictions. The unconditional LTA model was compared with a series of models that utilized pair wise comparisons of the drinking pattern probabilities within decision-making profiles using the probability parameterization and the *Model Test* command in Mplus version 7. Findings are summarized by the use of superscripts in Table 6. Italicized numbers that are differing odd and even number pairs (i.e., 1 versus 2, 3 versus 4, 5 versus 6) indicate a significant difference in the probability of belonging to each drinking pattern within each individual decision-making profile. For example,

**Table 6** Latent transition probabilities for decision making profiles (rows) and weekly drinking patterns (columns) and results from Wald's test of significant differences

Latent profile	Low	Low to moderate	Low to high	Moderate	High
Anti-drinker	1.00	0.00	0.00	0.00	0.00
Unfavorable	0.66, <i>1</i>	0.34, <i>2</i>	0.00	0.00	0.00
Mixed	0.07, <i>1</i>	0.46, <i>2,3</i>	0.13, <i>4,5</i>	0.33, <i>2,6</i>	0.01
Risky	0.08	0.08	0.08	0.21, <i>1</i>	0.55, <i>2</i>

Italicized numbers that are differing odd and even number pairs (i.e., 1 versus 2, 3 versus 4, 5 versus 6) indicate a significant difference in the probability of belonging to each weekly drinking pattern within each individual decision-making profile. Differences are based on Wald's test of parameter restrictions

among participants with Unfavorable decision-making, a model that constrained the transition probability of belonging to the low alcohol use pattern to be equal to the low to moderate use pattern had significantly worse fit compared to the unconditional model (Wald=6.89 (1),  $p<0.01$ ). Among Mixed participants, a model that constrained the transition probability of belonging to the low alcohol use pattern to be equal to the moderate alcohol use pattern had significantly worse fit compared with the unconditional model (Wald=24.10 (1),  $p<0.001$ ). A model that constrained the low alcohol use pattern and the moderate alcohol use pattern to be equal for Mixed participants was also found to have worse fit than the unconditional model (Wald=17.94 (1),  $p<0.001$ ). For the remaining comparisons, the significant differences noted by the subscripts represent models with significant Wald tests (all  $p$ 's<0.05).

## Discussion

Research is needed to determine the most effective methods to identify college students who may be at risk for drinking based on pre-matriculation characteristics (Larimer and Cronce 2002; Cronce and Larimer 2011). The current research utilized a novel approach to identify distinct patterns of pre-college decision-making variables and associated alcohol use during college. The examination of complex patterns of pre-college decision-making related to alcohol, based on variables from the TRA, is a unique feature of this study as well as the linking of these variables to alcohol used throughout the first semesters of college. These findings add to the early identification literature by demonstrating the utility of considering measures other than alcohol use for determining the need and appropriateness of alcohol prevention efforts.

There were four decision-making profiles. The largest, labeled Unfavorable, described individuals who reported, on average, slightly unfavorable alcohol expectancies and drinking attitudes, moderately favorable attitudes toward non-drinking alternatives, and did not perceive strong pro-drinking social influences. The Mixed profile reported alcohol expectancies and attitudes toward drinking that were moderately positive, moderately positive attitudes toward non-drinking alternatives, and perceived low amounts of alcohol consumption and moderate disapproval of risky alcohol use from their friends/peers. The Anti-drinker profile students reported strongly negative alcohol expectancies, strongly unfavorable attitudes toward drinking, and highly favorable attitudes toward non-drinking alternatives. These individuals perceived very little alcohol consumption and strong disapproval of drinking among their friends/peers. Finally, the Risky profile students reported moderately positive alcohol expectancies, attitudes toward drinking, and attitudes toward



non-drinking alternatives in addition to the highest amount of perceived risky drinking support among their friends/peers.

We also identified five distinct drinking patterns. The most common pattern described students who consumed alcohol at low levels prior to college and continued relatively low consumption throughout the measurement period. We also found a pattern with a somewhat more moderate consumption pattern throughout the measurement period and a pattern with comparatively high drinking throughout the first five semesters of college. Two patterns described students who reported low alcohol use levels prior to college and progressed into either moderate (28 % of the sample) or high levels (5 %) of alcohol use.

### Insights into Early Detection

Early identification tools that only assess pre-college alcohol use may not be as predictive of college drinking for students who are drinking at low levels in high school. Three drinking patterns described a large portion of the sample (82 % total) who engaged in relatively low levels of alcohol use prior to college. Early identification techniques that consider alcohol use alone prior to college would likely not identify these individuals as being at risk for alcohol use in college. For example, the AUDIT, a popular brief alcohol screening scale (Reinert and Allen 2002) that assesses problematic alcohol use, has been used to identify at-risk college students for the purposes of delivering alcohol interventions (Kypri et al. 2009; Saitz et al. 2007). Although a single weekly measure of alcohol use cannot be directly compared with AUDIT scores, it is highly likely that many of these students who were drinking at low levels in high school would not be identified as at-risk by such an assessment. However, two of the three drinking patterns with low rates of pre-college drinking, representing 33 % of the sample, progressed into moderate or heavy levels of alcohol use by the end of the first semester of college.

Early identification of those at risk for drinking heavily may be improved by a more comprehensive screening strategy that considers both risky alcohol use and favorable alcohol-related attitudes and beliefs (even in the presence of low alcohol use). Participants in the Low, Low to Moderate, and Low to High drinking patterns all consumed alcohol at low levels prior to college. If this was all the information available for early detection, then an assumption might be made that they are all at low risk, and intensive intervention efforts are not necessary. However, knowledge of decision-making patterns along with measures of pre-college drinking may provide a clearer sense of which students are at the most risk. A consideration of the latent transition probabilities suggests Anti-drinkers are highly likely to begin as low drinkers and continue as low drinkers. Among the Unfavorable profile, the probability of drinking at low levels prior to college and

continuing low rates throughout is lower and more than 1/3 progressed from low drinking pre-college to moderate drinking during college. For the Mixed profile, more than half were drinking at low levels prior to college, but only a small percent continued to drink at low levels. Approximately 46 % progressed to moderate drinking and 13 % progressed into heavy drinking. These findings suggest if an individual drinks at a low level prior to college and is an Anti-drinker, one can be more confident the individual will not progress to heavy drinking. However, if the individual is drinking at a low level but reports decision-making variables that are similar to those of the Mixed or Unfavorable profile, drinking in college seems to be more difficult to predict. Thus, these individuals may benefit from more intensive intervention efforts.

Jaccard et al. (1990) suggested two critical factors for the early identification of individuals for targeted prevention. First, individuals must be able to be identified prior to the onset of problematic behavior. Decision-making profiles may provide early insights into the possibility of students progressing into or beginning heavy drinking use. Second, data for early identification must be easily obtained. Our brief number of items could easily be included as a survey in standard contacts with incoming freshman and incorporating early identification measures in this manner can minimize reactivity to such attempts (Larimer and Cronce 2002).

### Implications for Prevention Science

The next step of this research is to develop an early identification/screening tool based on these variables and measures of pre-college alcohol use. This process that would entail the development of an algorithm for assigning individuals into decision-making profiles based on their responses to these variables and testing the accuracy of such algorithms by assigning individuals into the appropriate profiles and tracking their alcohol use. If the variability of drinking patterns within the assigned profiles is similar to these findings, confidence in these measures as an early identification tool would be increased. Incoming freshmen at many universities visit campus for orientation or have other types of extended contact prior to matriculation. During these visits, it may be possible to administer such a screening survey, identify students with risky drinking or risky alcohol-related attitudes and beliefs, and assign these students to receive targeted alcohol prevention efforts based on these results.

The LPA results also provide unique information about decision-making that may be informative to intervention strategies. For students who hold attitudes and beliefs similar to the Anti-drinker profile, not drinking or drinking very little may represent a goal state (Gerrard et al. 2002). Interventions for this group should reinforce existing protective alcohol expectancies and attitudes in addition to providing alcohol resistance skills. The Unfavorable profile represents the

decision making of individuals who would be unlikely to drink at high levels given their beliefs. Alcohol prevention strategies that may be effective in this group include those that reinforce their unfavorable drinking beliefs as opposed to those that teach alcohol self-monitoring skills or increase motivation not to drink. Providing corrective normative education to this profile may not be relevant as they already hold unfavorable normative beliefs. It may be important to reinforce their existing unfavorable drinking views while delivering the message that the majority of students think similarly about alcohol usage.

The Mixed profile reported slightly favorable alcohol expectancies, attitudes toward alcohol, and attitudes toward non-drinking alternatives, with low perceptions of normative drinking in their friends. Students resembling those in the Mixed profile may experience some ambivalence when making alcohol-related decisions, as these individuals hold both favorable and unfavorable drinking cognitions. The most effective prevention strategy for these individuals may be to try to shift students' beliefs/expectancies about alcohol to become more negative (e.g., Musher-Eizenman and Kulick 2003) or to encourage more favorable attitudes toward non-drinking alternatives (Turrisi 1999). It is important to note the decision-making variable pattern of the Mixed profile is quite similar to the Risky profile with the exception of higher perceptions of alcohol use in friends/peers among the Risky profile. It is possible that greater exposure to alcohol use or changes in normative beliefs may help to facilitate a transition to heavier rates of drinking in this group. The Risky profile seems to have the most potential for alcohol-related problems given the high rates of use and may benefit from more involved intervention efforts like brief motivational interviews.

It is important to note students in the profile that viewed drinking most favorably (the Risky profile) reported only slightly favorable alcohol expectancies and drinking attitudes as well as slight disapproval of risky drinking from their friends. It seems at-risk students may not be overtly favorable toward drinking prior to college, and early identification measures designed to identify only students who hold strongly favorable drinking perceptions would likely miss these individuals. The Risky profile represents a relatively small percentage of students, but their contribution to the college drinking problem is likely significant. Large universities may admit more than 10,000 first-year students each year, and a subgroup of 7 % would correspond to 700 students. The findings show a marked increase in consumption during the transition from the summer after high school to the beginning of the freshman year, and most of the drinking increases were observed by the end of the first freshman semester. Many college alcohol interventions are administered either after students arrive on campus or have received an alcohol citation. Programs delivered after students become acclimated to campus life miss the opportunity to prevent these increases in alcohol use.

## Limitations and Conclusion

The patterns described are heuristics, and variability exists within these heuristics. There is a need to replicate our findings in diverse samples to determine the validity of the observed decision-making profiles and drinking processes. Estimates of sample size requirements for mixture models are not readily available. We did conduct simulation studies in Mplus and found our sample size provided adequate power to test individual model parameters, evaluate the LMR-LRT, and use selection criteria to choose the appropriate number of latent classes. There was some evidence of unreliability in the regression parameter estimates produced LTA, but this may be expected as this aspect of LTA involves latent variables regressed on latent variables. The weekly alcohol use measure may not be sensitive to detecting non-regular heavy episodic drinking occasions (Borsari et al. 2001). There is need to consider longitudinal changes in decision-making patterns, including shifts to more risky perceptions once in college, and how these changes are related to alcohol use. Finally, we focused on decision-making variables from the TRA, and future work should consider additional factors, such as school culture.

Despite these limitations, the current analyses provide insights into how pre-college decision-making risk variables are related to alcohol consumption in college. Given the wide availability of alcohol prevention programs in college students, there is a need for research that helps to identify at-risk students prior to college matriculation and refer them to appropriate prevention programs. The current findings suggest that screening participants on decision-making and drinking prior to college can provide insights into targeted intervention approaches.

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