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Transitions in First-Year College Student Drinking Behaviors: Does Pre-College Drinking Moderate the Effects of Parent- and Peer-Based Intervention Components?

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Abstract

This study used Latent Transition Analysis (LTA) to examine a stage-sequential model of alcohol use among a sample of high-risk matriculating college students ($N = 1275$). Measures of alcohol use were collected via web-administered surveys during the summer before entering college and followed-up during the fall semester of college. Seven indicators of alcohol use were used in the LTA models, including temporal measures of typical drinking throughout the week. The results indicated that four latent statuses characterized patterns of drinking at both times, though the proportion of students in each status changed during the transition to college: (a) non-drinkers; (b) weekend non-bingers; (c) weekend bingers; and (d) heavy drinkers. Heavy drinkers were distinguished by heavy episodic drinking (HED), and increased likelihood of drinking throughout the week, especially on Thursdays. Covariates were added to the LTA model to examine the main and interaction effects of parent- and peer-based intervention components. Results indicated that participants in the parent and peer conditions were least likely to transition to the heavy drinkers status. Results also indicated that the parent condition was most effective at preventing baseline nondrinkers from transitioning to heavy drinkers whereas the peer condition was most effective at preventing escalation of use among weekend non-bingers. The results underscore the value of considering multiple dimensions of alcohol use within a person-centered approach. Differential treatment effects were found across baseline drinking class, suggesting the benefit for tailored intervention programs to reduce high-risk drinking among college students.

Keywords

College Students; Heavy Drinking; Developmental Transitions; Subgroup Analysis; Differential Treatment Effects

Introduction

The transition from high school graduation to college matriculation is associated with significant increases in alcohol use that occur over a relatively short period (Sher & Rutledge, 2007). Problem drinking patterns, including heavy episodic drinking (HED) have a negative impact on learning, retention, and graduation (Keeling, 2000), and are associated with accidental injury, crime, sexual violence, and suicide (Hingson, Zha & Weitzman,

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2009). First-year students are at heightened risk for these consequences, particularly during the first few weeks of the fall semester, when rates of drinking are highest (Beets et al., 2009; NIAAA, 2002). Many students arrive with established HED patterns, which are maintained or increased during this time (White et al., 2006). On the other hand, many students who did not drink or were lighter drinkers in high school may engage in HED in college (Weitzman, Nelson, & Wechsler, 2003).

In the present study, we extend previous work (Turrisi et al., 2009) to examine this phenomenon among former high school athletes, a group considered high-risk for problem alcohol use and associated negative consequences (Lisha & Sussman, 2010). College students participating in athletic activity (including varsity, intramural, and club sports) drink more frequently and consume more per occasion than nonathletes (Doumas, Turrisi, Coll, & Haralson, 2007; Hildebrand, Johnson, & Bogle, 2001). Because the first semester of college is a critical transition period, when high-risk drinking behaviors may be established, investigation of stability and changes in HED is needed to inform preventive efforts that intervene before alcohol-related consequences may occur.

Patterns of Drinking In High School and College

It is well established that alcohol use increases during adolescence and young adulthood, with peak rates occurring during the late teens or early twenties (Johnston, O'Malley, Bachman & Schulenberg, 2004). However, these general trends may obscure important variation in the timing and intensity of changes across individuals (Maggs & Schulenberg, 2004). Some individuals may begin using alcohol at an early age and escalate rapidly to HED, whereas other adolescents may not use alcohol until they reach the legal drinking age. By focusing on these divergent developmental courses, person-centered approaches that identify homogenous subgroups offer several advantages over traditional "variable-centered" approaches (e.g., regression analyses) that focus on average relations among variables. For example, identifying homogenous subgroups of alcohol users may help elucidate multiple pathways to diverse outcomes, (i.e., equifinality and multifinality; Cicchetti & Rogosch, 1996).

Several studies using person-centered approaches (e.g., growth mixture modeling) confirm the heterogeneity of drinking during adolescence and young adulthood (e.g., Tucker, Orlando, & Ellickson, 2003), Despite this consensus, trajectory-based models of drinking have relied on different aspects of alcohol use, each typically considered separately. However, taxonomies of drinking patterns may depend upon the specific measure of alcohol use employed (Jackson & Sher, 2005, 2006, 2008). In fact, there is evidence that alcohol use is best described by distinct combinations of frequency and quantity of use and problematic drinking (Auerbach & Collins, 2006). Other studies support a multidimensional view of alcohol use, documenting that adolescents tend to drink infrequently, but in large amounts. For instance, Johnston et al. (2004) estimated that nearly 30% of high school seniors engaged in HED, yet a small fraction (3%) drank daily. Similarly, Del Boca, Darkes, Greenbaum, and Goldman (2004) found that most first-year college students did not report any alcohol use during a given week, but of those who did, about one-half reported HED.

The multidimensional view of alcohol use suggests that trajectory-based models, based on a single aspect of drinking behavior, cannot adequately address our research question. Rather, models that characterize discrete changes among multiple behaviors may be more appropriate for studying patterns of alcohol use during matriculation to college. Latent transition analysis (LTA; Collins & Lanza, 2010) represents such an approach. LTA is a longitudinal extension of latent class analysis (LCA), which divides a population into mutually exclusive and exhaustive latent subgroups. Unlike trajectory-based models, subgroup membership in LTA is not assumed to be stable and individuals may change membership in latent statuses over time. LTA is thus ideal for research questions that examine qualitatively different states over time, such as transitioning from a non-drinker to a social drinker.

To date, few longitudinal studies have used LTA to study alcohol use during the transition to college. One study, Auerbach and Collins (2006), followed a sample of high school seniors for three waves at two-year intervals. Four types of drinkers were identified in the LTA: (a) occasional, low quantity users; (b) occasional, high quantity users; (c) frequent, high quantity users; and (d) frequent, high quantity users with recent HED. However, study design limitations precluded identification of more nuanced types of drinkers, such as frequent, low quantity drinkers. It is also likely that changes in alcohol use occurred between the two-year interval and were not captured in the LTA model, as suggested by evidence that measurement of alcohol use at shorter intervals is necessary for reliable models of alcohol use change and stability (Collins & Graham, 2002; Jackson & Sher, 2008). This requirement is especially important for modeling patterns of alcohol use during college matriculation, a time of rapid transitions across several contexts that corresponds to increased alcohol use and alcohol-related consequences.

Intervention Efforts to Reduce College Student Drinking

Several approaches for the prevention of high-risk drinking by college students have been developed (Larimer & Cronce, 2007). Among these, interventions based on two sources of interpersonal influence (peers and parents) show particular promise. Peer influence is widely recognized as an important factor in college students’ alcohol use. In particular, perceptions of peers’ alcohol use and approval of drinking have been positively associated with rates of alcohol use among college students (Larimer, Turner, Mallett, & Geisner, 2004). Recent research also indicates that parents remain influential throughout late adolescence and emerging adulthood (Patock-Peckham & Morgan-Lopez, 2007). For instance, parental modeling and permissibility of alcohol use is a risk factor for alcohol misuse and related consequences among college students (Abar, Abar, & Turrisi, 2009). Parents also directly influence their teen’s decision-making about alcohol use via communication of expectations, setting limits, and monitoring (Turrisi, Wiersma, & Hughes, 2000; Wood, Read, Mitchell, & Brand, 2004)

Interventions designed to target peer influences include brief motivational interviews (BMIs), which provide feedback to the student regarding normative alcohol use among their peers as well as the students’ own alcohol use and beliefs via one-on-one counseling sessions. BMIs are routinely associated with reductions in drinking behaviors among college students (Wood, Capone, Laforge, Erickson, & Brad, 2007) and first-year students in particular (LaBrie, Pederson, Lamb, & Bove, 2006). Although designed with a specific focus on heavy drinkers and treatment settings, these interventions have been successfully modified to reduce drinking among high-risk students as well as delay initiation of drinking (Larimer et al., 2001; 2007).

Parent-based interventions (PBIs) represent a second important avenue for reducing high-risk drinking among college students. The theoretical and empirical foundation for PBIs is based on decision-making and parent-teen communication (Turrisi & Wiersma, 1999). In the PBI approach, an informational handbook is disseminated to parents of incoming freshmen to encourage parent-teen communication about alcohol and reduce parental permissiveness of drinking. Thus, the PBI was designed with a specific focus on prevention and early intervention. Several studies have documented the efficacy of PBIs (Ichiyama et al., 2009; Turrisi, Jaccard, Taki, Dunham, & Grimes, 2001; Turrisi, Abar, Mallett, & Jaccard, 2010).

Recently, the relative efficacy of PBI and BMI, alone and in combination, has received attention. Turrisi et al. (2009), found that the combined intervention condition was associated with lower rates of alcohol consumption and alcohol-related consequences compared to the PBI-alone or BMI-alone conditions. Another study (Wood et al., 2010) used two-part latent growth curve modeling to examine intervention effects on HED. Wood and colleagues reported that the BMI condition was effective in reducing transitions into HED but did not curb escalation of HED. No significant main effects on either initiation or growth in HED were found for the PBI alone or combined conditions. However, it should be noted that Wood et al. (2010) used an adapted and shorter version of the PBI handbook, which was revised from its original abstinence-based focus to a more harm-reduction orientation.

While both Turrisi et al. (2009) and Wood et al. (2010) reported that students' baseline levels of drinking did not moderate the effects of the intervention, other studies suggest that these effects may depend on the parenting style of the students' parents (Mallett et al., in press) or the age at which the student began drinking (Mallett et al., 2010). However, all previous studies used a variable-centered approach to moderation and relied upon methods of detecting moderator effects by conducting post-hoc comparisons of baseline characteristics, each considered separately. For example, the number of drinks consumed in a typical week (Turrisi et al., 2009) or past-month frequency of HED (Wood et al., 2010).

Although this approach to moderator analysis can be informative, several methodological challenges may limit its usefulness (Lanza & Rhoades, 2011). First, as the number of potential moderators increase, higher Type I error rates are likely (Lagakos, 2006). Second, treatment effects estimated within each subgroup of the hypothesized moderator may be based on different sample sizes; thus, the statistical power available to detect a treatment effect may vary across the subgroups (McClelland & Judd, 1993). Third, there may be higher-order interactions among the moderator variables that cannot be examined due to the above-mentioned methodological limitations (i.e., statistical power). An alternative approach is offered by person-centered methods, such as LTA, which explicitly model sample heterogeneity. Moderation analyses can then be performed by examination of differential treatment effects across the latent subgroups. Importantly, these analyses can be conducted simultaneously, within a latent variable model.

The Current Study

The current study is a re-analysis of data from Turrisi et al. (2009), using a different outcome measure. The previous study examined mean levels of three drinking measures (peak BAC, drinks per weekend, drinks per week), each conducted separately. In contrast, the current study conceptualizes alcohol use as multidimensional and uses a person-centered approach (LTA) to address three new research questions.

First, we extend previous research (Auerbach & Collins, 2006) to examine changes in alcohol use during the narrow time frame of college matriculation. Because previous research with college students indicates that drinking varies considerably across the days of the week (Del Boca et al., 2004; Wood, Sher, & Rutledge, 2007), we distinguish Thursday drinking by including it as a separate indicator. We hypothesize that four latent statuses of drinking will emerge: no alcohol use, low use on weekends only, high use on weekends only, and frequent (daily) high use. We next examine whether the intervention conditions (PBI, BMI, or combined PBI and BMI) are associated with transitions in alcohol use. Prior research regarding these intervention effects is equivocal, due to distinct outcomes and non-equivalency of the PBI condition across studies. The outcome measure in the current study – longitudinal patterns of alcohol use – most closely resembles the growth in HED used by Wood et al. (2010); we thus hypothesize the combined condition will have the greatest impact on reducing transitions to HED. Finally, we examine if baseline drinking moderates the effect of the intervention on transitions in alcohol use. Previous research is again equivocal regarding this question. Based on the theoretical underpinnings of the two interventions, we hypothesize that the BMI condition will have stronger effects for baseline heavy drinkers while the PBI condition will be more effective for baseline abstainers or light drinkers.

Methods

Participants and Recruitment

Participants were recruited as part of a multisite study focusing on incoming college students who participated in athletics in high school. For a detailed description of the original efficacy study, please refer to Turrisi et al. (2009). Randomly selected incoming freshmen (*N*=4,000) at both a large, public northeastern university (site A) and a large, public northwestern university (site B), were screened during the early summer of 2006. Invitation letters explaining the study, procedures, and compensation and containing a URL and Personal Identification number (PIN) for accessing the survey were mailed to all 4,000 potential participants. Eligible participants met the following criteria: (a) provided consent to participate, (b) completed an online screening assessment, (c) participated in high school or club team athletics, and (d) completed a baseline assessment during the summer prior to college matriculation.

Of the 4,000 participants contacted, 1,796 consented to participate and completed the web-screening assessment yielding a 45% response rate, a number consistent with using a web-based recruitment approach (Larimer et al., 2007). Seventy-nine percent of those who completed the screening survey (*N* = 1,419) met athletic-eligibility inclusion requirements – slightly higher than in previous studies (Doumas, Turrisi, Coli & Haralson, 2007) or national averages of sports participation (Eaton et al., 2008). Of these individuals, 1,275 (90%) completed the baseline assessment and were randomized to BMI, PBI, combined BMI and PBI, or assessment-only control. A total of 1,121 (87.9%) of the students completed the follow-up survey conducted toward the end of the fall semester (five months after baseline). Participants received $10 for the screening survey, $25 for the baseline survey, and $35 for the follow-up. Individuals who completed the BMI were compensated $10 upon completion of a brief evaluation of the session.

At baseline, the average age of the participants was 17.97 years (range = 15 – 28 years). Slightly more than half (54.6%) were female; 3.3% identified as Hispanic or Latino (a); 83.5% identified as Caucasian, 6.1% as Asian, 3.2% as Multiracial, 1.5% as African American, 0.2% as Native Hawaiian or Other Pacific Islander, 0.2% as American Indian/ Alaskan Native, 2.1% as Other and 0.2% did not identify race/ethnicity. These proportions were comparable to the campuses with which respondents were drawn.

Intervention Procedures

Students who were randomized to either the BMI-only or combined BMI and PBI completed a 45-60 minute one-on-one session with a trained peer facilitator within the first two weeks on campus. Topics included the participant’s drinking pattern, perceived and actual descriptive norms for drinking, drinking consequences, alcohol caloric consumption, and hours of exercise required to burn those calories, and protective behavioral strategies aimed to reduce alcohol consumption and related harm. Participants who were randomized to one of the BMI conditions, but did not attend the one-on-one session, were mailed their materials (see Larimer et al., 2001; 2007).

The parents of students randomized to receive the PBI were mailed a handbook during the period between their teen's high school graduation and first year in college (see Turrisi et al., 2001 for detailed description of the handbook contents). The 35-page handbook included an overview of college student drinking, strategies and techniques for communicating effectively with teens, tips on discussing ways to help teens develop assertiveness and resist peer pressure, and in-depth information on teen drinking and how alcohol affects the body. To ensure that parents read the materials, they were asked to evaluate the handbook by filling out a brief questionnaire, as well as making notes directly on the handbook itself, and then returning both.

Participants in the assessment-only control group completed all procedures in an identical manner to the BMI-only, PBI-only, and combined-intervention conditions, except that the interventions were mailed and offered after all assessments were completed.

Measures

Measures of drinking were collected via web-surveys during the summer before college and during the fall semester. Participants were first asked to think of the occasion when they drank the most in the previous month, from which they then reported the maximum number of drinks consumed and the number of hours they spent drinking on that occasion, from the Quantity/Frequency/Peak Questionnaire (QFP; Dimeff, Baer, Kivlahan & Marlatt, 1999; Marlatt et al., 1998). From these responses, peak blood alcohol content (peak BAC) was calculated following established guidelines (Dimeff et al., 1999; Matthews and Miller, 1979). Participants were also asked how many times, during the past 30 days, they had gotten drunk or very high from alcohol and the number of times they had consumed four (females) or five (males) drinks in a row during the past two weeks. Finally, participants indicated the number of drinks consumed each day of a typical week, using the Daily Drinking Questionnaire (Collins, Parks & Marlatt, 1985). A standard drink definition was included for all measures (12 oz of beer, 10 oz of wine cooler, 4 oz of wine, 1 oz of 100-proof distilled spirits, or 1.25 oz of 80-proof distilled spirits).

At each time point, seven dichotomous indicators of drinking were created for the LTA models. These included: (1) any alcohol use in the past 30 days; (2) any reported drunkenness in the past 30 days; (3) peak BAC greater than 0.08 on last drinking occasion; (4) any binge episode in the past two weeks; (5) any weekday – Sunday, Monday, Tuesday, Wednesday – drinking (6) any Thursday drinking; and (7) any weekend – Friday and Saturday – drinking.

Analytic Strategy

The first phase of our statistical plan employed LTA to identify subgroups of individuals, based on developmental transitions in drinking behaviors. LTA is a statistical procedure in which discrete, mutually exclusive latent statuses of individuals are identified from a population based on responses to categorical manifest variables. In this study, drinking was modeled at each time as a categorical latent variable indicated by the seven observed variables listed in Table 1. Three sets of parameters are estimated in an LTA model. The first set is referred to as item-response probabilities, which represent the probability of each item response conditioned on latent status membership and reflect the amount of measurement error in the alcohol use items. Measurement parameter values that are close to 0 or 1 indicate that the alcohol use latent variable is measured well with that item. A second set includes the probabilities of membership in each latent status at each measurement occasion. Third, transition probabilities reflect the probability of transitioning from a latent status at time t to another latent status at time $t + 1$.

LTA models with different numbers of latent statuses were compared to determine the optimal statistical model. Large models (*df* > 99) suffer from sparseness in the observed data table; when data are sparse it has been shown that the distribution of the G^2 does not follow a chi-square distribution (Koehler, 1986). Thus, relative indices of fit such as AIC and BIC can provide information about the best-fitting model: lower AIC and BIC values reflect an optimal balance between model fit and parsimony. All analyses were conducted using PROC LTA (Lanza, Dziak, Huang, Xu, & Collins, 2011). Missing data were handled in this procedure, with data assumed to be missing at random; thus, the full sample (N = 1,275) was included in all analyses. Model identification was confirmed by examination of models using multiple seeds.

In the next step, treatment condition was added as an exogenous covariate to the LTA model to examine the effect of the intervention conditions on the transition probabilities. Because the study utilized a 2 × 2 factorial design, crossing the BMI and PBI conditions, three effects-coded dummy variables were created, reflecting the main effects of the two intervention strategies and their interaction (i.e., the combined-intervention condition). Within the LTA model, we then regressed the probability of latent status transitions on treatment condition, indicated by the three dummy variables. Hypothesis testing was performed by comparing the fit of pairs of models with and without a specific term (i.e., effects-coded intervention variable). Two times the difference in log-likelihood values between the two models is a likelihood ratio test (LRT) statistic and is distributed as a chi-square. A significant LRT value indicated that removal of the specific term resulted in a worse fitting model and the term should be retained. In contrast, non-significant LRT values indicated that removal of the specific term did not deprecate model fit; thus, the more parsimonious model without the term was preferred.

We focused our analyses on transitions to the drinking statuses that represent lowest and highest risk. Therefore, these associations were modeled using binary logistic regression to ascertain the effect of the treatment on transitioning to (1) the low-risk drinking status, relative to all other statuses at follow-up, and (2) the high-risk drinking status at follow-up, compared to all other statuses. The coefficients were exponentiated and transformed into more easily interpreted odds ratios. Within the context of this study, an odds ratio greater than 1.0 indicated an increased likelihood of membership in the specified latent status, relative to all other statuses. Odds ratios less than 1.0 are often more easily interpreted by using the inverse (1/OR). For example, an odds ratio of 0.5 means that a one-unit increase on the predictor corresponds to individuals being 0.5 times as likely to be in latent status A relative to latent status B. Equivalently, the odds ratio can be inverted (1/0.5 = 2.0), indicating that a one-unit increase on the predictor corresponds to individuals being 2.0 times *less likely* to be in latent status A relative to B.

The third phase examined whether latent drinking status at baseline moderated the effect of the interventions on transitions in drinking between baseline and the fall semester follow-up. We conducted a series of parallel analyses that examined the effect of the interventions on the latent status transition probabilities (as above) separately for each baseline drinking status.

Results

Table 1 displays the frequencies of the drinking indicators. With one exception, no significant differences between males and females were found among any items at either time. At the fall follow-up, more male students (10.69%) reported weekday (i.e., Sunday through Wednesday) drinking than female students (6.56%): t (1119 df) = 2.48, $p < 0.05$. Additional analyses indicated that, at baseline, students who did not complete the follow-up survey were more likely to report any alcohol use during the previous month and weekend (i.e., Friday and Saturday) drinking compared to those with complete data. No other differences between the attrition groups were found.

Identification of common patterns of alcohol use

A series of LTA models was compared to determine the optimal drinking pattern latent statuses at each of the two waves (see Table 2). Based on the AIC, BIC, model interpretability, and model identification, it was determined that four latent statuses provided the optimal fit of the data. For example, using multiple seeds, the same four-status solution was found in 48 out of 50 models; in contrast, the best-fitting five-class solution was found in less than half (46%) of the models with multiple starting seeds. Further examination of the models revealed that four statuses were consistent across both solutions, with the five-class model including an additional class that was not clearly distinguished (i.e., measurement parameters were not close to 0 or 1).

Table 3 presents the results of the four-status solution. *Non-drinkers* were unlikely to report any of the drinking behaviors at either time point. *Weekend non-bingers* reported using alcohol in the previous month and were also likely to report drinking only on Fridays and Saturdays (probability = 0.65); however, they were unlikely to report binge drinking in the previous two weeks nor were they likely to report being drunk in the past month or having a peak BAC above 0.08 on their heaviest recent occasion. In contrast, *weekend bingers* were very likely to report being drunk in the past month (probability = 0.99) as well as binge drinking (probability = 0.83) and having a peak BAC greater than 0.08 on their heaviest recent drinking occasion (probability = 0.89). *Heavy drinkers* were distinguished from the other drinking statuses by elevated probabilities of endorsement of all drinking indicators, including weekday drinking (probability = 0.30) and drinking on Thursdays (probability = 0.74).

The middle panel of Table 3 displays the proportion of students who belonged to each of the four latent statuses at each measurement occasion. At baseline, the *non-drinker* status was most prevalent (42%), followed by *weekend binger* (30%) and *weekend non-binger* (20%) statuses. *Heavy drinkers* comprised the smallest group at baseline, representing 8% of the students. *Non-drinkers* remained the most prevalent subgroup at follow-up, although their prevalence dropped from 42% to 30%. *Weekend bingers* also showed a decrease in prevalence at follow-up (from 30% to 22%). In contrast, the prevalence of the *heavy drinker* status increased substantially across time from 8% to 28% of the students. Interestingly, *weekend non-bingers* had a similar prevalence over time (20% at baseline and 19% at follow-up).

The probabilities of membership in the latent statuses at follow-up, given latent status membership at baseline (i.e., transition probabilities), are displayed in the bottom of Table 3. Entries along the diagonal of the transition probability matrix reflect the probability of membership in the same latent status at both times. *Heavy drinkers* at baseline were most likely to remain in the same status over time, with 96% of those at baseline remaining in that status at the fall semester. In contrast, individuals in the *weekend non-binger* or *weekend binger* statuses were less likely to be in the same status at follow-up (43% and 41%, respectively). *Weekend non-bingers* who changed status were most likely to transition to *weekend bingers* (24%) but were also likely to transition to *heavy drinkers* (18%). Among *weekend bingers* at baseline, more than half (51%) escalated their behaviors to include Thursday drinking, transitioning to *heavy drinkers*. Sixty-four percent of *non-drinkers* at baseline remained in that latent status after beginning college. Not surprisingly, among *non-drinkers* who changed status, the most likely transition was to the *weekend drinker* status (21%).

Evaluation of program effects on transition probabilities

Before adding the covariates to examine the effect of the treatment on transition probabilities, treatment condition was added as a grouping variable to the LTA model to ensure that the prevalence rates for each drinking latent status were similar across the four treatment conditions, as would be expected because of random assignment. Comparing models with the baseline prevalence rates across groups to be constrained or freely estimated resulted in a non-significant G^2 difference test ($\Delta G^2 = 4.77$, $df = 9$, $p = 0.85$). Thus, as expected, the proportion of students in each of the baseline drinking statuses did not differ across treatment condition. Similar analyses were conducted with gender as a grouping variable. The results indicated no significant differences between male and female students in either baseline prevalence rates ($\Delta G^2 = 0.43$, $df = 9$, $p = 1.00$) or latent status transitions ($\Delta G^2 = 9.40$, $df = 12$, $p = 0.67$).

We next added the effects-coded covariates to the LTA model to examine the effect of the treatment conditions on the transition probabilities across the two times. Two binomial regression models were specified. First, we estimated the effect of treatment condition on transitioning to the *non-drinker* latent status, compared to any other status. Relative to the baseline model without covariates, the model with all three effects-coded covariates did not result in a significant improvement of fit (LRT = 9.52, $df = 12$, $p = 0.66$). This result indicated that, in the overall sample, the intervention was not associated with transitions into the *non-drinker* latent status at the fall follow-up. Second, we estimated the effect of treatment on the likelihood of transitioning to the *heavy drinker* status at the fall follow-up, compared to any other status. The top panel of Table 4 displays these results among the entire sample.

As seen in the table, the fit of the model with all three covariates indicating treatment group was significantly improved compared to the fit of the baseline model without covariates (LRT = 25.66, $df = 12$, $p = .01$). This indicated that transition probabilities into the *heavy drinker* status differed among the four treatment groups. Additional models were estimated to determine which intervention component contributed to this omnibus difference. First, the removal of the interaction term did not result in significantly worse fit compared to the model with all three covariates (LRT = 2.68, $df = 4$, $p = 0.61$). This indicated that the effects of BMI and PBI on transitions to the *heavy drinker* latent status did not differ based on whether the other strategy was used. The fit of this model (two main effects for PBI and BMI) was then compared to the model with the main effect of PBI removed. This resulted in a significant difference (LRT = 11.94, $df = 4$, $p = 0.02$). Similarly, the last model compared the fit of the model with two main effects to one with the main effect of BMI removed. This result also was significant (LRT = 11.46, $df = 4$, $p = 0.02$). Thus, each intervention strategy (PBI and BMI) was associated with transitioning to (or, for baseline *heavy drinkers*, remaining in) the *heavy drinker* status, relative to all other statuses at the fall follow-up among the entire sample.

Moderation of intervention effects by baseline drinking status

We next replicated the steps for the two binomial regression models, separately for each of the four baseline drinking groups, to determine if baseline drinking status moderated the effects of the intervention on transitions to the *non-drinker* or *heavy drinker* statuses. None of the four additional models that estimated membership in the *non-drinker* latent status at the fall follow-up were improved by adding the covariates (all ps > 0.10). Thus, baseline drinking status did not moderate the effects of the intervention on transitions into the *non-drinker* subgroup.

The results of models predicting membership in the *heavy drinker* status, separately by each baseline drinking status, are presented in the lower panels of Table 4. In each subgroup, models that tested the significance of the interaction and each main effect were estimated. Among baseline *non-drinkers*, the model with all three covariates resulted in significant model improvement (LRT = 8.46, *df* = 3, *p* = 0.04). Subsequent models revealed this was due to the main effect of the PBI condition (LRT = 7.24, *df* = 1, *p* = 0.01). The beta coefficient and OR associated with the PBI are displayed in the last columns of Table 4. These results indicated that among *non-drinkers*, the PBI condition was significantly related to decreased odds of transitioning to the *heavy drinker* status, relative to all other statuses (OR = 0.20). Thus, the PBI strategy was associated with baseline *non-drinkers* being five times (1/OR = 1/0.20 = 5) less likely to transition to *heavy drinker* status, relative to any other status, at the fall follow-up.

The omnibus test of the intervention conditions on membership in the *heavy drinker* status at fall follow-up was also significant among students belonging to the *heavy drinker* status at baseline (LRT = 13.06, *df* = 3, *p* = 0.01). Additional analyses revealed that the interaction term was not significant; however, both PBI and BMI conditions led to decreased odds of remaining in the *heavy drinker* status (PBI: LRT = 5.30, *df* = 1, *p* = 0.02, OR = 0.02; BMI: LRT = 8.12, *df* = 1, *p* = 0.00, OR = 0.01). Put differently, these results indicated that the two intervention conditions were associated with baseline *heavy drinkers* being 50 to 100 times less likely to remain a *heavy drinker* at the fall follow-up, relative to transitioning to any other latent status. Finally, there was some evidence to suggest that among baseline *weekend non-bingers*, the BMI strategy was associated with lower odds of transitioning to *heavy drinker* status (LRT = 3.10, *df* = 1, *p* = 0.08, OR = 0.41). None of the models involving transitions to *heavy drinker* status among the baseline *weekend bingers* resulted in significant differences.

Discussion

The current study employed a person-centered analysis to examine a multidimensional model of alcohol use among a sample of high-risk matriculating college freshmen. Re-analyzing data presented by Turrisi et al. (2009), we estimated an LTA model of alcohol use that included several indicators of alcohol use measured during the summer before entering college and the fall semester of college. We found support for the hypothesis that four latent statuses, distinguished by frequency, quantity, and temporal variability of alcohol use, would characterize patterns of drinking behaviors during this vulnerable transition. Notably, we identified a latent status, *heavy drinkers*, that was defined by a strong likelihood of drinking on Thursdays and an elevated probability of reporting weekday (Sunday through Wednesday) drinking.

The results also offered partial support for our hypothesis that parent- and peer-based intervention components would be associated with transitions in drinking status between the summer prior to college enrollment and the first semester of college. Specifically, LTA models with covariates revealed that the BMI condition was a significant predictor of transitioning to the *heavy drinker* status. Notably, the results indicated that the PBI condition was also negatively related to transitioning to the *heavy drinker* status at fall follow-up. Contrary to our hypotheses, we found no evidence that the intervention components were associated with membership in the *non-drinker* latent status. These results were unexpected and warrant further investigation.

Our third hypothesis stated the BMI would be more effective among high-risk drinkers whereas the PBI would show strongest effects for abstainers or light drinkers. We found evidence that the PBI was significantly associated with reduced odds of transitioning to the *heavy drinker* status among *non-drinkers* and was also associated with less likelihood that *heavy drinkers* would remain in that status. Furthermore, the results indicated that the BMI was associated with reduced odds that baseline *heavy drinkers* would remain in that status at the fall follow-up. There was also some evidence to suggest that *weekend non-bingers* in the BMI were less likely to escalate to heavy drinking.

Patterns of Drinking In High School and College

The present study extended previous research (Auerbach & Collins, 2006) in two ways. First, by including indicators of temporal variability of weekday, weekend, and Thursday drinking in the multidimensional model of alcohol us, we were able to distinguish latent subgroups of students that were based on their drinking behaviors during a typical week. The group of students at highest risk (*heavy drinkers*) had an elevated probability of drinking on Thursdays or even throughout the entire week; however, we identified another high-risk group of students that was characterized by binge drinking only on the weekends (i.e. Friday and Saturday). Thus, the results add to the growing body of literature that emphasizes the variability in college students' drinking behaviors over time (Del Boca et al., 2004; Neighbors et al., 2007).

Our study is also the first to apply LTA to changes in drinking behaviors that occur during the very brief, but highly vulnerable, transition from high school to the first semester of college. Using LTA with measures timed to coincide with the college calendar, the results suggested that a substantial proportion of students transitioned into a more risky drinking status at the fall follow-up. In particular, *weekend non-bingers* and *weekend bingers* displayed the least stability across time. Students in both of these groups were more likely to increase their use, rather than decrease across time. These results underscore the risk associated with the transition to college and offer further evidence that students (particularly those who drink occasionally in high school) increase their drinking during the first semester of college (Sher & Rutledge, 2007).

Evaluation of program effects on transition probabilities

The second goal of this study was to determine if the intervention conditions were associated with transitions in alcohol use during college matriculation. Prior studies offered contradictory evidence regarding whether students in the BMI or combined condition would be least likely to transition to higher risk statuses, or more likely to transition to lower risk statuses. While Turrisi et al. (2009) concluded that the combined condition was associated with reductions in alcohol use, Wood et al (2010) found that students in the BMI were least likely to transition into HED. Our results showed consistent evidence that the combined PBI and BMI offered no significant advantage over either alone. Rather, we found that both parent- and peer-based interventions significantly reduced the odds that a student would belong to the *heavy drinker* status at the fall follow-up.

These inconsistent results may be viewed in light of several differences among the three studies. Foremost, both previous studies tested the intervention effects on *single* indicators of alcohol use. Turrisi et al. (2009) conducted separate analyses for three drinking indicators (peak BAC, drinks per weekend, and drinks per week) and Wood et al. (2010) considered only a single past-month HED item. The current study, in contrast, utilized a person-centered approach and conceptualized alcohol use as a multidimensional phenomenon that varied across latent subgroups of the population. In addition, the current study examined transitions in HED that occurred by the end of the first semester of college. Both prior studies conducted follow-up assessments at approximately 10 months after baseline (i.e., end of the spring semester) and thus may not have isolated the "college effect" whereby students rapidly increase their drinking behaviors upon arrival on campus (Sher & Rutledge, 2007). Finally, the content of the PBI component was not equivalent in the two previous studies, as Wood et al. (2010) revised the PBI handbook from its original abstinence-based focus to a more harm-reduction orientation.

Interpreting the findings across the three studies is complex, particularly given the different emphasis reflected in variable-centered and person-centered approaches. Previous studies, which relied on variable-centered approaches, focused on average relations among variables and examined intervention effects on reducing the average level of alcohol consumed. In contrast, the current study adopted a person-centered approach and focused instead on describing differences among subgroups of individuals who share patterns of alcohol use, including HED. The current findings, therefore, present a more nuanced perspective of alcohol use than offered by either previous study, allowing us to examine how the different intervention components predicted transitions in qualitatively different states over time (e.g., from *weekend binger* to *heavy drinker*) rather than mean-level changes in single measures.

Prevention Implications

By elucidating multiple pathways to multiple outcomes, the current results have implications for prevention and intervention programs designed to reduce alcohol, tobacco, and other drug use among children, adolescents, or young adults. Such programs are often administered to groups of individuals without consideration of individual characteristics that might predict differential treatment response. However, recent trends in prevention science underscore the need to administer the right program to the right individual. That is, adaptive intervention strategies that tailor the particular dosage or type of treatment in order to match the strategy with the individual's risk may be most effective in preventing substance use (Collins, et al., 2004; Lanza & Rhoades, 2011). For example, this approach is taken by the Adolescent Transitions Program (ATP), which uses a screening procedure to identify high-risk students and families and then delivers a multilevel family intervention within a public middle school environment (Dishion, Kavanagh, Schneiger, Nelson, & Kaufman, 2002).). The ATP has been shown to reduce initiation of ATOD use among both at-risk and typically developing students even though the parent intervention component was relatively brief (an average of five hours over two years).

The person-centered approach we used may also be useful for efforts aimed at reducing HED among college students. Foremost, by identifying profiles of risky drinking, our results suggest a different strategy for determining successful interventions. When using a variable-centered approach, the success of an intervention is typically gauged in terms of a reduction of the quantity or frequency of drinking. For instance, a statistically significant result may be found when students (on average) reduce their consumption from 18 to 12 drinks per weekend after receiving an intervention – an amount that remains clinically significant. In contrast, a person-centered approach may provide a better picture of what risky drinking looks like by identifying *patterns of drinking behaviors* that are shared by subgroups of students. In this approach, a successful intervention is one that either prevents students from joining the "risky" subgroup(s) in the first place, or that causes those in the "risky" subgroup(s) to disassociate from them.

In this vein, the results of this study suggest that it is possible to identify students who are at highest risk of escalating alcohol use during the first semester of college, *prior* to their matriculation. Using LTA, we identified a subgroup of students (*weekend bingers*) that were defined by relatively high-risk status at baseline and were very likely to transition to the highest level of risk during the fall semester of college. We also found that *heavy drinkers* were very likely to remain in that status at both times. Importantly, these groups appeared to be relatively impervious to either parent- or peer-based interventions. Because these two groups comprised more than a third of the sample at baseline, screening for high-risk alcohol use prior to college is warranted (Fleming, Barry, & MacDonald, 1991). However, these conclusions are qualified by our finding that both the BMI and PBI were significantly associated with less likelihood of *heavy drinkers* remaining in that status during the transition from high school to college. Future research is needed to more clearly understand the factors that contribute to differential treatment effects between these two high-risk groups.

It is possible that efforts to reduce escalation of use among high-risk students require different types of interventions than offered by either BMI or PBI., such as altering the drinking environment on college campuses. For example, several authors have proposed increasing Friday morning class offerings as a potential environmental strategy to reduce heavy drinking on Thursday nights (e.g., Borsari, Murphy, & Barnett, 2007; Wood, Sher,& Rutledge, 2007). Our results indicated that one of the distinguishing features of the high drinking statuses was the frequency with which students drank throughout the week, particularly on Thursdays. These findings support the benefit of increasing academic responsibility on Friday mornings. Further, previous work has shown that students find academic alcohol-related consequences (e.g., getting a lower grade) to be highly aversive (Mallett, Bachrach, & Turrisi, 2008), and may therefore be willing to curb their drinking in order to avoid them.

It is also noteworthy that *non-drinkers* were most likely to transition to *weekend non-bingers*, which could arguably be considered a “safer” drinking status. Nonetheless, our results suggest that parent-based interventions were more effective than peer-based interventions at preventing such students from transitioning to high-risk drinking during the freshman year of college. These results are consistent with other studies that have demonstrated the efficacy of the PBI in reducing alcohol use and related consequences (Turrisi et al., 2009; 2010). Given the likelihood of limited resources that are available to prevention efforts, the PBI represents a promising strategy to prevent high-risk drinking among both low-risk as well as high-risk students. The PBI approach is inexpensive, easy to administer and enthusiastically received by parents of incoming college students (Turrisi et al., 2001). Although there are currently no published data regarding student reactions to the PBI, this is a direction for future research.

Limitations

When drawing conclusions, it is important to bear in mind the limitations of the current study. Foremost among these is that the nature of self-reported alcohol use behaviors may introduce bias into the responses. However, several steps were taken to reduce the likelihood of dishonest reporting and no evidence was found of self-report bias (Turrisi et al., 2009). It should also be noted that the sample consisted of students from only two large public universities and that all students had participated in high school athletics. Thus, our findings are limited to high-risk students (i.e., former high school athletes) at large, primarily residential, state universities that are characterized by a strong emphasis on intercollegiate sports and a prominent Greek system. These institutional characteristics are associated with heavy drinking (Presley, Meilman, & Leichliter; 2002).); however, future studies should examine these questions with other samples, including students who attend smaller two- or four-year colleges and universities. There is also much need for studies that examine patterns of alcohol use among adolescents with other post-secondary experiences, such as those who enroll in the military or engage in full-time employment. It should also be noted that the baseline measure of the current study took place during the summer between high school graduation and college enrollment. While this allowed us to isolate changes in alcohol use during a brief, high-risk transition, studies suggest drinking behaviors are likely escalated during holidays and summer breaks (Tremblay et al., 2010). Thus, future studies that extend the measurement of alcohol use to earlier ages are warranted.

Our results must also be considered in light of the limitations inherent in the LTA models. Alternative models of latent statuses could be estimated based on continuous measures rather than dichotomous indicators, which would require a different approach (e.g., latent profile analysis). We note, however, that many variables involved in studying alcohol use behavior have extremely skewed distributions, so caution must be used when treating such variables as continuous (Lanza, Patrick, & Maggs, 2010). Finally, some of the transitions were experienced by only a small proportion of the students (e.g., transitioning to *non-drinker*), thereby limiting our ability to detect effects of the intervention statuses on these less frequently experienced transitions. Replication of the current study with larger samples may help clarify these effects.

Conclusion

The results underscore the value of a person-centered approach to understanding alcohol use during the transition from high school to the first semester of college, a period associated with significant increases in drinking that may set the stage for future problematic drinking patterns. This escalation occurs rapidly, often during the first few weeks of the fall semester; thus, identifying at-risk students and implementing effective interventions before alcohol-related consequences may occur is critical. Our findings suggest that parent- and peer-based interventions can prevent transitions to high-risk drinking, although the effectiveness of specific interventions may vary across different types of students. Typical intervention designs may not be able to detect such interactions due to several methodological limitations. Person-centered methods, such as LTA, represent an alternative approach that may inform such tailored interventions. This study is a first step in realizing this potential.

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Table 1

Percent of students reporting alcohol use behaviors at Baseline and Fall Semester Follow-Up, by Student Gender.

	Baseline		Follow-up	
Alcohol Use Behavior	**Males (*N* =566)**	**Females (*N* = 709)**	**Males (*N* =497)**	**Females (*N* = 627)**
Drink in past month	62.37	63.33	71.57	70.40
Been drunk in past month	46.64	45.52	59.68	60.32
Weekday (Sun to Wed) drinking	8.33	7.63	10.69	6.56
Thursday drinking	6.91	6.07	22.58	23.68
Weekend (Fri, Sat) drinking	45.13	45.28	64.11	62.08
Binge episode in past 2 weeks	36.57	34.89	45.93	45.66
Peak BAC > 0.08	35.40	39.69	50.51	51.76

Note: $N = 1275$ for all variables at baseline. At follow-up, $N = 1124$ for all variables except Binge episode in past 2 weeks ($N = 1114$) and peak BAC ($N = 1119$).

Table 2

Model fit statistics for LTA models with 2 to 6 latent statuses.

Number of latent statuses:	*-LL*	G^2	*df*	AIC	BIC
2	6009	1920	16,366	1954	2042
3	5574	1049	16,354	1107	1257
4	**5479**	**860**	**16,340**	**946**	**1168**
5	5436	775	16,324	893	1197
6	5426	753	16,306	907	1304

Note: Bold font indicates the selected model. LL = log likelihood; df = degrees of freedom; AIC = Akaike's Information Criterion; BIC = Bayesian Information Criterion.

Table 3

Item-response probabilities and transition probabilities for selected LTA model.

	Latent Status			
	Non-Drinker	**Weekend Non-Binger**	**Weekend Binger**	**Heavy Drinker**
Item-Response Probabilities				
Drink in past month	0.10	**0.99**	**1.00**	**1.00**
Been drunk in past month	0.00	0.53	**0.99**	**1.00**
Weekday (Sun, Mon, Tues, Wed) drinking	0.00	0.05	0.08	0.30
Thursday drinking	0.00	0.06	0.02	**0.74**
Weekend (Fri, Sat) drinking	0.02	**0.65**	**0.88**	**0.98**
Binge drank in past 2 weeks	0.00	0.10	**0.83**	**0.95**
Peak BAC > 0.08	0.00	0.23	**0.89**	**0.94**
Proportion of Statuses at:				
Time 1 (Baseline)	0.42	0.20	0.30	0.08
Time 2 (Fall Follow-up)	0.30	0.19	0.22	0.28
Transitions from Time 1 (rows) to Time 2 (columns):				
Non-Drinker	***0.64***	0.21	0.11	0.04
Weekend Non-Binger	0.14	***0.43***	0.24	0.18
Weekend Binger	0.02	0.06	***0.41***	0.51
Heavy Drinker	0.01	0.03	0.00	***0.96***

Note: Item-response probabilities are constrained to be equal at two time points. Entries in bold font indicate status-defining probabilities (>0.60). Entries in bold and italic font indicate membership in the same latent status at both times (i.e., stability)

Table 4

Comparison of Models with Reference = *Heavy Drinkers*

Sample	Model	*-LL*	LRT	*df*	*p*-value	*B*	*OR*
All Adolescents	All terms	5466.77	25.66^{**}	12	0.01		
	PBI × BMI removed	5468.11	2.68	4	0.61		
	PBI removed	5474.08	11.94^{*}	4	0.02		
	BMI removed	5473.84	11.46^{*}	4	0.02		
Non-Drinkers	All terms	5475.37	8.46^{*}	3	0.04		
	PBI × BMI removed	5476.46	2.18	1	0.14		
	PBI removed	5479.60	7.24^{**}	1	0.01	-1.61	0.20
	BMI removed	5476.49	0.06	1	0.81	0.13	1.14
Weekend Non-Bingers	All terms	5477.46	4.28	3	0.23		
	PBI × BMI removed	5477.46	0.00	1	1.00		
	PBI removed	5478.01	1.10	1	0.30	-0.53	0.59
	BMI removed	5479.01	3.10^{+}	1	0.08	-0.90	0.41
Weekend Bingers	All terms	5479.54	0.12	3	0.99		
	PBI × BMI removed	5479.56	0.04	1	0.84		
	PBI removed	5479.60	0.08	1	0.78	-0.09	0.92
	BMI removed	5479.56	0.00	1	1.00	-0.03	0.98
Heavy Drinkers	All terms	5473.07	13.06^{**}	3	0.01		
	PBI × BMI removed	5473.11	0.08	1	0.78		
	PBI removed	5475.76	5.30^{*}	1	0.02	-3.97	0.02
	BMI removed	5477.17	8.12^{**}	1	0.00	-4.59	0.01

Note: LL = log likelihood, LRT = likelihood-ratio test, df = degrees of freedom, *B* = binary logistic regression coefficient, OR = Odds Ratio.

$^{+}p < 0.10$,

$^{*}p < 0.05$,

$^{**}p < 0.01$.