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Trajectories of Adolescent Alcohol Use after Brief Treatment in an Emergency Department

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Abstract

Objective—The primary aim of this study was to identify distinct classes of trajectories of adolescent substance use following a brief motivational interviewing (MI) intervention in an Emergency Department (ED). The secondary aim was to identify predictors of class membership.

Methods—Latent growth mixture modeling was used with 177 adolescents who participated in two randomized clinical trials evaluating MI for an alcohol-related event.

Results—Three classes were identified: (1) *moderate use, decreasers* consisting of 56.8% of participants; (2) *heavy use, decreasers*, consisting of 10.5% of participants, and (3) *heavy use sustainers*, consisting of 32.7% of participants. Hispanic ethnicity, parental monitoring, and days of high-volume drinking were significant predictors of class membership. Hispanic ethnic status and high levels of parental monitoring were associated with decreased likelihood of belonging to either of the two heavy use classes. More frequent high-volume drinking at baseline was associated with increased likelihood of belonging to the *heavy use, sustainer* class, and decreased likelihood of belonging to the *heavy use, decreaser* class. Across all three classes, being female and having frequent high-volume drinking at baseline were associated with worse response to the intervention.

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Conflict of Interest

All of the study authors declare they have no conflicts of interest.

Author Contributions

Dr. Spirito was the PI of the original trials and takes responsibility for the integrity of the data and the accuracy of the data analysis. Each author listed on the manuscript has seen and approved the submission of this version of the manuscript and takes full responsibility for the manuscript. Specific author contributions are as follows:

Concept and design of current analysis: Becker, Spirito, Hernandez, and Eaton. *Concept and design of original trials:* Spirito, Barnett, Lewander, Rohsenow, and Monti. *Statistical analysis:* Becker and Eaton. *Drafting of the manuscript:* Becker, Spirito, and Hernandez. *Critical revision of the manuscript for important intellectual content:* Barnett, Rohsenow, and Monti. *Obtained funding:* Spirito, Barnett, Lewander, Rohsenow, and Monti. *Administrative, technical, and material support:* Spirito, Barnett, Lewander, and Monti. *Study supervision:* Spirito and Lewander.

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Conclusions—These findings have important implications for identifying adolescents who may benefit from different or additional intervention, and for anticipating and informing families of adolescents' potential drinking course following treatment.

Keywords

adolescent; alcohol; trajectory; mixture modeling; motivational interviewing

1. Introduction

Trajectory analysis has become increasingly used to identify homogeneous subgroups within alcohol abusing populations (Chassin et al., 2004; 2002; Li et al., 2001). Longitudinal, epidemiologic studies have most commonly used categorical trajectory-based approaches in community populations to detect subgroups with different patterns of alcohol use onset and escalation. These studies have also examined relevant demographic, behavioral, and psychological characteristics associated with various patterns in order to understand factors that predict group membership. To date, most studies using categorical trajectory-based approaches have examined different patterns of change in adolescents' alcohol use from late adolescence to emerging adulthood (Bennett et al., 1999; Casswell et al., 2002; Flory et al., 2004). Further, a preponderance of studies have focused on trajectories of high-volume drinking (e.g., 5+ drinks per day), which represents a specific aspect of drinking behavior (Chassin et al., 2002; Schulenberg et al., 1996; Windle et al., 2005).

Relatively few studies have focused on normative drinking trajectories of young and mid-adolescents (age 11 to 18) in large community samples. Two of the earliest studies (Li et al., 2002; 2001) revealed only two alcohol use subgroups in 11 to 15 year olds. The primary difference between groups was baseline status: one group had high levels of initial use and another had low levels of initial use. More recent studies have found 3–5 distinct drinking trajectories in early and mid-adolescence. Trajectories found in at least three studies include light drinkers, heavy drinkers, and increasers (Colder et al., 2002; Danielsson et al., 2010; Van Der Vorst et al., 2009), although the pattern of increased drinking has been inconsistent across studies. Additionally, two studies found a distinct abstainer group (Flory et al., 2004; Van Der Vorst et al., 2009), whereas other studies did not find different groups of abstainers and light drinkers (Colder et al., 2002; Danielsson et al., 2010).

The three predominant trajectories found in community studies of early and mid-adolescents (e.g., light drinkers, heavy drinkers, and increasers) are consistent with those identified in a recent review by Sher and colleagues (2011). In their review of analyses using categorical trajectory-based approaches, the authors identified four predominant alcohol use trajectories across age groups: a low or non-using trajectory ("low"), a chronic/persistently high use trajectory ("high"), a trajectory of high use that gradually declines ("decreasers"), and a trajectory of low use that gradually increases ("increasers"). The authors further noted that studies of early and mid-adolescents might be less likely to detect a decreaser group due to the relatively low base rates of use in younger samples.

To date, only one study by Chung and colleagues (2005) has characterized alcohol use trajectories of adolescents (age 14 to 18) receiving addictions treatment. Adolescents in this study were treated across multiple clinics and received a variety of different intervention models with regard to modality (e.g., family, individual, group), duration, and dose of treatment. Analyses of this clinical sample indicated the same trajectories of alcohol use as identified in the review by Sher and colleagues: high, low, increasing, and decreasing. Thus, prior community and clinical studies of early to mid-adolescents suggest convergence around 3–4 trajectories, with high, low, and increasing trajectories appearing most often.

Despite a burgeoning, and seemingly converging, body of research identifying trajectories of alcohol use in early to mid-adolescence, no prior studies have examined alcohol trajectories following receipt of a brief, evidence-based intervention. The most common approach to analyzing treatment response has been to identify a uniform trajectory of change across all adolescents receiving the same intervention. Studies using this approach have generally found that brief evidence-based intervention is associated with reduced alcohol use (Bien et al., 1993; Moyer et al., 2002; Wilk et al., 1997). However, the extent to which adolescents exhibit different patterns of alcohol use following treatment is not well understood.

Characterizing different alcohol use trajectories in treated adolescents could potentially help clinicians and families to anticipate an adolescent's symptom course following treatment, which might facilitate the setting of tailored treatment goals (Maalouf et al., 2012). Furthermore, using categorical trajectory-based approaches could provide greater insight into whether treatment disrupts the typical patterns of use found in community samples. For instance, treatment could appear to have no effect on some adolescents, when in reality, treatment may be protective against a trajectory of increased use. Indeed, the detection of an "increaser" or sustained "high" group could help to identify those adolescents who might benefit from different or additional treatment.

Several clinical studies have recently targeted alcohol-abusing teens presenting to the ED, reasoning that the salience of an alcohol-related event may increase the adolescent's receptivity to treatment by capitalizing on a teachable moment (Barnett et al., 2002; Flocke and Lawson, 2009; Spirito et al., 2001; 2004). The primary aim of this study was to examine whether there were distinct subgroups of response to a motivational interview (MI) intervention with personalized feedback delivered in the ED following an alcohol-related event. In order to facilitate comparisons with the trajectories identified in prior community samples, this study used latent growth mixture modeling (LGMM), a categorical trajectory-based analytical approach. Data for this paper were taken from two separate randomized controlled trials (RCT; Spirito et al., 2004; 2011), both of which measured alcohol use in adolescents four times over 12 months. Based on the recent review by Sher and colleagues (2011), as well as the established finding that brief treatment is associated with reduced alcohol use (Bien et al., 1993; Moyer et al., 2002; Wilk et al., 1997), we expected to find 3 trajectories: *high, low, and decreasing*. Relative to the trajectories identified in prior studies of early and mid-adolescents, we expected receipt of the MI intervention to be associated with lower likelihood of detecting an increasing class and greater likelihood of detecting a decreasing class. The secondary aim was to explore whether variables easily collected in the ED - age, gender, ethnicity, depressed mood, and parental monitoring -were predictive of class membership.

2. Method

2.1. Participants

Participants were recruited to one of two RCTs evaluating the efficacy of MI plus personalized feedback for alcohol use (Spirito et al., 2004; 2011). Participants in the first RCT (Study 1) were enrolled between 1998 and 2002, and consisted of 97 adolescents (63.2 % male) between the ages of 13 and 18. Participants in the second RCT (Study 2) were enrolled between 2003 and 2008 and consisted of 80 adolescents (46.3% male) between the ages of 13 and 17.

In both studies, the primary inclusion criterion was an alcohol-related incident that merited ED treatment. The majority of adolescents (90%) were identified in the ED at an urban Level 1 Trauma Center in the Northeast by ED or biochemistry lab staff; ED staff referred adolescents who reported consuming any alcohol within six hours of admission, while

biochemistry lab staff referred adolescents with a blood alcohol concentration (BAC) level greater than .000. The remaining 10% of adolescents ($n = 17$, all enrolled in Study 2) were referred to the study by health care professionals in the community after experiencing an alcohol-related incident that could have but did not result in ED treatment.

Exclusion criteria for adolescents included: in police custody, attempted suicide, admitted for psychiatric evaluation, or non-English speaking. Eligible adolescents were not approached until their BAC was under 0.10% g/ml and/or they could pass a mental status exam. Of 412 eligible teens approached for both studies, 177 (43%) agreed to participate. The most common reason for non-participation was discharge from the ED prior to completion of recruitment.

Table 1 presents basic demographics for each sample and the combined sample. Relative to Study 2, the Study 1 sample was older and comprised of more males. There were no significant differences between the samples in mean frequency of alcohol use.

2.2. Intervention

In both studies, interventionists with Masters degrees in counseling or psychology conducted all aspects of baseline contact, including obtaining written informed consent from parents and assent from adolescents, administering the assessment, and conducting the intervention. Approximately half of the sample was unable to complete the intervention during their initial ED visit; these adolescents provided consent/assent and then returned for a follow-up appointment within a few days of discharge. The remaining adolescents completed all aspects of the baseline contact and received the intervention during their initial ED visit. The overseeing university and hospital Institutional Review Boards approved all research procedures. After completing the assessment, participants were randomized to one of two conditions based on assignments in sealed envelopes: MI intervention with personalized feedback (Barnett et al., 2001; Hernandez et al., 2011) or comparison condition. In Study 1, the comparison was 5-minutes of “standard care” ED advice, which consisted of brief advice to stop drinking and a handout on avoiding drinking and driving. In Study 2, the comparison was the adolescent MI condition plus a 35–45 minute parent-based MI called the Family Check-up (Dishion and Kavanagh, 2003). The 177 participants who received the adolescent MI without the Family Check Up comprise the current sample.

The adolescent MI condition was 35–45 minutes and consisted of standard MI plus personalized feedback that was derived from the baseline assessment and delivered in an MI style. Specifically, the intervention consisted of a review of perceived benefits and consequences of drinking, provision of personalized feedback with normative alcohol use comparisons, and the development of realistic goals related to drinking. In addition to being collaborative and empathic, interventionists attempted to develop discrepancies between the teen’s current drinking and longer-term goals, and support the teen’s sense of self-efficacy (Miller and Rollnick, 2001). In each study, interventions were audio recorded and later coded for adherence and fidelity to the MI intervention protocol by independent coders (see Spirito et al., 2004; 2011).

2.3. Measures

Measures were administered by research assistants blind to treatment at baseline, 3-months, 6-months, and 12-months. At baseline, adolescents completed measures of demographics, alcohol use, and depressed mood, while parents completed a measure of parental monitoring. At follow-up, adolescents completed the alcohol use measure.

Alcohol use—The Adolescent Drinking Questionnaire (ADQ; Jessor et al., 1989) was used to assess alcohol use at all four intervals. It assesses frequency of drinking (days per month) and frequency of high-volume drinking (days consumed 5+ drinks per month) over the prior three months, using 8-point Likert scales. This study uses the frequency of drinking item as the dependent variable to provide a broad view of adolescent drinking behavior, and includes baseline frequency of high-volume drinking as a predictor. Of note, the frequency of drinking days variable and frequency of high-volume drinking days variable were highly correlated ($r = .77, p < .005$), suggesting that the results of the current model are likely robust to measures of high-volume drinking.

Depressed mood—The Center for Epidemiologic Studies-Depression Scale (Radloff, 1977) was used to assess depressed mood at baseline. It contains 20 depressive symptoms that are each rated on a four-point scale from 0 (rarely or none of the time) to 3 (most or all of the time) and summed for a total score. The CES-D has demonstrated good internal consistency and test-retest reliability with both adults and adolescents (Radloff, 1977; 1991).

Parental monitoring—Six items assessing parental monitoring were selected from a survey of parenting practices related to teen drinking (Beck et al., 1995). Three items evaluated whether parents had rules related to alcohol use and three items evaluated parental enforcement of rules in response to hypothetical situations, including: teen wants to attend an alcohol party; teen returns home with alcohol on his/her breath; and teen needs a ride because he/she is too intoxicated to drive. Because each item had a different number of response options, item scores were divided by the number of responses to create an interpretable mean score. Mean scores for each item were then averaged to create a composite monitoring score. Composite parental monitoring scores ranged from 0 (lowest) to 1 (highest).

2.4. Missing data

Of 177 adolescents who completed baseline interviews, 161 (91%) participated in at least one follow-up; 149 (84%) participated in at least two, and 136 (77%) completed all three. A total of 141 adolescents (80%) completed the final 12-month assessment. Adjusting for multiple comparisons, a series of paired t-tests compared adolescents with or without complete longitudinal data on frequency of drinking days and the hypothesized predictors. Additional analyses compared adolescents who did or did not complete the 12-month assessment on each of the study variables. In both cases, no significant effects were revealed for any study variables, providing no evidence of attrition biases. Analyses were thus conducted with all available data.

2.5. Analysis Plan

LGMM was selected as the analytical approach to enable the identification of distinct alcohol use trajectories following receipt of MI, and to facilitate comparisons with prior community-based studies (see Sher et al., 2011). Whereas traditional growth models assume that all individuals' trajectories can be adequately described using a single estimate of growth parameters, LGMM allows for differences in growth parameters across unobserved subgroups (Muthen and Muthen, 2000; Muthén and Shedden, 1999). Because LGMM enables cross-group differences in both the shape of trajectories and the influence of predictors, it is well-suited to identify heterogeneity in response trajectories following brief intervention.

All analyses were conducted in MPlus version 6.0 (Muthen and Muthen, 2010), using full information maximum likelihood (FIML) estimation. FIML uses all available data, and has been shown to generate unbiased parameter estimates when data are missing at random

(MAR; Enders, 2006). The high retention and lack of differences between those adolescents with complete and incomplete data supported our use of FIML estimation.

Our analyses consisted of three steps. First, to facilitate model specification, we identified an unconditional (no covariates) single-class growth model with frequency of drinking days as the dependent variable. To determine the growth parameters for the LGMM, we systematically compared models with linear, quadratic, and freely estimated constraints. Second, we determined the optimal number of classes. We incrementally added classes to the unconditional model and compared fit using five indicators of model fit: Bayesian information criteria (BIC), Akaike's Information Criterion (AIC) Index, posterior probabilities, entropy, and the Lo, Mendell, and Rubin Likelihood Test (LMR-LRT). We sought a model with lower BIC and AIC values, higher posterior probabilities and entropy values, and a significant p-value for the LMR-LRT test.

The final step was to extend the LGMM to include covariate predictors of class membership. In this step, we simultaneously added all of the putative baseline variables to the model. Hypothesized predictors included gender, age, ethnicity, high-volume drinking days, depressed mood, parental monitoring, and trial participation (e.g., Study 1 vs. Study 2). Only those ethnic groups endorsed by over 15% of participants (e.g., Caucasian, Hispanic) were included as predictors. Consistent with guidelines for correct model specification (Muthén, 2004), we regressed both the latent class variable and the latent growth factors on the covariates, allowing each to be influenced by the covariates as well as predicted by them. In an iterative process, we sequentially removed those covariates that did not significantly predict class membership or any of the growth factors. We retained a final model in which the inclusion of covariates improved model fit and also predicted class membership. Model comparisons using -2 times the difference in the log-likelihood values (distributed as chi-square) evaluated whether the inclusion of significant predictors improved model fit relative to the unconditional model.

Throughout our modeling procedures, a number of specifications were used to facilitate convergence. Within-class variances were constrained to be equal across classes to define trajectories based on a pattern shared among individuals in a given class rather than being driven by variability. Statistically nonsignificant within-class variances were fixed to zero to facilitate estimation. To avoid potential problems with local optima (Hipp and Bauer, 2006), the number of random starts was increased to 5000 and the second stage of optimization increased to 100.

3. Results

3.1. Analyses of Alcohol Use Trajectory Classes

Preliminary analyses indicated that the best-fitting 1-class solution was an unconstrained model: the linear and quadratic growth models did not fit the data as well as the model in which the slope parameters were allowed to be freely estimated. The estimated slope parameters across the four time points were 0, 1.0, .80, and .87, reflecting an acute decrease in frequency of drinking days, followed by a slight rebound in use over the 12 month period. A trajectory with freely estimated constraints was maintained and tested in models with 1, 2, 3, 4, and 5-classes. A 6-class model was also tested, but it was not possible to obtain adequate model convergence.

Fit statistics of the possible class solutions are presented in Table 2. Interpretation of these statistics indicated that the BIC and AIC values continued to decrease with increasing numbers of classes. However, the entropy value, posterior probabilities, and LMR-LRT

statistic all favored a 3-class model. Thus, a 3-class model was used to test the influence of covariates.

3.2. Analyses of Hypothesized Predictors

In the full LGMM model, three of the eight predictors – study membership, Caucasian ethnicity, and age – did not have significant effects on the growth parameters or on class membership. Because the inclusion of too many covariates can impede estimation, these three covariates were excluded from the final model, leaving five predictors: Hispanic ethnicity, gender, depressed mood, parental monitoring, and high-volume drinking days. The final model with these predictors demonstrated significantly better fit than the model without predictors, $\Delta\chi^2(20, N=177) = 202.94, p < .001$. In addition, the entropy value with the covariates increased from .95 to .97, indicating improved classification accuracy.

Figure 1 depicts the fitted growth curves for the 3 trajectory classes in the conditional model. The pattern of trajectories indicated two decreaser classes and one sustained heavy use class. Class 1, the *moderate use, decreaser class* (56.8%), consisted of adolescents who presented with a moderate level of use and then experienced an acute reduction in use. Class 2, the *heavy use, decreaser class* (10.5%), consisted of youth who presented with heavy use and then experienced an acute decline in use. The primary difference between Class 1 and Class 2 appeared to be level of use at baseline. Class 3, the *heavy use, sustainer class* (32.7%), contained youth who presented with heavy use and exhibited sustained heavy use following the MI.

In addition to improving model fit and classification accuracy, the covariates had meaningful associations with class membership. Class 1 (*moderate use, decreaser*) was the largest class and was used as the reference group in logistic regression analyses assessing the degree to which each covariate affected the odds of belonging to a specific class. Relative to Class 1 (*moderate use, decreaser*), Hispanic ethnicity and higher levels of parental monitoring were both associated with lower likelihood of membership in the two classes characterized by more frequent days at baseline: Class 2 (*heavy use, decreaser*) and Class 3 (*heavy use, sustainer*). In addition, more high-volume drinking days at baseline was associated with lower likelihood of membership in Class 2 (*heavy use, decreaser*), and higher likelihood of membership in Class 3 (*heavy use, sustainer*). Finally, there was a trend ($p = .05$) for higher depressed mood to be associated with greater likelihood of membership in Class 2 (*heavy use, decreaser*) relative to Class 1 (*moderate use, decreaser*).

Several of the baseline predictors also had effects on the growth parameters. Across the three classes, only frequency of high-volume drinking days was associated with the latent intercept, such that adolescents with more high-volume drinking days at baseline also reported more days of use at baseline ($b = .88, p < .001$). Three other baseline variables – high-volume drinking days, gender, and depressed mood – were associated with the latent slope, reflecting an influence on change in frequency of drinking days across the 12-month assessment period. A positive effect on the slope indicated a better response to treatment, whereas a negative effect indicated a worse response. More high-volume drinking days at baseline and being female were each associated with a more negative effect over 12 months (for high-volume drinking, $b = -.71, p < .001$; for females, $b = -.47, p < .01$). By contrast, greater depressed mood was associated with a more positive response over the follow-up period ($b = .01, p < .05$).

4. Discussion

The primary aim of this study was to examine whether distinct subgroups of response to an MI intervention could be identified among adolescents who had experienced an alcohol-

related event. We initially hypothesized the emergence of three alcohol use trajectories following MI – high, low, and decreasers. In partial support of our hypothesis, we detected a sustained heavy use trajectory (*heavy use, sustainers*) and a decreasing trajectory (*moderate use, decreasers*). Also consistent with our hypothesis, and counter to the predominant trajectories in community samples, we failed to detect an increasing use trajectory, suggesting that the receipt of MI may have had a dampening effect on increased use over time. This is an important potential benefit of MI that would not be detected using conventional analytical approaches.

Counter to our hypothesis, we did not identify a sustained low use trajectory, but rather detected another decreasing trajectory, characterized by heavy use at baseline. In both of the decreasing trajectories, receipt of MI was associated with acute reductions in drinking days by 3-months and with a slight increase to a leveling off trajectory between 6 and 12 months. These results are consistent with those of previous adolescent alcohol abuse studies demonstrating strong intervention effects that decrease with length of follow-up (Monti et al., 1999; Tripodi et al., 2010). Taken together, our results indicate that about two-thirds of adolescents experience decreased use following MI; for these adolescents, MI may have its greatest effect on drinking behavior during the first 3 months following intervention. Future trials should examine whether adding booster sessions or pairing MI with another intervention could help to extend and/or strengthen these initial intervention effects.

The second aim of the current study was to explore whether data easily collected in an ED setting, including patient demographic variables (e.g., age, gender, ethnicity) and clinical variables (e.g., depressed mood, parental monitoring) would predict class membership. Results highlight the nature of the differences observed between the two heavy use group trajectories. More frequent high-volume drinking at baseline was associated with a trajectory of heavy use that was non-responsive to MI. Further, frequency of high-volume drinking at baseline was also associated with worse response to MI across all three classes. This finding is incongruent with previous findings demonstrating MI's effect on high-volume drinking (e.g., 5+ drinks per day) among college-age students (Borsari and Carey, 2000; Feldstein Ewing et al., 2007). However, some recent studies of college-age students have found evidence that brief interventions are not as effective with heavier and/or dependent drinkers (Carey et al., 2007; Moreira et al., 2009) or drinkers with high levels of impulsivity (Feldstein Ewing et al., 2009; MacKillop and Kahler, 2009). Future research might examine whether personality factors such as impulsivity might account for the relationship between high-volume drinking and non-response observed in this study. Also, our analyses cannot provide clinical guidance as to a threshold of heavy drinking that can identify risk of non-response to MI; future work might conduct sensitivity-specificity analyses to do so.

While gender was not one of predictors of class membership, gender was associated with the slope of response across all three classes. That is, the MI had a smaller effect on females' drinking trajectories across all three classes. Although a recent meta-analytic review of 119 studies supports MI's efficacy with both males and females (Lundahl et al., 2010), prior studies have generally focused on static, short-term outcomes. Therefore, future studies should examine gender as a potential moderator of drinking trajectories following MI intervention, as well as consider potential adaptations that could be made in order to develop and utilize MI intervention components that are sensitive to gender differences.

Results also revealed that adolescents identifying as Hispanic were more likely to be part of the *moderate use, decreaser* class, than the two heavy use classes. This finding is consistent with national survey data suggesting that Hispanic adolescents use alcohol less frequently than White non-Hispanic adolescents (Johnston et al., 2011). Also consistent with Hettema and colleague's (2005) review and theories supporting MI's idiographic perspective for use

with ethnic/racial minority populations, this study's findings suggest that the MI intervention may be particularly useful for Hispanic adolescents. However, this conclusion should be considered with caution given that Hispanics had more moderate use at baseline. Nonetheless, these findings emphasize the need to identify specific contributing, as well as protective factors in Hispanic adolescents' alcohol use trajectories and their response to MI interventions. Future research might consider the influence of ethnocultural variables such as acculturation, familism, ethnic identity and immigration status and experiences on Hispanic adolescents' alcohol use trajectories following brief interventions.

Parental monitoring was also associated with membership in the *moderate use, decreaser* class. This finding is consistent with previous research demonstrating the protective role that parental monitoring plays in safeguarding adolescents against alcohol use and related problems (Beck et al., 1999; Stattin and Kerr, 2000), and suggests that adolescent MI might be strengthened by adding a parenting component focused on increasing parental monitoring. Indeed, there is evidence adding a brief parent component for this population reduces alcohol use at follow-up more than an individual MI alone (Spirito et al., 2011).

Finally, there was a statistical trend indicating that adolescents reporting depressive symptoms were more likely to be part of the *heavy use, decreaser* class than the *moderate use, decreaser* class. It is possible that the adolescents reporting depressed mood and heavier alcohol use were more likely to be drinking as a way to cope with depression than those with moderate use. The experience of the alcohol-related event and an MI designed to review the pros and cons of drinking, including drinking to cope with depression, may have resulted in alternative strategies for coping with depressed mood other than drinking.

4.1. Limitations

Several limitations must be considered when interpreting the results. Most critically, because LGMM is a data-driven approach, it is important not to overly ascribe theoretical or conceptual meaning to the derived groups. In the review by Sher and colleagues (2011), the authors caution against the "reification of groups," particularly when the derived groups follow the prototypic pattern identified across prior studies (high, low, increasers, decreasers). In the current study, we used the prototypic pattern as a null model against which to test other trajectories, and found two meaningful differences: we detected a second decreaser group, and failed to detect an increaser group. Thus, our approach addressed some of the limitations of prior LGMM studies by focusing on deviations from the most commonly found solution.

Other limitations of this study pertain to the setting, sample, and measurement of predictors. Our findings on adolescents in an ED setting, none of which were actively seeking treatment, may not generalize to adolescents in outpatient substance abuse treatment. In addition, self-report data were not corroborated by either parents or peers, although there is no reason to expect misreporting to be systematically confounded with any trajectory class or predictor variable. Finally, there may be other important variables that could determine trajectories of alcohol use that were not assessed in this study, such as peer and sibling substance use.

4.2. Clinical Implications

Results of the current study have three major implications for clinical service and research. First, our results indicate that typical approaches to studying response to treatment using a uniform response curve may mask important differences across adolescents. Whereas prior studies have found that receipt of MI is associated with an acute reduction in use, our findings indicate that about one third of adolescents will have sustained heavy use.

Furthermore, our approach highlights an important potential benefit of MI – protection against a pattern of increased use – that would not be detected using conventional approaches. Second, the MI seemed to have its greatest effect on drinking behavior during the first three months following intervention. Therefore, clinicians may want to consider either pairing MI with another intervention or adding additional treatment at three months to sustain the initial effects of MI on adolescents' drinking trajectories. Finally, the approach used in this study may enable ED clinicians and researchers to better pinpoint factors that will affect adolescents' drinking course following intervention. This knowledge could help to inform families of adolescents' potential drinking course following treatment, and could guide subsequent individually tailored treatment recommendations. For example, ED clinicians might consider recommending parent sessions to augment MI for teens who report frequent high-volume drinking or minimal parental monitoring.

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Figure 1. Trajectories of days of drinking for the conditional latent growth mixture model with three classes ($N = 177$). *Note.* Frequency of drinking days scored on an 8-point Likert scale ranging from 0 (no days) to 7 (daily use).

Table 1

Participant Characteristics by Study

Characteristic	Study 1 (N = 97)	Study 2 (N = 80)	t or χ^2
Age (Mean (SD))	16.1 (1.4)	15.6 (1.2)	2.29 *
Sex			7.74 **
Male	67.0%	46.3%	
Female	33.0%	53.7%	
Race			4.90
White	77.3%	67.5%	
Hispanic	15.5%	22.5%	
Black	4.1%	8.8%	
Asian	2.1%	0.0%	
Unknown	1.0%	1.3%	
Drinking Frequency ^a (Mean (SD))	2.9 (1.9)	2.4 (1.5)	1.90

Note. Study 1 = Teen Alcohol Project; Study 2 = Project REFRAME.

^aDrinking frequency scored on an 8-point Likert scale ranging from 0 (none) to 7 (daily use).

*
p < .05,

**
p < .01

Table 2

Model Fit Indices for One- to Five-Class Unconditional Growth Mixture Models

No. of classes	Model fit indices				
	BIC	AIC	E	LMR-LRT test	LMR-LRT p-value
1	2839	2804	-	-	-
2	2663	2619	.98	179.77	.00
3	2625	2571	.95	50.06	.02
4	2615	2542	.94	16.56	.15
5	2593	2520	.91	36.63	.06

Note. BIC: Bayesian Information Criterion; AIC: Akaike's Information Criterion; E: Entropy; LMR-LRT test: Lo, Mendell, and Rubin likelihood ratio test.

Table 3

Covariate Prediction of Trajectory Class Membership: Odds Ratio Estimates

	Class 2	Class 3
	Heavy use, responder	Heavy use, non-responder
Sex	.28	-.13
Hispanic	-2.33 *	-1.68 *
Parental monitoring	-2.09 *	-1.29 *
Youth depressed mood	.05 <i>T</i>	-.00
High-volume drinking days	-1.44 **	.23 *
Overall model fit:		
-2 LL null model = 2540.30		
-2 LL final model with predictors = 2337.36; $\Delta\chi^2(20, N=177) = 202.94^{**}$		

Note. Class 1 (*moderate use, responder*) is the reference class for the odds ratio estimates.

T denotes trend at $p = .05$,

* $p < .05$,

** $p < .001$