Transitional Life Events and Trajectories of Cigarette and Alcohol Use During Emerging Adulthood: Latent Class Analysis and Growth Mixture Modeling

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ABSTRACT. Objective: Emerging adulthood (ages 18–25 years) has been associated with elevated substance use. Transitional life events (TLEs) during emerging adulthood in relation to substance use are usually examined separately, rather than as a constellation. The purposes of this study were (a) to explore distinct subgroups experiencing various TLEs during emerging adulthood, (b) to identify heterogeneous trajectories of cigarette and alcohol use during emerging adulthood, and (c) to examine the association of TLEs with cigarette and alcohol use trajectories. **Method:** Five waves of longitudinal data (mean age range: 19.5–26.0 years) were used from a community-based drug prevention program ($n = 946$, 49.9% female). Distinct subgroups of emerging adults who experienced various TLEs were identified using latent class analysis. Cigarette and alcohol use were examined using a latent growth mixture model. **Results:** A three-class model fit the data best in identifying TLE subgroups (new family, college attenders [NFCA]; uncommitted relationships, college attenders [URCA]; hibernators [HBN]). Three-trajectory models fit the data best for cigarette and alcohol use during emerging adulthood. The TLE categories were significantly associated with the cigarette ($p < .05$) and alcohol use groups ($p < .001$); specifically, the URCA and HBN groups were significantly more likely to be classified as accelerating cigarette users, relative to NFCA ($ps < .05$). The NFCA and HBN groups were significantly more likely to be classified as accelerating alcohol users, relative to URCA ($ps < .01$). **Conclusions:** To characterize an "at-risk" emerging adult group for cigarette and alcohol use over time, a range of life events during emerging adulthood should be considered. Interventions tailored to young adulthood may benefit from targeting the absence of these life events typifying "independence" as a potential marker for underlying substance use problems and provide supplemental screening methods to identify young adults with similar issues. (*J. Stud. Alcohol Drugs, 74,* 727–735, 2013)

SINCE ARNETT (2000) FIRST COINED the term *emerging adulthood* (ages 18–25 years), this developmental period has received increasing attention from researchers in various fields. Emerging adulthood is characterized by increased freedom, instability, self-exploration, feeling caught in between, and being self-focused (Arnett, 2007). Along with these characteristics comes a marked increase in risky behaviors (e.g., heavy drinking, experimenting with illicit drugs, and impaired driving; Arnett, 2000). Arnett (2005) hypothesized that psychological experiences associated with emerging adulthood—specifically, identity conflicts and instability experienced during this developmental period—would lead to increased substance use. He also contended that decreased social control and increased freedom of selecting peers and romantic partners could be positively associated with substance use.

Research has indeed shown that personal and psychological factors unique to emerging adulthood affect health risk behaviors. Schwartz et al. (2010) found that college students with lower identity consolidation showed higher levels of risky behaviors, including illicit drug use, unsafe sexual behaviors, and impaired driving. Also, poor parental relationship (e.g., lower perceived parental monitoring, higher parental permissibility for drugs and alcohol, and lower parental nurturance) during emerging adulthood has been shown to be related to greater drug and alcohol use among college students (Abar et al., 2009; Padilla-Walker et al., 2008; Schwartz et al., 2010).

Typically, such psychological changes are accompanied by transitional life events (TLEs) that are common to emerging adults (Arnett, 2000). Leaving home to attend college or to begin a career, establishing new living arrangements, becoming a parent, and engaging in a committed relationship are examples of TLEs. These TLEs signify developmental tasks in multiple domains. These domains and contexts typically involve occupational, social, and romantic competency (Schulenberg et al., 2004), as well as identity and achievement (Schulenberg and Maggs, 2002). Although the definition of "positive" development during emerging adulthood has changed over time and is still quite varied, the importance of achieving these tasks has been emphasized for psychosocial development and functioning (Hawkins

et al., 2012; Schulenberg et al., 2004). Further, these major transitions themselves are believed to influence the trajectory of health behaviors such as substance use–related problems (Bachman et al., 2002; Schulenberg and Maggs, 2002; Schulenberg et al., 2004).

The trajectories of substance use and related problems generally show increases through late adolescence and peaks during emerging adulthood, followed by steady declines in young adulthood (Gotham et al., 1997; Muthén and Muthén, 2000a). Past research has linked this normative, "maturing out" phenomenon to dynamic role transitions common during emerging adulthood (Dawson et al., 2006; Kypri et al., 2004; Staff et al., 2010). Adapting to adult roles (e.g., entry into/exit from marriage or becoming a parent) has been found to be positively related to "natural" recovery from alcohol dependence (Dawson et al., 2006), although inconsistent effects of marriage on problematic alcohol use have been found across studies (Gotham et al., 1997). Staff et al. (2010) demonstrated that role transitions involving family formation may be the most influential in reducing substance use, relative to career- or school-related role transitions. In contrast, independent living arrangement has been related to increased alcohol use among young adults with or without the history of illicit substance use (Kypri et al., 2004). Important familial and individual covariates—such as family history of substance use (Dawson et al., 2006), personality traits (Gotham et al., 1997), and self-perceived maturity (Winograd et al., 2012)—have also been noted.

Other studies have focused on the adverse effects of attending college on substance use, (e.g., elevated heavy drinking, alcohol use, and marijuana use; Timberlake et al., 2007; White et al., 2006). It has been found that attending college led to increased frequency of alcohol use and increased heavy episodic drinking while transitioning from high school to emerging adulthood (White et al., 2006). Attending college also moderated the effects of factors predicting alcohol use. Sensation-seeking tendency, for instance, was inversely related to alcohol use for college attenders but not for their non–college-attending peers (White et al., 2006). Regarding cigarette use, White et al. (2009) examined transitions across progressive smoking stages during emerging adulthood. They showed that college-attending emerging adults reported lower overall smoking than their non–college-attending peers and that those emerging adults who had already been heavy smokers had the highest likelihood of remaining heavy smokers 2 years after high school. The college-attending group also showed lower probabilities of transitioning from light and intermittent smokers into heavy smokers than the non–college attendees (White et al., 2009).

With a few exceptions (Staff et al., 2010), most studies on TLEs have involved college-attending cohorts (Gotham et al., 1997; Winograd et al., 2012) and/or those with prior alcohol dependency (Dawson et al., 2006; Kypri et al., 2004). To improve generalizability of the current literature, more research is warranted to investigate the influence of transitional roles on substance use among a general population that includes non–college attendees.

Latent class approach to transitional life events during emerging adulthood

In the literature, TLEs during emerging adulthood in relation to substance use have often been examined separately (Dawson et al., 2006; Staff et al., 2010), rather than as a constellation of events. In reality, however, various life events tend to occur conjointly. Therefore, assessing such contexts simultaneously, as well as their association to substance use, might be more ecologically valid. One way to achieve this goal is by classifying subgroups based on various life events that are common to emerging adulthood. For instance, some emerging adults might experience a combination of life events (e.g., attending college, moving away from home, and experiencing troubles with romantic partners) that place them at an elevated risk for alcohol use. For others, transitional roles incompatible with risky behaviors (e.g., getting married, having children, and starting a career) might discourage substance use (Staff et al., 2010). Thus, it is worthwhile to investigate heterogeneity with respect to having experienced TLEs during emerging adulthood. In addition, inclusion of a non–college population in the study would add to ecological validity.

In contrast to the traditional, variable-centered approach, a latent class analysis (LCA) yields unobserved (latent) classes of people, based on categorical indicators (Muthén and Muthén, 2000b). In classifying people into distinct groups, LCA is based on measurement theory (i.e., true and error scores) and quantifies the extent to which indicators are not perfectly related to class membership (i.e., measurement error) (Lanza et al., 2010). LCA models estimate the probabilities of identified classes and probabilities of responses for each indicator, conditional on class membership. Further, probabilities for each class are also estimated for each individual (i.e., posterior probabilities) (Muthén and Muthén, 2000b). With LCA, the goal is to obtain the most parsimonious and interpretable set of classes. The resulting latent class variable would represent the groups of homogeneous individuals who show similar probabilities of experiencing certain combinations of TLE. The groups of individuals would be heterogeneous across different TLE classes. We can further investigate the extent to which subgroups of TLEs typically experienced during emerging adulthood are related to developmental trajectories of substance use.

Modeling heterogeneity of growth trajectories of substance use

Latent growth mixture modeling (LGMM; Muthén, 2001) extends the traditional latent growth modeling to allow for

individual variations in growth factors within latent, distinct developmental classes (Tucker et al., 2005). LGMM helps differentiate trajectories of substance use and, in doing so, affords opportunities for tailoring interventions according to those trajectories. Using LGMM strategies, researchers have demonstrated heterogeneous patterns of development in adolescent alcohol use (Colder et al., 2002; Li et al., 2001), in cigarette smoking from adolescence to adulthood (Orlando et al., 2004), and in marijuana use from adolescence to adulthood (Ellickson et al., 2004; Schulenberg et al., 2005; Windle and Wiesner, 2004). These results support the more reasonable and less stringent assumption of LGMM that individuals exhibit multiple pathways to substance use than the latent trajectory models that do not allow for random effects (e.g., latent class growth analysis) (Glantz and Leshner, 2000). Some authors argue that LGMM is a better representation of the data than any prior statistical methods (Muthén, 2004; Tucker et al., 2005). In this study, we used LGMM, currently the optimal approach in modeling heterogeneous trajectories, to explore how substance use trajectories during emerging adulthood vary in relation to subgroups experiencing certain combinations of TLEs.

Thus, the purposes of the current study were (a) to explore distinct subgroups of emerging adults who experience different types of TLEs documented to be associated with substance use, (b) to model heterogeneous trajectories of monthly cigarette and alcohol use during emerging adulthood, and (c) to examine the relationship between latent classes of TLEs and patterns of trajectories of cigarette use and alcohol use during emerging adulthood.

Method

Data and sample

A subsample from the longitudinal data for a cohort from the Midwestern Prevention Project was used (see Pentz et al., 1989, for more details of the study). All study procedures were approved by the University of Southern California Institutional Review Board. At baseline in 1984, participants were students in the sixth or seventh grades (11–12 years of age); the first follow-up was conducted 6 months after the baseline. After another four annual follow-ups of the original sample, a subsample of 1,206 was interviewed annually through 1994 and then every 18 months thereafter until 2000. Almost all participants had turned 18 years of age by 1993. The current study focuses on five waves of data for the participants who were in seventh grade at baseline ($N = 1,001$), beginning in 1993 ($M_{age} = 19.43$ years, $SD = 0.61$) through 1999 ($M_{age} = 24.03$ years, $SD = 3.54$). Therefore, subsequent sections pertain to the waves of data collected during emerging adulthood. The analyses included only those participants who had data for at least one emerging adulthood wave ($n = 946$). There were 30 different patterns of missingness for monthly cigarette use (MCIG) and 31 patterns of missing for monthly alcohol use (MALC); 40.7% of the sample had complete data on MALC, and 44.0% of the sample had complete data on MCIG. Fifty-five participants (5.5%) were excluded from the analyses due to missing on the outcome variables for all emerging adulthood waves; data values for these individuals could not be imputed because no information was available. There was no significant difference in age and gender distribution between the sample used in this study and those excluded from the analyses. There were significantly more non-White participants among those who were excluded from the analyses than in the sample analyzed (38.18% vs. 24.20%). Those who were excluded from the analyses showed greater levels of cigarette use at baseline than the sample analyzed ($p = .002$); the two groups did not differ in the amount of alcohol use at baseline.

Measures

Transitional life events during emerging adulthood. At each follow-up during emerging adulthood, participants were asked to report whether they experienced each of the total 26 TLEs in the past year. The literature on psychological and social development in young adulthood (Arnett, 2000; Hawkins et al., 2012; Schulenberg et al., 2004; Shanahan, 2000) guided our selection of pivotal domains as interpersonal/intimate relations, postsecondary education, and occupational functioning. Seventeen of these items were determined not to be pertinent to transitional developmental tasks (e.g., death of friend/family, parental divorce, being victim of crime) and, therefore, were not included as indicators. Nine relevant TLE variables were used in constructing the LCA model. These were starting a new steady relationship, getting engaged, getting married, having a child, breaking up with boyfriend/girlfriend or divorcing, moving out of parents' home, experiencing major financial difficulties, starting to attend college, and starting a new job. Responses to these items were binary (*yes* or *no*). Life event indicators were subsequently recoded as dichotomous variables to reflect ever experiencing the event of interest during the entire emerging adulthood period.

Monthly cigarette use and monthly alcohol use. At each follow-up, participants were asked about the number of cigarettes and alcoholic drinks they consumed in the past month. MCIG was measured with 6-point scales in terms of number of cigarettes used in past month: 1 (*none*), 2 (*one puff to one cigarette*), 3 (*2–20 cigarettes*), 4 (*>1 pack but <6 packs*), 5 (*6–10 packs*), 6 (*>10 packs*). MALC was measured with a 7-point scale to assess monthly consumption level in past month: 1 (*none*), 2 (*≤1 drink*), 3 (*2–4 drinks*), 4 (*5–10 drinks*), 5 (*11–20 drinks*), 6 (*>20 drinks but <100 drinks*), 7 (*≥100 drinks*). The test–retest reliability of these drug use measures exceeded .75 (Sussman et al., 1998).

TABLE 1A. Model-fit indices for latent class analysis for transitional life events

Variable	No. of classes		
	2	3	4
No. of parameters	19	29	39
Log likelihood	-4,885.688	-4,752.146	-4,713.591
AIC	9,809.375	9,562.292	9,505.182
BIC	9,900.726	9,701.722	9,692.691
N-adjusted BIC	9,840.385	9,609.623	9,568.833
Lo–Mendell–Rubin testing the null hypothesis	1 vs. 2	2 vs. 3	3 vs. 4
Lo–Mendell–Rubin probability	<.001	<.001	.197
Entropy	.636	.700	.688

Notes: No. = number; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion.

Statistical analysis

Latent class analysis. LCA is an optimal strategy for identifying unobserved (latent) subpopulations represented in a heterogeneous sample, using categorical, cross-sectional indicators. A series of latent class models was iteratively conducted using TLE indicators. A variety of model-fit indices were evaluated including Pearson chi-square, likelihood ratio chi-square, Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and sample size–adjusted BIC. Model fits were compared to arrive at the most parsimonious and interpretable model. Lo–Mendell–Rubin likelihood ratio (LMRLR) compared n versus $n − 1$ class models (Lo et al., 2001). Based on LMRLR test, the three-class model was selected as the best-fitting model (Table 1a).

Latent growth mixture model. LGMMs were conducted to identify heterogeneous classes of growth trajectories for MCIG and MALC. The final models for both MCIG and MALC were determined in the following fashion. First, a single-class model with linear growth and another with linear + quadratic growths were compared. For both outcomes, models with linear + quadratic growth factors fit the data better; this was also corroborated by our previous work showing nonlinear patterns of substance use during emerging adulthood (Chou et al., 2012, unpublished data). To obtain a finite number of latent classes of trajectories, a series of mixture models was conducted for each substance outcome. The following model-fit indices were evaluated: Pearson chi-square, likelihood ratio chi-square, AIC, BIC, and sample size–adjusted BIC (Tables 1b and 1c). As the number of classes increased, AIC and BIC decreased, indicating improved model fit. LMRLR compared n versus $n − 1$ trajectory models (Lo et al., 2001). Content and distinctiveness of classes of trajectories were also considered. AIC, *n*-adjusted BIC, and LMRLR clearly favored three-trajectory model for MCIG (Table 1b). For MALC, even though model-fit indices favored the five-trajectory model, solution for the five-trajectory could not reach global maximum; neither could the solution for the four-trajectory model (Table 1c).

Given the local maxima problems of four- and five-trajectory models, we adapted the three-trajectory model.

All analyses were conducted using Mplus Version 6.1 (Muthén and Muthén, 1998–2011). Last, the associations among the obtained classes of MCIG, MALC, and TLE were examined.

Results

Three latent subgroups with respect to transitional life events during emerging adulthood

Three distinct subgroups of TLE were identified (Figure 1). A prevalent class showed high probability of going to college and experiencing new relationships but with low probability of getting engaged or married (uncommitted relationships, college attenders [TLE-URCA]; 38.5%, $n = 348$). Another group, equally prevalent as URCA, exhibited overall low probability of such significant TLEs as attending college, moving out of parents' homes, and getting a new job (hibernators [TLE-HBN]; 37.7%, $n = 341$). About a quarter of the sample was expected to belong to a class characterized as new family, college attenders (TLE-NFCA) (23.9%, $n = 216$).

Three latent classes of trajectories of monthly cigarette use during emerging adulthood

A three-trajectory model fit the data best in describing MCIG during emerging adulthood (Figure 2). A majority of the sample was classified as steady decelerators (SDC; 73.8%, $n = 698$). A majority of nonsmokers (i.e., one puff to one cigarette or less in the past month) were classified as SDC, ranging from 72.2% at Wave 1 to 100.0% at Wave 5. Approximately one quarter of the sample was classified as steady accelerators (SAC; 22.7%, $n = 215$). A small proportion of the participants (3.5%) constituted another class of trajectory who maintained their MCIG throughout emerging adulthood (moderate maintainers [MMC]; $n = 33$).

TABLE 1B. Model-fit indices for latent growth mixture modeling for the number of cigarettes used per month

Variable	No. of classes		
	2	3	4
No. of parameters	18	22	26
Log likelihood	-6,307.221	-5,940.557	-5,575.965
AIC	12,650.442	11,925.115	11,203.930
BIC	12,737.783	12,031.864	11,330.088
N-adjusted BIC	12,680.616	11,961.994	11,247.513
Lo–Mendell–Rubin testing the null hypothesis	1 vs. 2	2 vs. 3	3 vs. 4
Lo–Mendell–Rubin probability	<.001	<.001	.196
Entropy	.873	.892	.895

Notes: No. = number; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion.

TABLE 1C. Model-fit indices for latent growth mixture modeling for the number of drinks per month

Variable	No. of classes			
	2	3	4	5
No. of parameters	18	22	26	30
Log likelihood	-7,001.826	-6,864.778	-6,810.901	-6,713.175
	14,039.652	13,773.557	13,673.801	13,486.350
BIC	14,126.993	13,880.306	13,799.959	13,631.918
N-adjusted BIC	14,069.826	13,810.435	13,717.385	13,536.639
Lo–Mendell–Rubin testing the null hypothesis	1 vs. 2	2 vs. 3	3 vs. 4	4 vs. 5
Lo–Mendell–Rubin probability	<.001	<.001	<.001	.261
Entropy	.769	.880	.867	.898

Notes: No. = number; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion.

Three latent classes of trajectories of monthly alcohol use during emerging adulthood

A three-trajectory model yielded the following classes of growth patterns for MALC during emerging adulthood (Figure 3). About half of the sample was characterized by steady increase in alcohol use through emerging adulthood (steady accelerators [SAA]: 50.9%, *n* = 481). One quarter of the sample was classified as moderate maintainers (MMA; 24.9%, *n* = 236), and the remaining quarter of the sample was expected to belong to a class of growth pattern described as steady decelerators (SDA; 24.2%, *n* = 229).

Relationship between monthly cigarette use, monthly alcohol use, and transitional life events during emerging adulthood

The TLE subgroups were significantly associated with the MCIG, $\chi^2(4, n = 905) = 9.51$, $p < .05$, and MALC classes, $\chi^2(4, n = 905) = 52.7$, $p < .001$ (Table 2). Specifically, the TLE-URCA and TLE-HBN groups were significantly more likely to be classified as SAC, relative to TLE-NFCA (odds

ratios [ORs] = 1.98, 1.72, ps < .05, respectively). The likelihood of being classified as SAC did not differ between the TLE-URCA and TLE-HBN groups (p = .42). The TLE-NFCA and TLE-HBN groups were significantly more likely to be classified as SAA relative to TLE-URCA (ORs = 1.71, 2.31, ps < .01, respectively). The TLE-HBN group was marginally more likely to be classified as SAA than TLE-NFCA (p = .09).

Supplemental analyses of heavy drinking trajectories and transitional life events during emerging adulthood

Supplemental analyses were conducted using the frequency of heavy drinking (i.e., the number of times having been drunk) in the past month (MHVY), also measured with a 7-point scale: 1 (*never*), 2 (*not been drunk in the last month*), 3 (*1 time*), 4 (*2 or 3 times*), 5 (*4–6 times*), 6 (*7–10 times*), 7 (*>10 times*). We found that a three-trajectory model also fit the data best for MHVY (steady accelerator [SAH]: *n* = 946, 7.3%; steady decelerator [SDH]: 76.1%; moderate maintainers [MMH]: 16.7%, data not shown). The TLE-NFCA and TLE-HBN groups were significantly less likely
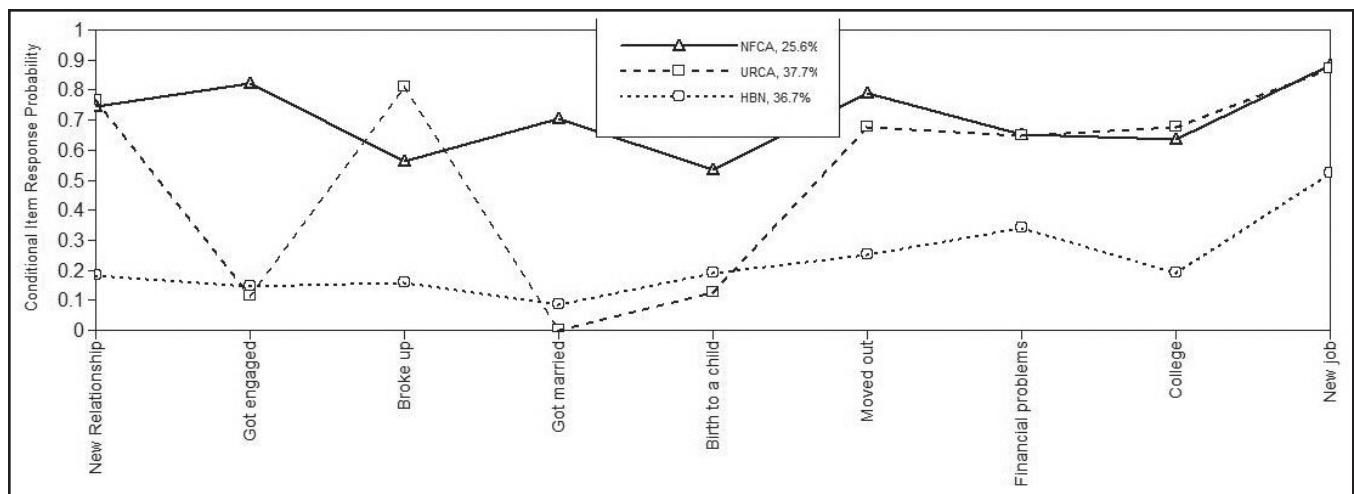

FIGURE 1. Conditional item response probabilities of latent classes of transitional life events during emerging adulthood (*n* = 905)

TABLE 2.   Column proportion of use trajectories for transitional life events latent class

Variable	New family, college attenders [NFCA]	Uncommitted relationships, college attenders [URCA]	Hibernators [HBN]
No. of cigarettes used per month (MCIG)	(n = 216)	(n = 348)	(n = 341)
Steady accelerators (SAC)	.17	.27	.24
Steady decelerators (SDC)	.78	.69	.74
Moderate maintainers (MMC)	.05	.04	.02
No. of drinks per month (MALC)	(n = 216)	(n = 348)	(n = 341)
Steady accelerators (SAA)	.54	.39	.61
Steady decelerators (SDA)	.14	.34	.21
Moderate maintainers (MMA)	.32	.27	.18
Frequency of heavy drinking (MHVY)	(n = 214)	(n = 347)	(n = 328)
Steady accelerators (SAH)	.03	.12	.05
Steady decelerators (SDH)	.86	.69	.82
Moderate maintainers (MMH)	.12	.19	.13

Notes: The final sample sizes vary per the number of cases excluded from the analyses due to missing on the outcome variables for all emerging adulthood waves (55 cases excluded for MCIG and MALC; 71 cases excluded for MHVY). No. = number.
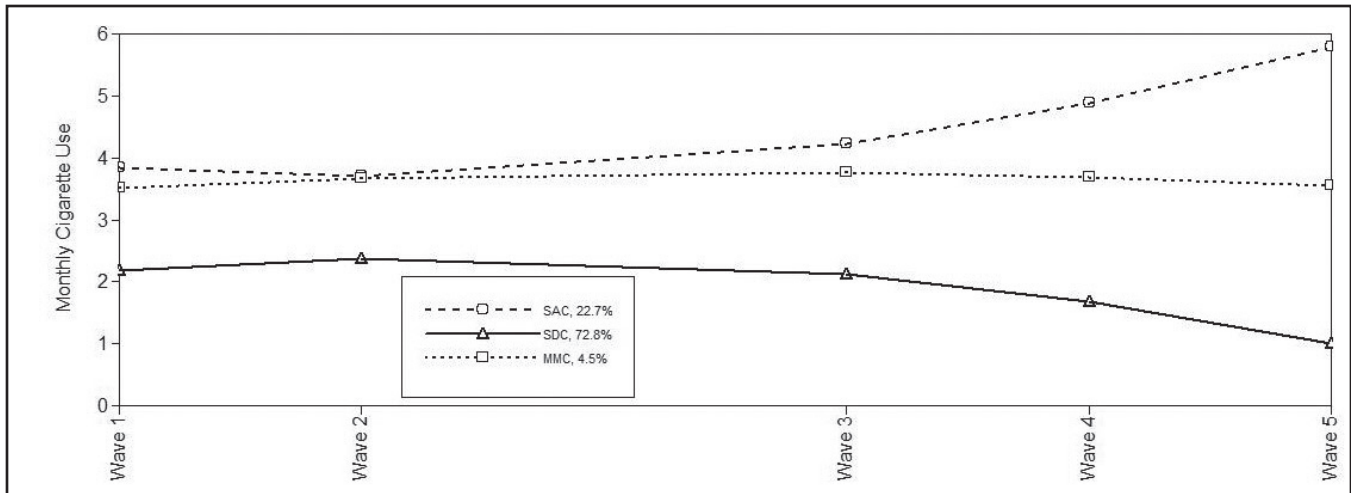

FIGURE 2.   Growth profiles of monthly cigarette use during emerging adulthood (n = 946)
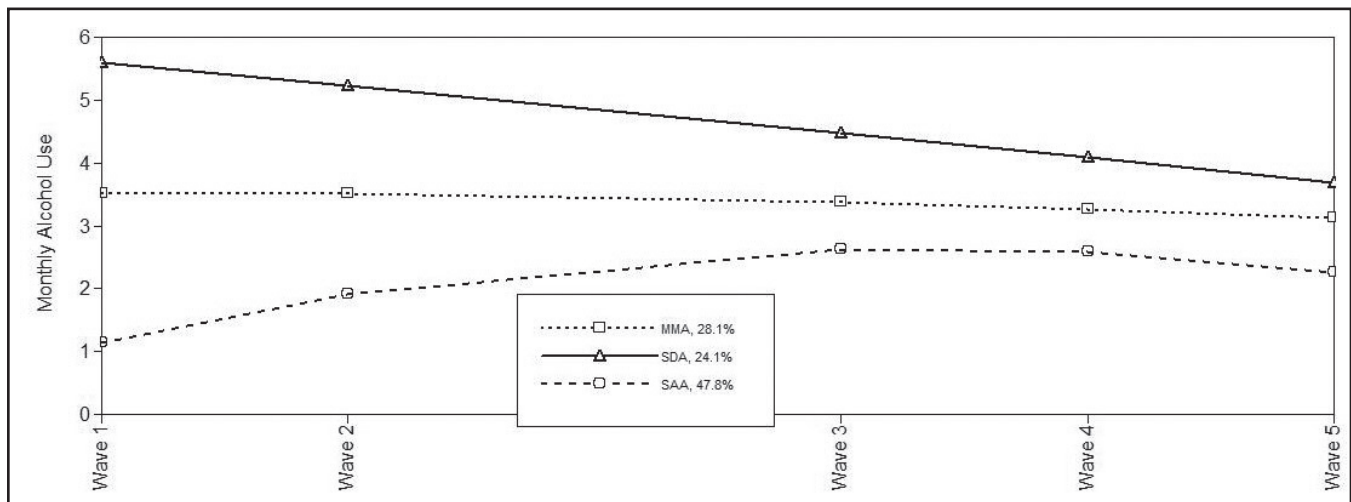

FIGURE 3.   Growth profiles of monthly alcohol use during emerging adulthood (n = 946)

to be classified as SAH, relative to TLE-URCA (OR = 0.23, 0.42, ps < .01, respectively). The TLE-NFCA and TLE-HBN groups showed similar likelihood of being classified as SAH (p = .21). The TLE-NFCA and TLE-HBN groups were significantly more likely to be classified as SDH, relative to TLE-URCA (ORs = 2.21, 1.49, ps < .03, respectively). The TLE-NFCA group was marginally more likely to be classified as SDH than the TLE-HBN group (p = .09).

Discussion

To the best of our knowledge, the current project is the first attempt to construct latent subgroups based on TLEs experienced during emerging adulthood and to examine their association with longitudinal cigarette and alcohol use trajectories. Approximately one quarter of our sample showed high probabilities of experiencing life events transitioning into adulthood (e.g., starting new family and careers, attending college). The rest of the sample was roughly equally divided between the unmarried/college attendees and those not likely to have experienced these transitions. Our findings support that LCA provides an adequate alternative to a variable-centered approach in contextualizing TLEs during emerging adulthood as they relate to growth patterns of substance use. Also consistent with the existing research (Colder et al., 2002; Li et al., 2001; Orlando et al., 2004), we demonstrated heterogeneity in growth patterns of cigarette and alcohol use during the emerging adulthood period. The majority of our nonclinical sample (~73%) showed a decreasing (or non-use) trend of cigarette use during emerging adulthood, which closely coincides with the national smoking rates (~28%) among U.S. adults ages 18–24 years recorded at about 1999 (Centers for Disease Control and Prevention [CDC], 2001). In contrast, the majority of the sample (~76%) exhibited an increasing level or continued moderate level of alcohol use during emerging adulthood. For frequent heavy drinking, however, a decreasing trend was observed for a majority of the sample (~76%); approximately a quarter of the sample showed either an increasing or continued moderate frequency of heavy drinking.

In addition, we found that emerging adults who experienced different combinations of transitional events showed varying degrees of risk for cigarette and alcohol use. For instance, the unmarried/college-attending emerging adults were more likely to report an increase in cigarette use than their college-attending counterparts who were starting a new family. In contrast, the latter group was more likely to engage in a steady increase in the quantity of alcohol use than the former group. These findings contribute to the current literature (Timberlake et al., 2007; White et al., 2009) in that family structure and living arrangement are important moderators to consider when addressing substance-related outcomes among young adults attending college. It is important to note that the unmarried/college-attending emerging

adults were more likely to show continued frequent heavy drinking, which is more symptomatic of problematic alcohol use. This finding is consistent with recent studies (Dawson et al., 2006; Staff et al., 2010) in which a greater likelihood of heavy drinking was found to be associated with the lack of family and/or relational transitional roles.

Further, the subgroup labeled hibernators exhibited a higher risk of increased use over time for both cigarettes and alcohol. The characteristics of this latent group also revealed that not receiving postsecondary education is accompanied by other factors (e.g., low probabilities of moving out of parents' homes and applying themselves to new careers). The prevalence of the hibernator group in our sample (~40%) and their higher likelihood of exhibiting problematic trajectories of substance use raise concerns. That the hibernator class was more likely to report a steady increase in both cigarettes and alcohol use is consistent with the findings reported by Staff et al. (2010) in that the lack of experiencing family-, social-, and work-related transitional roles is associated with increased alcohol and cigarette use. Contrary to our findings, however, Staff et al. (2010) found that residing with parents was related to decreased alcohol and cigarette use. This might underscore the significance of selection of particular statistical methods (i.e., regression analysis vs. LCA) in examining the effects of the transitioning events (Cunningham, 2005).

Thus, the findings of the present study call for increased public health services targeted to young adults who report similar patterns of absence of timely typical developmental transitions. Our results may signify underlying psychological distress of these individuals who have not successfully negotiated at least some of these developmental transitions and tasks (Schulenberg et al., 2004). Although the definition of positive development in early adulthood varies in the current literature, "successful developmental transitions" in this period generally refers to achievement in various contexts with regard to career, education, and social roles (Moore and Glei, 1995; Schulenberg et al., 2004). Thus, the continued increase in and/or steady high levels of cigarette and alcohol use associated with the hibernator and unmarried/college-attending subgroup might represent underlying psychopathology that requires attention from public health providers.

Limitations, strengths, and implications

Because of extensive missingness, we did not account for other illicit drug use (including marijuana), which has been documented to conjointly vary with alcohol and tobacco use (Palmer et al., 2009) and to be independently related to various outcomes in young adulthood (Fergusson et al., 2002). With regard to problematic alcohol use, the *frequency of heavy drinking* variable used in the supplemental analyses also had low response rate (only 25% of sample with complete data). Further, because we treated the TLEs

cumulatively over the entire emerging adulthood period, we are unable to determine the temporality between cigarette/alcohol use and life events. Past research has shown that the temporal proximity of transitional events is associated with the likelihood of maturing out of alcohol dependence (Dawson et al., 2006). We also did not include individual-difference covariates (e.g., family history of substance use), which have been linked to substance use behavior across transition periods (Gotham et al., 1997). Last, the generalizability of our findings is limited because our sample is from a single Midwestern state and is racially homogeneous (75.3% White).

Nevertheless, our study demonstrates the importance of considering TLEs experienced during emerging adulthood in multiple domains simultaneously in order to effectively characterize "at-risk" groups for cigarette and alcohol use over time. Inclusion of non–college attendees was one of the current study's strengths. The hibernator subgroup identified in our study, in particular, underscores the importance of targeting psychosocial characteristics of a non–college population when addressing substance use among emerging adults. Also, among emerging adults who attended college, those who had not attained other life transitions (e.g., being engaged, entering parenthood) showed increased odds of continued, frequent heavy drinking. Interventions tailored to young adulthood should consider the absence of these transitions as a potential marker for underlying substance use problems and provide supplemental screening methods to identify young adults with similar issues.

References

Abar, C., Abar, B., & Turrisi, R. (2009). The impact of parental modeling and permissibility on alcohol use and experienced negative drinking consequences in college. *Addictive Behaviors, 34,* 542–547.

Arnett, J. J. (2000). Emerging adulthood. A theory of development from the late teens through the twenties. *The American Psychologist, 55,* 469–480.

Arnett, J. J. (2005). The developmental context of substance use in emerging adulthood. *Journal of Drug Issues, 35,* 235–254.

Arnett, J. J. (2007). Emerging adulthood: What is it, and what is it good for? *Child Development Perspectives, 1,* 68–73.

Bachman, J. G., O'Malley, P. M., Schulenberg, J. E., Johnston, L. D., Bryant, A. L., & Merline, A. C. (2002). *Why substance use declines in young adulthood: Changes in social activities, roles, and beliefs.* Mahwah, NJ: Lawrence Erlbaum Associates.

Centers for Disease Control and Prevention [CDC] (2001, October 12). Cigarette smoking among adults—United States, 1999. *Morbidity and Mortality Weekly Report, 50,* 869–873. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5040a1.htm

Chou, C.-P., Huang, Z., Huh, J., Liao, Y., & Pentz, M.A. (2012). [*Nonlinear patterns of substance use during emerging adulthood*]. Unpublished raw data.

Colder, C. R., Campbell, R. T., Ruel, E., Richardson, J. L., & Flay, B. R. (2002). A finite mixture model of growth trajectories of adolescent alcohol use: Predictors and consequences. *Journal of Consulting and Clinical Psychology, 70,* 976–985.

Cunningham, J. (2005). On reasons for drinking less: A framework of methodological considerations. *Addiction, 100,* 1886–1888.

Dawson, D. A., Grant, B. F., Stinson, F. S., & Chou, P. S. (2006). Maturing out of alcohol dependence: The impact of transitional life events. *Journal of Studies on Alcohol, 67,* 195–203.

Ellickson, P. L., Martino, S. C., & Collins, R. L. (2004). Marijuana use from adolescence to young adulthood: Multiple developmental trajectories and their associated outcomes. *Health Psychology, 23,* 299–307.

Fergusson, D. M., Horwood, L. J., & Swain-Campbell, N. (2002). Cannabis use and psychosocial adjustment in adolescence and young adulthood. *Addiction, 97,* 1123–1135.

Glantz, M. D., & Leshner, A. I. (2000). Drug abuse and developmental psychopathology. *Development and Psychopathology, 12,* 795–814.

Gotham, H. J., Sher, K. J., & Wood, P. K. (1997). Predicting stability and change in frequency of intoxication from the college years to beyond: Individual-difference and role transition variables. *Journal of Abnormal Psychology, 106,* 619–629.

Hawkins, M. T., Villagonzalo, K. A., Sanson, A. V., Toumbourou, J. W., Letcher, P., & Olsson, C. A. (2012). Association between positive development in late adolescence and social, health, and behavioral outcomes in young adulthood. *Journal of Adult Development, 19,* 88–99.

Kypri, K., McCarthy, D. M., Coe, M. T., & Brown, S. A. (2004). Transition to independent living and substance involvement of treated and high risk youth. *Journal of Child & Adolescent Substance Abuse, 13,* 85–100.

Lanza, S. T., Savage, J. S., & Birch, L. L. (2010). Identification and prediction of latent classes of weight-loss strategies among women. *Obesity, 18,* 833–840.

Li, F., Duncan, T. E., & Hops, H. (2001). Examining developmental trajectories in adolescent alcohol use using piecewise growth mixture modeling analysis. *Journal of Studies on Alcohol and Drugs, 62,* 199–210.

Lo, Y., Mendell, N. R., & Rubin, D. B. (2001). Testing the number of components in a normal mixture. *Biometrika, 88,* 767–778.

Moore, K. A., & Glei, D. A. (1995). Taking the plunge: An examination of positive youth development. *Journal of Adolescent Research, 10,* 15–40.

Muthén, L.K., & Muthén, B.O. (1998–2011). *Mplus user's guide* (6th ed.). Los Angeles, CA: Authors.

Muthén, B. (2001). Second-generation structural equation modeling with a combination of categorical and continuous latent variables: New opportunities for latent class-latent growth modeling. In L.M. Collins & A. G. Sayer (Eds.), *New methods for the analysis of change. Decade of behavior* (pp. 291–322). Washington, DC: American Psychological Association.

Muthén, B. (2004). Latent variable analysis: Growth mixture modeling and related techniques for longitudinal data. In D. Kaplan (Ed.), *Handbook of quantitative methodology for the social sciences* (pp. 345–368). Newbury Park, CA: Sage.

Muthén, B. O., & Muthén, L. K. (2000a). The development of heavy drinking and alcohol-related problems from ages 18 to 37 in a U.S. national sample. *Journal of Studies on Alcohol, 61,* 290–300.

Muthén, B., & Muthén, L. K. (2000b). Integrating person-centered and variable-centered analyses: Growth mixture modeling with latent trajectory classes. *Alcoholism: Clinical and Experimental Research, 24,* 882–891.

Orlando, M., Tucker, J. S., Ellickson, P. L., & Klein, D. J. (2004). Developmental trajectories of cigarette smoking and their correlates from early adolescence to young adulthood. *Journal of Consulting and Clinical Psychology, 72,* 400–410.

Padilla-Walker, L. M., Nelson, L. J., Madsen, S. D., & Barry, C. M. (2008). The role of perceived parental knowledge on emerging adults' risk behaviors. *Journal of Youth and Adolescence, 37,* 847–859.

Palmer, R. H. C., Young, S. E., Hopfer, C. J., Corley, R. P., Stallings, M. C., Crowley, T. J., & Hewitt, J. K. (2009). Developmental epidemiology of drug use and abuse in adolescence and young adulthood: Evidence of generalized risk. *Drug and Alcohol Dependence, 102,* 78–87.

Pentz, M. A., Dwyer, J. H., MacKinnon, D. P., Flay, B. R., Hansen, W. B.,

Wang, E. Y. I., & Johnson, C. A. (1989). A multicommunity trial for primary prevention of adolescent drug abuse: Effects on drug use prevalence. *Journal of the American Medical Association, 261,* 3259–3266.

Schulenberg, J. E., & Maggs, J. L. (2002). A developmental perspective on alcohol use and heavy drinking during adolescence and the transition to young adulthood. *Journal of Studies on Alcohol, Supplement 14,* 54–70.

Schulenberg, J. E., Merline, A. C., Johnston, L. D., O'Malley, P. M., Bachman, J. G., & Laetz, V. B. (2005). Trajectories of marijuana use during the transition to adulthood: The big picture based on national panel data. *Journal of Drug Issues, 35,* 255–280.

Schulenberg, J. E., Sameroff, A. J., & Cicchetti, D. (2004). The transition to adulthood as a critical juncture in the course of psychopathology and mental health. *Development and Psychopathology, 16,* 799–806.

Schwartz, S. J., Forthun, L. F., Ravert, R. D., Zamboanga, B. L., Umaña-Taylor, A. J., Filton, B. J., . . . Hudson, M. (2010). Identity consolidation and health risk behaviors in college students. *American Journal of Health Behavior, 34,* 214–224.

Shanahan, M. J. (2000). Pathways to adulthood in changing societies: Variability and mechanisms in life course perspective. *Annual Review of Sociology, 26,* 667–692.

Staff, J., Schulenberg, J. E., Maslowsky, J., Bachman, J. G., O'Malley, P. M., Maggs, J. L., & Johnston, L. D. (2010). Substance use changes and social role transitions: Proximal developmental effects on ongoing trajectories from late adolescence through early adulthood. *Development and Psychopathology, 22,* 917–932.

Sussman, S., Dent, C. W., Simon, T. R., Stacy, A., & Craig, S. (1998). One year outcomes of Project Towards No Drug Abuse. *Preventive Medicine, 27,* 632–642 (erratum, *27,* 766).

Timberlake, D. S., Hopfer, C. J., Rhee, S. H., Friedman, N. P., Haberstick, B. C., Lessem, J. M., & Hewitt, J. K. (2007). College attendance and its effect on drinking behaviors in a longitudinal study of adolescents. *Alcoholism: Clinical and Experimental Research, 31,* 1020–1030.

Tucker, J. S., Ellickson, P. L., Orlando, M., Martino, S. C., & Klein, D. J. (2005). Substance use trajectories from early adolescence to emerging adulthood: A comparison of smoking, binge drinking, and marijuana use. *Journal of Drug Issues, 35,* 307–332.

White, H. R., Bray, B. C., Fleming, C. B., & Catalano, R. F. (2009). Transitions into and out of light and intermittent smoking during emerging adulthood. *Nicotine & Tobacco Research, 11,* 211–219.

White, H. R., McMorris, B. J., Catalano, R. F., Fleming, C. B., Haggerty, K. P., & Abbott, R. D. (2006). Increases in alcohol and marijuana use during the transition out of high school into emerging adulthood: The effects of leaving home, going to college, and high school protective factors. *Journal of Studies on Alcohol, 67,* 810–822.

Windle, M., & Wiesner, M. (2004). Trajectories of marijuana use from adolescence to young adulthood: Predictors and outcomes. *Development and Psychopathology, 16,* 1007–1027.

Winograd, R. P., Littlefield, A. K., & Sher, K. J. (2012). Do people who "mature out" of drinking see themselves as more mature? *Alcoholism: Clinical and Experimental Research, 36,* 1212–1218.