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Stressful Life Events Influence Transitions Among Latent Classes of Alcohol Use

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Abstract

Stressful life events (SLEs) have been associated with an increased risk of heavy drinking, suggesting individuals may use alcohol to cope with negative life events. However, little research has explored the extent to which SLEs have different effects on later alcohol use based on one's current alcohol use pattern. We replicated prototypical patterns of alcohol use via latent class analysis at Waves 2, 3, and 4 of the National Longitudinal Study of Adolescent to Adult Health (n = 4,569). Latent transition analysis was then used to examine the extent to which SLEs influenced the likelihood of stability or change in class membership from adolescence to early adulthood. Results suggested that adolescents were more likely to transition into different patterns of alcohol use as they entered early adulthood but were more likely to retain the same drinking pattern once in early adulthood. Among those who typically abstained, experiencing SLEs was associated with greater odds of transitioning to heavier drinking or problematic patterns of alcohol use. However, among those who had heavy or problematic alcohol use patterns, SLEs were associated with greater odds of decreasing alcohol use to either heavy or abstaining levels. Results suggest those who previously abstained may begin to use alcohol as a coping mechanism following stressful events, whereas those who drank heavily may decrease or abstain from alcohol use following life stress as a means of enacting positive life changes. The results encourage further study into factors that differentiate changes in alcohol use among light drinkers following SLEs.

Keywords

adolescence; latent transition analysis; stressful life events; alcohol use; early adulthood

Prior research has suggested that experiencing stressful life events (SLEs) is a risk factor for alcohol use (Cooper, Russell, Skinner, Frone, & Mudar, 1992; Keyes, Hatzenbuehler, & Hasin, 2011; Newcomb & Harlow, 1986). Adopting our definition from Adkins, Wang, Dupre, van den Oord, and Elder (2009), SLEs refer to sudden, acute, undesirable experiences that have occurred within the past 12 months but are limited in duration. Although early life stressors (e.g., childhood trauma, sexual abuse, or neglect) have also been shown to demonstrate strong associations with later alcohol use (Elliott et al., 2014),

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we chose to examine recent SLEs because these events are implicated as factors in early alcohol use initiation, increased alcohol consumption, and the emergence of hazardous alcohol use among adolescents and increased risk for alcohol use disorder (AUD) in early adulthood (Boden, Fergusson, & Horwood, 2014; Dawson, Grant, & Li, 2007; Fetzner, McMillan, Sareen, & Asmundson, 2011; Keyes et al., 2011). Given normative patterns of increasing alcohol use across adolescence and decreasing alcohol use into early adulthood, it is of interest to consider the extent to which SLEs may contribute to changes in typical alcohol use patterns across these ages (Chen & Jacobson, 2012). Further, research that links SLEs with increased alcohol use has corroborated theories positing alcohol may be consumed to help reduce stress (i.e., the tension-reduction hypothesis; Powers & Kutash, 1985) or relieve negative affect (i.e., the self-medication hypothesis; Khantzian, 1997) associated with certain life events. Empirical research has supported both the tension-reduction and self-medication hypotheses of substance use, indicating that individuals may begin or continue to use alcohol after encountering SLEs (Hart & Fazaa, 2004).

However, not all individuals are equally likely to drink in response to stress. Although there are many factors that may influence one's likelihood of drinking in response to stress, research from the broader substance use literature has inferred that stress may have differential effects on later substance use depending upon one's substance use history (Perreira & Sloan, 2001). For instance, the effects of SLEs on continued or relapse into cigarette smoking differed across current and former smokers depending on their remission status (McKee, Maciejewski, Falba, & Mazure, 2003). Similarly, SLEs reduced the likelihood of remission from substance use disorders among those who met criteria of the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM–IV;* American Psychiatric Association, 1994) for substance use disorder (McCabe, Cranford, & Boyd, 2016). Additionally, individuals who already drink heavily or have an AUD may experience more SLEs than those who drink less (Dawson, Grant, & Ruan, 2005; Keyes et al., 2011; Lijffijt, Hu, & Swann, 2014), indicating that the extent to which SLEs influence alcohol use may be directly related to the amount of alcohol use one is already consuming. Chronic alcohol use is associated with increased responsivity in neurobiological pathways associated with stress, suggesting that problematic drinkers are more sensitive to the effects of stress (Koob & Kreek, 2007). As a result, those who have previously been alcohol-dependent experience increased feelings of craving and are more likely to relapse (Sinha, 2012). Problem drinkers may use alcohol to self-medicate or reduce tension and may be less likely to quit following stressful events because they need alcohol to cope (Lijffijt et al., 2014). As such, SLEs may be associated with increased likelihood of continued problem drinking among those who are already problematic drinkers, in addition to increasing likelihood of alcohol use among those who have not yet begun to drink.

Alternatively, some individuals who already engage in problem drinking may decrease their alcohol consumption following a negative life event. The experience of "hitting bottom" is frequently a precipitating event that may lead one to pursue treatment for alcohol use (Kirouac, Frohe, & Witkiewitz, 2015, p. 313; Klingemann, 1991). This hitting-bottom event may be followed by developing a greater appreciation for life, greater sense of personal capability or self-efficacy, and identifying a new path for one's life, referred to as posttraumatic growth (PTG; Tedeschi & Calhoun, 2004). As part of this newfound

appreciation, individuals may elect to engage in positive behavior changes, such as decreasing substance use. As such, problem drinkers may decrease their drinking as a means of fostering positive growth following a negative life event. Much research has found that experiencing a negative life event is a primary reason for cutting down on drinking, either through entering a formalized alcohol treatment program or autoremitting from alcohol use (Blomqvist, 2002; Cunningham, Sobell, Sobell, & Kapur, 1995; Klingemann, 1991; Matzger, Kaskutas, & Weisner, 2005). Thus, there is some evidence that although average, typically light drinkers appear to increase alcohol use following recent life stress, those with heavy or problematic alcohol use patterns may either continue to use or may deescalate use after experiencing SLEs. As such, it is of interest to distinctly examine the extent to which SLEs influence changes in alcohol use based on one's current alcohol use habits.

Although research has shown that experiencing life stressors may be differentially associated with alcohol use based on current drinking habits, the way in which these studies operationalized alcohol use has been relatively limited, frequently conceptualized as a single item or composite measure such as frequency or quantity of use (Blomeyer et al., 2011; Dawson et al., 2007; L. O. Lee, Young-Wolff, Kendler, & Prescott, 2012; Newcomb & Harlow, 1986; Sartor & O'Malley, 2016; Schmid et al., 2010) or frequency of heavy drinking (Schmid et al., 2010; Tamers et al., 2014). These studies isolate only a few alcohol use behaviors for study when many of these behaviors cluster together to create patterns of use. An alternative strategy is to identify common patterns of alcohol use behaviors and categorize like individuals into typologies based on exhibition of similar characteristics. Such an approach provides a more holistic understanding of alcohol use by broadening the definition of alcohol use to incorporate a number of characteristics that may vary across qualitatively different types of alcohol users.

Latent class analysis (LCA) is an example of a person-centered approach that classifies qualitatively different groups of individuals by identifying latent homogeneous subgroups (i.e., classes) of individuals who have a high likelihood of providing similar response patterns across a set of items and determines each individual's probability of being a member in each of the classes (Auerbach & Collins, 2006; McCutcheon, 1987). LCA has been used to derive typologies of alcohol users in previous work (Auerbach & Collins, 2006; Beseler, Taylor, Kraemer, & Leeman, 2012; Connell, Gilreath, & Hansen, 2009; Donovan & Chung, 2015; Hoyland, Rowatt, & Latendresse, 2017; Kuvaas, Dvorak, Pearson, Lamis, & Sargent, 2014; Rist, Glöckner-Rist, & Demmel, 2009; Smith & Shevlin, 2008). Although these studies have found anywhere from three to six classes of alcohol use, most have found three or four (Auerbach & Collins, 2006; Hoyland et al., 2017; Kuvaas et al., 2014). Notably, Donovan and Chung (2015) deciphered empirically meaningful item-response thresholds for alcohol use indicators to be used in LCA and subsequently identified four prototypical patterns of alcohol use in a nationally representative sample of adolescents, consisting of *abstainers, low-intake drinkers, nonproblem drinkers,* and *problem drinkers*. These same four patterns were identified in the same sample 1 and 13 years later, indicating a need to address the extent to which individuals continue to demonstrate the same pattern across time (Donovan & Chung, 2015; Hoyland et al., 2017).

LCA may be extended longitudinally by addressing probabilities of stability (i.e., remaining in the same class) or change (i.e., transitioning to a different class) in class membership between two or more time points. Latent transition analysis (LTA) calculates the probability of membership in a particular class conditioned on class membership at the previous time point. Using LTA, previous research has found that as they mature into adulthood, adolescents generally transition into patterns of alcohol use characterized by slightly increased consumption and frequency of alcohol use, signifying regular, but not necessarily hazardous, drinking, consistent with normative changes in alcohol use across this developmental period (Shin, Lee, Lu, & Hecht, 2016). However, these transitions among alcohol use classes may also be influenced by a number of distal and proximal factors (Dauber, Paulson, & Leiferman, 2011; Jackson, Sher, Gotham, & Wood, 2001; M. R. Lee, Chassin, & Villalta, 2013). Given that SLEs are associated with an increased risk of heavy drinking (Unger et al., 2001), but that this association may depend on one's history of alcohol use (Lijffijt et al., 2014; Perreira & Sloan, 2001), it is of interest to examine whether SLEs are predictive of an increased likelihood of transitioning to a heavy or problematic alcohol use pattern (as defined by LCA) and whether these associations differ based on drinking pattern at the previous time point. As such, the present study used data from the National Longitudinal Study of Adolescent to Adult Health (Add Health; Harris et al., 2009) to examine patterns of alcohol use at three time points from mid-adolescence to early adulthood and to assess the extent to which SLEs influenced transitions among alcohol use patterns.

Method

Sample

This study used data from Add Health, a longitudinal, nationally representative sample of American adolescents (Harris et al., 2009). Wave 1 of the data was collected during the 1994–1995 school year when the adolescents were in seventh through 12th grades, and follow-ups were conducted with the same sample during Wave 2 in 1996, Wave 3 in 2001–2002, and Wave 4 in 2007–2008. A representative subset of the data from Wave 1 (n = 6,504) was deidentified and made available for public use. Data from these individuals' in-home interviews at Waves 2 (n = 4,834), 3 (n = 4,882), and 4 (n = 5,114) are also available for public use. A detailed explanation of the sampling procedure is available in Harris et al. (2009). Whereas Add Health participants provided written consent to participate in the study in accordance with University of North Carolina School of Public Health Institutional Review Board guidelines, this secondary data analysis was exempt from institutional board review.

We conducted LTA using full-information maximum likelihood, which allows for missing endogenous variables but not missing exogenous covariates (Nylund, Muthén, Nishina, Bellmore, & Graham, 2006). As such, we limited the sample to those who had complete demographic covariates at Wave 1, had data on SLEs and externalizing covariates on at least one time point, and had alcohol use data on at least one of Waves 2, 3, and 4 (e.g., an individual with data on Wave 2 but not on Waves 3 and 4 would be retained in the sample). The final sample consisted of 4,569 individuals (51.3% female) with a mean age of 15.83

years at Wave 1 (*SD* = 1.69), 16.42 at Wave 2 (*SD* = 1.54), 22.16 at Wave 3 (*SD* = 1.74), and 28.74 at Wave 4 (*SD* = 1.73). Of these individuals, 61.2% were White, 21.4% were African American, 10.2% were Hispanic, and the remaining 7.7% of the sample consisted of American Indian, Asian, or "other" race. The parents of these individuals reported a mean past-year income per capita of $16,728 and an average of 13.56 years of education.

We conducted independent-samples *t* tests to assess differences between those who were included in the LTA and those who were excluded from the analysis. Examining data from Wave 1, individuals included in the LTA were significantly younger, $t(3138.46) = 13.80$, $p < .001$; had more educated parents, $t(5484) = 9.25$, $p < .001$; drank alcohol less frequently, $t(2907.35) = 2.26$, $p < .024$; engaged in binge drinking less frequently, $t(2738.54) = 3.11$, $p < .002$; and got drunk less frequently, $t(2900.72) = 2.17$, $p < .030$, than did those not included in the LTA. There were no significant differences in age of alcohol initiation, $t(1254.61) = 1.83$, $p < .068$, or in average number of drinks consumed per occasion, $t(6327) = .40$, $p < .687$, between those included and not included in the LTA.

Measures

Demographics—All demographic information was taken from information provided by either the adolescents or their parents at the Wave 1 in-home interview. Sex was self-reported by the adolescent and dummy-coded as 0 (female) and 1 (male). Age was calculated at each wave by subtracting the adolescents' date of birth from the date of their interview. Income per capita was calculated by dividing the total household income (reported by one parent) by the total number of household members (calculated from information reported by the adolescent). The responding parents provided their own highest level of education, which was dichotomously coded into 0 (less than high school) and 1 (high school graduate and higher).

Stressful life events—SLEs were assessed at Waves 1, 2, and 3 using items selected from a previous study examining SLEs in the Add Health cohort (Adkins et al., 2009). The criteria for selecting these items were taken from guidelines presented in Turner and Wheaton (1997). The 13 items along with their frequencies are listed in Table 1. Items were endorsed if individuals had experienced this event in the 12 months prior to the Waves 1, 2, or 3 interviews. We created separate SLE indices at each of the three waves by summing the number of SLEs experienced in the past 12 months, each index ranging from 0 to 13 (Wave 1 *M* = 1.03, *SD* = 1.29; Wave 2 *M* = .71, *SD* = 1.12; Wave 3 *M* = .51, *SD* = .89).

Alcohol use—We assessed alcohol use at Waves 2, 3, and 4, utilizing responses to the same items at each wave. These items were the same as those used in Donovan and Chung's (2015) LCA of alcohol use items in Add Health and were recoded in accordance with their findings of empirically meaningful item-response thresholds. The first item asked whether the respondent "had a drink of beer, wine, or liquor more than two or three times" since the last interview, with response options 0 (no) and 1 (yes); individuals who responded no were also coded as 0 for all subsequent items. Three separate items asked about the number of days drinking alcohol, drinking more than five drinks in a row, and being drunk in the past 12 months, all with response categories from 0 (*none*) to 6 (*every day or almost every day*).

These items were recoded into response categories of 0 (*none*), 1 (*once/year to 2–3 days/month*), and 2 (*once/week plus*) based on Donovan and Chung's empirical findings. A single item assessed average quantity of alcohol consumption on each drinking occasion, where respondents provided a number from 0 to 18. In accordance with Donovan and Chung, this item was recoded into four response categories of 0 (*none*), 1 (*1 drink*), 2 (*2–6 drinks*), and 3 (*7 drinks*). Although Donovan and Chung also included a measure of alcohol-related consequences in their LCA of these alcohol use items, we were unable to include these items, due to a lack of consistency in the consequences measured across Waves 2–4.

Externalizing covariate—Given strong correlations between externalizing behaviors and alcohol use, we included an externalizing behavior covariate when using SLEs to predict transitions across alcohol use classes (Chassin, Colder, Hussong, & Sher, 2016). Including this covariate allowed us to control for the possible confounding effects of externalizing behaviors on alcohol use, increasing our confidence that transitions across alcohol use classes were due to SLEs and not part of an externalizing pathway to alcohol use. We examined 10 items referencing frequency of the following: damaging property, stealing something worth more than $50, committing burglary, stealing something worth less than $50, threatening someone with a weapon, selling drugs, taking part in a group fight, pulling a knife or gun on someone, shooting or stabbing someone, and hurting someone in a physical fight in the past 12 months. Some items were originally responded to on a scale from 0 (*never*) to 3 (*5 or more times*), whereas others were responded to on a scale from 0 (*never*) to 2 (*more than once*). Given the low frequencies of some of the violence items and nonoverlapping original response scales, we recoded these items into 0 (never) and 1 (one or more times) in the past 12 months and created the externalizing covariate by summing dichotomous responses (Wave 1 $M = 1.03$, $SD = 1.59$; Wave 2 $M = .85$, $SD = 1.49$; Wave 3 $M = .49$, $SD = 1.06$). These items demonstrated acceptable internal consistency (Wave 1 α . 73; Wave 2 α .75; Wave 3 α .66).

Analytic Plan

All analyses were conducted in Mplus Version 7.2 (Muthén & Muthén, 1998–2012). Although we conducted LCA and LTA with a robust maximum likelihood estimator, which can account for missing data on the variables of interest (i.e., alcohol use items), maximum likelihood does not allow for missing data on covariates. As such, we first conducted multiple imputation on any missing SLEs or covariates, resulting in 10 complete data sets. We conducted the analyses and pooled results across all 10 data sets.

We categorized typologies of alcohol users at Waves 2, 3, and 4 utilizing LCA, a type of mixture model that conceptualizes the construct of interest as a latent categorical variable (Lanza, Patrick, & Maggs, 2010). LCA identifies discrete patterns of responding to a set of items and probabilistically categorizes like individuals into subgroups, construing the average patterns of behavior (e.g., average alcohol use behaviors) among subgroup members (Nylund, Asparouhov, & Muthén, 2007). Because LCA is a probabilistic technique, all cases have a likelihood of membership in all latent classes; in a well-classified solution, cases have a high likelihood of membership in one class and low likelihood of membership in all others. LCA is conducted by comparing a model with $k + 1$ classes to that with k classes to

determine whether the addition of another class significantly decreases the overall model fit. Subsequent models wherein additional classes are extracted from the data (e.g., a model of k + 2 classes vs. a model with k + 1 classes) are compared until the extraction of an additional class exhibits a significant decrement in model fit. A number of fit indices are consulted in determining model fit, including Bayesian information criterion (BIC; Schwarz, 1978), entropy (Pastor, Barron, Miller, & Davis, 2007), and the Vuong-Lo-Mendell-Rubin likelihood ratio test (Lo, Mendell, & Rubin, 2001; Vuong, 1989). Lower BIC values demonstrate improved model fit with k + 1 as opposed to k classes (Nylund et al., 2007). Entropy measures the amount of organization or accuracy in determining class membership on a scale from 0 to 1, with increasing values indicating better classification (Pastor et al., 2007). We conducted LCA on the recoded alcohol use items for Waves 2, 3, and 4, determining the best fitting number of classes at each wave independently. We did not identify latent classes of alcohol use at Wave 1, because Donovan and Chung (2015) previously established the presence of four latent classes of alcohol use during Wave 1. Additionally, we wanted to use covariates at Wave 1 to longitudinally predict initial likelihood of membership in latent classes at Wave 2.

Although latent classes identified within each wave of data are independent of those within all other waves of data, LTA estimates the probability of transitioning to each of the other latent classes at the next time point relative to the probability of remaining in the same class conditional upon latent class membership at the previous time point (Lanza et al., 2010). This second parameter allowed us to infer the likelihood of transitioning to a different pattern at a subsequent time point. Thus, we constructed an LTA model wherein the likelihood of class membership at Wave 3 was conditioned on membership in Wave 2 classes, and the likelihood of class membership in Wave 4 was conditioned upon class membership in Wave 3. Item response thresholds are generally fixed to be invariant at each time point in LTA, indicating equivalence of classes across time. Although we expected to find similar patterns of item endorsement at each wave, we did not expect to find exactly identical thresholds across Waves 2–4, given evidence for developmental changes in alcohol use across time (White et al., 2006). As such, we constrained the item response thresholds for the latent categorical variable at each time point to be equal to those obtained in the unconditional LCAs at each separate wave. We then accounted for demographic covariates of race, age, parent's highest level of education, income per capita, externalizing, and SLEs (all covariates from Wave 1 data). In a final model run, theoretically depicted in Figure 1, we allowed SLEs at Wave 2 to influence the transitions between latent classes at Waves 2 and 3 and allowed SLEs at Wave 3 to influence the transitions between latent classes at Wave 3 and 4, all while controlling for contemporaneous externalizing behavior and age.

Results

LCA Model Selection

Table 2 presents the model fit statistics for the LCA, indicating that the four-class model was selected at each wave. For all waves, BIC increased when moving from a four-class model to a five-class model, indicating a decrement in model fit when extracting a fifth class. These

empirical data are also supported by the presence of four classes identified as a function of the same five items at both Waves 1 and 2 of Add Health (Donovan & Chung, 2015).

Characteristics of Alcohol Use Classes

Latent classes represent prototypical patterns of responses, the characteristics of which may be elucidated by examining probabilities of endorsing items conditional upon membership in each latent class. We adopted the class names conventionally assigned by Donovan and Chung (2015) to distinguish among the latent classes. It is important to note that class labels indicate only the prototypical patterns of item responses empirically identified in LCA; these labels should not be used to label specific individuals, given that class membership is probabilistic and individuals have a likelihood of exhibiting all item response patterns. Table 3 contains the conditional item-response probabilities describing the characteristics of all latent classes.

Across all three waves, the first response pattern (conventionally named *abstainers*) was represented by low probabilities of endorsing all alcohol use items. Although some did report having a drink of alcohol more than two or three times since the last interview, individuals most likely to be members of this class were the least likely to drink regularly, binge-drink, or become intoxicated. A second item-response pattern represented individuals who were more likely to endorse consuming alcohol but in relatively small quantities, representing occasional light drinkers. This response pattern, referred to as *low-intake drinkers,* was characterized by a high probability of drinking between one and six drinks on no more than 2–3 days per month but low probabilities of binge drinking and being drunk more than once per year. The third item response pattern was referred to as *nonproblem drinkers* and reflected more frequent alcohol consumption with larger quantities per intake on average, representing regular, moderate drinkers. Individuals most likely to demonstrate this response pattern were likely to endorse drinking two to six drinks anywhere from once per year to once per week or more. Individuals most likely to be members of the nonproblem drinkers category had high probabilities of binge drinking and being intoxicated between once a year and 2–3 days per month. The final response pattern (referred to as *problem drinkers*) reflected high probabilities of heavy, regular drinking. Individuals likely to demonstrate this response pattern had high probabilities of endorsing drinking between two to seven or more drinks at least once a week or more. This response pattern also reflected the highest probabilities of binge drinking and being drunk at least once per week.

Unconditional Transition Probabilities

Table 4 depicts the probabilities of transitioning to latent classes at Waves 3 and 4 conditional upon likelihood of membership in latent classes at Waves 2 and 3, respectively, prior to accounting for the effects of SLEs. That is, transition probabilities reflect the likelihood of demonstrating a certain alcohol use pattern based on the pattern of alcohol use demonstrated at the previous time point. The transition probabilities suggested that those who were most likely to be members of the abstainers at Wave 2 were approximately equally likely to transition to the abstainers or nonproblem drinkers at Wave 3 but were less likely to transition to the low-intake drinkers or problem drinkers. Individuals who were most likely to be members of the low-intake drinkers at Wave 2 were most likely to transition to the

nonproblem drinkers and were less likely to be members of any of the other classes at Wave 3. Those who were most likely to be members of the nonproblem drinkers at Wave 2 were most likely to demonstrate this same response pattern at Wave 3, whereas those most likely to be members of the problem drinkers at Wave 2 were most likely to be members of the problem drinkers or nonproblem drinkers at Wave 3.

There were fewer transitions in latent class membership between Waves 3 and 4. Those who were most likely to be members of the abstainers, low-intake drinkers, and nonproblem drinkers at Wave 3 were most likely to demonstrate the same pattern at Wave 4. However, individuals most likely to be members of the problem drinkers at Wave 3 were approximately equally likely to be members of either the nonproblem or problem drinkers at Wave 4.

Influence of Stressful Life Events on Transition Probabilities

Table 5 presents odds ratios representing the odds of being either abstainers, low-intake drinkers, or nonproblem drinkers relative to the odds of being problem drinkers for every additional SLE experienced, conditioned upon most likely latent class membership at the previous time point. The effect of SLEs on odds of class membership was significant for all possible transitions, which is likely due to the large sample size. As such, we focused mainly on the relative magnitude of the odds ratios when describing the effect of SLEs on transition probabilities.

Examining the effects of SLEs on the transitions from Waves 2 to 3, we found that those who were most likely to be members of the abstainers at Wave 2 had 39% increased odds of transitioning to the nonproblem drinkers at Wave 3 relative to transitioning to the problem drinkers for every additional SLE experienced. Those most likely to be members of the abstainers also had increased odds of transitioning to the low-intake drinkers (20%) or remaining in the abstainers (16%) with the addition of each SLE. Those most likely to be members of the low-intake drinkers had 30% increased odds of transitioning to the abstainers and relatively negligible odds of transitioning to the nonproblem drinkers or remaining in the low-intake drinkers, compared to transitioning to the problem drinkers, for every additional SLE experienced. Those most likely to be members of the nonproblem drinkers had 45% increased odds of transitioning to the low-intake drinkers relative to transitioning to the problem drinkers for every additional SLE. These individuals had 15% increased odds of transitioning to the abstainers or 12% increased odds of remaining in the nonproblem drinkers with every additional SLE. Relative to remaining in the problem drinkers, those most likely to be members of the problem drinkers had 34% increased odds of transitioning to the abstainers and 21% increased odds of transitioning to the nonproblem drinkers for every SLE experienced. Individuals most likely to be members of the problem drinkers were also 25% less likely to transition to the low-intake drinkers for each additional SLE experienced.

Assessing the effects of SLEs on transitions between alcohol use classes from Waves 3 to 4, we found that those most likely to be members of the abstainers at Wave 3 had 25% decreased odds of remaining in the abstainers, 18% decreased odds of transitioning to the nonproblem drinkers, and 10% decreased odds of transitioning to the low-intake drinkers at

Wave 4 relative to transitioning to the problem drinkers. Those most likely to be members of the nonproblem drinkers had 20% increased odds of transitioning to the abstainers, 8% increased odds of transitioning to the low-intake drinkers, and relatively negligible odds of remaining in the nonproblem drinkers relative to transitioning to the problem drinkers for every additional SLE experienced. Finally, those most likely to be members of the problem drinkers had 65% increased odds of transitioning to the low-intake drinkers, 48% increased odds of transitioning to the abstainers, and 24% increased odds of transitioning to the nonproblem drinkers relative to remaining in the problem drinkers for each additional SLE experienced. We do not present odds ratios representing transitions among those most likely to be members of the low-intake drinkers at Wave 3, given a small reference class ($n = 18$) for these transitions.

Discussion

This investigation into alcohol use behaviors during the transition from adolescence to adulthood provides additional support for four prototypical patterns of alcohol use that have been identified in prior research (Cable & Sacker, 2008; Donovan & Chung, 2015; Hoyland et al., 2017; Jackson et al., 2001; Shin et al., 2016). Analyzing stability and change in patterns of alcohol use via a person-oriented approach allows for examination of how unique combinations of behaviors may be related to distinct outcomes, providing an opportunity to explore how alcohol use may change among individuals with qualitatively different drinking patterns following the experience of SLEs.

The effect of SLEs on transitions among the four identified alcohol use classes suggest that the extent to which severe life events influence alcohol use may differ based on one's current alcohol use pattern. During adolescence, those who did not drink (i.e., those most likely to be members of the abstainers) had greater odds of transitioning to a class characterized by heavier, but not necessarily problematic, alcohol use following the experience of SLEs. These results reflect previous research showing that individuals who abstained from drinking alcohol in early adulthood were more likely to use alcohol use after experiencing life stress (Blomeyer et al., 2011; Casement, Shaw, Sitnick, Musselman, & Forbes, 2015). The unconditional transition probabilities presented in Table 4 support prior research suggesting normative developmental trends of increasing alcohol use during the transition from adolescence to adulthood (White et al., 2006), because we found that only one third of adolescent abstainers were likely to remain abstainers in their early 20s. Even with this developmental trend, the odds of transitioning to a heavier drinking class are compounded with the experience of SLEs; that is, individuals are even more likely to transition to heavier drinking classes after experiencing SLEs than would be expected by a normative developmental trajectory. Our results contribute to the empirical evidence supporting the *self-medication* and *tension-reduction* hypotheses, which suggest individuals drink as a means of coping with negative affect stemming from stressful events (Blomeyer et al., 2011; Khantzian, 1997; Powers & Kutash, 1985).

A similar, but more extreme, pattern was seen when examining the effects of SLEs on transitions among alcohol use classes from the early to late 20s for those most likely to be members of the abstainers. Individuals who were most likely to abstain in their early 20s had

greater odds of transitioning to a problematic drinking pattern by their late 20s as a function of increasing SLEs. These results support previous findings that individuals with disordered alcohol use have increased odds of having a history of experiencing stressful events (Boden et al., 2014). Additionally, the slight differences in the effects of SLEs on transitions from adolescence to the early 20s and from the early 20s to late 20s may also reflect a developmentally relevant pattern of escalation. Given that alcohol use does not become legal until age 21, the findings just described may indicate that the increased availability and normalcy of alcohol use during the 20s contributes to increased severity of alcohol use following SLEs in adulthood. Regardless of the time period examined, the results indicate that for those who previously did not drink, alcohol use may increase in response to the experience of SLEs (Khantzian, 1997; Powers & Kutash, 1985).

A different pattern of results was seen for those who were most likely to be members of heavy-drinking or problematic alcohol use classes. It is interesting that individuals who demonstrated heavy or problematic alcohol use patterns generally had greater odds of transitioning to lighter drinking or abstaining patterns as a function of increasing SLEs. Those who were frequent and heavy, but not problematic, alcohol users (i.e., those most likely to be members of the nonproblem drinkers) in adolescence had greater odds of deescalating their alcohol use to a more infrequent pattern in their early 20s following SLEs. Among those who had problematic patterns of alcohol use (i.e., those most likely to be members of the problem drinkers) in adolescence, experiencing SLEs was associated with deescalating alcohol use to either a nonproblematic or abstaining pattern of use in emerging adulthood. However, these individuals were not likely to remain at light or infrequent patterns of drinking; that is, problem drinkers were not likely to become low-intake drinkers following SLEs in adolescence. These results indicate that those who drank heavily were likely to remit from alcohol use following SLEs, potentially as a result of enacting positive life changes following stressful or traumatic events. The SLEs examined in our study are severe events and may signify “hitting bottom” for individuals who already have heavy or problematic alcohol use patterns (Kirouac et al., 2015, p. 313), and the precipitating event or events may be a “critical transition point” where one decides to enact positive life changes, indicating an experience of PTG (Tedeschi & Calhoun, 2004; Tsourtos et al., 2011, p. 299). It is possible that some individuals who drank heavily experienced SLEs followed by PTG and then engaged in behavior change that resulted in greater odds of abstaining from alcohol years later. Although work examining the influence of PTG on substance use in adolescence has been limited, findings from both cross-sectional (Milam, Ritt-Olson, & Unger, 2004) and prospective (Arpawong et al., 2015) analyses suggest that PTG is associated with decreased frequency of alcohol use. Research has also begun to examine the possibility that individuals who previously demonstrated problematic levels of alcohol use may decrease their alcohol use to lower risk levels while still drinking heavily (Witkiewitz et al., 2018). Although future research is necessary, it may be that SLEs influence individuals’ lives to the extent that they become motivated through PTG to reduce their alcohol use somewhat but not to abstaining levels.

We also observed developmentally relevant patterns when examining the effects of SLEs on alcohol use among both problematic and nonproblematic drinkers across emerging and into early adulthood. Those who were most likely to be nonproblem drinkers in their early 20s

had greater odds of quitting drinking by their late 20s as a function of increasing SLEs, whereas those who were most likely to be problem drinkers were likely to deescalate, but not completely stop, their drinking as they experienced more SLEs across the same time frame. These results slightly differ from those seen across the transition from adolescence to the early 20s, because problematic drinkers were now more likely to reduce their drinking to light levels rather than stop drinking completely. This may be because alcohol use is more developmentally normative and legal during the 20s, so former problematic drinkers may be able to cut back on alcohol use somewhat, but not stop completely, as they make positive life changes. This is also in line with prior research indicating that many who have remitted from AUDs still drink more than recommended levels (Tuithof, Ten Have, van den Brink, Vollebergh, & de Graaf, 2013). It may also be that it is more challenging for problematic users to stop drinking completely but manageable to cut back a bit, whereas it may be easier for nonproblem drinkers to stop drinking completely as part of their positive life changes due to their less severe initial levels of use.

These findings should also be considered in light of some limitations. Future research would benefit from understanding whether certain types of SLEs are predictive of transitions in patterns of alcohol use. Although there is research regarding alcohol use following a single SLE (Fetzner et al., 2011; L. O. Lee et al., 2012), we were unable to divide our composite measure into dimensions of SLEs, because there has been little theoretical evidence to distinguish empirically similar SLEs. Theoretical research on the nature of SLEs would be beneficial to understanding how specific types of SLEs are associated with alcohol use. Additionally, there was unequal temporal spacing between SLEs and the alcohol use patterns; that is, SLEs used to predict Wave 2 class membership were measured only 1 year earlier, but SLEs used to predict Wave 3 to Wave 4 class membership were measured 6 years earlier. It may be that SLEs have a larger impact on initial class membership at Wave 2 given the close temporal association, whereas SLEs may have an attenuated effect on membership at Waves 3 and 4. Given the low income per capita in the analytic sample, and considering that those with low incomes are at greater risk for heavy drinking and AUD, it may be that our analyses consider a sample of individuals who are generally at greater risk of alcohol use relative to the general population (Grant et al., 2015). Further, individuals who were retained in the analytic sample were younger, had more educated parents, and used alcohol less frequently overall than did those who were not included in the analytic sample, which may have resulted in a sample of individuals who had more resources to change their alcohol use patterns following SLEs. Given that Add Health does not have a measure of PTG, and that PTG is generally unrelated to other trauma reactions such as depression (Milam et al., 2004), we were unable to specifically account for PTG in our analyses. However, examining whether PTG influences the association between SLEs and patterns of alcohol use is a rich area for future research. We did not fix item-response thresholds in the LTA to be equivalent at all waves, potentially resulting in different classes being estimated at each time point. However, we felt that it was theoretically inappropriate to impose strict measurement invariance, given developmentally normative changes in alcohol use across time (White et al., 2006). Given that similar patterns of item responses were found at each wave (see Table 3), it is likely that the same class structure was identified at each wave. Finally, although we suppose that of the four classes, the problem drinkers class would be most likely to

demonstrate symptoms of AUD, Add Health does not provide consistent measures of *DSM–IV* or *DSM–5* (American Psychiatric Association, 2013) AUD criteria across waves, precluding us from mapping these classes onto diagnoses of AUD. We feel that our operationalization of alcohol use provides unique insight into how alcohol use may not meet criteria for disorder yet still influences one's life (Chung, Martin, Armstrong, & Labouvie, 2002), but the clinical research literature may benefit from comparing rates of AUD within each of these classes to understand whether SLEs influence patterns of alcohol use differently among those who have and have not been diagnosed with AUD.

In sum, the results of this study suggest that adolescents transition to light or heavy drinking patterns as they age into adulthood in accordance with a developmentally normative process. However, those who previously abstained from alcohol use are likely to drink more after experiencing SLEs, potentially as a means of coping with negative affect or stress, whereas those who previously had moderate or problematic alcohol use patterns remitted to lighter or abstaining patterns, possibly the result of personal growth stemming from the stressful experience. Future research should include attention to other factors that may differentiate whether occasional or light drinkers continue to use alcohol following SLEs as coping strategies, optimism, and social support (Prati & Pietrantoni, 2009); strengths of character (Peterson, Park, Pole, D'Andrea, & Seligman, 2008); positive affect (Lelorain, Bonnaud-Antignac, & Florin, 2010); biological stress response (Schmid et al., 2010); or affiliation with deviant peers (Fergusson, Swain-Campbell, & Horwood, 2002). These results demonstrate the importance of examining patterns of alcohol use and drinking history when identifying how adolescents and early adults utilize alcohol in response to stress.

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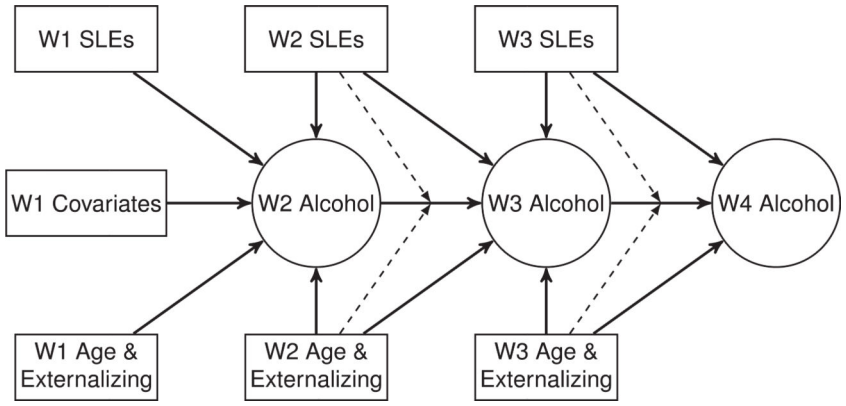

Figure 1.

Theoretical model depicting latent transition analysis across alcohol use classes with stressful life events (SLEs) influencing transitions from Waves 2 to 3 and Waves 3 to 4. Wave 1 captures SLEs and covariates at age 15.83; Wave 2 captures SLEs, covariates, and alcohol use patterns at age 16.42; Wave 3 captures SLEs, covariates, and alcohol use patterns at age 22.16; and Wave 4 captures alcohol use patterns at age 28.74. Solid arrows indicate direct effects of SLEs and covariates on alcohol use patterns and transitions across latent classes, and dashed arrows indicate effects of SLEs and covariates on transition probabilities. W = wave.

Table 1

Stressful Life Events Experienced and Corresponding Frequencies Among Members of the Analytic Sample

	Wave 1		Wave 2		Wave 3	
Event	***n***	**% endorsed[a]**	***n***	**% endorsed[a]**	***n***	**% endorsed[a]**
Skipped necessary medical care	1,250	19.3	954	19.7	1,094	22.5
Death of a parent	21	.3	12	.2	5	.1
Suicide attempt resulting in injury	66	1.0	35	.7	28	.6
Friend committed suicide	179	2.8	131	2.7	114	2.3
Relative committed suicide	69	1.1	44	.9	39	.8
Saw violence	786	12.2	394	8.2	263	5.5
Threatened by a knife or gun	814	12.6	467	9.7	294	6.1
Was shot	84	1.3	56	1.2	25	.5
Was stabbed	314	4.9	178	3.7	40	.8
Was jumped	722	11.2	405	8.4	130	2.7
Was injured in a physical fight	569	15.2	202	20.8	184	3.8
Romantic relationship ended	1,867	28.7	1340	20.6	461	7.1
Contracted an STD	181	3.5	129	3.4	423	8.9

Note. STD = sexually transmitted disease.

[a]Refers to percentage of total sample who endorsed that SLE.

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Table 2

Fit Statistics for Models Testing 2–5 Latent Classes of Alcohol Use at Waves 2, 3, and 4

Wave and criterion	Model 2	Model 3	Model 4	Model 5
Wave 2				
BIC	17,416.504	16,160.979	**15,390.923**	15,477.360
Entropy	1.000	.970	**.941**	.921
p^a	.000	.000	**.000**	.000
Wave 3				
BIC	23,556.095	21,402.568	**20,215.391**	20,492.542
Entropy	1.000	.909	**.896**	.858
p^a	.000	.000	**.000**	.000
Wave 4				
BIC	24,707.530	22,542.892	**21,469.922**	21,479.840
Entropy	1.000	.888	**.902**	.916
p^a	.000	.000	**.000**	.001

Note. Boldface type indicates data for the ultimately selected model. BIC = Bayesian information criterion.

[a]For the Vuong-Lo-Mendell-Rubin likelihood ratio test of $k + 1$ versus k classes.

Table 3

Item Response Probabilities Conditional on Membership in Alcohol Use Classes at Waves 2, 3, and 4

	Abstainers			Low-intake drinkers			Nonproblem drinkers			Problem drinkers		
Variable	**W2**	**W3**	**W4**	**W2**	**W3**	**W4**	**W2**	**W3**	**W4**	**W2**	**W3**	**W4**
n in sample	2,026	995	1,002	467	573	735	888	1,545	1,604	277	537	477
% of sample	55.4	27.3	26.2	12.8	15.7	19.3	24.3	42.3	42.0	7.6	14.7	12.5
Mean posterior probability	1.00	1.00	1.00	.96	.94	.96	.89	.91	.89	.97	.96	.98
Mean no. of SLEs	.68	.57	—	.85	.46	—	1.15	.67	—	1.62	.85	—
Drank >2–3 times												
No	.941	.815	.711	.000	.000	.000	.000	.000	.000	.000	.000	.000
Yes	.059	.185	.289	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Drinking frequency/year												
None	1.000	1.000	1.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
Once/year to 2–3 days/month	.000	.000	.000	.951	.923	.904	.878	.666	.564	.120	.007	.027
Once/week plus	.000	.000	.000	.049	.077	.096	.122	.334	.436	.880	.993	.973
Usual intake												
None	1.000	1.000	1.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
1 drink	.000	.000	.000	.437	.401	.381	.019	.032	.073	.035	.013	.017
2–6 drinks	.000	.000	.000	.535	.558	.591	.628	.818	.835	.481	.586	.644
7+ drinks	.000	.000	.000	.028	.041	.028	.353	.150	.092	.485	.401	.339
Binge drinking												
None	1.000	1.000	1.000	.897	.919	.899	.126	.145	.118	.040	.016	.009
Once/year to 2–3 days/month	.000	.000	.000	.092	.081	.098	.859	.838	.874	.083	.122	.100
Once/week plus	.000	.000	.000	.012	.000	.003	.015	.017	.008	.877	.862	.890
Intoxication												
None	1.000	1.000	1.000	.852	.832	.866	.109	.112	.087	.020	.042	.037
Once/year to 2–3 days/month	.000	.000	.000	.135	.168	.134	.874	.874	.906	.234	.309	.363
Once/week plus	.000	.000	.000	.013	.000	.000	.017	.014	.007	.746	.649	.601

Note. The robust maximum likelihood estimator utilized in the latent transition analysis allowed for missing responses to items used to derive the latent classes. As such, the numbers of individuals in each latent class at each wave (W) do not add up to the total sample size. Dashes indicate that SLEs are not available for each class at Wave 4 because we did not analyze SLEs at this wave.

Table 4

Transition Probabilities Across Alcohol Use Classes From Waves 2 to 3 and Waves 3 to 4

Wave and class	Abstainers	Low-intake drinkers	Nonproblem drinkers	Problem drinkers
			Wave 3 class	
Wave 2 class				
Abstainers	.357	.217	.335	.092
Low intake drinkers	.190	.198	.466	.147
Nonproblem drinkers	.135	.099	.551	.215
Problem drinkers	.201	.059	.335	.405
			Wave 4 class	
Wave 3 class				
Abstainers	.549	.223	.177	.052
Low intake drinkers	.263	.469	.235	.033
Nonproblem drinkers	.133	.185	.570	.112
Problem drinkers	.096	.060	.440	.404

Table 5

Odds Ratios (ORs) of Stressful Life Events' Influencing Transition Probabilities

	Abstainers		Low-intake drinkers		Nonproblem drinkers	
Wave and class	***OR***	***p***	***OR***	***p***	***OR***	***p***
			Wave 3 class			
Wave 2 class						
Abstainers	1.156	.001	1.197	.006	1.390	.003
Low intake drinkers	1.301	.000	.974	.001	.997	.001
Nonproblem drinkers	1.148	.001	1.448	.002	1.122	.001
Problem drinkers	1.344	.001	.753	.002	1.210	.002
			Wave 4 class			
Wave 3 class						
Abstainers	.745	.001	.903	.000	.821	.001
Low intake drinkers	—	—	—	—	—	—
Nonproblem drinkers	1.200	.002	1.081	.001	1.007	.005
Problem drinkers	1.478	.000	1.645	.000	1.235	.000

Note. *OR*s present the odds of membership in the listed class relative to membership in the problem drinkers class conditioned upon class membership at the previous time point. Dashes indicate that we were unable to calculate odds ratios accounting for transitions from the low-intake drinkers class at Wave 3 to all other classes at Wave 4 due to a small reference class (n = 18).