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Interactive effects of drinking history and impulsivity on college drinking

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Abstract

The transition from adolescence into emerging adulthood is a critical developmental period for changes in alcohol use and drinking related problems. Prior research has identified a number of distinct developmental alcohol use trajectories, which appear to be differentially related to young adult drinking outcomes. Another correlate of alcohol use in early adulthood is impulsivity. The primary aim of this study was to examine the moderating role of impulsivity in the relation between patterns of past alcohol use and hazardous drinking during the first year of college. Participants (N=452; 49% male; mean age 18.5 years; 82% Caucasian) completed self-report measures during the first year of college, including retrospective alcohol use calendars, current alcohol use and drinking problems, and personality. Group-based trajectory modeling was used to identify groups with similar adolescent drinking history from retrospective, self-report. Four groups were identified: abstainers/very light users, late/moderate users, early/moderate users, and steep increase/heavy users. The abstainer/very light user group reported the lowest levels of alcohol use and problematic drinking in college; the steep increase/heavy use group reported the highest levels of alcohol use and problematic drinking. As predicted, the role of personality—specifically urgency, or emotion-based rash action—was strongest among moderate use groups. These findings may be helpful in guiding targeted prevention and intervention programs for alcohol use and abuse.

Keywords

alcohol; impulsivity; urgency; college students; drinking trajectories

1. Introduction

Alcohol use among adolescents and young adults presents a tremendous public health concern. Teens who drink are at an increased risk for academic and social problems as well

as changes in brain development (Brown et al., 2009; Windle et al., 2009). The transition to college coincides with marked increases in the rates of alcohol use and problem drinking (Schulenberg & Maggs, 2008). A substantial research effort has centered on defining risk factors for problem drinking in late adolescence and early adulthood (e.g., Brown et al., 2009; Masten, Faden, Zucker, & Spear, 2009; Windle et al., 2009). Two reliable predictors are (a) patterns of prior use, and (b) impulsivity, yet relatively little attention has been paid to the possible interaction between these domains. Therefore, the primary goal of this study was to examine whether impulsivity moderated the relation between adolescent alcohol use and college drinking habits.

1.1 Prior use as a predictor of current and future use

A strong predictor of alcohol use in early adulthood is one's pattern of prior use (Maggs & Schulenberg, 2004; Schulenberg & Maggs, 2008). Alcohol use may be conceptualized as a complex developmental process, marked by diverse inter- and intra-individual patterns of change and maintenance (Masten et al., 2009). It is possible to identify subgroups in a population who follow similar alcohol use patterns or trajectories over time and to differentiate the groups based on risk factors or outcomes (e.g., Chassin, Pitts, Prost, 2004; Colder, Campbell, Ruel, Richardson, & Flay, 2002; Flory, Lynam, Milich, Leukefeld, & Clayton, 2004; Hersh & Hussong, 2006). Although the number and nature of groups identified based on adolescent alcohol use trajectories differ across studies (Maggs & Schulenberg, 2004), some commonly observed groups have emerged. Most studies yield a subset of individuals who are abstainers or very low frequency drinkers throughout adolescence. A second group comprises individuals who begin drinking at low frequencies during early adolescence and gradually increase use throughout adolescence. A third group includes individuals who begin drinking early in adolescence and report sustained, high-frequency alcohol use throughout adolescence.

Although method bias may contribute to some commonality in the number and nature of groups derived from trajectory analyses (Sher, Jackson, & Steinley, 2011), the identified groups tend to differ in reliable ways. For instance, adolescents who start drinking later, consume less alcohol, and drink less frequently have been shown to experience more positive, healthier outcomes than people who drink earlier, more heavily, and more frequently (Chassin et al., 2002; Flory et al., 2004; Hersh & Hussong, 2006). Hersh and Hussong (2006) examined the relations between high school drinking patterns and drinking habits following the transition to college. Each participant was assigned to one of four high school "drinker typologies" (abstainers, experimenters/light users, moderate users, and heavy users) based on retrospective reports of adolescent alcohol use. High school abstainers used alcohol at significantly lower frequency and engaged in less binge drinking than the other three groups during the first semester of college. Experimenters were no more likely than abstainers to experience alcohol-related problems, whereas both moderate and heavy users were.

Patterns of past use are not perfectly predictive of current or future use, however. Hersh and Hussong (2006) studied the stability of high school drinking typologies and found that heavy drinkers (90%) and abstainers (70%) were most likely to be classified the same way in

college as in high school. Stability estimates for experimenters (47%) and moderate drinkers (26%) were significantly lower than those for the other two groups: 65% of moderate drinkers were reclassified as heavy drinkers in college. The authors found that students' perceptions of parental permissiveness moderated the relation between high school and college drinking. Specifically, abstainers who perceived their parents to be more restrictive drank alcohol and binged more frequently in college than other high school abstainers. Perceived permissiveness did not, however, account for heterogeneity in college drinking among the experimenter and moderate user groups, highlighting the need to consider other potential moderators. Candidate moderators include already established predictors of alcohol use patterns, such as impulsivity.

1.2 Impulsivity is an important correlate of alcohol use and problems

Impulsivity, broadly defined, is a reliable predictor of alcohol use. Higher levels of impulsivity are related to earlier use, higher frequency and volume of use, and more symptoms of dependence and alcohol-related problems (e.g., Chassin, Flora, & King, 2004; Kuntche, et al., 2006; Lejuez et al., 2010; Lynam & Miller, 2004). Impulsivity is not a unitary construct, however, and there are a number of strategies for measuring the various aspects of impulsivity (Dick et al., 2010; Lejuez et al., 2010).

Whiteside and Lynam (2001) evaluated the multifactorial nature of impulsivity by performing an exploratory factor analysis using several impulsivity-related questionnaires. A four-factor solution emerged from which the UPPS Impulsive Behavior Scale (UPPS) was developed with a scale for each trait. Urgency assesses an individual's tendency to act rashly or give into cravings or act rashly under conditions of significant emotional arousal. Urgency can be expressed in the context of negative emotions (i.e., negative urgency) or positive emotions (i.e., positive urgency; Cyders & Smith, 2008). Premeditation assesses an individual's ability to think through the potential consequences of a behavior before acting and is thought to most closely reflect traditional definitions of impulsivity. Perseverance assesses an individual's ability to sustain effort and persist in completing jobs or obligations despite boredom or fatigue. Sensation seeking assesses an individual's preference for excitement and stimulation, even in dangerous or risky situations. The UPPS model has been supported by several confirmatory factor analyses (Lynam & Miller, 2004; Magid & Colder, 2007; Smith et al., 2007).

Lynam and Miller (2004) studied the relations between the UPPS dimensions and alcohol use and problems. Low premeditation was a strong predictor of early alcohol use and abuse. A similar, weaker pattern was observed for sensation seeking. Sensation seeking is a useful predictor of early onset of alcohol use and frequency of use, but not necessarily alcohol problems in adolescence or emerging adulthood (Lynam & Miller, 2004; Magid & Colder, 2007; Smith et al., 2007). Whereas lack of premeditation has been advanced as a strong predictor of problematic substance use (Lynam & Miller, 2004; Magid & Colder, 2007; Verdejo-Garcia, Bechara, Recknor, & Perez-Garcia, 2007), others have found negative urgency to be an equally if not more important predictor of alcohol problems (Fischer, Anderson, & Smith, 2004; Fischer & Smith, 2008; Smith et al., 2007). Taken together, these

findings support consideration of multiple impulsivity-related traits when evaluating relations to alcohol use and problems.

1.3 Relations between impulsivity and drinking histories

Few studies have investigated the relation between impulsivity and alcohol use trajectories (Chassin et al., 2004; Colder et al., 2002; Littlefield, Sher, & Steinley, 2010; Schulenberg et al., 1996). Schulenberg et al. (1996) compared six binge drinking trajectory groups on several factors, including risk-taking. Whereas risk-taking was significantly associated with binge drinking at age 18, the relation was not significant 4–5 years later. Risk-taking was also ineffective in differentiating among the trajectory groups. The observed null findings may reflect insufficient assessment of risk-taking; participants responded to only two self-report items. Also, the trajectory groups were based on drinking habits starting at age 18, rather than early adolescence when alcohol use emerges. Using such truncated patterns of alcohol use may have masked important differences among participants that preceded the transition to college.

Colder and colleagues (2002) used latent growth mixture modeling with prospective longitudinal data on adolescent alcohol use and identified five drinking trajectory groups. They compared these groups based on self-reported risk taking propensity and emotional distress and found that adolescents who abstained or used alcohol at occasional, very low levels were characterized by lower mean levels of risk taking than all other groups. Additionally, the occasional heavy drinking and rapid escalation groups were associated with higher levels of risk taking and emotional distress. Using groups derived via composites of alcohol and other drug use, Chassin and colleagues (2004) found that higher levels of impulsivity measured in early adolescence were associated with higher probability of belonging to a chronic heavy drinking/heavy drug-using group relative to light and moderate use groups. The heavy use group was also most likely to experience problems with dependence. The moderate/experimental use group had intermediate levels of impulsivity and was at a higher risk for alcohol dependence problem than the light use group. These studies highlight the utility of impulsivity-related traits in predicting patterns of alcohol use during adolescence and early adulthood.

1.4 The current study

Despite promising results regarding main effects of adolescent drinking trajectories and impulsivity on alcohol use and alcohol problems in emerging adulthood, as well as suggestive findings regarding the relation between drinking trajectories and impulsivity, gaps in the literature remain. Few studies have thoroughly assessed impulsivity-related traits in a single sample to evaluate relations with drinking history. Further, no studies to our knowledge have examined the possible moderating role of impulsivity in the relation between adolescent alcohol use and college drinking habits. To address these gaps, we examined the effects of past alcohol use, different types of impulsivity, and the interaction between past alcohol use and impulsivity on alcohol use and problems during the first year of college.

Based on prior research, adolescent drinking history groups marked by early initiation were predicted to show higher levels of sensation seeking and lower levels of premeditation relative to groups with later ages of initiation. We predicted that groups with patterns of sustained, escalating alcohol use would show the lowest levels of premeditation and highest levels of negative urgency relative to other groups. Previous research suggests that drinking habits among heavy users remain fairly homogeneous in college, whereas greater variability is observed among experimenters and moderate users, and, to a lesser degree, abstainers following the transition to college (e.g., Hersh & Hussong, 2006). Thus, we predicted that individual differences in impulsivity (i.e., premeditation, urgency, and sensation seeking) would play a stronger role in predicting college use among low to moderate users than among heavy drinkers.

2. Method

2.1. Participants

Participants were 443 students (49% male) who completed measures during their first year of college. The average age of participants at assessment was 18.5 years ($SD = .7$), and all participants were under 21 years of age. Participants were recruited from introductory psychology courses and received course credit for participation. Approximately 82% of participants self-identified as Caucasian, 13% African-American, and 4% as other.

2.2. Procedure

Participants completed measures as part of a larger battery designed to assess factors that may influence substance use in early adulthood. The battery was administered individually to each participant, and all questionnaires were completed on a computer. Data for the current study were collected over a two-year period; there were no significant differences between year cohorts for any of the measures included here. The study was approved by the university's Institutional Review Board, and all participants provided written informed consent.

2.3. Materials

2.3.1. Drinking habits: Life history calendar (LHC)—Participants completed a life history calendar (LHC) of their substance use. The LHC is a retrospective, computer-assisted interview method for collecting data on life events and behaviors (Caspi, Moffitt, Thornton, & Freedman, 1996). Information was obtained regarding nine groups of substances: cigarettes, alcohol, marijuana, cocaine, inhalants, amphetamines, hallucinogens, depressants, and club drugs. Only indices of alcohol use were employed to generate the retrospective developmental trajectories here. The strong reliability and validity of the LHC have been documented previously (e.g., Flory et al., 2004; Lynam & Miller, 2004; Miller & Lynam, 2003). Each year was divided into three periods that corresponded to the two semesters of the school year and the summer. Participants reported their alcohol use from age 13 through the time of the interview. Participants selected from five choices describing how *frequently*, on average, they used alcohol during each period (1 = once per month or less, 2 = once per week, 3 = two or three times per week, 4 = four or five times per week, 5 = every day). Participants selected from seven choices describing the *average amount* of

alcohol they used per occasion during each period (1 = one drink, 2 = two drinks, 3 = three drinks, 4 = four drinks, 5 = five drinks, 6 = six to ten drinks, 7 = ten or more drinks). From these responses, an *average weekly alcohol use* variable was computed. First, responses for average amount of alcohol consumed were recoded so that each response represented a discrete number of drinks; for responses that originally represented a range, the midpoint was used, and ten drinks was used for the uppermost category. Next, responses for average frequency of alcohol use were recoded so that the resulting values represented an average number of drinking occasions per week. Finally, the product of the recoded variables was calculated to index the average number of drinks per week consumed by each participant in each period (average weekly alcohol use).

2.3.2. Current average weekly alcohol use—The average weekly alcohol use variable derived from the LHC was used as a measure of current alcohol use in the first year of college. Specifically, values for the period during which a participant was assessed were used as an index of current average weekly use. There were no significant differences in current average weekly alcohol use between participants assessed in the fall and spring semesters.

2.3.3. Hazardous drinking—Potentially hazardous or problematic drinking was measured using the Alcohol Use Disorders Identification Test (AUDIT; Babor et al., 2001). The AUDIT was developed as a simple method to screen for hazardous and harmful patterns of alcohol consumption during the past year. The instrument consists of 10 questions purported to assess three conceptual domains: recent hazardous alcohol consumption (Items 1–3), alcohol dependence (Items 4–6), and harmful alcohol use (Items 7–10). The total score from the AUDIT was used here, and adequate internal consistency was observed (alpha: .79). AUDIT total scores were the primary dependent variable in this study. There were no significant differences in AUDIT scores between participants assessed in the fall and spring semesters.

2.3.4. Trait impulsivity: UPPS-P Impulsive Behavior Scale—The UPPS-P (Lynam, Smith, Whiteside, & Cyders, 2006) is a 59-item inventory designed to measure five personality trait pathways to impulsive behavior: Negative Urgency, (lack of) Perseverance, (lack of) Premeditation, Sensation Seeking, and Positive Urgency. Each item is rated on a 4-point scale (1 = strongly disagree, 4 = strongly agree). Scale scores were calculated for each trait. All scales demonstrated adequate internal consistency in the present sample (alphas: negative urgency = .89, positive urgency = .93, premeditation = .86, perseverance = .82, sensation seeking = .84).

2.4. Calculating adolescent drinking history groups

Group-based trajectory modeling, performed using the PROC TRAJ (Jones et al., 2001; Jones & Nagin, 2007) application in the SAS statistical software package, was used to estimate the retrospective developmental trajectory groups in the population of which the sample is representative. This statistical approach yields a discrete number of relatively homogeneous groups, characterized by a latent variable, that represent prototypical patterns of change over time for a given variable of interest, as well as the estimated proportion of

the population that would follow each trajectory (Charnigo et al., 2011; Jones et al., 2001; Nagin & Odgers 2010). To ensure convergence of model fitting algorithms, summary scores for each year were computed for each participant by averaging each participant's retrospectively reported alcohol use across that year's three-period interval and then rounding to the nearest integer. Thus, trajectories were estimated using six data points per individual representing average weekly alcohol use for each year from ages 13 to 18 years. The last interval for all participants corresponded to the summer prior to starting college.

The number and shape of group trajectories were determined through an iterative process to identify an optimal compromise between fitting the sample data well and parsimony. The Bayes information criterion (BIC) was the primary index of fit in this procedure. The number of groups was adjusted systematically within a range from 1 group to 6 groups. Additionally, the order of the polynomials used to describe each trajectory (i.e., linear, quadratic, cubic) was adjusted systematically. Because the distribution of average weekly alcohol use was non-normal, partly due to the high proportion of zero responses, trajectories were estimated based on a zero-inflated Poisson distribution. Additional analyses involving comparisons among the identified groups are described below.

3. Results

3.1. Identified adolescent drinking trajectory groups

Using the procedure described in Section 2.4, a four-group model was selected, as illustrated in Figure 1. The largest group (an estimated 50.7% of the population) comprised individuals who abstained from alcohol use or used at very low rates (<1 drink per week; abstainers/very light users) throughout adolescence¹. The second largest group in the current sample (late/moderate drinkers; 31.0%) followed a trajectory involving initiation of low level alcohol use at around age 16, followed by a gradual increase at ages 17 and 18 to an average of approximately 4 drinks per week. The third group (steep increase/heavy drinkers; 10.5%) included individuals who, on average, initiated light alcohol use at approximately age 15, followed by a small increase at age 16 and then steeper increases in alcohol use through the remainder of high school. This group was notable for reporting the sharpest increase in alcohol use during mid- to late adolescence. The typical individual following this trajectory was also among the heaviest drinkers in the sample, consuming approximately 14 drinks per week at age 18. Finally, the smallest group (early/moderate drinkers; 7.8%) was characterized by a relatively early onset of alcohol use at age 14, followed by a steady increase until age 16, when their average weekly alcohol use plateaued at approximately 6 drinks per week. The two groups of moderate drinkers did not substantially differ in the average amount of alcohol consumed per week at age 18; however, one group initiated use nearly two years before the other group.

One may use PROC TRAJ to calculate estimated probabilities that a participant would belong to each of the trajectory groups. For all subsequent analyses, participants were

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¹Within the abstainer/very light user group, 42 participants (19.2% of the group) reported never having consumed alcohol during the time periods assessed in the current study. Post hoc comparisons indicated that these participants did not significantly differ from the other participants classified to the abstainer/very light user group on any demographic variables or UPPS-P scale scores (all p 's > .05).

assigned to the trajectory group to which they had the highest estimated probability of belonging based on the model. The average estimated probabilities of participants belonging to their assigned groups were quite high (abstainers/very light users, 97.7%, $sd = 4.4$, $min = 74.2$, $max = 99.8$; late/moderate users, 88.6%, $sd = 16.5$, $min = 45.1$, $max = 100.0$; steep increase/heavy users, 93.5%, $sd = 11.5$, $min = 45.7$, $max = 100.0$; early/moderate users, 95.9%, $sd = 8.1$, $min = 70.9$, $max = 100.0$). Thus, although assigning participants to trajectory groups for the subsequent analyses does not explicitly account for uncertainties associated with the latent variable of group membership, these uncertainties appear small enough in the present sample not to warrant the computational and interpretational complexities of explicitly accounting for them.

3.1. Differences among adolescent drinking trajectory groups

Table 1 summarizes group demographic characteristics. To compare trajectory groups on age, a one-way analysis of variance (ANOVA) was performed; chi-square analyses were performed to compare trajectory groups on sex (% male) and race (% Caucasian/White). As shown in Table 1, group membership was not significantly associated with age or sex. There was, however, a difference in the racial distribution among the groups. Specifically, there was a higher proportion of African-American participants in group 1 compared to the other three groups ($X^2 = 40.65$, $p < .001$). This is consistent with prior research demonstrating that African-American college students generally initiate alcohol use later and abstain from alcohol use during early adulthood at greater rates than Caucasian students (e.g., Johnston et al., 2001). A chi-square analysis also revealed that there were no significant differences among groups with regard to when the participants completed the study (i.e., fall versus spring semester).

Table 2 summarizes mean values for the trajectory groups on each of the dependent variables and possible moderators, and Table 3 summarizes the correlations among those variables. To compare the trajectory groups on drinking behavior and personality during the first year of college, a series of multivariate analyses of variance (MANOVAs) was conducted. Separate MANOVAs were conducted for alcohol-related outcomes and personality-related outcomes given the interrelatedness of the variables in each of these domains.

Significant group differences were observed during the first year of college for average weekly alcohol use and AUDIT scores (Table 2). Post hoc contrasts revealed that individuals in the abstainers/very light user group continued to use alcohol at lower levels than individuals in the other three groups. Additionally, the two moderate user groups consumed alcohol at lower average weekly levels during the first year of college than the steep increase/heavy users group; the two moderate drinking groups did not significantly differ from each other. A similar pattern was observed for total AUDIT scores. Given that the first three items of the AUDIT measure patterns of alcohol use and were largely redundant with average weekly alcohol use measured via the LHC, only AUDIT scores were used for all subsequent analyses.

Regarding personality, significant group differences were observed for negative urgency, premeditation, sensation seeking, and positive urgency. Post hoc contrasts revealed that for

negative urgency, the abstainers/very light users had significantly lower scores (i.e., less predisposed to rash action under conditions of distress) than individuals in the other three groups. The same pattern was observed for sensation seeking and positive urgency. With regard to premeditation, abstainers/very light users again reported lower mean scores than the late/moderate users and steep increase/heavy users, and the late/moderate users reported lower mean scores than early/moderate users. However, there was no significant difference between abstainers/very light users and early/moderate users. Individuals in the steep increase/heavy user group reported highest scores compared to all other groups.

3.2. Evaluating interactive effects between impulsivity and adolescent drinking history on college drinking

To test whether dispositions to rash action moderated the relation between adolescent drinking trajectories and college drinking habits, a series of regression analyses was performed. For each moderator (i.e., UPPS-P scale scores), regression equations were estimated relating AUDIT scores to adolescent drinking trajectory group and the moderator. Results address two key questions of interest: first, how influential are different impulsivity-related dimensions in predicting hazardous drinking in each adolescent drinking trajectory group during the first year of college; and second, does the strength of this influence vary across groups. The first point was addressed by examining the magnitude and significance of the coefficients for the impulsivity terms of the estimated regression equations for each group. The second point was addressed by testing the significance of the interaction between trajectory groups and the moderator. Two planned contrasts were also performed to test the specific hypotheses: a) impulsivity would be more influential in predicting drinking outcomes among abstainers and light to moderate users than heavy users, and b) impulsivity would be more strongly related to drinking outcomes among moderate users than abstainers/light users. Estimates of the regression coefficients representing the slopes of the relations between the impulsivity-related variables and AUDIT scores for each group are presented in Table 4, along with significance values from *F* tests testing overall significance of main effects of trajectory groups, main effects of the moderator, and interaction between trajectory groups and the moderator.

Negative urgency was a significant predictor of AUDIT scores in three of the drinking trajectory groups; there was a trend toward significance in the steep increase/heavy user group ($b = 2.74$, $p = .08$). The relation between negative urgency and AUDIT scores was strongest in the early/moderate user group. Contrasts revealed that this effect was significantly greater than the effects for the late/moderate and abstainer/very light user groups (see Table 4; Figure 2). The strength of association observed in the steep increase/heavy user group was not significantly different from that in the abstainer/very light user or late/moderate user groups.

Premeditation was a significant predictor of AUDIT scores in the abstainer/very light, late/moderate, and steep/heavy user groups. The magnitude of this relation was similar across groups. There was a significant, positive main effect for premeditation and a main effect for group on problematic drinking, but no significant interaction between group status and premeditation score was observed.

Perseverance was not significantly associated with AUDIT scores in any groups. There were no significant differences in the strength of the association across groups.

Sensation seeking was a significant predictor of AUDIT scores in the abstainer/very light user and late/moderate user groups. No significant interaction was observed.

Positive urgency was significantly related to AUDIT scores in all four groups. There was a significant difference between abstainers/very light users and moderate users. The estimated slope for the early/moderate users was more than double that for either the abstainer/very light users or late/moderate users.

4. Discussion

The current study addressed two main questions. The first question concerned how adolescent drinking trajectory groups compared to each other with regard to impulsivity related personality traits and patterns of alcohol use during the first year of college. A generally consistent pattern of group differences was observed, whereby the abstainer/very light user group demonstrated the lowest levels of alcohol use and the lowest self-reported levels on impulsivity-related personality traits. The steep increase/heavy user group generally fell at the opposite extreme, and the two moderate user groups demonstrated intermediate levels of alcohol use and impulsivity. The moderate groups were not significantly different from each other with regard to drinking outcomes during the first year of college, though there was a trend for the early onset group to more closely resemble the steep increase/heavy user group on drinking problems. The significant main effects for group status on hazardous drinking, as measured by scores on the AUDIT, are consistent with predictions that the rank ordering of alcohol use for the adolescent drinking trajectories would remain stable over time. That the groups had significantly different means for negative urgency, premeditation, sensation seeking, and positive urgency supports previous findings linking these domains to individual differences in alcohol use during adolescence and early adulthood (Lynam & Miller, 2004; Magid & Colder, 2007).

A distinction from previous studies concerns how age of onset was related to group trajectory and subsequent outcomes. In most studies, the group with the highest level of alcohol use at the end of adolescence typically initiates use earliest and escalates consistently throughout adolescence (Chassin et al., 2002; Flory et al., 2004; Maggs & Schulenberg, 2004). The steep increase/heavy users in the current sample demonstrated this characteristic pattern of escalation and consumed alcohol at the highest levels both at the end of high school and during the first year of college, but they consumed lower amounts of alcohol, on average, later than the early/moderate user group up to age 16. Thus, in the present study, early levels of alcohol use did not necessarily predict the highest levels of consumption at the end of adolescence or in the first year of college. A related deviation from previous findings is the pattern shown by the early/moderate user group, which demonstrated a slow initial increase followed by a plateau at relatively moderate levels of alcohol use during adolescence and early adulthood. Although a number of studies have identified moderate drinking groups, the observation of a stable, moderate drinking group that initiated use prior to heavy drinkers is uncommon.

One possible explanation for these discrepancies relates to interaction effects between developmental trajectories and impulsivity related domains. When personality was considered as a moderator, an early onset, high-risk group emerged. Though not all early/moderate users demonstrated heavy alcohol use or problematic drinking in the first year of college, individuals in that group reported high levels of problematic drinking if they were high on negative urgency. At one standard deviation above the mean for those traits, participants in the early/moderate user group were indistinguishable on the corresponding outcomes from participants in the steep increase/heavy adolescent drinking group. Conversely, at one standard deviation below the mean for premeditation, individuals from the early/moderate user group were consuming alcohol at levels similar to individuals from the abstainer/very light user group during the first year of college. Thus, the interactive effect of developmental trajectory and personality (i.e., premeditation and negative urgency) seems to account for why some individuals who initiate alcohol use early are at high risk for heavy, problematic drinking in college and others are not.

Several environmental factors may limit the influence of personality on alcohol use among a subset of adolescents and young adults. For instance, even among teens who are high in impulsivity, limited access to alcohol and strict parental monitoring has been linked to less drinking and driving among high school students living at home (Pederson & McCarthy, 2008). When more opportunities are available for these individuals to make decisions about their environment and to access alcohol, personality may play a stronger role in predicting behavior. Current results indicating that the strongest influence of negative and positive urgency on alcohol use was observed for moderate adolescent drinkers support this hypothesis; contextual factors may have limited the role of these traits in driving alcohol use and problems earlier in development. Further support is suggested from the finding that sensation seeking was a significant predictor of alcohol use in the first year of college among previous abstainers/very light users and late/moderate users. It is possible that changes in context from high school to college removed restrictive environmental factors that previously attenuated the influence of personality in those groups. Alternatively, it may be that sensation seeking only influences drinking outcomes in the early stages of alcohol use. One test of this hypothesis would be to examine whether sensation seeking remains a significant predictor of drinking outcomes among individuals in the light or late onset groups who demonstrate escalations in alcohol use over time.

These results contribute to the literature supporting conceptualization of impulsivity as a heterogeneous construct (Dick et al., 2010; Whiteside & Lynam, 2001). While all of the impulsivity related traits except perseverance demonstrated significant associations with hazardous drinking in at least one group, the strength of these associations differed across drinking trajectory groups. This suggests that the impulsivity related traits studied here operate in distinct ways. Future work should examine how these traits may interact with each other to predict patterns of substance use and related problems during adolescence and early adulthood.

4.1. Limitations, future directions, and clinical implications

The current findings are qualified by limitations that may be used to guide future research. The first limitation was the use of retrospective self-reported alcohol use during adolescence to develop trajectory groups. It is possible that participants' recall of their alcohol use in the 5 years prior to the interview was inaccurate and may have been influenced by their current patterns of use (e.g., Collins, Graham, Hansen, & Johnson, 1985). Inaccuracies in recall may have influenced the number, nature, and composition of the trajectory groups observed here, which may account for differences between the groups identified here and those found in other studies. The use of timeline follow-back interviews to assess alcohol use has been well-supported in the literature (e.g., Caspi et al., 1996; Sobell & Sobell, 1992); however, to better characterize how the relations observed here develop, prospective longitudinal data are needed. Reinforcing the importance of investigating these relations over time, recent work has shown that changes in some traits during adolescence and adulthood predict changes in alcohol use, even when accounting for prior use (e.g., Littlefield, Sher, & Steinley, 2009; Littlefield, Sher, & Wood, 2010; MacPherson, Magidson, Reynolds, Kahler, & Lejuez, 2010). Littlefield et al. (2009; 2010) found that changes in impulsivity and neuroticism were linked to changes in alcohol use and problems in early adulthood, and MacPherson et al. (2010) observed that increases in sensation seeking and risk taking propensity were linked to increases in early adolescent alcohol use. Inconsistent methodologies make it difficult to generalize these results to related constructs, underscoring the need for further research.

A second limitation was the absence of a measure of binge drinking over time. Binge drinking has been linked consistently to a range of negative outcomes, including dependence and alcohol abuse, in adolescents and young adults (Chassin et al., 2002). Information on binge drinking may clarify the composition of the groups identified in the present study and the manner in which they use alcohol. Despite the absence of this information, it is possible to infer whether individuals engaged in binge drinking on a regular basis. For instance, the moderate and heavy user groups consumed, on average, more than five drinks per occasion during the first year of college, suggesting that most alcohol use in these groups occurred as binges.

Third, sampling here was limited to first-year college students, which reduces the representativeness of this sample and thus, perhaps, the generalizability of findings to the broader population of young adults. However, college students represent a large, high-risk group with regard to alcohol-related problems, so information gained by studying this population remains of great public health importance.

The composition of the groups identified in the current study differed somewhat from that detected in previous studies. The first notable difference is that the abstainer/very light user group was estimated to constitute approximately half of the underlying population, a higher estimated proportion than in other studies (e.g., 30% in Lexington Longitudinal Study, Milich et al., 1999; 27% abstainers, Hersh & Hussong, 2006). This may have been a result of the averaging over multiple time intervals and rounding preceding trajectory estimation. In particular, individuals who consumed less than two drinks per month (i.e., < .5 drinks/week) would have been classified as abstainers. This aggregation of abstainers with very

light users—who may have been classified as experimenters or light users in other studies—may have inflated the size of the abstainer/very light user group in this study. When only college drinking habits (i.e., average drinks per week for the period during which participants completed the study) are considered, 21.9% of the sample reported no alcohol use, which is in line with the estimates noted above. There is considerable variability across studies in the estimated proportion of abstainers/light drinkers (20–65%, Brown et al., 2009), however, and the abstainer/very light user group observed here falls within this range.

Adolescence and early adulthood are high-risk developmental periods for the initiation and escalation of alcohol use. This time is also marked by dramatic changes in brain maturation—particularly in networks associated with self-control and emotion regulation—and concurrent development of personality (Spear, 2010). Although a thorough range of impulsivity related traits was considered in the present study, several other variables may influence the relation between adolescent drinking history and drinking outcomes during college. Candidates for future study include contextual factors (e.g., neighborhood factors, fraternity/sorority affiliation, extracurricular activities, peer group, price of alcohol) and intraindividual factors (e.g., agreeableness vs. antagonism, distress tolerance, drinking motives, gene polymorphisms) (Brown et al., 2009; Wagenaar, Toomey, & Lenk, 2004).

Although self-report questionnaires are the most widely used strategy for measuring impulsivity, a growing body of research has used behavioral tasks to assess links between impulsivity and substance use. Different tasks have been designed to measure the cognitive processes involved in impulsive behavior (Dick et al., 2010; Lejuez et al., 2010). These performance indices represent distinct but related domains that have been linked to substance use that may provide more proximal measures of rash action than do broad traits. Future work should examine whether the trends observed here generalize to behavioral indices of impulsivity.

A major effort is underway to identify and tailor specific intervention programs to high-risk individuals, in part due to limited resources and ineffectiveness of popular universal prevention programs (e.g., Lynam et al., 1999). The current results have implications for identifying individuals or subgroups of students who may be at highest risk for problematic drinking following the transition from high school to college. Certainly, well-established risk factors such as age of onset, low premeditation, high sensation seeking, and high negative urgency should continue to be considered when assessing risk for later alcohol related problems. Even more targeted efforts should focus on individuals who initiate alcohol use early in adolescence and who report high levels of negative urgency and lack or premeditation relative to their peers. Early evidence suggest that interventions that target personality risk factors can be effective in reducing alcohol use and alter drinking motives among adolescents (Conrod, Castellanos-Ryan, & Mackie, 2011). Possible interventions may focus on problem-solving skills to improve consideration of consequences, and emotion recognition and regulation skills to provide adaptive ways of coping with distress.

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Figure 1.

Average weekly alcohol use estimated trajectories for ages 13 to 18: four-group, zero-inflated Poisson model. Abst/Very Light = abstainers/very light user group. Late/Mod = late/moderate user group. Steep/Heavy = steep increase/heavy user group. Early/Mod = early/moderate user group.

Figure 2.

The interaction between negative urgency and adolescent drinking history in predicting AUDIT Total scores during the first year of college. Abst/Very Light = abstainers/very light user group. Late/Mod = late/moderate user group. Steep/Heavy = steep increase/heavy user group. Early/Mod = early/moderate user group.

Table 1

Demographics, sample characteristics by trajectory group

	Trajectory group					
	abstainers/very light (<i>n</i> = 218)	late/moderate (<i>n</i> = 146)	steep increase/heavy (<i>n</i> = 47)	early onset/moderate (<i>n</i> = 32)	<i>F</i>	<i>p</i>
Age in years	18.9 (.5)	19.0 (.5)	18.8 (.4)	18.9 (.4)	.87	.46
Sex (% male)	46.3	47.3	66.0	50.0	–	.10
Race					–	40.65 <.001
(% Caucasian/White)	75.7	89.0	87.2	90.6		
(% African-American/Black)	20.2	6.2	4.3	3.1		
(% Other)	4.1	4.8	8.5	6.25		
Semester (% fall) ^{<i>I</i>}	42.2	50.0	51.1	46.9	–	2.70 .44

Note.

^{*I*} There were no significant differences across trajectory groups with regard to which semester individuals completed the study. Further, there were no significant differences between individuals who completed the study in the fall versus spring semesters with regard to the primary dependent variables of interest: average weekly alcohol use, $F(1, 441) = .01$, $p = .92$, or alcohol problems, $F(1, 441) = .04$, $p = .85$.

Table 2

Mean comparisons for drinking outcomes and personality across trajectory groups

	Trajectory group Mean (SD)				<i>F</i>	<i>p</i>	Partial eta squared
	abstainers/very light (<i>n</i> = 218)	late/moderate (<i>n</i> = 146)	steep increase/heavy (<i>n</i> = 47)	early onset/moderate (<i>n</i> = 32)			
Drinking outcomes							
Average drinks/week	1.87 ^a (3.40)	7.68 ^b (6.99)	13.60 ^c (10.66)	8.44 ^b (7.89)	58.24	<.001	.29
AUDIT total score	4.17 ^a (4.77)	10.24 ^b (5.13)	13.57 ^c (6.04)	11.19 ^b (5.97)	70.67	<.001	.33
Personality							
Negative urgency	2.10 ^a (.52)	2.30 ^b (.60)	2.45 ^b (.57)	2.37 ^b (.61)	7.56	<.001	.05
(lack of) Premeditation	1.89 ^a (.41)	2.08 ^b (.48)	2.29 ^c (.43)	1.91 ^a (.45)	13.91	<.001	.09
(lack of) Perseverance	1.81 (.45)	1.86 (.41)	1.98 (.42)	1.84 (.37)	2.19	.09	.02
Sensation seeking	2.49 ^a (.44)	2.64 ^b (.44)	2.73 ^b (.47)	2.66 ^b (.48)	6.37	<.001	.04
Positive urgency	1.85 ^a (.55)	2.08 ^b (.66)	2.26 ^b (.63)	2.16 ^b (.62)	8.96	<.001	.06

Note: Values in the same row not sharing a superscript are significantly different from each other, $p < .05$.

Table 3

Correlations among key variables in the whole sample ($N = 443$).

	1	2	3	4	5	6	7
1. Average weekly alcohol use	1.00	.74***	.18***	.31***	.10**	.27***	.22***
2. Problematic drinking		1.00	.35***	.37***	.15**	.27***	.37***
3. Negative urgency			1.00	.39***	.31***	.06	.74***
4. (lack of) Premeditation				1.00	.38***	.36***	.47***
5. (lack of) Perseverance					1.00	.04	.32***
6. Sensation seeking						1.00	.22***
7. Positive urgency							1.00

Note.
***
 $p < .001$.
**
 $p < .01$.

Spearman's rho correlations were computed for all associations involving average weekly alcohol use due to departures from parametric test assumptions (i.e., non-normality). All other values are Pearson correlations.

Table 4

Estimated regression coefficients and group comparisons for the relations between moderators and AUDIT total scores.

	B_{abst}	B_{late/mod}	B_{steep/heavy}	B_{early/mod}	p_{group}	p_{moder}	p_{group*moder}
Negative urgency	2.16 (.62)	2.25 (.69)	2.74 (1.52)	6.46 (1.36)	<.001	<.001	.052
Premeditation	2.57 (.79)	3.94 (.82)	4.32 (1.97)	3.35 (2.34)	<.001	<.001	.64
Perseverance	1.24 (.73)	1.37 (1.04)	2.21 (2.10)	-1.05 (2.91)	<.001	.26	.76
Sensation seeking	2.00 (.73)	3.27 (.94)	.20 (1.93)	2.52 (2.21)	<.001	.004	.41
Positive urgency	1.77 (.59)	2.63 (.61)	3.11 (1.36)	5.34 (1.46)	<.001	<.001	.13

Note. abst = abstainer/very light users. late/mod = late/moderate users. steep/heavy = steep increase/heavy users. early/mod = early/moderate users. moderate = participants in the late/mod and early/mod groups. Bold values are significantly different from zero, $p < .05$. Standard errors are listed in parentheses below estimated regression coefficients. As an example of interpreting entries in this table, consider the abstainer/very light user group. For this group, a 1 unit increase in negative urgency is estimated to augment AUDIT scores by an average of 2.16 units. p -values are reported for the main effects of trajectory groups (p_{group}), the main effects of the moderator (p_{moder}), and the interaction between group and the moderator ($p_{group*moder}$) on AUDIT scores. To illustrate, the value for p_{group} in the negative urgency row implies that the four groups are significantly different on AUDIT scores when averaged across trajectory groups. The value for p_{moder} in the same row implies that negative urgency is a highly significant predictor of AUDIT scores when averaged across trajectory groups.