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# Indirect effects of personality on high-intensity drinking: The role of drinking motives

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## Abstract

**Background:** Researchers have long been interested in identifying risk factors for binge drinking behavior (4+/5+ drinks/occasion for females/males), but many studies have demonstrated that a substantial proportion of young adults are drinking at levels far beyond (often 2 to 3 times) the standard binge threshold. The consumption of such large quantities of alcohol, typically referred to as high-intensity drinking (HID), can cause severe alcohol-related problems, such as blackouts, unintended sexual experiences, and death. This study is the first to investigate whether personality is indirectly associated with the likelihood of HID via drinking motives in a large ($N = 999$) sample of underage young adult drinkers. We hypothesized that trait neuroticism would be indirectly associated with the likelihood of HID via coping motives and that extraversion would be indirectly associated with the likelihood of HID via social and enhancement motives.

**Methods:** To investigate these hypotheses, we used two archival data sets that recruited current underage (18- to 20-year-old) adult drinkers residing in the United States from online panel services. Participants completed self-report survey items assessing constructs of interest. To investigate the role of drinking motives in the association between personality and HID, both the direct and indirect effects were calculated via three path analyses.

**Results:** Findings revealed that neuroticism was partially indirectly associated with the likelihood of HID via coping motives ($b = 0.02$, SE = 0.004, $p < 0.01$). In addition, extraversion was indirectly associated with the likelihood of HID via social ($b = 0.031$, SE = 0.002, $p < 0.01$) and enhancement motives ($b = 0.01$, SE = 0.002, $p = 0.01$).

**Conclusions:** These findings are an initial step in examining the interplay among personality traits, drinking motives, and HID in underage drinkers and point to the need for longitudinal studies assessing these associations.

KEYWORDS
drinking motives, emerging adulthood, high-intensity drinking, personality

  

## INTRODUCTION

Binge drinking, sometimes referred to as "heavy episodic drinking," is defined as consuming 4+/5+ drinks/occasion for females/males (NIAAA, 2004) and peaks in young adulthood with approximately 35% to 40% of 18 to 21 year-olds in the United States reporting at least one episode of binge drinking in the past 2 weeks (Patrick et al., 2019). Binge drinking contributes to a substantial proportion of alcohol-related deaths, including suicide, in addition to a host of other negative outcomes such as alcohol poisoning, unintentional injuries, vehicular accidents, and increased risk of developing alcohol use disorder (Chikritzhs et al., 2001; Creswell et al., 2020; Rehm et al., 2010; Spillane et al., 2020). The probability that negative alcohol-related consequences will occur greatly increases with more frequent binge drinking episodes and when individuals consume larger quantities of alcohol during a particular drinking episode (Jackson, 2008; Miller et al., 2007; Read et al., 2008).

Importantly, a substantial proportion of young adults drink at levels far beyond the standard binge threshold, typically referred to as high-intensity drinking (HID; Hingson et al., 2017; Patrick, Evans-Polce et al., 2017; White et al., 2006). For example, White et al. (2006) found that approximately 43% of college student drinkers endorsed drinking at levels twice the standard binge cutoff (i.e., 8+/10+ drinks for females/males) in a single sitting. In a nationally representative sample of US high school seniors (modal age 18), Patrick and Terry-McElrath (2017) found that approximately 25% consumed 5+ alcoholic drinks, 10% consumed 10+ drinks, and 5% consumed 15+ drinks in a single setting at least once in the last 2 weeks. Young adults who engage in HID are particularly vulnerable to severe alcohol-related harms, including blackouts and death (Hingson et al., 2017; White et al., 2006). Identifying young adults who are at risk of engaging in HID, and understanding why these individuals are at increased risk is a research priority (e.g., Chung et al., 2018; Creswell et al., 2020; NIAAA Working Group on High-Intensity Drinking, 2018; Patrick, 2016), yet very few prior studies have examined these questions.

Personality is one such construct that has long been identified as an important predictor of unhealthy alcohol use (a spectrum of use ranging from drinking above recommended limits to meeting criteria for alcohol use disorder (AUD; Saitz, 2005); e.g., Sher et al., 1999). Various trait-level personality constructs have been found to be associated with alcohol use, including—to varying degrees—all five personality traits from the Five-Factor Model of personality (Costa & McCrae, 1992). Specifically, high extraversion, low agreeableness, low conscientiousness, high neuroticism, and high openness to experience have been associated with unhealthy alcohol use (see Malouff et al., 2007 for review). However, some traits are more consistently found to be associated with binge drinking (as traditionally defined) in emerging adulthood and include neuroticism and extraversion (Adan et al., 2017; Malouff et al., 2007; Pilatti et al., 2015; Sellés et al., 2015). These traits may also help identify who is at increased risk of engaging in HID, but we are aware of only two papers on this topic. The first study (Ramchandani et al., 2019) investigated impulsivity and aggression (two facets of neuroticism) in a nontreatment seeking sample of adults classified into four groups: Level 0 (no binges), Level 1 (4 to 7/5 to 9 drinks for females/males), Level 2 (8 to 11/10 to 14 drinks for females/males), and Level 3 (12+/15+ drinks for females/males). They found significant differences in impulsivity and aggression between high-intensity drinkers (Levels 2 and 3) and binge/nondrinkers (Levels 0 and 1), such that high levels of trait impulsivity and aggression indicated higher likelihood of HID. The second study examined the relationship between the Big 5 personality traits and HID in a sample of midlife adults (Lee & Sibley, 2020), using data from the 2014 to 2016 New Zealand Attitudes Values Study. Results suggested that extraversion and neuroticism positively correlated with HID, and there was no relationship between conscientiousness and HID. Interestingly, they also found that high neuroticism was associated with coping motives and that high extraversion was associated with social and enhancement motives, but they did not investigate whether personality was indirectly associated with HID through these motives.

A substantial portion of the research on predictors of HID has focused on motivations or reasons for drinking (Patrick et al., 2016, 2021; Patrick, Evans-Polce et al., 2017; White et al., 2016), as this information can aid in identifying alternative reinforcement options to target in treatment and prevention programs (Creswell et al., 2020). Several theories propose that drinking motives are the most proximal predictors of alcohol use that all other distal determinants (e.g., personality traits) operate through (Cooper, 1994; Cox & Klinger, 1988; Kuntsche et al., 2005). Four possible drinking motives have been identified based on the perceived valence and locus of the outcomes, including social (positive-external; drinking to obtain/facilitate social gains), conformity (negative-external; drinking to feel included/avoid social rejection), enhancement (positive-internal; drinking to enhance a positive mood), and coping (negative-internal; drinking to avoid/regulate negative feelings; Cooper, 1994; Cox & Klinger, 1988).

A large body of research has accumulated showing that drinking motives predict alcohol use and alcohol-related consequences, including binge drinking (Cooper et al., 2016) and HID (e.g., Creswell et al., 2020; Patrick, Evans-Polce et al., 2017; White et al., 2016). For example, White et al. (2016) found that, over 6 months, increases in social and enhancement motives were larger among college students who transitioned from non-binge drinking to HID. In a large national sample of young adult drinkers, Patrick, Evans-Polce et al. (2017) investigated longitudinal self-report data on HID (10+ drinks) collected from the national Monitoring the Future study between 2005 and 2014 from 2664 participants ages 18 to 26. They found stable associations over time between HID and the following four "reasons for drinking": drinking to get away from problems, to feel good or get high, to relax or relieve tension, and to get to sleep. Finally, in a clinical sample of adolescents with alcohol-related problems, Creswell et al. (2020) studied 432 adolescents (aged 12 to 18 years) followed into young adulthood (aged 19 to 25 years). They found that the maintenance of relatively high endorsement of enhancement and social motives over time was associated with HID in young adulthood

and that decreases in coping motives were associated with less risky drinking (i.e., standard threshold binge drinking) in young adulthood. Thus, although several studies have investigated whether drinking motives predict HID, no prior studies, to our knowledge, have tested whether drinking motives might modify the relationship between personality and HID, specifically. Taken together, drinking motives seem to be a promising avenue to pursue in better understanding the emergence of HID in young adults, particularly since several studies have shown that personality traits are indirectly associated with both typical alcohol consumption and alcohol-related problems via motives (e.g., Kuntsche et al., 2008; Littlefield et al., 2010; Stewart et al., 2001; Stewart & Devine, 2000). Therefore, this will be the first study to investigate whether personality traits are indirectly associated with the likelihood of HID via drinking motives. Results from such a study could provide information about who might be at risk of engaging in this type of unhealthy alcohol use, as well as why they are at increased risk, which could aid in more targeted intervention programs.

The current study extends prior research on the associations between personality traits, motives, and HID in three important ways. First, while prior studies have tended to focus on midlife (e.g., mean age of around 50 years; Lee & Sibley, 2020) and wide age ranges of emerging adults mostly of legal drinking age (e.g., 18 to 29/30 year olds; Patrick, Terry-McElrath, Miech, et al., 2017), we focus on a large sample of underage drinkers who have been shown to be most at-risk for engaging in HID (Patrick, Terry-McElrath, Schulenberg, et al., 2017). Indeed, HID increases sharply across late adolescence, peaks during the early 20s, and then decreases through adulthood (Patrick & Terry-McElrath, 2019). Second, prior studies have tended to define HID similarly across males and females (i.e., consuming 10+ drinks per occasion; e.g., Patrick & Terry-McElrath, 2019), which does not accurately reflect that blood alcohol concentration (BAC) increases faster at lower drinking levels in the average adult woman as compared to the average adult man (Baraona et al., 2001). Our study aims to rectify this by defining HID in accordance with national recommendations (see Methods below). Specifically, as discussed at the NIAAA Working Group on High-Intensity Drinking (2018), assessment of binge drinking as traditionally defined typically offers a dichotmous threshold (yes/no) and does not take into account the risks of drinking at higher levels. Separating out HID from traditional binge definitions, while also accounting for sex differences in consumption (8+ drinks for women, 10+ drinks for men), allows for a more accurate assessment of this unhealthy drinking practice. Third, our study is the first to determine whether certain personality traits (i.e., neuroticism, extraversion) are indirectly associated with the likelihood of HID via drinking motives. This framework builds on a body of work indirectly linking facets of personality to alcohol use and/or alcohol-related problems via drinking motives (e.g., Adams et al., 2012; Bruce et al., 2013; Littlefield et al., 2010: Loxton et al., 2015). For example, Littlefield et al. (2010) found that changes in neuroticism over time (from ages 18 to 35) predicted changes in coping motives over time, which in turn predicted changes in alcohol-related problems over time. Our focus here specifically on HID as an outcome may help to identify correlates of this risky drinking practice.

As discussed above in more detail, the present study focuses specifically on the personality traits of neuroticism and extraversion due to prior research findings linking these traits consistently with both HID (Lee & Sibley, 2020) and unhealthy alcohol use in general (Adan et al., 2017; Malouff et al., 2007). Consistent with prior research examining alcohol consumption and related problems as outcome variables (Cooper, 1994; Loose et al., 2018; Mezquita et al., 2010), we hypothesized the following: (1) neuroticism would be indirectly associated with the likelihood of HID via coping motives and (2) extraversion would be indirectly associated with the likelihood of HID via social and enhancement motives.

## METHODS

### Participants

Two archival data sets based on two separate studies were combined and used for the current project ($N = 1237$). Both studies recruited underage (18 to 20 year old) adult drinkers residing in the United States from online panel services (i.e., Amazon TurkPrime and Qualtrics). Reliable and valid substance use data have been obtained through such online samples (e.g., Arditte et al., 2016; Kim & Hodgins, 2017). The first sample was recruited through an Amazon TurkPrime panel (see Skrzynski et al., 2018 for additional details), and 727 eligible individuals (i.e., those who were 18 to 20 years old, current alcohol drinkers, and residing in the United States) were included in the current analyses. The second sample was recruited through a Qualtrics panel, and 510 eligible individuals (i.e., current alcohol drinkers between 18 and 20 years old who were residing in the United States) were included in the current analyses. We defined current drinking status for both samples by asking potential participants, "Do you currently drink alcohol?" with response options of yes and no. Those that answered "yes" were considered current drinkers and eligible. Manipulation checks were used during data collection to assess whether participants were paying attention or answering items at random, which led to the removal of 238 participants. The final sample size was 999.

### Measures

#### Demographics

Participant characteristics were assessed with age, sex, race, education, and parent education. Sex was examined as a binary categorical variable (0 = female and 1 = male). Participants were asked to then identify their race (White, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, American Indian/Alaska Native, and Multiracial) and education level (response options ranged from 8th grade or less through 4+ years of graduate school).

Finally, parental education was assessed and categorized as follows: completed grade school or less, attended some high school, completed high school, attended some college, completed college, and attended graduate or professional school post-college.

### Alcohol consumption

Past month frequency of binge drinking was assessed with the following question, "During the past month, how often did you have 4 (for females)/5 (for males) or more drinks containing any kind of alcohol within a two-hour period?" (NIAAA, 2004). Responses were marked on a 7-point scale (1 = *every day*, 2 = *5 to 6 times a week*, 3 = *3 to 4 times a week*, 4 = *twice a week*, 5 = *once a week*, 6 = *2 to 3 times in the past month*, 7 = *once in the past month*). Past month HID was assessed with two questions asking about frequency of drinking 8+/10+ (for females and males, respectively) and 12+/15+ drinks (for females and males, respectively) within a 2-h period (Patrick, 2016). Response options were the same as those used for the standard binge drinking question. Participants were then categorized into a binary HID variable: 0 = non-HID drinker (i.e., engaged in drinking but not HID) or 1 = endorsed engaging in HID (i.e., drank 8+/10+ drinks or more) at least once in the past month. This binary HID variable was the primary outcome variable in all multivariate models.

### Drinking motives

Reasons for drinking were assessed with the well validated (e.g., Kuntsche et al., 2005) Drinking Motives Questionnaire-Revised (DMQ-R; Cooper, 1994), a 20-item measure that assesses why individuals might be motivated to drink alcohol. The DMQ-R contains four subscales measuring four facets of reasons for drinking: coping (e.g., "because it helps you when you feel depressed or nervous"), social (e.g., "to be sociable"), enhancement (e.g., "because you like the feeling"), and conformity (e.g., "to fit in with a group you like"). Items were rated on a 5-point Likert scale (*almost never/never*, *some of the time*, *half of the time*, *most of the time*, *almost always/always*) and averaged to create each subscale. Based on study hypotheses, we used the following three subscale scores in the proposed analyses: coping ($\alpha = 0.86$), social ($\alpha = 0.91$), and enhancement ($\alpha = 0.86$).

### Personality traits

Two domains of adult personality, neuroticism ($\alpha = 0.79$) and extraversion ($\alpha = 0.79$), were assessed using the abbreviated 60-item version of the NEO Five-Factor Inventory (NEO-FFI; Costa & McCrae, 1992). The NEO-FFI asked participants to rate how well statements describe them (e.g., "I am not a worrier") on a 5-point scale from 1 to 5 (*Disagree strongly*, *Disagree a little*, *Neither agree or disagree*, *Agree a little*, *Agree strongly*). Items were then summed to create neuroticism and extraversion scale scores.

## Data analyses

For the descriptive results, we calculated means, standard deviations, and percentages for all variables of interest across the combined sample. We then conducted *F*-tests (for continuous variables), chi-square statistics (for categorical variables), and their effect sizes to compare participants recruited for study 1 compared to study 2 on all variables of interest. Last, bivariate correlations among study variables were calculated using the combined sample. All descriptive analyses used IBM SPSS Statistics for Windows, version 27 (2021).

To investigate the role of drinking motives in the association between personality and HID, we calculated both the direct and indirect effects via three path analyses using maximum likelihood estimation with Monte Carlo integration via Mplus, version 8 (Muthén & Muthén, 2017). Three models were conducted with personality traits (neuroticism, extraversion), drinking motives (coping, social, and enhancement), and covariates (age, sex, study, and parent education) as the independent variables and HID as the dichotomous dependent variable (0 = non-HID drinkers, 1 = engaged in HID). Specifically, we examined whether (1) higher trait neuroticism was directly associated with the likelihood of HID and whether higher levels of coping motives modified this association (model 1) and (2) higher trait extraversion was directly associated with the likeilhood of HID and whether higher levels of social (model 2) and/or enhancement motives (model 3) modified this association.

# RESULTS

## Descriptive analyses

### Missing data

There were no missing data on the DMQ-R or on items assessing HID status and <1% missing data on personality variables ($n = 78$). Due to low rates of missingness, listwise deletion was used in models including personality traits.

### Descriptive statistics

Table 1 presents the means, standard deviations, and percentages for all study variables of interest across the combined sample and compares participants recruited for study 1 with participants recruited for study 2 via *F*/chi-square tests and their respective *p*-values and effect sizes. Overall, participants ($N = 999$, $M_{age} = 19.1$, $SD_{age} = 0.8$) mostly identified as female (70.0%) and White (73.6%), but a substantial proportion identified as more than one race (11.0%) or Black (9.2%). The remaining participants identified as Asian (3.9%), American Indian/Alaska Native (1.5%), or Native Hawaiian or other Pacific Islander (0.7%). In regards to the participants' education levels, the majority had completed 1 year of college, with 57.6% of the sample completing at least high school. Regarding parental education

**TABLE 1** Descriptives statistics comparing participants recruited for study 1 and study 2 on demographics, personality, drinking motives, and drinking status

| | Total ($N = 999$) | Study 1 ($N = 489$) | Study 2 ($N = 510$) | | | |
|---|---|---|---|---|---|---|
| **Variable** | ***M* (SD)/%** | | | $F/\chi^2$ | ***p*-Value** | $\eta^2/\varphi$ |
| Demographics | | | | | | |
| Age | 19.1 (0.8) | 19.2 (0.8) | 18.9 (0.9) | 44.4 | <0.001 | 0.04 |
| Female gender | 70.0% | 90.8% | 50% | 197.7 | <0.001 | 0.45 |
| Education | 6.0 (1.6) | 6.2 (1.5) | 5.8 (1.6) | 16.7 | <0.001 | 0.02 |
| Parent education | 4.1 (1.2) | 4.3 (1.2) | 4.0 (1.2) | 9.4 | 0.002 | 0.01 |
| Persons of color | 26.4% | 29.0% | 23.5% | 3.4 | 0.07 | 0.06 |
| NEO-FFI | | | | | | |
| Neuroticism | 40.4 (10.2) | 41.1 (9.9) | 39.9 (10.4) | 3.2 | 0.07 | 0.003 |
| Extraversion | 37.9 (8.7) | 37.7 (8.6) | 38.0 (8.7) | 0.2 | 0.65 | <0.001 |
| DMQ-R | | | | | | |
| Social | 3.0 (1.1) | 3.0 (1.1) | 3.1 (1.0) | 1.0 | 0.33 | 0.001 |
| Coping | 2.3 (1.1) | 2.3 (1.1) | 2.3 (1.0) | 0.2 | 0.70 | <0.001 |
| Enhancement | 2.8 (1.0) | 2.8 (1.1) | 2.8 (1.0) | 0.0 | 0.99 | <0.001 |
| Drinking group | | | | | | |
| Never binge drank | 42.4% | 42.9% | 42.0% | 1.9 | 0.39 | 0.04 |
| Binge drinking | 27.2% | 28.6% | 25.9% | | | |
| High-intensity drinking | 30.3% | 28.4% | 32.2% | | | |

*Note*: Never binge drank = under 4/5 drinks for females/males per occasion in the past month. Binge drinking = 4+/5+ drinks per occasion in the past month. High-intensity drinking = 8+/10+ drinks per occasion in the past month.

(a socioeconomic status proxy), the parents of most participants completed some college, with 90.2% of these parents completing at least high school. Participants recruited for study 1 were slightly older, more likely to endorse being female, and more educated.

Binge drinking and HID were relatively common in the overall sample. More than half ($n = 575$; 57.6%) of participants met the cut-off for drinking at least 4 (female) or 5 (male) drinks per occasion at least once in the past month. In addition, 30.3% of participants fell into the highest HID category—drinking at least 8/10 or 12/15 (female/male, respectively) drinks per occasion at least once in the past month. Results also revealed that drinkers typically drank two to three times in the past month and 39.8% of the sample drank at least once a week. There were no significant differences between study 1 and study 2 participants regarding personality, drinking motives, or binge drinking/HID frequency. Skewness and kurtosis values indicated that variables of interest had a symmetrical disribution (skew close to 0) and the distributions were platykurtic (thin-tailed) indicating outliers were infrequent (Table S1).

## Bivariate correlations

Table 2 presents the bivariate associations among study variables. HID was significantly positively correlated with coping, social, and enhancement motives ($p$-values $< 0.01$), but was not significantly related to neuroticism or extraversion. As expected, neuroticism was significantly positively correlated with coping motives, and extraversion was significantly positively correlated with social and enhancement motives.

## Multivariate models

Results of all three models, including unstandardized path coefficients ($b$), standardized path coefficients ($\beta$) where the outcome is continuous, and odds ratios (OR) where the outcome is categorical, can be found in Figure 1. Model 1 indicated that the total effect of neuroticism predicting the likelihood of HID was nonsignificant ($b = -0.004$, SE = 0.008, 95% CI = −0.02 to 0.01, $p = 0.66$). However, the indirect effect of neuroticism on the likelihood of HID through coping motives was significant ($b = 0.02$, SE = 0.004, 95% CI = 0.02 to 0.03, $p < 0.01$). The direct effect of neuroticism on likelihood of HID was also significant, but negative in direction ($b = -0.03$, SE = 0.01, 95% CI = −0.22 to −0.07, $p < 0.01$; OR = 0.97, 95% CI = 0.96 to 0.99).

Model 2 indicated that the total effect of extraversion on likelihood of HID was nonsignificant ($b = 0.001$, SE = 0.01, 95% CI = −0.01 to 0.02, $p = 0.93$). However, the indirect effect was significant ($b = 0.031$, SE = 0.002, 95% CI = 0.003 to 0.01, $p < 0.0$) indicating that higher extraversion was associated with higher social motives, which in turn was associated with the likelihood of engaging in HID. In addition, the direct effect between extraversion and likelihood of HID was nonsignificant ($b = -0.01$, SE = 0.01, 95% CI = −0.02 to 0.01, $p = 0.50$; OR = 1.00, 95% CI = 0.98 to 1.01),

TABLE 2 Bivariate correlations among study variables

| Variable | *n* | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| 1. DMQ-R social | 999 | – | | | | | |
| 2. DMQ-R coping | 999 | 0.39** | – | | | | |
| 3. DMQ-R enhancement | 999 | 0.63** | 0.42** | – | | | |
| 4. Neuroticism | 921 | 0.001 | 0.37** | 0.06 | – | | |
| 5. Extraversion | 921 | 0.13** | −0.23** | 0.09** | −0.52** | – | |
| 6. HID[a] | 999 | 0.21** | 0.24** | 0.24** | −0.04 | 0.01 | – |

*Note*: All correlation coefficients are Pearson's *r*.

Abbreviation: DMQ-R, Drinking Motives Questionnaire-Revised.

[a] HID, high-intensity drinking, coded as: 0 = non-HID drinker, 1 = engaged in HID.

** Correlation is significant at the 0.01 level (2-tailed).

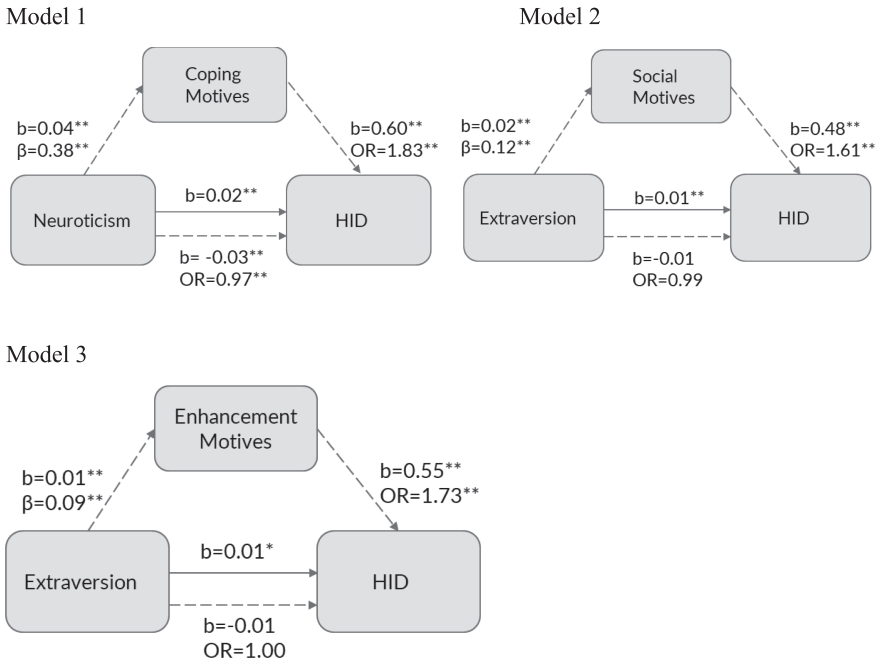


FIGURE 1 Direct and indirect effects models examining the relationship between personality, drinking motives, and high-intensity drinking. Dotted lines signify direct effects and solid lines signify indirect effects **p<0.01; *p<0.05.

indicating extraversion was associated with the likelihood of HID via higher social motives.

Model 3 revealed that when we instead examined enhancement motives in the model, the indirect effect from extraversion to likelihood of engaging in HID was significant ($b$ = 0.01, SE = 0.002, 95% CI = 0.002 to 0.01, $p$ = 0.01) such that higher extraversion was associated with higher enhancement motives, which in turn was associated with an increased likelihood of engaging in HID. In addition, the direct effect from extraversion to likelihood of HID was not significant ($b$ = −0.01, SE = 0.01, 95% CI = −0.02 to 0.01, $p$ = 0.54; OR = 1.00, 95% CI = 0.98 to 1.01).

Furthermore, because both social and enhancement motives were significantly associated with the likelihood of HID in models 2 and 3 above, we decided to test a final model with both motive constructs together in order to understand whether each still exhibited a unique effect in their association with HID or a possible shared effect. Results revealed a signficant total indirect effect ($b$ = 0.01, $p$ < 0.01) and a nonsigificant direct effect from extraversion to HID ($b$ = −0.01, $p$ = 0.42). The model indicated unique and signficant indirect effects for both social motives ($b$ = 0.003, SE = 0.002, 95% CI = 0.001 to 0.01, $p$ = 0.04) and enhancement motives ($b$ = 0.01, SE = 0.002, 95% CI = 0.001 to 0.01, $p$ = 0.02) in their association with the likelihood of engaging in HID.

## DISCUSSION

Almost half of college student drinkers report drinking at levels twice the standard binge threshold in a single sitting (White et al., 2006), and young adults who engage in HID are especially vulnerable to severe alcohol-related consequences, including blackouts and death (Hingson et al., 2017). It is therefore a research priority to identify

predictors of HID in these at-risk populations. Personality traits (i.e., neuroticism and extraversion; Lee & Sibley, 2020) and drinking motives (i.e., coping, enhancement, and social; Creswell et al., 2020; White et al., 2016) have been shown to be associated with high-risk drinking in prior studies, but the current study is the first to investigate whether personality was indirectly associated with the likelihood of HID through facets of drinking motives in underage drinkers who are most at-risk for engaging in this behavior (Patrick, Terry-McElrath, Schulenberg, et al., 2017). We hypothesized that trait neuroticism would be indirectly associated with the likelihood of HID via greater drinking to cope motives, and that trait extraversion would be indirectly associated with the likelihood of HID via greater enhancement and social motives.

Descriptively, HID prevalence (~30%, respectively) was slightly higher than what has been reported previously in the literature. This can be attributed to several possible reasons, including (1) the present sample is made up of individuals identifying as current drinkers, (2) we assessed past month HID (as opposed to past 2-week), (3) we included 8+ drinks as our lower threshold (as opposed 10+), and/or (4) the sampling strategy used in the present study could have attracted a heavier drinking sample (i.e., the current study used online panel recruitment as opposed to school-based sampling). For example, recent data from the Monitoring the Future study revealed that for underage adult drinkers (18 to 20 years old), 12.1% endorsed engaging in HID (Patrick & Terry-McElrath, 2019). This indicates that HID prevalence will vary based on a multitude of factors, including sample recruitment and definition of HID.

Bivariate correlations showed that HID was significantly and positively associated with coping, social, and enhancement motives. These findings are consistent with previous research investigating associations between drinking motives and binge drinking, as traditionally defined (Cooper et al., 2016) and HID (Creswell et al., 2020; White et al., 2016). In addition, neuroticism was significantly positively correlated with coping motives, and extraversion was positively correlated with social and enhancement motives, which is consistent with much prior research on alcohol consumption (e.g., Kuntsche et al., 2008; Lee & Sibley, 2020; Stewart et al., 2001; Stewart & Devine, 2000). Contrary to expectations, neuroticism and extraversion were not significantly correlated with HID, which contrasts with the findings of Lee and Sibley (2020), the only other study that examined the Big 5 personality traits as predictors of HID. These discrepant findings might be due to differences in participant characteristics across studies, study designs, and/or HID measures. Specifically, we investigated underage drinkers in the United States, while Lee & Sibley investigated older individuals (mean age of 50) in New Zealand. In addition, the present study used a cross-sectional design and Lee & Sibley examined findings longitudinally. Finally, their study measured HID by asking about quantity of drinks containing alcohol consumed on a typical day when drinking (i.e., 1 to 2, 3 to 4, … 10 or more), whereas we assessed HID using two questions that assessed frequency of drinking 8+/10+ (for females and males, respectively) and 12+/15+ drinks (for females and males, respectively) within a 2-hour period.

As hypothesized, our first multivariate model showed a partial indirect effect of neuroticism and likelihood of engaging in HID via higher coping motives. However, both the indirect and direct effects were significant, and the indirect effect was positive while the direct effect was negative. Thus, the null total effect was obscuring an indirect effect that was positive and a direct effect that was negative. Results suggest that higher neuroticism was associated with higher coping motives, which in turn was associated with increased likelihood of HID. However, after controlling for coping motives, we found a negative direct effect, such that holding constant coping motives revealed that higher neuroticism was associated with a decreased likelihood of HID. Although Lee and Sibley (2020) found a significant positive association between neuroticism and HID, this may only hold true when examining personality as an individual predictor, and it is possible that our results indicate a suppression effect. Our results suggest, then, that coping motives should be accounted for in order to reveal the indirect relationship between neuroticism and HID.

Consistent with our other hypothesis, our latter models showed that extraversion was significantly and indirectly associated with the likelihood of HID via both higher enhancement and social motives. This held true in a final model that included both enhancement and social motives together, indicating that each construct provides unique information in the association with HID engagement. Given that extraversion did not have a significant direct effect on HID, these results suggest that examining personality or motives in isolation will most likely not provide a nuanced understanding regarding how each relates to HID.

Our study has limitations. The most important limitation is the cross-sectional design, which precludes us from making claims about causality or the directions of the associations between personality traits, drinking motives, and HID. Future work examining these constructs longitudinally will be important to test in order to demonstrate temporal precedence. Further, although we were able to recruit a large sample of underage drinkers ($N = 999$), we were unable to recruit a sample that was racially and ethnically representative of the US population, as only about a quarter of our sample identified as a person of color. In addition, approximately 70% of our sample identified as female. Future studies using more nationally representative samples are indicated. Another limitation is that we specifically focused on trait neuroticism and extraversion and only on coping, social, and enhancement motives in the present study. We focused on these particular personality traits and drinking motives based on previous binge drinking research, but future analyses could examine the remaining five factor traits (i.e., conscientiousness, agreeableness, and openness) and other drinking motives (e.g., conformity) to obtain a more complete understanding of the links between personality, motives, and HID. Finally, although underage individuals who engage in HID represent a clinically relevant population, our findings should be replicated in other age groups in order to determine their generalizability.

In summary, this study provides initial evidence that trait neuroticism and extraversion may be indirectly associated with the

likelihood of engaging in HID via commonly endorsed drinking motives among underage drinkers. These findings provide a preliminary step toward examining the interplay between drinking motives and personality traits in predicting HID. If future longitudinal studies replicate our findings, it may suggest the potential clinical utility of prevention and intervention programs targeting drinking motives (e.g., developing appropriate coping skills, engaging in healthier social networks, etc.) for unhealthy drinking underage populations who are higher in neuroticism and/or extraversion.

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## CONFLICT OF INTEREST

None to declare.

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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