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Opportunities for reducing college drinking: The roles of drinking attitudes and blackout experience

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Abstract

Background: As many as 35% of college students report having been drunk in the past month, and greater alcohol use and alcohol-related problems are associated with a positive attitude toward heavy drinking. One serious consequence of heavy drinking is alcohol-induced blackout. When they occur, alcohol-induced blackouts present a unique opportunity to increase motivation to change drinking. However, it is unclear under what conditions an alcohol-related heavy drinking attitude and experiencing a blackout represent an opportunity to change and how experiencing a blackout(s) influences an individual's motivation to reduce drinking and actual behavior.

Methods: This study tested the interplay between one's positive attitude toward heavy drinking and experiencing a blackout in the past year in predicting motivation to reduce drinking (Study 1) and its impact on drinking over time (Study 2). Data were derived from complementary datasets collected at two universities (Study 1 n = 703, mean age = 20.63 years, 44% male, 52% White; Study 2 n = 568, mean age = 19.18 years, 72% male, 84% White). Drinking behavior was measured using a modified Daily Drinking Questionnaire, the Drinking Norms Rating Form, the Alcohol Use Disorders Identification Test (AUDIT), and estimated peak blood alcohol concentration (BAC). Regression analyses were conducted to determine whether a blackout would moderate the association between attitude and motivation to reduce drinking (Study 1) and drinking over time (Study 2).

Results: Results revealed a significant interaction between attitude and blackout, such that individuals who experience a blackout (vs. those who do not) and positively evaluate heavy drinking evidenced lower motivation to reduce drinking (Study 1) and higher levels of estimated peak BAC (Study 2).

Conclusions: Drinkers with a negative attitude toward heavy drinking who have experienced a blackout have the strongest motivation to reduce drinking and the greatest reductions in peak drinking behavior over time. These effects are over and above that related to the level of alcohol consumed. For young adults who do not positively endorse heavy drinking, blackouts may present a "moment of opportunity" for intervention.

INTRODUCTION

College drinking

College is a time when late adolescents explore their relationship with alcohol and other drugs, and campuses deal with the effects of this youthful exploration. Although more than half of students attending college are under the minimum legal drinking age of 21 (American College Health Association, 2012), 79.2% report lifetime alcohol use (Schulenberg et al., 2019). Regardless of age, a significant minority of college students endanger themselves and their fellow students by drinking large quantities of alcohol. Nearly one-third of college students (32.7%) report heavy episodic drinking (5+ drinks in a single sitting) at least once in the past 2 weeks, and more than one-third (34.8%) report having been drunk at least once in the past 30 days (Johnson et al., 2012). Indeed, the college environment appears to promote a drinking style involving high quantities per occasion, as college attendance increases the risk for heavy drinking for both underage and of-legal-age students (Hingson et al., 2009). High-quantity drinking is accompanied by substantial negative consequences, with college student drinkers reporting adverse effects such as blackouts, academic underperformance, and interpersonal problems (White & Hingson, 2013). Experiencing negative consequences does not always dissuade future high-quantity drinking, so a more nuanced understanding of what might motivate risk reduction is needed.

Drinking attitudes

Among college drinkers, social cognitive factors (e.g., norms, motives) have been consistently identified as predictors of alcohol use and related problems (Kuntsche et al., 2005; Neighbors et al., 2007). Personal attitudes toward alcohol consumption are a particularly strong and consistent predictor of drinking behavior (Burden & Maisto, 2000; Collins & Carey, 2007; Collins et al., 2011; DiBello et al., 2018a; Wiers et al., 2002).

Broadly defined, attitudes represent evaluative judgments of a person's experience (e.g., an idea, a person, a behavior) that range from negative to positive and are influenced by situational factors, including observations of one's own behavior (Bem, 1967). Attitudes are a key element of many explanatory models of health behavior (Montano & Kasprzyk, 2008). In the context of alcohol use, attitudes are consistent and powerful predictors of drinking behavior in both cross-sectional (e.g., Stacy et al., 1994; Trafimow, 1996) and longitudinal studies (Collins & Carey, 2007; Guo et al., 2001). Personal attitudes are stronger predictors of alcohol consumption than subjective norms (perception of social pressure to engage or not in a behavior; Collins & Carey, 2007; Collins et al., 2011), injunctive norms (perceptions of others' approval

of behaviors; Kenney et al., 2013; Krieger et al., 2016), and descriptive norms (perceptions of others' rate or frequency of behaviors; DiBello et al., 2018a; Krieger et al., 2017). Thus, positive drinking attitudes appear to be more proximal predictors of drinking intentions and behavior than many other psychosocial correlates of drinking.

Given that attitude toward drinking is correlated with current and future drinking, it follows that one's attitude would not necessarily be predictive of desire to *change* drinking in the absence of another event that triggered thoughts of change. However, if such a trigger were to occur, then individuals holding a negative attitude toward heavy drinking may be more likely to contemplate a reduction in drinking. This study considers 1 such trigger—alcohol-induced blackout.

Blackout

Alcohol-induced "blackouts," defined as permanent (en bloc) or temporary (fragmentary) memory loss for drinking events, are common among young adults (Wetherill & Fromme, 2016). Such memory loss often occurs when an individual's acute consumption results in a rapid rise in their blood alcohol concentration (BAC) (Rose & Grant, 2010; White, 2003). In studies using cross-sectional, longitudinal, and diary designs, alcohol-induced blackouts have been associated with increased odds of injury (Mundt et al., 2012), sexual assault (Valenstein-Mah et al., 2015), other alcohol-related problems (Miller et al., 2020; Wilhite & Fromme, 2015), and the incidence and severity of alcohol use disorder (AUD) (Studer et al., 2019). Importantly, alcohol-induced blackouts have been linked to other alcohol consequences even after accounting for drinking quantity (Mundt et al., 2012; Valenstein-Mah et al., 2015), suggesting unique characteristics of blackouts that contribute to other alcohol-related problems.

Emergent research suggests that blackouts may also increase young adults' motivation to change their drinking behaviors. Specifically, blackout experienced in the final years of college is associated with motivation to drink less 1 year later (Marino & Fromme, 2018). In event-level studies, young adults also report less favorable evaluations of drinking events and stronger perceptions that the event was not worthwhile the morning after experiencing a blackout (Fairlie et al., 2016; Merrill et al., 2019). In the context of alcohol interventions, recent experience of a blackout has also been associated with increased responsiveness to personalized alcohol feedback (Miller et al., 2018a; Miller et al., 2019a). Collectively, these studies suggest that blackouts may motivate and facilitate drinking reductions. However, some young adult drinkers evaluate blackouts as neutral or positive, and these subjective evaluations of alcohol-related consequences have also been associated with subsequent change in drinking behavior (Barnett et al., 2015; Merrill

et al., 2013). Thus, the potential impact of blackouts on subsequent drinking behavior may largely depend on one's underlying attitude toward heavy drinking.

Current study

The current work uses two complementary datasets to explore the impact of blackout on the association between attitude toward heavy drinking and (a) concurrent motivation to reduce drinking (Study 1) and (b) changes in prospective estimated peak BAC (Study 2). Within Study 1, we examine the attitude by blackout interaction to determine under what conditions individuals would report more or less motivation to reduce their drinking. We hypothesized that, overall, a more positive attitude toward heavy drinking would be associated with lower motivation to reduce drinking because those with a positive attitude toward heavy drinking tend to demonstrate increases in alcohol use and associated problems over time (DiBello et al., 2018a). In contrast, those with a negative attitude toward drinking, on average, tend to be lighter drinkers with fewer reasons to consider reducing drinking. However, we expected that the association between attitude toward heavy drinking and motivation to reduce drinking would be stronger among drinkers who experienced a blackout in the past year. Among drinkers who have experienced a blackout, we would still expect one's positive attitude to be associated with lower motivation to reduce drinking. However, among drinkers who have experienced a blackout, a negative attitude would likely indicate, at least to some extent, subjective experiences of a blackout as an adverse, perhaps scary event, which they would prefer not to repeat. Study 2 aimed to extend these findings to actual changes in behavior over time by examining the impact of the attitude by blackout interaction with respect to changes in estimated peak BAC over a one-month period of time. We chose estimated peak BAC over other consumption outcomes because blackouts are believed to occur as a result of the rapid increase in BAC, in which case estimated peak BAC is the drinking outcome most closely aligned with the experience of a blackout. Consistent with the hypotheses for Study 1, we hypothesized that attitude toward heavy drinking would be positively associated with changes in estimated peak BAC (such that a positive attitude is associated with higher estimated peak BAC), but only among those who reported a blackout in the past year.

MATERIALS AND METHODS

Participants and procedures

Study 1

In the spring of 2019, undergraduate students (*N* = 1072) were recruited from two 4-year universities to participate in a web-based normative documentation study aimed at developing behavior risk

profiles for each respective campus. At each university, a random, representative sample of students was sent an email invitation with a link to participate in the online survey. Data were collected at 1 time point. Of the total sample, 369 were excluded because they did not report using alcohol. Thus, the final sample for the current work included 703 students (44% male, 52% White) with a mean age of 20.63 years (*SD* = 2.97) who reported drinking alcohol in the past month. Most were either second-year (30%) or third-year (25%) students, and 50% lived in on-campus housing. The Study 1 sample drank a mean of 6.4 (*SD* = 5.7) drinks per week, and 43% reported a blackout in the past year (see Table 1). All study procedures were approved by the Institutional Review Board of the designated university, in concordance with the NIH Single IRB Policy for Multi-site Research.

Study 2

Undergraduate students from a large public university were recruited on a rolling basis between 2011 and 2013 to participate in a larger research project evaluating the efficacy of an intervention for students mandated for campus alcohol violations (Carey et al., 2018). The final sample consisted of 568 students (71.65% male, 84% White) with a mean age of 19.18 years (*SD* = 1.16). Most were either first-year (38%) or second-year (35%) students, and 88% lived in on-campus housing. The Study 2 sample drank a mean of 12.6 (*SD* = 9.8) drinks per week, and 71% reported a blackout in the past year (see Table 2). All students who consented to participate in the larger study were included in current analyses. Data for this study were collected at baseline and 1-month assessments. All participants received an identical single brief alcohol intervention between baseline and the 1-month assessment. All study procedures were approved by the university's Institutional Review Board.

Measures

Demographic information

Participants in both studies provided information regarding their sex, age, race/ethnicity, year in college, and current residence (i.e., on-campus housing).

Alcohol use

In both studies, past-month alcohol consumption was assessed by a 7-day grid representing typical number of drinks consumed each day of the week, modeled after the Daily Drinking Questionnaire (Collins et al., 1985). For all measures of alcohol consumption, a standard drink was defined as one 12-ounce bottle of beer, one 5-ounce glass of wine, or 1.5 ounces of distilled spirits. The number of standard drinks was summed across the 7 days to yield the typical number of drinks consumed per week.

TABLE 1 Descriptive statistics and zero-order correlations for study 1 variables

	1.	2.	3.	4.	5.
1. Sex	–				
2. Drinks Per Week	0.11***	–			
3. Attitude toward Heavy Drinking	0.01	0.38***	–		
4. Blackout Experience	−0.03	0.40***	0.23***	–	
5. Motivation to Reduce Drinking	−0.09**	0.14***	−0.09*	0.15***	–
	% Male (N)	M (SD)	M (SD)	% Blackout (N)	M (SD)
	43.53 (306)	6.38 (5.65)	2.80 (0.92)	43.44 (298)	2.12 (0.60)

Note: Sex male = 0, female = 1; blackout experience 0 = no blackout history, 1 = 1 any past year blackout history; ***$p < 0.001$, **$p < 0.01$.

TABLE 2 Descriptive statistics and zero-order correlations for study 2 variables

	1.	2.	3.	4.	5.	6.
1. Sex	–					
2. BL Drinks Per Week	0.27***	–				
3. BL Attitude Toward Heavy Drinking	0.18***	0.49***	–			
4. BL Blackout Experience	0.03	0.33***	0.23***	–		
5. BL Estimated Peak BAC	0.04	0.52***	0.36***	0.35***	–	
6. Month 1 Estimated Peak BAC	0.07	0.32***	0.35***	0.22***	0.45***	–
	% Male (N)	M (SD)	M (SD)	% Blackout (N)	M (SD)	M (SD)
	71.65 (407)	12.57 (9.75)	2.75 (0.87)	71.60 (406)	0.16 (0.10)	0.10 (0.08)

Note: Sex female = 0, male = 1; blackout experience 0 = no blackout history, 1 = 1 any past-year blackout history; ***$p < 0.001$.
Abbreviations: BAC, blood alcohol concentration; BL, baseline.

Alcohol-related attitude

Attitude toward heavy drinking was assessed using a 5-item measure assessing one's thoughts toward drinking heavily (DiBello et al., 2018a). Participants responded to five items following the stem: "For me, having five or more drinks (for males)/four or more drinks (for females) in a sitting over the next month would be…" Responses were made on bipolar scales ranging from unenjoyable–enjoyable, bad–good, harmful–beneficial, foolish–wise, and unpleasant–pleasant adjectives, with the negative adjective coded as 1 and the positive adjective coded as 5. The five items were averaged to create the attitude toward heavy drinking score. Alpha for Sample 1 was 0.89 and Sample 2 was 0.90.

Blackout

Participants reported their previous frequency of blackout on the Alcohol Use Disorders Identification Test (AUDIT; Saunders et al., 1993) using the item, "How often during the last year have you been unable to remember what happened the night before because you had been drinking?" Responses were dichotomized to represent no blackouts (coded as 0) versus 1 or more blackouts in the past year (coded as 1).

Motivation to reduce drinking

Motivation to reduce drinking was only assessed in Study 1. Three items, conceptually derived from the Readiness to Change Questionnaire (Heather et al., 2000), described degree of motivation for reducing drinking. Items were selected to represent the continuum from pre-contemplation ("I am happy with the way I drink now"), contemplation ("I am considering how to drink less or drink safer"), and through preparation ("I intend to drink less in the near future"). Response options ranged from strongly disagree (1) to strongly agree (4), and the first item was reverse scored. Alpha for the current sample was 0.66.

Estimated peak BAC

Estimated peak BAC was assessed at all time points in Study 2. Participants reported the maximum number of standard drinks consumed in a single day in the past month and the number of hours spent drinking on that day. These items were used to calculate peak blood alcohol concentration (BAC) using the formula: [(drinks/2) *(GC/weight)] - (0.016 * hours), where drinks = number of standard drinks consumed, hours = number of hours over which the drinks were consumed, weight = weight in pounds, and GC = gender constant (9.0 for females and 7.5 for males) (Matthews & Miller, 1979).

Data analysis plan

Prior to conducting substantive analyses, data were screened for missing values, outliers, and normality. For studies 1 and 2, no imputation procedures were used for missing values; therefore, Ns vary across analyses in Study 2. The primary outcome for Study 1 was motivation to reduce drinking (skew = 0.128; kurtosis = 0.553). For Study 2, the primary outcome was change in estimated peak BAC at one-month postbaseline (skew = 0.943; kurtosis = 0.734); skewness and kurtosis estimates for outcome variables for both studies were within the normal range, and no changes were made to the variables (Kline, 2011).

Hierarchical multiple regression analyses were conducted in SAS 9.4 to test the hypothesis that blackout experience would moderate the association between attitude toward heavy drinking and drinking outcomes. Specifically, motivation to reduce drinking (Study 1) and change in estimated peak BAC (Study 2) were examined as a function of attitude, blackout, and the attitude by blackout interaction. All nondichotomous variables were mean-centered prior to analyses. The blackout variable was dichotomized as a 0 (no blackout in the last year) vs. 1 (1+ blackout in the previous year). In all models, participants' sex (0 = female and 1 = male) and baseline drinking were included as covariates. When modeling change in one-month estimated peak BAC, baseline estimated peak BAC was added as a covariate. This approach to examining change, controlling for baseline values of estimated peak BAC, was chosen over alternative approaches (e.g., constructing change scores or using repeated measures) as we felt this was the most parsimonious and clear approach given our research question.

Moderation analyses were conducted in 2 steps. First, motivation to reduce drinking (Study 1) and change in estimated peak BAC at one month (Study 2) were regressed onto attitude toward heavy drinking and blackout experience. Next, motivation to reduce drinking (Study 1) and one-month estimated peak BAC (Study 2) were regressed onto the interaction between attitude toward heavy drinking and blackout and their respective main effects. When significant interactions emerged, tests of simple slopes were used to evaluate the association between attitude toward heavy drinking and motivation to reduce drinking (Study 1) and estimated peak BAC (Study 2) among those who did (1) and did not (0) experience a blackout (Cohen et al., 2003). When graphing the interactions, for the independent variables,

high and low values of motivation to reduce drinking (Study 1) and attitude toward heavy drinking (Study 2) were plotted using +/− one standard deviation from their respective means (Cohen et al., 2003).

RESULTS

Descriptive information

Table 1 depicts the zero-order correlations, means, and standard deviations for predictor and outcome variables in Study 1. As expected, the attitude and blackout variables were significantly and positively correlated with each other. Drinking variables also correlated positively with attitude toward heavy drinking. Blackout experience was positively correlated with motivation to reduce drinking, while attitude toward heavy drinking was negatively correlated with motivation to reduce drinking. Table 2 depicts the zero-order correlations, means, and standard deviations for predictor and outcome variables in Study 2. Again, as expected, the attitude and blackout variables were significantly and positively correlated with each other. Drinking variables also correlated positively with attitude toward heavy drinking.

Study 1

To test the hypothesis that blackout experience would moderate the association between attitude toward heavy drinking and motivation to reduce one's drinking, a hierarchical multiple regression analysis was used. As summarized in Table 3, results revealed a negative association between attitude toward heavy drinking and motivation to reduce drinking, as well as a significant interaction between attitude and blackout, $t = -4.13$, $p < 0.001$. To better understand the nature of this interaction, we examined the effects of attitude on motivation to reduce drinking for those who do and do not blackout. As shown in Figure 1, the association between attitude and motivation to reduce drinking was significant for those with blackout experience ($B = -0.248$, 95% CI [−0.341, −0.170]), but nonsignificant for those without blackout experience ($B = -0.030$, 95% CI [−0.104, 0.023]). Attitude toward heavy drinking does not have a significant association with motivation to reduce drinking in

TABLE 3 Study 1 Unstandardized hierarchical regression results examining motivation to reduce drinking

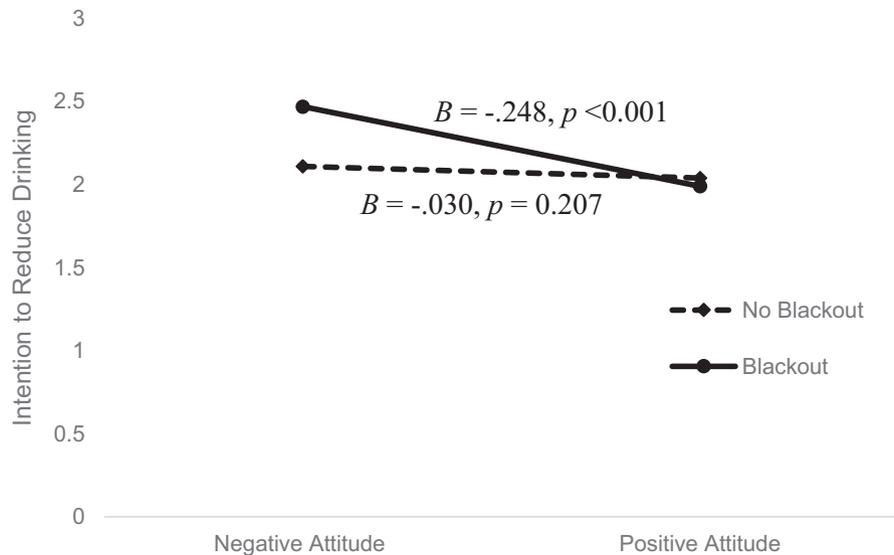|	Variable	Motivation to Reduce Drinking		
		B	p	95% CI
Step 1	Sex	−0.127	<0.001	−0.216, −0.037
	Drinks Per Week	0.019	<0.001	0.010, 0.028
	Attitude Toward Heavy Drinking	−0.114	<0.001	−0.166, 0.062
	Blackout	0.139	0.005	0.042, 0.236
Step 2	Attitude × Blackout	−0.217	<0.001	−0.319, −0.114

FIGURE 1 Moderation of heavy drinking attitude by blackout predicting motivation to reduce drinking

the absence of blackout experience. However, for those who experienced a blackout in the past year, a positive attitude toward heavy drinking was associated with lower motivation to reduce drinking while those with a negative attitude toward heavy drinking evidenced the highest motivation to reduce their drinking.

Study 2

To test the hypothesis that blackouts would moderate the association between attitude and change in estimated peak BAC at one month, we again used hierarchical multiple regression analyses. Overall, participants reported lower estimated peak BAC from baseline to one month (baseline $M = 0.16$; month 1 $M = 0.10$), thus resulting interactions and discussions with respect to change can be read as those that enhance or attenuate the reduction over the one-month period of time. Results revealed positive associations between attitude toward heavy drinking and change in estimated peak BAC (see Table 4), and a significant interaction between attitude and blackout experience at one month, $t = 2.72$, $p = 0.0007$. As shown in Figure 2, the association between attitude and estimated peak BAC at one month was significant for those with blackout experience ($B = 0.040$, 95% CI [0.022, 0.059]), but not for those who had no blackout experience in the past year ($B = 0.005$, 95% CI [−0.015, 0.025]). Having a positive attitude toward heavy drinking was associated with less of a reduction in estimated peak BAC one month postbaseline, only for those who reported a blackout in the last year.[1]

DISCUSSION

Attitudes have a robust relationship with drinking behavior, but their role in predicting variations in drinking over time is unclear. The

current study tested the impact of a potentially motivating alcohol-related consequence (alcohol-induced blackout) on the association between attitude toward heavy drinking and 2 alcohol-related outcomes: motivation to reduce drinking and reductions in drinking behavior. Blackout experience moderated the cross-sectional relationship between attitude toward heavy drinking and motivation to reduce drinking, as well as the prospective relationship between attitude toward heavy drinking and change in estimated peak BAC over time. Based on these data, the combination of a positive attitude toward drinking and experience with alcohol-induced blackout seems to have a synergistic effect on risk for alcohol-related harm, such that a positive attitude was associated with lower motivation to reduce drinking and less reduction in estimated peak BAC over time, only among those with a past-year history of blackout. Our findings confirm that the impact of one's drinking evaluations on motivation to reduce and actual behavior change will vary based on the experience of having an ostensibly negative alcohol consequence (such as a blackout) and these results were found over and above the amount of alcohol consumed.

In Study 1, attitude toward heavy drinking had no association with motivation to reduce drinking. However, for individuals with a history of blackout, a *negative* attitude toward heavy drinking was associated with stronger motivation to reduce drinking behaviors when compared to those with a *positive* attitude toward heavy drinking. Thus, as attitude favorability increased, there was a reduction in motivation to reduce drinking. This finding may be interpreted in light of the associations between attitudes, drinking, and consequences. Drinkers who hold positive evaluations of heavy drinking tend to drink more heavily and experience a broad range of alcohol-related consequences (DiBello et al., 2018a). Therefore, they are more familiar with negative consequences such as blackouts and yet maintain their positive evaluations of heavy drinking despite them. Typical drinking occasions for college drinkers include positive consequences and occasional negative consequences

TABLE 4 Study 2 unstandardized hierarchical regression results examining change in estimated peak BAC at one month

		DV: 1 month Estimated peak BAC		
	Variable	B	p	95% CI
Step 1	Sex	−0.007	0.571	−0.031, 0.017
	Drinks Per Week	0.000	0.933	−0.001, 0.001
	Baseline Estimated Peak BAC	0.311	<0.001	0.174, 0.449
	Attitude Toward Heavy Drinking	0.025	<0.001	0.011, 0.034
	Blackout	0.017	0.182	−0.008, 0.042
Step 2	Attitude × Blackout	0.036	0.006	0.010, 0.061
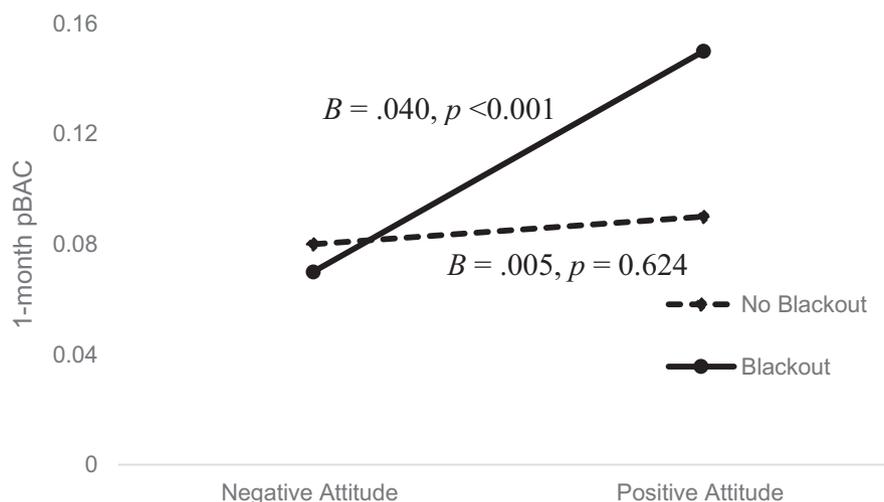
FIGURE 2 Moderation of heavy drinking attitude by blackout predicting change in peak BAC at 1 month

(Barnett et al., 2014). One explanation for the observed effect may be that enough positive consequences are occurring during heavy drinking occasions to offset the experience of blackout and other unpleasant consequences. Alternatively, it is now well known that young adult drinkers vary in their evaluations of consequences both between and within person (Mallett et al., 2008; Merrill et al., 2013). Only when negative consequences are evaluated more negatively than usual will they result in reduced drinking in the future (Barnett et al., 2015).

Study 2 was a conceptual replication, which showed that a positive attitude toward heavy drinking, as opposed to a negative attitude toward heavy drinking, was associated with less of a reduction in estimated peak BAC over time, but only among individuals with a past-year history of blackout. The participants in Study 2 were mandated students, who tend to drink more than the general student body (Merrill et al., 2014). Descriptive data confirmed that they were heavier drinkers and more likely to have experienced blackout than the participants in Study 1. For the minority of drinkers who did not have blackout experience, drinking attitude did not predict drinking over the follow-up period. However, the combination of a *positive* attitude toward heavy drinking and experiencing a blackout predicted less of a reduction in estimated peak BAC over a one-month period when compared to those with a *negative* attitude who experienced a blackout. This combination appears to define a particularly risky

group, as after an alcohol intervention, those with a combination of a blackout experience and a positive attitude toward heavy drinking evidenced less reduction in peak intoxication than those with a combination of a blackout and a negative attitude toward heavy drinking. It is worth noting that the intervention did not directly address positive attitudes, nor did it provide specific education or risk sensitization related to blackout drinking. Qualitative research suggests that many heavy drinking students do not understand the role of drinking speed in blackouts and, therefore, may not understand the most effective way to prevent them (Miller et al., 2018b). Thus, the active ingredients of the intervention did not necessarily mitigate these baseline risk factors. In addition, endorsing drinking as part of one's identity is a prospective predictor of consumption and problems (Lindgren et al., 2016). Although speculative, it is possible that blackout experiences become a salient part of one's identity as a drinker, further exacerbating the risk associated with positive evaluations of heavy drinking.

Clinical implications

Both of the studies presented here identified optimal outcomes associated with the combination of having a negative attitude toward heavy drinking and blackout experience in the past year.

That is, young adults who experienced a blackout in the past year and currently view heavy drinking as unenjoyable, bad, harmful, foolish, or unpleasant report motivation to reduce their drinking and decreases in estimated peak BAC over the subsequent month. In this psychological context, blackouts may serve as "moments of opportunity" for alcohol intervention. Blackouts in this study were defined as being "unable to remember what happened the night before because you had been drinking" at least one time in the past year. We do not know if participants included both fragmentary and en bloc blackout experiences in their interpretation of this item, so we cannot determine if a certain level of blackout severity is required to motivate behavior change. However, because this was a dichotomized variable assessing memory impairment in the past year, data appear to indicate that any inability to remember drinking events in the past year may be sufficient to warrant clinical intervention. It is also worth noting that the results of this study seem to indicate that interventions should target both blackouts and attitudes toward drinking, as it was the combination of these variables that influenced actual behavior change. Consistent with this idea, both of these variables have been found to impact the effectiveness of drinking-related intervention programs in previous studies (DiBello et al., 2018b; Miller et al., 2018a; Miller et al., 2019a).

Strengths and limitations

The findings of this pair of studies should be considered in light of their strengths and limitations. Both used large samples and contained students attending large public universities, which enhances generalizability. Many of the measures were common across these samples, reducing the noise of measurement variance. Our attitude measure was highly reliable, and evidence of validity has been obtained by this team in other studies (DiBello et al., 2019; DiBello et al., 2018a). However, one limitation is that the common measure of blackout experience was a single item derived from the AUDIT. Although blackout history is commonly assessed using single-item measures, single items do not distinguish between en bloc and fragmentary blackout experiences (Miller et al., 2019b), which are evaluated differently and may confer different levels of alcohol-related risk (Hartzler & Fromme, 2003; Miller et al., 2018c; White et al., 2004). Thus, it may be important to consider whether having a fragmentary, as opposed to en bloc, blackout would evidence the same interactive association with attitude toward heavy drinking with respect to motivation to reduce drinking and changes in estimated peak BAC. Furthermore, it should be noted that the blackout item assessed the experience of a blackout over the last year, whereas the attitude measure assessed current attitudes toward heavy drinking. Future work should endeavor to examine the contemporaneous association between attitudes and blackout. Although attitudes toward heavy drinking are more general (and, therefore, more generalizable) than attitudes toward blackouts specifically, future research may also determine whether results are consistent when examining attitudes toward the blackout experience.

Finally, the Study 2 sample consisted of primarily white, male, mandated students, limiting generalizability. These findings need to be replicated with diverse samples.

CONCLUSION

Heavy alcohol use is prevalent among young adults and results in a range of negative health outcomes. The findings from this study suggest that drinkers who have a negative attitude toward heavy drinking and have experienced a blackout are those who evidenced the strongest motivation to reduce drinking and the greatest reductions in peak drinking behavior over time. Importantly, these findings emerged controlling for baseline levels of alcohol, suggesting that these effects persist over and above level of alcohol consumed. Collectively, these data indicate their promise for interventions designed to target attitudes and blackout in the service of reducing risky drinking behavior.

CONFLICTS OF INTEREST
The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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ENDNOTE
[1] Note, analyses for Study 2 were conducted with and without controlling for the effects of the intervention. The results were virtually identical between the two models; thus, the more parsimonious model (the model without intervention) is presented here.

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