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Blackouts as a Moderator of Young Adult Veteran Response to Personalized Normative Feedback for Heavy Drinking

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Abstract

Background—Blackouts – or periods of alcohol-induced amnesia for all or part of a drinking event – have been identified as independent predictors of alcohol-related harm that may be used to identify individuals who would benefit from intervention. However, little is known about the prevalence and impact of blackouts among Veterans. This study examined blackouts as a moderator of young adult Veteran response to a brief, online personalized normative feedback (PNF) intervention for heavy drinking.

Methods—Veterans scoring $\geq 3/4$ (women/men) on the Alcohol Use Disorders Identification Test (AUDIT) completed a baseline and one-month assessment as part of a larger intervention trial ($N=571$; 83% male; age $M=28.9$, $SD=3.3$). Participants were randomized to alcohol PNF ($n=285$) or a video game attention control ($n=286$). Hierarchical regression was used to examine the interaction between intervention condition and blackouts on alcohol-related outcomes at 1-month follow-up.

Results—At baseline, 26% of participants reported loss of memory for drinking events in the past 30 days. The interaction between condition and blackouts was significant, such that PNF participants who had experienced blackouts at baseline reported greater decreases in drinking quantity at one month than those who had not, and only PNF participants who had experienced baseline blackouts reported a decrease in alcohol problems at follow-up.

Conclusions—PNF appears to be particularly effective for individuals who have experienced alcohol-induced blackout, perhaps because blackouts prime them for feedback on their alcohol use. While other negative consequences may also prime individuals for behavior change, blackouts are posited as a particularly useful screening tool because they are prevalent among young adults,

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have a strong association with alcohol-related harm, and are assessed in widely-used clinical measures.

Keywords

alcohol; blackout; amnesia; returning Veteran; brief intervention

Introduction

Blackouts are periods of alcohol-induced amnesia, in which individuals lose all or part of their memory for a drinking event (Wetherill and Fromme, 2016, White, 2003). They occur when alcohol impairs the hippocampus, a region of the brain fundamental to memory function, which causes cognitive deficits in transferring visual and auditory information from short-term to long-term memory (Goodwin et al., 1969, White, 2003). Despite being conscious and responding to their environment, individuals experience partial (i.e., fragmentary blackouts) or complete (i.e., en bloc blackouts) memory loss for the events that occur while they are drinking (Wetherill and Fromme, 2016, White, 2003). The prevalence of alcohol-induced blackouts among young adults and college students is estimated at 50% lifetime and 20% in the past six months (Hingson et al., 2016, Wetherill and Fromme, 2016), and experience of blackouts tends to recur within individuals over time (Barnett et al., 2014, Merrill et al., 2016). Of particular concern, there is a dose-dependent association between number of alcohol-induced blackouts and risk of injury among young adults, such that individuals who report 6+ blackouts at baseline are 2.6 times more likely than those without a history of blackouts to experience an alcohol-related injury over a 24-month period (Mundt et al., 2012).

Given the strength and consistency of the association between blackouts and alcohol-related harm (Hingson et al., 2016, Mundt et al., 2012, Wilhite and Fromme, 2015), experience of a blackout may serve as a teachable moment, after which young adults are more likely to respond to intervention. Researchers seemed to propose this hypothesis in previous work, by suggesting that blackout screening questions be used to identify individuals who may benefit from intervention due to increased risk of consequences (Wilhite and Fromme, 2015). Indeed, there is some evidence that adverse consequences of drinking increase motivation to change in young adults (Barnett et al., 2006). Presumably, then, the risk and/or experience of negative consequences during an alcohol-induced blackout – or the loss of memory itself – may motivate behavior change, making individuals more likely to respond to alcohol intervention.

Veterans may be particularly vulnerable to the experience of alcohol-induced blackout. Although few studies have examined the prevalence and impact of blackouts in primarily Veteran samples, rates of heavy episodic drinking are higher among both young male (56% vs. 48% among 18–25 year olds) and female (43% vs. 39%) Veterans compared to young adult civilians (Hoggatt et al., 2017). Such high rates of heavy drinking raise concern that alcohol-induced blackouts may be common among young adult Veterans. The only study documenting the prevalence of alcohol-induced blackouts among Veterans surveyed female Veterans seeking treatment at the Veterans Affairs Healthcare System (VA). In that sample

of women, primarily between ages 35 and 49 years, 23 to 31% of those who drank alcohol also reported alcohol-induced blackouts in the past year (Chavez et al., 2012). Given higher rates of heavy episodic drinking among younger Veterans (Hoggatt et al., 2017), this may be an underestimate of alcohol-induced blackout among young adult Veterans outside the VA.

The aims of the current study were three-fold. First, given the dearth of research in this area, we aimed to estimate the prevalence of alcohol-induced blackout among young adult Veterans who use alcohol. Second, we aimed to determine if alcohol-induced blackout influences participant response to a brief alcohol intervention. Specifically, we hypothesized that participants reporting alcohol-induced blackout in the past 30 days would report greater decreases in drinking quantity (drinks per week), binge drinking frequency, and alcohol-related consequences as a result of intervention than those who had not experienced alcohol-induced blackout. To isolate the effect of blackouts from mental health symptoms and heavy drinking that may be a result of intensive combat exposure, analyses controlled for combat severity and symptoms of depression and PTSD, which have been independently associated with heavy and problematic drinking among young adult Veterans (Jakupcak et al., 2010, Williams et al., 2015). Similarly, to ensure that blackouts were not serving as a proxy for heavy drinking, individuals' scores on the 10-item Alcohol Use Disorders Identification Test (Saunders, Aasland, Babor, de la Fuente, & Grant, 1993) were included as a covariate in analyses. Finally, to determine the specificity of blackouts (relative to other drinking consequences) in influencing young adult response to alcohol intervention, we also examined four randomly selected alcohol-related consequences as moderators of intervention efficacy.

Materials and Methods

Participants and Procedure

Young adult Veterans were recruited to participate in an online randomized controlled trial examining the efficacy of a personalized normative feedback (PNF) intervention for heavy alcohol use (Pedersen et al., 2017a, Pedersen et al., 2017b). Eligible participants ($N = 784$) were separated from active military duty, between ages 18 to 34 years, and scored $\geq 3/4$ (women/men) on the Alcohol Use Disorders Identification Test (Saunders et al., 1993). Participants completed a baseline assessment and were randomized to receive alcohol ($n = 388$) or video game feedback ($n = 396$) online from remote locations. One month later, 622 participants completed the follow-up assessment. Of these, 571 participants provided follow-up data on alcohol-related consequences and were included in analyses for this study (see Data Screening and Analysis Plan). All procedures were approved by the RAND Human Subjects Protection Committee.

Measures

Demographic information and covariates—Participants reported their age, gender, and race/ethnicity at baseline. An 11-item scale developed for use with U.S. military Veterans was used to assess combat exposure and severity (Schell and Marshall, 2008). Participants indicated (*yes/no*) if they had been exposed to combat during deployment. Those who indicated exposure to combat then indicated (*yes/no*) if they had experienced

situations such as “seeing dead or seriously injured non-combatants” or “having a friend who was seriously wounded or killed.” Responses were summed (0–11) to estimate combat severity.

The Patient Health Questionnaire (PHQ-8) (Kroenke et al., 2009) was used to assess symptoms of depression in the past two weeks. Participants indicated how often they were bothered by eight symptoms (e.g., “feeling down, depressed, or hopeless”) on a scale from 0 (*not at all*) to 3 (*nearly every day*). Responses were summed to create a total symptom score. Internal consistency in this sample was high ($\alpha = .93$). A cut-off score 10 was used to categorize participants as screening positive versus negative for depression for descriptive purposes. This cut-off score has demonstrated good sensitivity and specificity (100% and 95%, respectively) in detecting major depressive disorder in the general population (Kroenke et al., 2009).

The PTSD Checklist for DSM-5 (PCL-5) (Weathers et al., 2013) was used to assess symptoms of PTSD in the past 30 days. Participants indicated how much they were bothered by 20 potential responses to a stressful experience (e.g., “repeated, disturbing dreams”) on a scale from 0 (*not at all*) to 4 (*extremely*). Responses were summed to create a total score, and internal reliability in this sample was high ($\alpha = .98$). For descriptive purposes, a cut-off score 31 was used to categorize participants as screening positive versus negative for PTSD. A cut-off score of 31 has demonstrated good sensitivity and specificity (88% and 69%, respectively) in detecting PTSD among Veterans (Bovin et al., 2016).

The 10-item Alcohol Use Disorders Identification Test (AUDIT) was used as a baseline measure of alcohol risk. This measure has been validated as an indicator of harmful or hazardous alcohol consumption in six countries (Saunders et al., 1993). Three items assess the quantity and frequency of alcohol use in the past year, and seven items assess symptoms of hazardous drinking (e.g., failing to do what was normally expected of you) on a scale from 0 (*never*) to 4 (*daily or almost daily*). Responses were summed to create an AUDIT total score. For descriptive purposes, a cut-off score 8 was used to categorize participants as screening positive versus negative for hazardous drinking at baseline. A cut-off score of 8 or more demonstrates good sensitivity and specificity in predicting alcohol use disorder among male (80% and 86%, respectively) and female (70% and 95%) returning Veterans (Crawford et al., 2013). One of the AUDIT items assesses experience of alcohol-induced blackout in the past year (i.e., “how often during the last year have you been unable to remember what happened the night before because you had been drinking”). Removing this item from the measure did not change the pattern of results; thus, all items were retained in analyses to maintain the integrity of the measure. Reliability in this sample was good, both with ($\alpha = .84$) and without ($\alpha = .81$) the blackouts item.

Alcohol use—The Daily Drinking Questionnaire (Collins et al., 1985) was used to assess drinking quantity and frequency at baseline and one-month follow-up. After being provided standard drink definitions (e.g., 12oz regular beer, 8–9oz malt liquor, 5oz table wine, 1.5oz 80-proof distilled spirits), participants indicated how many drinks they consumed on each day of a typical week in the past month. Responses were summed to calculate the number of drinks consumed per week (drinks per week). Participants also indicated how many days

they had consumed 4/5 (for women/men) or more drinks in one day in the past month (binge frequency).

Alcohol-related consequences—The Brief Young Adult Alcohol Consequences Questionnaire (BYAACQ) was used to assess experience of alcohol-related consequences at baseline and one-month follow-up. Participants indicated (*yes/no*) if they had experienced each of 24 consequences in the past 30 days (e.g., “I have felt very sick to my stomach or thrown up after drinking”). This instrument has been validated for use in young adult samples (Kahler et al., 2008), and reliability in this sample was high ($\alpha = .93$). One of the BYAACQ items assesses blackouts. In order to avoid confounds between predictor and outcome variables, the blackout item was removed from the total BYAACQ score at baseline and follow-up in models examining ‘blackout’ as a moderator of intervention effect. In subsequent analyses, when examining four other BYAACQ consequences as moderators of intervention effect, the item serving as the moderator was removed from the total BYAACQ score. Thus, possible sum scores for all analyses ranged from 0 to 23. Internal consistency remained high, whether including ($\alpha = .93$) or excluding each of these single items (all $\alpha = .92$).

Alcohol-induced blackout—The BYAACQ item, “In the past month, I have not been able to remember large stretches of time while drinking,” was used as a single-item (*yes/no*) measure of alcohol-induced blackout in the past 30 days.

Interventions

Interventions were modeled after previously developed, efficacious interventions and delivered online from remote locations (see Pedersen et al., 2016). In both conditions, which were matched for attention, written feedback portrayed a bar graph and explanatory text comparing the participant’s behavior to the perceived and actual behavior of their peers.

Personalized normative feedback (PNF)—PNF compared personal drinking patterns (drinks consumed per week, drinks consumed per occasion, and days of binge drinking per month) to (a) the participant’s perception of same-sex young adult Veterans’ drinking patterns and (b) same-sex young adult Veterans’ actual drinking patterns (see Pedersen et al., 2016 for sample PNF).

Video game control—The video game control compared personal video game behavior (days played per week, hours played per day, and hours played per week) to (a) the participant’s perceptions of same-sex young adult Veterans’ video game behavior and (b) same-sex young adult Veterans’ actual video game behavior (Pedersen et al., 2016).

Data Screening and Analysis Plan

Data were screened for missing values prior to analysis. Fifty-one participants from the parent trial were excluded from the analytic sample because they were missing more than 30% data on the BYAACQ at one-month follow-up. Participants who were included versus excluded from analyses did not differ significantly at baseline in age, gender, combat severity, AUDIT score, frequency of binge drinking, or experience of alcohol-related

consequences. Those excluded from analyses reported fewer baseline drinks per week [12.7 vs 18.4; $t(620) = -2.15, p = .03$] and more baseline symptoms of depression [12.7 vs 9.5; $t(620) = 3.01, p = .003$] and PTSD [39.2 vs 27.9; $t(620) = 3.39, p = .001$]. Thus, results of this study may not generalize to those who drink within low-risk guidelines according to the National Institute of Alcohol Abuse and Alcoholism (<8/14 per week for women/men) or those who screen positive for depression (≥ 10) or PTSD (≥ 31) (Bovin et al., 2016, Kroenke et al., 2009).

Data from the analytic sample were screened for normality, baseline group differences (see Table 1), and multicollinearity (see Table 2) prior to analysis. Skewness estimates for predictor and outcome variables fell within the acceptable range (< 3). There was some evidence of kurtosis for the drinks per week and frequency of binge drinking variables; however, data were not adjusted because kurtosis is unlikely to change outcomes in samples of 200+ cases (Tabachnick and Fidell, 2007). Diagnostic statistics indicated moderate to high levels of tolerance (0.3–1.0) and low variance inflation (1.0–3.5) among variables in each model, indicating that independent variables were not redundant in their prediction of each outcome (Kutner et al., 2005). Intervention and control groups differed significantly on the total AUDIT score at baseline. Blackout vs. no-blackout groups differed significantly in combat severity, symptoms of PTSD and depression, and drinking variables at baseline (see Table 1). All models controlled for these baseline differences between groups.

Primary outcome analyses were conducted in IBM SPSS Statistics 24. We used hierarchical multiple regression to examine alcohol-induced blackout as a moderator of intervention effect on drinks per week, binge drinking frequency, and alcohol-related consequences. Gender, combat severity, baseline symptoms of depression and PTSD, baseline AUDIT score, and baseline levels of the outcome variable were included in each model as covariates. Baseline drinks per week was also included as a covariate in the model predicting alcohol-related consequences. In Step 1 of the model, covariates, condition (PNF vs control), and alcohol-induced blackout (yes vs no) were examined as predictors of each outcome at one-month follow-up. In Step 2, the interaction evaluating alcohol-induced blackout as a moderator of intervention effect (group $\times$ blackout) was included in the model.¹ Change in R^2 was used as an estimate of the effect size of the interaction, although the unstandardized coefficients depicted in Table 3 may also be used as indicators of effect size (Baguley, 2009). The unstandardized coefficient can be interpreted as the change in the dependent variable associated with one unit increase in the independent variable. Follow-up tests of simple slopes were conducted to determine the significance of the intervention effect on alcohol-related outcomes at high and low levels of the moderator (Aiken and West, 1991, Cohen et al., 2003). High and low values were specified as a positive versus negative screen for blackouts in the past month. Predictor variables were mean centered to aid in interpretation of results.

We conducted follow-up tests to determine the specificity of alcohol-induced blackouts (relative to other consequences of alcohol use) in moderating PNF effect on alcohol-related

¹AUDIT score did not moderate intervention effect in the primary outcomes paper for this project (Pedersen et al., 2017); therefore, AUDIT was examined only as a covariate in this study.

outcomes. Because running each item of the BYAACQ as a moderator of intervention effect would inflate Type I error, a random number generator ([random.org](https://www.random.org)) was used to identify four additional consequences to examine as moderators of intervention effect. The first four numbers were 16, 17, 11, and 6, which correspond to BYAACQ items “felt bad about myself because of my drinking” (endorsed by 37% of the sample), “had less energy or felt tired because of my drinking” (53%), “have not gone to work or missed class because of drinking, a hangover, or illness caused by drinking” (19%), and “passed out from drinking” (27%), respectively.

Results

Descriptive statistics

Participants ($N = 571$, 83% male) were all young adult Veterans reporting alcohol use in the past year (see Table 1). Approximately one in four men (27%) and women (23%) reported alcohol-induced blackout in the past month. Of the 151 (26%) who reported a blackout in the past month, 98% indicated hazardous drinking on the AUDIT. Conversely, of the 407 (71%) who screened positive for hazardous drinking on the AUDIT, 36% reported a blackout in the past month. On the AUDIT, which measures drinking behaviors and related problems in the past year (as opposed to the past month), 286 men (61%) and 44 (44%) women reported alcohol-induced blackout in the past year.

Blackouts as a Moderator

Main effects and interaction terms are presented in Table 3, and descriptive statistics for each outcome (full sample and by gender) are depicted in Table 4. Step 1 predictors accounted for a significant amount of variance in drinks per week at one-month follow-up, $F(8) = 65.11$, $p < .001$, $R^2 = .47$. In Step 2 of the model, there was a significant interaction between intervention condition and alcohol-induced blackout that accounted for 1% of unique variance in change in drinks per week, $F(9) = 58.81$, $p < .001$, $R^2 = .48$ (see Table 3). Follow-up tests of simple slopes indicated that PNF participants who experienced alcohol-induced blackout in the past month reported a greater decrease in drinks per week ($\beta = -6.41$, $SE = 1.62$, $p < .001$) than those who denied past-month blackout ($\beta = -2.25$, $SE = 0.97$, $p = .02$; see Figure 1).

Step 1 predictors also accounted for a significant amount of variance in alcohol-related consequences at one-month follow-up, $F(9) = 43.43$, $p < .001$, $R^2 = .40$. In Step 2 of the model, there was a significant intervention by blackout interaction that accounted for 1% of unique variance in change in alcohol-related consequences, $F(10) = 39.92$, $p < .001$, $R^2 = .41$ (see Table 3). Follow-up tests indicated that PNF participants who experienced alcohol-induced blackout in the past month demonstrated a decrease in alcohol-related consequences ($\beta = -2.62$, $SE = 0.74$, $p < .001$), while those who denied past-month alcohol-induced blackout did not ($\beta = -0.62$, $SE = 0.44$, $p = .16$; see Figure 1).

Step 1 predictors accounted for a significant amount of variance in the frequency of binge drinking at one-month follow-up, $F(8) = 47.84$, $p < .001$, $R^2 = .40$; and the model remained significant when including the condition by blackout interaction in Step 2, $F(9) = 43.01$, p

$< .001$, $R^2 = .40$. However, the interaction did not account for a significant amount of unique variance in change in frequency of binge drinking ($p = .08$; see Table 3).

Other Consequences as Moderators

We conducted follow-up tests to determine the specificity of alcohol-induced blackouts (relative to other consequences of alcohol use) in moderating PNF effect on alcohol use and consequences. PNF did not interact with ‘feeling bad about oneself’ ($B = -1.25$, $SE = 1.73$, $p = .47$), ‘having less energy’ ($B = -1.60$, $SE = 1.68$, $p = .34$), ‘missing work or class’ ($B = -0.70$, $SE = 2.12$, $p = .74$), or ‘passing out’ ($B = -1.58$, $SE = 1.91$, $p = .41$) in the prediction of drinks per week. In contrast, ‘feeling bad about oneself’ significantly moderated intervention effect on alcohol-related consequences at one-month follow-up ($B = -2.00$, $SE = 0.79$, $p = .01$), with only PNF participants who had felt bad about themselves because of drinking reporting a decrease in alcohol-related consequences at one-month ($\beta = -2.46$, $SE = 0.63$, $p < .001$ vs. denied feeling bad, $\beta = -0.46$, $SE = 0.48$, $p = .34$). ‘Having less energy’ ($B = -0.68$, $SE = 0.76$, $p = .38$), ‘missing work or class’ ($B = 0.33$, $SE = 0.98$, $p = .74$), and ‘passing out’ from drinking ($B = -0.93$, $SE = 0.87$, $p = .29$) did not moderate intervention effect on alcohol-related consequences.

Discussion

In this large randomized controlled trial of young adult Veterans, alcohol-induced blackout interacted with personalized normative feedback in the prediction of alcohol use and consequences. Normative feedback was associated with greater decreases in drinking quantity – and was only associated with decreases in alcohol-related consequences – among the 1 in 4 participants reporting a past-month history of alcohol-induced blackout at baseline. This effect was observed independent of more general alcohol risk measured using the AUDIT and independent of other predictors of alcohol use, including symptoms of depression and PTSD. Findings suggest that alcohol-induced blackout is not only common among young adult Veterans, but may also be used to identify individuals who would benefit from brief normative feedback on their alcohol use.

Approximately one in four men (27%) and women (23%) in this sample reported alcohol-induced blackout in the past 30 days, while closer to half (61% of men and 44% of women) reported a blackout in the past year. It is difficult to compare these numbers to those in previous research because timeframes used for assessment of blackouts varies across studies. In college student samples, estimates range from 20 to 25% in the past month (Brett et al., 2016, LaBrie et al., 2011), 54% in a one-year period (Barnett et al., 2014), and 66% in a three-year period (Marino and Fromme, 2015). In a nationally representative sample of young adults one year out of high school, estimates were 22% of men and 17% of women in the past six months (Hingson et al., 2016). Prevalence in the current sample was somewhat higher than some of these estimates; however, eligibility for this sample required alcohol use in the past year, in which case higher rates of alcohol-induced blackout may be expected.

Normative feedback was associated with greater decreases in drinks per week – and was only associated with decreased consequences – among those who had experienced alcohol-induced blackout in the past month at baseline. The fact that this effect was independent of

more general alcohol risk (AUDIT score) and other predictors of heavy drinking and alcohol-related problems suggests that alcohol-induced blackout is a unique predictor of intervention response. The idea that blackouts may prime individuals for alcohol intervention is consistent with the Health Belief Model (Strecher et al., 1997), in that the combination of a perceived threat (i.e., perceived susceptibility and severity of risk during an alcohol-induced blackout) and cue to action (feedback about one's alcohol use) is expected to stimulate behavior change. This study was not designed to test this specific theory; therefore, future studies may determine if blackouts truly serve as a 'perceived threat,' consistent with the Health Belief Model.

While speculative, the Health Belief Model would also explain why blackouts are not the only drinking outcome that moderates intervention effect: individuals who feel bad about themselves because of drinking, presumably due to drinking behavior that they regret, may also feel increased susceptibility or severity of alcohol-related consequences (a 'threat') that primes them for behavior change. However, not every drinking outcome was associated with increased responsiveness to intervention. Having less energy or feeling tired due to alcohol use, missing work or class, and passing out from drinking did not influence participant response to normative feedback. Thus, it seems the drinking outcomes that are associated with other negative consequences of drinking (i.e., blackouts increase risk and are associated with other negative drinking outcomes; feeling bad indicates regret for something else that occurred while drinking) are the ones that make young adults more amenable to behavior change. Future research is needed to determine if (a) it is the specific consequence (e.g., blackout/regret) that primes individuals for behavior change or (b) any negatively-valenced outcome of drinking is sufficient to influence behavior (e.g., missing class due to drinking may also make one more amenable to change if s/he then fails an important quiz or exam).

Alternatively, there is some evidence that alcohol-induced blackouts are an indicator of atypical neural activity that makes it difficult to inhibit behavior such as substance use (Wetherill et al., 2013). In this case, individuals who experience a blackout may feel less control over their behavior while drinking, making them more amenable to change following an intervention. If this is the case, individuals with a history of alcohol-induced blackout may benefit from intervention (regardless of the consequences experienced during the blackout) because it requires more cognitive effort for them to inhibit alcohol use (Wetherill et al., 2013). While this seems to imply that interventions for those who have experienced a blackout would need to focus specifically on skills that reduce alcohol use or consequences (e.g., protective behavioral strategies), it is possible that these individuals have the skills to reduce their alcohol use but have to exert more cognitive effort to implement them during a drinking episode. In this case, normative feedback indicating that they drink more than their peers may serve as an additional reason and reminder to use these skills. Given the strong association between alcohol-induced blackout and other negative consequences of drinking (Hingson et al., 2016, Mundt et al., 2012), it may be difficult to tease apart these aspects of alcohol-induced blackout in future research (i.e., do blackouts moderate intervention effect because they are associated with other negative consequences or because loss of memory is associated with loss of control). Studies examining day-to-day associations between alcohol-induced blackouts, other consequences, and subsequent drinking behavior may be ideally suited to shed light on this research question.

Clinical Implications

While it remains unclear how alcohol-induced blackouts exert their influence on response to intervention, individuals with a past-month history of blackout reported greater decreases in drinking quantity and alcohol problems in response to normative feedback on their alcohol use. This finding has the potential to streamline the screening and brief intervention process for providers with limited time and resources to intervene on heavy drinking. In terms of screening for alcohol risk, blackouts serve as an indicator of high-intensity drinking because some form of heavy/rapid drinking (and/or use of other drugs in combination with alcohol) is necessary to experience an alcohol-induced blackout (White, 2003). In the current sample, nearly three out of four participants screened positive for hazardous drinking on the AUDIT, but only one of those reported a blackout in the past month; thus, experience of blackouts would serve as a higher threshold for screening, but also an unequivocal indicator of risky drinking. Results of this study suggest that focusing intervention efforts on the individual who reports blackouts would not only target an individual at high risk for alcohol-related harm, but may also lead to higher likelihood of intervention efficacy. Items assessing alcohol-induced blackout are included on a number of widely used alcohol screening tools, including the AUDIT. Thus, healthcare providers are encouraged to screen for alcohol-induced blackout among young adults who drink and target these individuals for intervention, as appropriate.

Given our interest in examining blackouts as a moderator (predictor) of intervention response, we did not examine blackouts as an intervention outcome. Within the literature, blackouts have been conceptualized as both a consequence of heavy drinking and a predictor of other alcohol-related harm (Mundt et al., 2012, Hingson et al., 2016, Wetherill and Fromme, 2016, White, 2003). Our conceptualization of blackouts in this study placed greater emphasis on blackouts as an indicator of risk than a consequence of drinking. However, other studies have documented intervention effects on alcohol-induced blackout. Specifically, Motivational Interviewing (MI) has been associated with decreases in blackouts among young adults in their first year of college (Kazemi et al., 2013), indicating that MI may be an effective intervention for blackout drinking behavior. Similarly, Su et al. (2017) evaluated a campus-wide social norms marketing campaign and found that more exposure to the campaign materials correlated with fewer blackouts. The difference in rates of PTSD and depression among those who had versus had not experienced a blackout also raises the possibility that individuals with a history of blackout are drinking to cope with these symptoms (McDevitt-Murphy et al., 2015a). Since drinking to cope has also been associated with high-risk drinking among Veterans (Cucciare et al., 2011), future studies may examine the efficacy of coping-specific interventions within this population (McDevitt-Murphy et al., 2015b).

Limitations and Future Directions

The biggest limitation to the current research, which is a limitation to most studies in this area, is the use of a single-item indicator of alcohol-induced blackout (Wetherill and Fromme, 2016). Given the use of a single blackouts item, prevalence estimates are non-specific to the level of memory impairment experienced. That is to say, it is unclear if participants are experiencing 'en bloc' or 'fragmentary' blackouts. En bloc blackouts are

characterized by definitive onset and offset with complete and permanent amnesia for the interim, despite all efforts to cue recall; while fragmentary blackouts are characterized by partial memory loss that is typically resolved using contextual cues (Hartzler and Fromme, 2003, White, 2003). Although fragmentary blackouts are expected to be much more common (Hartzler and Fromme, 2003), much of existing research is based on single-item measures that do not differentiate between these levels of memory impairment (Wetherill and Fromme, 2016). Thus, standardized measures and studies assessing the prevalence and impact of these distinct forms of alcohol-induced memory loss are needed.

Two additional limitations need to be considered in the interpretation of results. First, data were collected via self-report. Self-report data do not correspond perfectly with objective measures of alcohol use (Kraus et al., 2005, White et al., 2003). However, self-reported alcohol use is highly convergent with transdermal alcohol measurement when confidentiality is assured (Simons et al., 2015). Second, we are unable to determine the mechanism by which alcohol-induced blackout influences intervention response because the parent study was not designed for this purpose and, therefore, did not measure potential mediators of this association. Future research examining why PNF is more effective among individuals who have experienced blackouts is encouraged (e.g., blackouts increase perceptions of risk/personal threat; individuals who experience blackouts perceive alcohol-related consequences as more negative).

Conclusion

Personalized normative feedback is associated with greater reductions in alcohol use and related consequences among young adult Veterans who have recently experienced an alcohol-induced blackout. While at least one other consequence of heavy alcohol use (feeling bad about oneself because of drinking) also moderated intervention effect on alcohol-related problems, we argue that alcohol-induced blackouts are a particularly useful signal for intervention because they are prevalent among young adults, have a strong association with other negative alcohol consequences, and are assessed on widely-used clinical measures. Future studies are needed to determine the prevalence and impact of en bloc versus fragmentary blackouts and the mechanisms by which they influence intervention response. Among Veterans in particular, research examining the interplay of mental health symptoms, drinking to cope, and alcohol-induced blackout seems warranted.

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Figure 1. Condition by alcohol-induced blackout interaction on drinks per week and alcohol-related consequences, adjusted for other variables in the model.

Table 1

Group differences in demographic, predictor, and outcome variables at baseline (N = 571).

Variables	Total Sample (N = 571)	PNF (n = 285)	Control (n = 286)	χ^2 / df	Blackout (N = 151)	No Blackout (N = 420)	χ^2 / df
Age in years (<i>SD</i>)	28.9 (3.3)	29.0 (3.2)	28.9 (3.4)	-0.24 (569)	28.7 (3.4)	29.0 (3.3)	0.96 (569)
Female (%)	99 (17%)	42 (15%)	57 (20%)	2.69 (1)	23 (15%)	76 (18%)	0.64 (1)
Race (white vs. non-white)	--	--	--	0.22 (1)	--	--	0.12 (1)
Caucasian (%)	482 (84%)	243 (85%)	239 (84%)	--	129 (85%)	353 (84%)	--
African American (%)	24 (4%)	11 (4%)	13 (5%)	--	6 (4%)	18 (4%)	--
Asian American (%)	7 (1%)	4 (1%)	3 (1%)	--	2 (1%)	5 (1%)	--
Native Hawaiian / Pacific Islander (%)	3 (1%)	2 (1%)	1 (<1%)	--	2 (1%)	1 (<1%)	--
American Indian / Alaskan Native (%)	13 (2%)	6 (2%)	7 (3%)	--	1 (1%)	12 (3%)	--
Bi/Multiracial (%)	35 (6%)	17 (6%)	18 (6%)	--	9 (6%)	26 (6%)	--
Other (%)	7 (1%)	2 (1%)	4 (1%)	--	2 (1%)	4 (1%)	--
Hispanic / Latino (%)	64 (11%)	26 (9%)	38 (13%)	2.45 (1)	15 (10%)	49 (12%)	0.34 (1)
Combat severity (<i>SD</i>)	4.0 (3.0)	3.9 (3.0)	4.0 (3.1)	0.39 (569)	4.4 (3.2)	3.8 (3.0)	-2.23 (569)*
PTSD (<i>SD</i>)	27.9 (22.6)	26.2 (21.8)	29.6 (23.2)	1.83 (569)	36.0 (21.6)	25.0 (22.2)	-5.30 (569)***
PCL 33 (%)	214 (38%)	100 (35%)	114 (40%)	1.319 (1)	80 (53%)	134 (32%)	21.05 (1)***
Depression (<i>SD</i>)	9.5 (7.2)	8.9 (7.0)	10.0 (7.4)	1.78 (569)	12.1 (7.1)	8.5 (7.0)	-5.33 (569)***
PHQ 10 (%)	255 (45%)	116 (41%)	139 (49%)	3.60 (1)	94 (62%)	161 (38%)	25.7 (1)***
Drinks per week (<i>SD</i>)	18.4 (17.9)	17.7 (18.1)	19.1 (17.7)	0.95 (569)	30.6 (23.3)	14.0 (13.0)	-8.32 (185 $\pm$)***
Drinks per drinking day (<i>SD</i>)	4.0 (2.7)	3.9 (2.7)	4.1 (2.7)	0.48 (560)	5.7 (3.4)	3.4 (2.1)	-8.07 (195 $\pm$)***
Binge frequency per mo (<i>SD</i>)	5.9 (7.6)	5.4 (7.2)	6.4 (8.0)	1.47 (556 $\pm$)	10.7 (9.0)	4.1 (6.1)	-8.33 (203 $\pm$)***
Blackout (%)	151 (26%)	71 (25%)	80 (28%)	0.69 (1)	151 (100%)	0 (0%)	--
AUDIT score (<i>SD</i>)	11.5 (6.2)	10.8 (5.9)	12.2 (6.5)	2.78 (564)**	16.7 (6.3)	9.6 (5.1)	-12.46 (225 $\pm$)***
AUDIT 8 (%)	407 (71%)	194 (68%)	213 (75%)	2.86 (1)	148 (98%)	259 (62%)	71.67 (1)***
Alcohol consequences (<i>SD</i>) [†]	7.2 (6.2)	6.9 (6.3)	7.5 (6.1)	1.10 (569)	13.9 (5.1)	4.8 (4.6)	-20.55 (569)***

Note.

* $p < .05$,

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*,

 $p < .01$,

 $p < .001$.
/ Blackout item was removed from total score.
± Equal variances not assumed. Mo = month.

Table 2

Zero-order correlations among study variables (N = 571).

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. Condition	--											
2. Gender	-.07	--										
3. Combat severity	-.02	-.23*	--									
4. PHQ	-.07	.05	.21*	--								
5. PCL	-.08	.02	.29*	.83*	--							
6. AUDIT	-.12*	-.15*	.20*	.44*	.44*	--						
7. BL drinks per week	-.04	-.21*	.20*	.26*	.25*	.72*	--					
8. BL binge frequency	-.06	-.15*	.16*	.24*	.26*	.67*	.81*	--				
9. BL consequences <i>f</i>	-.05	-.09*	.15*	.46*	.45*	.72*	.51*	.48*	--			
10. Blackout	-.04	-.03	.09*	.22*	.22*	.50*	.41*	.39*	.65*	--		
11. Imo drinks per week	-.14*	-.18*	.14*	.16*	.19*	.49*	.68*	.59*	.35*	.33*	--	
12. Imo binge frequency	-.13*	-.14*	.15*	.10*	.11*	.45*	.64*	.62*	.31*	.29*	.81*	--
13. Imo consequences <i>f</i>	-.14*	-.06	.14*	.37*	.33*	.51*	.42*	.38*	.61*	.45*	.48*	.39*

Note.

* $p < .05$.*f* Blackout item was removed from total score. BL = baseline. Imo = 1 month.

Table 3

Main effects and interaction terms in the prediction of alcohol use outcomes at one month (N = 571).

	Drinks per week			Frequency of binge drinking			Alcohol-related consequences		
	B	SE	p	B	SE	p	B	SE	p
<i>Step 1: Main Effects</i>									
Intercept	5.99	1.19	< .001	1.20	0.53	.02	0.27	0.54	.62
Female (vs. male)	-2.12	1.16	.07	-0.58	0.51	.26	0.05	0.53	.92
Combat severity	-0.05	0.15	.73	0.11	0.07	.11	0.06	0.07	.41
Symptoms of depression (PHQ-8)	-0.17	0.11	.11	-0.003	0.05	.95	0.12	0.05	.01
Symptoms of PTSD (PCL-5)	0.06	0.03	.08	-0.02	0.02	.18	-0.02	0.02	.32
AUDIT	-0.10	0.10	.30	0.03	0.04	.52	0.02	0.05	.75
BL drinks per week	0.51	0.03	< .001	--	--	--	0.04	0.02	.01
BL binge drinking frequency	--	--	--	0.43	0.03	< .001	--	--	--
BL alcohol-related consequences [/]	--	--	--	--	--	--	0.40	0.05	< .001
PNF (vs. control)	-3.35	0.84	< .001	-1.03	0.37	.01	-1.16	0.38	.003
Blackout (vs. no blackout)	2.59	1.12	.02	0.74	0.49	.13	1.13	0.58	.05
<i>Step 2: Interaction</i>									
Condition × Blackout	-4.17	1.89	.03	-1.44	0.83	.08	-1.99	0.86	.02

Note. Variables are not mean centered.

[/] Blackout item was removed from total score. AUDIT = Alcohol Use Disorders Identification Test. BL = baseline. PCL-5 = PTSD Checklist for DSM-5. PHQ-8 = Patient Health Questionnaire.

Table 4

Descriptive statistics for men and women in the intervention (n = 285) and control (n = 286) conditions.

	Total (N = 571)			Men (n = 472)			Women (n = 99)		
	n	BL	Imo	n	BL	Imo	n	BL	Imo
Drinks per week									
Blackout / PNF	71	31.1 (26.5)	17.1 (17.8)	60	33.5 (27.7)	18.6 (19.0)	11	18.1 (12.9)	8.9 (4.5)
Blackout / control	79	30.0 (20.3)	22.7 (19.0)	67	31.2 (20.2)	23.3 (18.8)	12	23.1 (20.3)	19.4 (20.8)
No blackout / PNF	214	13.2 (11.3)	8.4 (8.5)	183	14.3 (11.8)	9.2 (8.9)	31	7.0 (5.2)	3.8 (3.1)
No blackout / control	206	14.8 (14.6)	11.2 (11.4)	161	16.9 (15.6)	12.8 (12.2)	45	7.2 (6.2)	5.4 (4.5)
Binge frequency									
Blackout / PNF	71	10.4 (9.2)	4.9 (7.1)	60	10.8 (9.6)	5.3 (7.6)	11	8.3 (6.9)	2.8 (2.8)
Blackout / control	80	11.0 (8.9)	7.3 (7.7)	68	11.5 (8.9)	7.5 (7.7)	12	8.7 (8.7)	6.3 (8.1)
No blackout / PNF	211	3.8 (5.4)	2.1 (3.5)	181	4.2 (5.7)	2.3 (3.7)	30	1.4 (1.6)	0.6 (1.2)
No blackout / control	202	4.5 (6.8)	3.0 (5.1)	159	5.1 (7.4)	3.5 (5.5)	43	2.2 (2.5)	1.1 (1.9)
Consequences¹									
Blackout / PNF	71	14.1 (5.5)	7.8 (6.9)	60	14.1 (5.8)	7.5 (6.9)	11	14.0 (3.6)	9.4 (6.5)
Blackout / control	80	13.8 (4.7)	10.3 (6.5)	68	13.8 (4.8)	10.3 (6.4)	12	13.3 (4.3)	10.8 (7.5)
No blackout / PNF	214	4.5 (4.5)	2.7 (4.2)	183	4.9 (4.6)	2.9 (4.4)	31	2.1 (2.8)	1.4 (2.8)
No blackout / control	206	5.0 (4.7)	3.7 (4.8)	161	5.1 (4.8)	4.0 (5.0)	45	4.8 (4.4)	2.7 (4.0)

Note. = mean change, not accounting for baseline group differences or other variables in the model.

¹ Blackouts item removed from total score. Consequences = alcohol-related consequences. PNF = personalized normative feedback.