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Mindfulness is Inversely Associated with Alcohol Attentional Bias Among Recovering Alcohol-Dependent Adults

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Abstract

Although mindfulness has been linked with salutary clinical outcomes, less is known about its relation to cognitive mechanisms implicated in the onset and maintenance of alcohol dependence. Because trait mindfulness is associated with attentional control and emotion regulation, we hypothesized that trait mindfulness would be inversely associated with attentional bias towards visual alcohol cues. We tested this hypothesis in a sample of alcohol-dependent adults residing in a treatment facility, who completed questionnaires on trait mindfulness, craving, and stress, as well as a spatial cueing task designed to assess alcohol attentional bias. Recovering alcohol-dependent individuals high in trait mindfulness exhibited less alcohol attentional bias (AB), stress, and craving, and greater alcohol-related self-efficacy, than their counterparts low in trait mindfulness. Multiple linear regression analyses indicated that trait mindfulness was more predictive of alcohol AB than stress, craving, alcohol-related self-efficacy, time in treatment, or pre-treatment level of alcohol consumption. Identification of malleable traits that can offset automatic cognitive mechanisms implicated in addiction may prove to be crucial to treatment development efforts.

Keywords

mindfulness; attentional bias; craving; stress; alcohol dependence

Alcohol dependence involves implicit cognitive processes (Wiers et al., 2006) and attentional biases (AB) toward alcohol-relevant stimuli (Field & Cox, 2008) that contribute to appetitive states and compulsive drinking. Recurrent alcohol misuse is thought to impart incentive salience to alcohol cues through a learned motivational response subserved by alcohol-induced mesocorticolimbic sensitization (Robinson & Berridge, 2008). This learned appetitive response is linked with the development of alcohol use action schemas, i.e., memory systems that compel and coordinate alcohol consumption through automatized sequences of stimulus-bound, context-dependent behavior (Tiffany, 1990). Once alcohol cues have acquired incentive salience through conditioning, alcohol use action schemas deploy attention to search for and focus on such cues as a means of subserving the goal of

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alcohol consumption. According to biased competition models of attention (Desimone & Duncan, 1995), attended stimuli gain preeminence at the expense of other stimuli in the competitive processing of neural networks, and consequently engage perceptual systems and behavioral responses. In turn, the allocation of attention may be guided by motivationally-salient stimuli (Bruner, 1957), as representations of current goals held in working memory automatically bias the competition for attention to select and favor stimuli that match the goal (Soto, Hodsoll, Rotshstein, & Humphreys, 2008). Insofar as the consumption of alcohol is a motivationally-salient goal for alcohol dependent individuals, the engagement of alcohol use action schemas may result in implicit processing of salient stimuli, manifested as an involuntary AB towards alcohol cues and away from neutral cues.

Such bias is evident on attentional measures such as dot probe tasks, in which heavy drinkers preferentially attend to alcohol cues, resulting in decreased reaction times (RTs) to probes replacing alcohol photographs compared to probes replacing neutral photographs (Field, Mogg, Zetteler, Bradley, 2004). This RT difference is held to be an index of alcohol AB. According to basic perceptual research, participants typically require 50 ms to orient attention to a simple visual stimulus (Duncan, Ward, & Shapiro, 1994), while requiring at least 150 ms to disengage attention from that stimulus and shift it to another location in space (Theeuwes, 2005). Thus, one can assess initial orienting or disengagement of attention depending on the length of time a stimulus is presented (stimulus onset asynchrony, or SOA) (Field, Munafo, & Franken, 2009). On tasks involving simultaneous presentation of visually complex alcohol and neutral cues, AB for a cue presented for ≤ 200 ms SOA is believed to index initial orienting, because orienting, disengagement, and re-orienting to a new complex stimulus would not be possible within 200 ms (Field & Cox, 2008). In contrast, AB for longer duration stimuli (> 500 ms SOA) is believed to index delayed disengagement of attention from alcohol cues (Field & Cox, 2008). Alcohol AB has been linked to subjective craving; persons experimentally manipulated to attend to alcohol stimuli experience increased cravings and consume more beer than persons trained to attend to neutral stimuli (Field and Eastwood, 2005). Although the causal relationship between AB and alcohol consumption has yet to be firmly established, data suggest that drinking urges and behaviors can be modulated by attention. Among persons who drink to cope with negative affect, stress increases alcohol AB and craving (Field and Powell, 2007). Whether through invocation of automatic, appetitive responses or displacement of cognitive resources, alcohol AB may foster and/or maintain alcohol dependence, impeding recovery in alcohol dependent persons.

Given that automaticity and AB may be integral components of alcohol dependence, interventions affecting attention and implicit cognition may hold promise for its treatment. One such intervention, mindfulness meditation, has in recent years gained prominence for its apparent efficacy in treating stress-related, biobehavioral conditions (Ludwig & Kabat-Zinn, 2008). The *practice* of mindfulness meditation (which involves repeated orienting of attention onto an object while alternately accepting and letting go of distracting thoughts and emotions) is believed to foster the *trait* of mindfulness (Chambers, Gullone, & Allen, 2009), that is, the propensity to exhibit nonreactive, nonjudgmental, awareness of moment-by-moment cognition, emotion, perception, and sensation without fixation on thoughts of past and future (Garland, 2007; Lutz, Slagter, Dunne, & Davidson, 2008). Although trait mindfulness appears to vary naturally among meditation-naive individuals and negatively correlates with factors such as thought suppression, alexithymia, and emotion dysregulation (e.g., Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006), the practice of mindfulness has been shown to lead to significant increases in trait mindfulness which in turn mediate the effects of formal mindfulness practice on psychological symptom reduction (Carmody & Baer, 2008). Thus, to the extent that mindfulness-based interventions may improve clinical outcomes in substance-misusing populations (e.g., Bowen et al., 2006, Garland, Gaylord,

Boettiger, & Howard, 2010), they may do so via the promotion of trait mindfulness and concomitant cognitive processes. While there is evidence that the salutary effect of mindfulness training on substance use is partially mediated by reductions in thought suppression (Bowen et al., 2007), it is plausible that such clinical outcomes may also be mediated by the influence of mindfulness on attentional mechanisms implicated in addiction.

A recent randomized controlled pilot trial of mindfulness-oriented cognitive intervention for alcohol dependence (Garland et al., 2010) identified effects of mindfulness training on alcohol AB. Individual difference analyses revealed a number of significant associations. Among mindfulness participants, pre-post reductions in AB were significantly correlated with decreases in thought suppression, which were in turn associated with decreases in impaired alcohol response inhibition (i.e., the subjective sense of being unable to regulate alcohol impulses), and increased autonomic recovery from stress-primed alcohol cues.

Results from this initial study provide preliminary evidence that the *practice* of mindfulness may modulate alcohol AB, and converge with the growing body of literature identifying facilitative effects of mindfulness training on cognitive tasks measuring disengagement of attention and attentional control, in general (e.g., Jha, Krompinger, & Baime, 2007; Slagter et al., 2007; Tang et al., 2007; Zeidan, Johnson, Diamond, David, & Goolkasian, 2010). Yet to our knowledge, the relationship between *trait* mindfulness and alcohol AB remains unspecified. Given that higher trait mindfulness has been associated with greater self-reported attentional control (Baer et al., 2006; Herndon, 2008), decreased errors on sustained attention tasks (Schmertz, Anderson, & Robins, 2009), and improved selective attention, inhibitory control, and cognitive flexibility (Moore & Malinowski, 2009), we hypothesized that alcohol dependent individuals with higher levels of trait mindfulness would evidence less AB toward visual alcohol cues relative to individuals with lower levels of mindfulness. Because disengagement of attention from longer duration stimuli is thought to be governed by “top-down,” self-regulatory processes (Corbetta & Shulman, 2002, Posner & Rothbart, 1998), we surmised that trait mindfulness, with its associations to attentional control, would be most closely linked to AB for cues presented for 2000 ms, a SOA commonly used to measure addiction AB (Field et al., 2009). Additionally, we hypothesized that individuals with higher trait mindfulness would report less stress and alcohol craving and greater self-efficacy over drinking urges in high risk situations than their less mindful counterparts. To our knowledge, the present study is distinct in that it is the first to examine relationships between trait mindfulness, alcohol AB, stress, craving, and alcohol-related self-efficacy among alcohol-dependent adults.

Material and Methods

Sample characteristics and study design

Potential participants were alcohol-dependent adults living in a residential treatment facility serving persons with alcohol and substance-use disorders. Potential participants met study inclusion criteria if they were ≥18 years old, satisfied lifetime Diagnostic and Statistical Manual of Mental Disorders-Fourth Edition (DSM-IV) alcohol dependence criteria, and had resided in the treatment facility for ≥18 months. For programmatic reasons, treatment facility administrators required that residents have at least 18 months in the program to participate in the study. In addition, 18 months marks the time of transition to employment and residence outside of the facility, and thus represents a point of increased relapse risk. Alcohol dependence criteria were assessed with a semi-structured psychiatric interview adapted from section I of the Mini-International Neuropsychiatric Interview (Sheehan et al., 1998). Interviews were conducted by a licensed psychiatrist and licensed clinical social worker with training and expertise in making addiction diagnoses. Potential participants

were recruited through an informational presentation about the study made at the treatment facility, as well as through flyers and direct referrals from facility staff. Residents were not required to participate in the study. Of the 71 residents who were eligible for study participation due to having resided in the program for ≥18 months, 10 declined to participate, and 3 were ineligible for the study due to their not meeting full DSM-IV criteria for alcohol dependence. Participants were paid $25 for their participation in the present study.

Study participants were 58 alcohol-dependent adults who had resided for an average of 22.2 ± 3.6 months in a residential treatment facility. Treatment consisted of participation in a therapeutic milieu, psychoeducation on topics related to addiction, process therapy groups, and coping skills training (c.f., Monti, Abrams, Kadden, & Cooney, 1983). Most participants were male (81%) and African American (55.2%); 39.7% were Caucasian. With regard to income in the year before entering treatment, 56.9% had earned < $20,000, and 29.3% had earned $20,000–$40,000. The mean age of the sample was 39.8 (SD = 9.3). The mean total AUDIT score for the sample was 32.4 (SD = 5.6). The mean number of standard alcoholic drinks consumed per day in the year before entering treatment was 18.9 (SD = 10.8). All participants reported having continuously abstained from use of psychoactive substances during their residence in the TC. Reports of abstinence were corroborated by random urinalyses conducted at the TC on an as needed basis, as well as through daily observation by program staff. See Table 1 for sample characteristics.

During a single, hour-long assessment period conducted on premises at the TC, study participants first completed several standardized psychosocial instruments. Next, participants were engaged in a computer-based spatial cueing task as a measure of alcohol AB. All measures were administered in the same order across participants in a single session. This measurement protocol was part of a baseline assessment of a randomized controlled pilot trial of a mindfulness-oriented treatment for alcohol dependence. After this baseline assessment, participants were randomly assigned to either a mindfulness-oriented treatment or social support group for alcohol dependence. The results of this clinical intervention study are reported elsewhere (Garland et al., 2010).

Measures

Mindfulness—The *Five Facet Mindfulness Questionnaire* (FFMQ, α = .81), comprised of 39 likert-type items rated on a five-point scale (1 = never or very rarely true, 5 = very often or always true), was used to measure trait mindfulness. The FFMQ yields a total score (computed by summing responses across all 39 items) and scores for five internally consistent mindfulness factors each with their own convergent and predictive validity: nonreactivity to inner experience (tapped by items such as “I watch my feelings without getting lost in them”), observing and attending to experience (“I pay attention to sensations, such as the wind in my hair or the sun on my face”), describing and discriminating emotional experiences (“I’m good at finding words to describe my feelings”), nonjudging of experience (reverse coded item: “I tell myself I shouldn’t be feeling the way that I am feeling”), and acting with awareness (reverse coded item: “I find myself doing things without paying attention”) (Baer et al., 2006).

Alcohol attentional bias—A spatial cueing task created in E-Prime 2.0 (PST Inc., Pittsburgh, PA) and presented on an IBM T60 laptop with a 15″ screen was used to measure alcohol AB. In each trial, first a fixation cross was presented for 500 ms. Next, two grayscale images appeared side by side: one image was neutral in content, the other was alcohol-related. The pair of images was presented for a 2000 ms SOA. Left/right position of the alcohol images and presentation duration were both randomized and counterbalanced

across 20 practice trials and 160 trials. Following a 50 ms inter-stimulus interval (ISI), a target probe (two dots) replaced one of the images and a distracter probe (one dot) replaced the other image; probes appeared for 100 ms. Participants were instructed to indicate the location of the target probe by responding with a left or right button press on a keypad. Target probes randomly replaced alcohol and neutral images with equal frequency.

Some parameters of the task employed here vary slightly from the visual probe tasks often used to study addiction-related AB (c.f., Field et al., 2004), but accord with well-validated cognitive neuroscience methods used to probe attentional processes. In light of the large body of research that suggests attentional effects are more robust when targets appear with distracters relative to when targets are presented alone (for a review, see Carrasco, 2006), in our spatial cueing task, stimuli (one or two dots) appear in both cue locations, requiring participants to discriminate between target and distracter probes. This task design was chosen to enhance AB detection and eliminate confounding contributions of automatic, reflexive attention that are not related to the emotional salience (e.g., alcohol-relatedness) of the image cues. In particular, both sudden onsets and offsets have been found to capture attention (Theeuwes 1991; Hopfinger & Maxwell, 2005), and if a probe appeared in only location, participants' attention would be reflexively captured by the probe (Theeuwes, 1991) irrespective of the emotional salience of the preceding cue. Including a place marker in the opposite target probe location, requires the participant's attention to be directed to the spatial location of the target probe and ensures that response selection cannot be based on reflexive detection of the probe through peripheral vision. Moreover, use of target and distracter probes requires greater attentional resources than detection of a single probe and thus this design may have more power to resolve attentional shifts elicited by alcohol cues. Specifically, the use of two probes may lead to longer RTs when attention is originally captured to a non-target location, and greater facilitation of responding when attention is already directed to the target location, thereby increasing our ability to measure addiction-related attentional effects. While the use of two probes may add an additional mental task compared to single-probe tasks, other forms of discrimination tasks, such as those requiring participants to report the direction a target arrow, have found reliable attentional biases toward drug-related stimuli (e.g., Field et al., 2004; Field & Powell, 2007).

Alcohol stimuli included 13 photographs of alcoholic drinks (i.e., liquor, beer, etc), as well as 7 photos of persons drinking alcohol. Neutral stimuli included 13 photos of kitchen items and 7 photos of persons in kitchen scenes. Stimulus sets were analyzed with respect to their spatial frequency (i.e., spectral peak and width) to ensure that they did not differ in terms of basic visual properties, which could elicit reflexive attentional capture irrespective of image content. Spectral peak and width are measures of the distribution of spectral frequencies across an image, which may affect the psychophysical saliency of a given image. Power in the higher frequencies reflects a more highly detailed, edge-rich image, while power in the lower frequencies reflects grosser object information and generally higher image contrast. The spectral peak measure gives the spatial frequency with the greatest power for an image, while the spectral width provides a measure of the distribution of spatial frequencies within an image. On measures of spectral peak (Neutral: 0.0180, Alcohol: 0.0176, $t_{(38)}$=0.383, p=0.704) and spectral width (Neutral: 59.20, Alcohol: 59.29, $t_{(38)}$=−0.027, p=0.979), the two stimulus sets were not significantly different." Three participants were missing data on this measure due to hardware issues.

Alcohol craving, alcohol-related self-efficacy, and perceived stress—Subjective alcohol craving was assessed with *Penn Alcohol Craving Scale* (PACS, α = .91) (Flannery et al., 2001). Participants use a 7-point scale to indicate craving frequency and intensity over the past week on items like "How often have you thought about drinking or about how good a drink would make you feel?" and "At its most severe point, how strong was your

craving?" Alcohol-related self-efficacy, i.e., the subjective sense of being able to resist the urge to drink in high-risk situations, was assessed with the *Situational Confidence Questionnaire* (SCQ, α = .96) (Breslin, Sobell, Sobell, Agrawal, 2000). Respondents use a 6-point scale to indicate how confidently they could cope with alcohol urges in each of 39 high risk drinking scenarios involving negative or positive emotions, bodily discomfort, alcohol temptations, testing control, interpersonal conflict, social pressure to drink, or pleasant social experiences. The 10-item *Perceived Stress Scale* (PSS-10, α = .85) was used to assess on a 5-point scale how often (0 = never, 4 = very often) in the past month participants found their lives unpredictable, uncontrollable, and overwhelming (Cohen, Kamarck, & Mermelstein, 1983), and includes items such as "How often have you felt nervous and 'stressed'?" and "How often have you felt that you were on top of things?"

Data analysis

Before calculating individual AB scores for each participant, trials with extreme RTs, defined as those with RTs 3 SD above or below the individual mean RT (c.f., Field, Mogg, Zetteler, & Bradley, 2004), were eliminated as outliers (mean 2.5 ± 1.5 trials per participant, 1.5% of all trials); error trials were also eliminated (mean 6.4 ± 0.6 trials per participant, 4% of all trials). For each participant, AB scores were calculated by subtracting their mean RT to target probes replacing alcohol photos from their mean RT to target probes replacing neutral photos, such that positive bias scores indicate an AB toward visual alcohol cues. All data are reported as means ± SD unless otherwise noted.

Bivariate correlations, t-tests, and multiple linear regression analyses were performed with SPSS 16.0. Multiple linear regression was used for hypothesis testing, in which age, gender, number of drinks/day in the year prior to treatment, AUDIT total score, mindfulness, craving, and perceived stress were entered simultaneously, to examine the percentage of variance in alcohol AB explained by these variables. Potential multicollinearity issues were screened by examining the variance inflation factor (VIF) of each variable.

Results

Spatial cueing task

Mean accuracy on the spatial cueing task was 97.2% ± 0.4%. Mean RT to target probes replacing alcohol photos presented for 2000 ms was 587.7 ± 120.8 ms, whereas mean RT for neutral photos was 585.3 ± 123.9 ms. AB data was approximately normally distributed (yielding a non-significant Kolmogorov-Smirnov test for normality). Paired t-tests revealed nonsignificant differences between RTs to alcohol and neutral photos displayed for 2000 ms, $t(53) = .96$, $p = .34$. Although the overall sample mean AB was not significantly greater than zero, inspection of the raw data revealed that 30 participants had an AB away from alcohol cues (M = −14.78 ± 13.33 ms), whereas 25 participants had an AB towards probes replacing alcohol photos (M = 17.30 ± 22.63 ms). Given the substantial heterogeneity in individual AB scores, an individual difference analysis was warranted.

Importantly, 2000 ms alcohol AB was significantly correlated with number of drinks/day in the year prior to entering treatment, r = .33, p = .02, and marginally correlated with the AUDIT total score, r = .26, p = .06, indicating that persons who reported a more severe pattern of alcohol use prior to entering treatment exhibited greater difficulty disengaging attention from alcohol cues.

Bivariate relationships between mindfulness, stress, craving, alcohol-related self-efficacy, and alcohol consumption

Correlation coefficients for variables of interest are reported in Table 1. Trait mindfulness was significantly positively associated with alcohol-related self-efficacy and significantly negatively associated with 2000 ms alcohol AB, subjective alcohol craving, perceived stress, and number of drinks/day. The mindfulness facets of *describing experiences with words* and *acting with awareness* were significantly inversely correlated with number of drinks/day. *Nonreactivity to inner experience* and *describing experience with words* were the only mindfulness factors significantly inversely correlated with 2000 ms alcohol AB.

Multivariate analysis of alcohol AB

Given demonstrated associations between addiction severity, craving, stress, and alcohol AB (c.f., Field & Cox, 2008), we tested a multiple linear regression model with demographics (age and sex), number of drinks/day, alcohol craving (PACS), and perceived stress (PSS) as possible predictors of 2000 ms AB (R^2 = .18). Of these factors, only number of drinks/day was a significant predictor of 2000 ms AB (β= −.50, p =.01, sr = −.37). Next, using hierarchical multiple regression, we tested a model where the aforementioned variables were entered in Step 1, and FFMQ total mindfulness was entered in Step 2 as predictors of 2000 ms alcohol AB (R^2 = .29). In this model, mindfulness was the only statistically significant predictor (β= −.50, p =.02; sr = −.33), indicating that total mindfulness scores accounted for a significant portion of variation in alcohol AB after controlling for the influence the demographic and clinically-relevant variables listed above. Regression parameters are reported in Table 2.

To ascertain which mindfulness facets most robustly predicted alcohol AB, the three mindfulness facets with the largest zero-order correlations to alcohol AB (*nonreactivity to inner experience*, *describing experience with words*, and *acting with awareness*) were entered simultaneously into a regression model. In this model, nonreactivity was a marginally significant predictor of alcohol AB (β= −.28, p =.07, sr = −.25), whereas the other two mindfulness facets were not significantly associated with alcohol AB.

Lastly, to determine whether the association between trait mindfulness and alcohol AB could be explained by time in treatment or alcohol self-efficacy, we conducted a hierarchical multiple regression with simultaneous entry of age, sex, # of drinks/day, craving, and stress in step one, and time in treatment and alcohol self-efficacy in step two. Time in treatment and alcohol self-efficacy did not significantly predict alcohol AB, nor did they add a significant amount of variance explained (R-squared change) to the model. In step three, we added trait mindfulness to the model, and this variable continued to significantly predict alcohol AB (β= −.50, p =.02, sr = −.36) after controlling for the set of variables in step 1 and 2.

Discussion

The present study sought to test the following hypotheses: a) recovering alcohol dependent persons endorsing higher levels of trait mindfulness will exhibit less alcohol AB than those with lower levels of mindfulness, and b) recovering alcohol dependent persons endorsing higher levels of trait mindfulness will report less stress and alcohol craving, and greater ability to resist the urge to drink in high risk situations, than those with lower levels of mindfulness. In support of these two hypotheses, we found that trait mindfulness was significantly inversely associated with alcohol AB, perceived stress, and subjective alcohol craving among recovering alcohol dependent adults, and positively correlated with alcohol-related self-efficacy. Moreover, although pre-treatment levels of alcohol consumption

significantly predicted 2000 ms alcohol AB, adding trait mindfulness to a model containing this variable and other factors that have been linked with AB in prior studies (i.e., stress and craving, c.f., Field & Cox, 2008) led to a significant increase in the amount of variance explained in 2000 ms alcohol AB. Indeed, trait mindfulness was the sole significant predictor of 2000 ms alcohol AB when demographic and the aforementioned clinically-relevant factors were controlled. To our knowledge, this is the first report to identify a significant association between trait mindfulness and alcohol AB among alcohol dependent individuals.

Notably, we identified a nonsignificant mean 2000 ms alcohol AB in this sample of recovering alcohol dependent adults. This finding is congruent with results from a study by Noel et al. (2006), who found an absence of AB in alcohol dependent inpatients at 1,250 ms stimulus durations. Despite reports that heavy drinkers have AB towards alcohol cues on visual probe tasks (cf., Field, 2006), other research has identified attentional disengagement from such cues among abstinent alcohol dependent persons in treatment (Stormark, Field, Hugdahl, & Horowitz, 1997; Townshend and Duka, 2007). Although the mean 2000 ms AB for our sample was not statistically significantly different than zero, closer inspection of individual differences revealed that the sample was roughly split into persons with AB towards alcohol cues and those with AB away from such cues. This finding is understandable given that one might expect substantial heterogeneity of responses to long-term participation in a TC; many residents might successfully learn to avoid temptation by directing their attention away from alcohol while others might still harbor covert urges to drink indexed by alcohol approach AB. Alternatively, the lack of a significant mean AB in this study may stem from our use of a spatial cueing task with target and distracter probes that differs somewhat from the usual tasks used to assess addiction AB. However, the sensitivity and construct validity of our spatial cueing task was supported by our finding of a significant positive correlation between alcohol consumption and 2000 ms AB. Future studies should attempt to replicate our findings using alternate measures of AB like dot probe and the addiction Stroop task. A third explanation for the lack of significant mean alcohol AB across the sample may be due to the fact that study participants had resided in a therapeutic milieu for an average of nearly 22 months. On the whole, alcohol AB may have been attenuated by participation in such long-term residential treatment. Yet, the individual difference analyses conducted in the present study suggest that degree of trait mindfulness may predict the extent to which the attention of alcohol dependent individuals is biased towards alcohol cues.

Among the present sample of alcohol dependent adults in residential treatment, mindfulness was more closely related to alcohol AB than measures of stress or craving. Indeed, low trait mindfulness may reflect enhanced risk for addictive urges, automatic appetitive responses, and/or attentional fixation onto alcohol cues. Persons in recovery with low levels of mindfulness may be especially susceptible to relapse. However, trait mindfulness only accounts for a portion of the variance in alcohol AB among alcohol dependent individuals, and clearly, other important factors that were omitted by the present investigation may contribute to attentional fixation on alcohol cues. Moreover, the measure of trait mindfulness used in this study, which was significantly correlated with greater self-efficacy resisting a drink in high-risk situations but not statistically associated with time in treatment, might be partially coextensive with factors such as readiness to change and distractibility, variables that may have some impact on alcohol AB. Although participants had not received formal mindfulness training at the time of this study, extended exposure to treatment in a therapeutic milieu may have led to higher levels of mindfulness than may be observed in typical alcohol dependent populations.

Because mindfulness was inversely correlated with attentional bias towards visual alcohol cues presented for 2000, it appears as if trait mindfulness relates to disengagement of attention from alcohol cues. It may be that relative to those who are low in mindfulness, recovering alcohol dependent persons reporting high levels of mindfulness are better able to disengage and shift attention away from alcohol cues. Given that mindfulness training has been shown to potentiate attentional re-orienting functions (Jha et al., 2007), mindfulness-promoting interventions may facilitate disengagement of attention from alcohol to allow for a focus on neutral or health-promoting objects, persons, and experiences. Ultimately, repetitively engaging, disengaging, and moving attention away from alcohol cues toward innocuous or beneficial stimuli may weaken associative networks of alcohol use action schemas and strengthen an alcohol dependent person's ability to avoid relapse. Although a recent study found that a 10-week mindfulness training program exerted significant effects on alcohol AB (Garland et al., 2010), it should be noted that the present investigation is correlational in nature, and no mindfulness training was delivered to participants at the time of the assessments; thus, the identified relationship between trait mindfulness and alcohol AB should not be taken as evidence in support of a potential effect of mindfulness training on addiction-related attentional processes.

Among mindfulness factors, nonreactivity to thoughts and emotions and describing/differentiating cognitive-emotional experience appear to be related to decreased alcohol AB. These findings are interesting in light of the relationship between emotion dysregulation and alcohol dependence. A large corpus of research has identified linkages between stress reactivity, negative affect, implicit cognitive processes, and the appetitive drive to consume alcohol (Garland, Boettiger, & Howard, in press). Additionally, alexithymia has predicted poor outcomes among alcohol-misusing inpatients (Loas, Fremaux, Otmani, Lecercle, & Delahousse, 1997). The observed inverse relationship between mindfulness facets and alcohol AB may reflect self-regulatory competence among recovering alcohol dependent persons reporting high levels of mindfulness. Thus, mindfulness may reduce attentional fixation on alcohol cues by promoting awareness of and detachment from experiences of negative affect or addictive urges.

Notably, the mindfulness facet of acting with awareness was significantly inversely associated with quantity of alcohol consumption in the year prior to entering treatment. In contrast to alcohol dependent individuals who reported greater mindful awareness of their actions, those who reported a more severe tendency toward distractibility, mind wandering, and doing things without paying attention while "running on automatic" tended to drink larger quantities of alcohol. This finding is congruent with a recent study which found that alcohol consumption increases mind wandering while, at the same time, decreasing awareness that mind wandering has occurred (Sayette, Reichle, & Schooler, 2009). Conversely, Rohsenow et al. (1994) found that greater attention and sensory awareness to cue-reactivity predicted less drinking in a sample of recovering alcohol dependent individuals. Moreover, in light of Tiffany's (1990) proposal that automaticity drives appetitive alcohol responses, mindful awareness of one's automatized reactions would presumably allow for greater self-regulation of such responses and lower levels of alcohol consumption. In contrast, Ostafin and Marlatt (2003) found that mindful acceptance was a stronger moderator of the relation between alcohol approach motivations and hazardous alcohol consumption than mindful awareness. Experimental research is needed to test the hypothesis that awareness is only effective in changing drinking behavior when it is coupled with acceptance of one's own internal state (e.g., alcohol-related thoughts and urges).

In summary, the present data provide novel evidence associating trait mindfulness and factors linked to the maintenance of alcohol dependence. Given that trait mindfulness has been shown to be plastic and able to be enhanced by mindfulness-based interventions

(Carmody & Baer, 2008), the current study has implications for the identification malleable traits that can offset automatic cognitive mechanisms implicated in addiction maintenance and relapse. Identification of such traits may prove to be crucial to treatment development efforts. Whether mindfulness training can reliably impact alcohol AB over time remains a question to be explored by further research.

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Table 1

Sample Characteristics

Variable	M or %
Length of stay in residential program (M, SD)	22.2 (3.6)
Gender N (%)	
Male	47 (81.0)
Female	11 (19.0)
Race N (%)	
African American	32 (55.2)
Caucasian	23 (39.7)
Other	3 (5.1)
Age (M, SD)	39.8 (9.3)
Income before entering TC N (%)	
<$20,000	33 (56.9)
$20,000–40,000	17 (29.3)
$41,000–60,000	5 (8.6)
$61,000–80,000	1 (1.7)
>$80,000	2 (3.4)
Drinks per day (M, SD)	18.8 (10.9)
AUDIT (M, SD)	32.3 (4.9)

Table 2

Bivariate Correlations Between Mindfulness, Craving, Stress, Time in Treatment, Alcohol-Related Self-Efficacy, Alcohol Use Patterns, and Attentional Bias in Abstinent Alcohol Dependent Adults

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1. Total mindfulness (FFMQ)	1												
2. Nonreactivity to inner experience	.46***	1											
3. Observing/attending to experience	.61***	.29*	1										
4. Describing experience with words	.76***	.31*	.34*	1									
5. Nonjudging of experience	.38**	.03	.13	−.06	1								
6. Acting with awareness	.67***	−.10	.03	.48***	.17	1							
7. Alcohol attentional bias 2000 ms (AB2000)	−.39**	−.34*	−.20	−.37**	−.07	−.26	1						
8. Alcohol Use Disorders Identification Test (AUDIT)	−.27*	−.18	−.17	−.01	−.26	−.16	.26	1					
9. Number of drinks/day	−.35*	−.19	−.11	−.32*	−.20	−.30*	.33*	.51***	1				
10. Alcohol craving scale (PACS)	−.38**	−.28*	−.49***	−.32*	.12	−.18	.13	.11	.14	1			
11. Perceived stress scale (PSS-10)	−.37**	−.41**	−.19	−.27	−.13	−.19	.02	.15	.18	.17	1		
12. Alcohol-related self-efficacy (SCQ)	.30*	.17	.16	.28	−.18	.13	−.20	−.13	−.20	−.44**	−.18	1	
13. Number of months in treatment	−.04	.16	−.02	−.11	−.11	−.26	−.00	−.12	.08	.07	.−.18	−.13	1

N's ranged from 54 to 48 due to missing data.

* $p<.05$

** $p<.01$

*** $p\leq.001$

Table 3

Summary of Hierarchical Multiple Linear Regression Analysis for Variables Predicting 2000 ms Alcohol AB Among Alcohol Dependent Patients

Variable	*B*	*SE B*	β
Step 1:			
Age	−.46	.29	−.26
Sex	−3.10	6.45	−.07
# of drinks a day	.66	.25	**.42** *
Craving (PACS)	.30	.50	.09
Perceived stress (PSS-10)	−.11	.41	−.04
Step 2:			
Age	−.25	.28	−.14
Sex	−3.74	6.07	−.08
# of drinks a day	.38	.26	.25
Craving (PACS)	−.15	.50	−.05
Perceived stress (PSS-10)	−.65	.44	−.24
Mindfulness (FFMQ total score)	−.50	.20	**−.50** *

Note. R^2 = .18 for Step 1; ΔR^2 = .11 for Step 2 (p < .05). N = 48.

* $p < .05$.