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Abstract

Rationale: Research shows that alcohol-related stimuli have the propensity to capture attention among individuals motivated to consume alcohol. Research has further demonstrated that impulsive individuals are especially prone to this type of attentional bias. Recently, it is suggested that alcohol cue exposure can also produce a general narrowing of attention consistent with the activation of approach motivational states.

Objective: Based on previous models of addiction and recent research on the activation of approach motivational states, we predicted that impulsive individuals would demonstrate a constriction of attentional focus in response to alcohol cue exposure.

Methods: Participants (n = 392) completed a task assessing attentional breadth in response to alcohol and non-alcohol cues, followed by measures of alcohol use and impulsivity.

Results: The findings revealed that impulsivity scores predicted narrowing of attentional scope following the presentation of alcohol cues for heavier drinkers, but not for light drinkers.

Conclusion: These results suggest that impulsive individuals who drink more heavily demonstrate a narrowing of attention in the presence of alcohol-related incentive cues. Implications for how these findings might account for the link between impulsivity and alcohol use and misuse are discussed.

Key Words: alcohol myopia, motivational intensity, impulsivity, approach motivation, attentional scope, attentional bias

Peering Through the Bottleneck: Heavy Drinking, Impulsivity and Attentional Narrowing Following Alcohol Cue Exposure

Substance use is frequently related to emotional and cognitive reactivity to substance-related stimuli (e.g., Carter and Tiffany 1999; Baumann and Sayette 2006). For example, research shows that alcohol-related stimuli have the propensity to capture attention among individuals motivated to consume alcohol (e.g., Field et al. 2007). In addition to capturing attention, recent findings reveal that alcohol-related stimuli can produce a general narrowing of attentional focus, prompting some individuals to focus on the details of their environment (i.e., "the trees") as opposed to the big picture (i.e., "the forest"; Hicks et al. 2012). In the present study, we use the motivational intensity model to guide our prediction that trait impulsivity would moderate the extent to which alcohol-related stimuli produce a narrowing of attention.

The Motivational Intensity Model

According to the Motivational Intensity Model (MIM), approach-related affective states (e.g., anger, desire) cause thoughts to coalesce around the elicitor of the emotion, prompting a general narrowing of attentional scope (e.g., Gable et al. 2013; Harmon-Jones et al. 2012; Harmon-Jones et al. 2013). For example, after exposure to appetitive images, individuals are more likely to attend to the local elements in their visual field (e.g., the details that make up a large figure) compared to the global properties (e.g., the figure itself; Gable and Harmon-Jones 2008). This tightly focused attentional spotlight is adaptive to the extent that it limits the cognitive access to thoughts that might otherwise distract from or impede goal progress. More than 15 studies, using diverse approach-related affect manipulations and indicators of attentional narrowing, support the idea that states high in motivational intensity lead to a general narrowing of attention (e.g., Gable and Harmon-Jones 2010a; Gable and Harmon-Jones 2010b).

The idea that approach motivation narrows attentional breadth is central to many models of addiction (see Robinson and Berridge 1993; Cox and Klinger 1988; Franken 2003; Field et al. 2006). For instance, Cox and Klinger (1988) argue that the implicit activation of the goal to drink will limit the processing of goal irrelevant stimuli to the extent that people value the incentive. Moreover, a critical competent of the incentive-sensitization theory states that drug-related stimuli attract attention for individuals motivated to consume the drug (Robinson and Berridge 1993). While these arguments are supported by findings demonstrating various attentional biases, such as when alcohol-related words interfere with subsequent performance on alcohol Stroop tasks, only recently have researchers directly shown that exposure to alcohol-related stimuli produces a more narrowed focus of attention for individuals who possess strong approach motives toward alcohol consumption (Hicks et al. 2012).

Overall, theory and limited empirical findings support the contention that alcohol-related stimuli shape the scope of attentional breadth when the incentive value of alcohol is high. While these effects are analogous to those predicted by other models (e.g., Alcohol Myopia Theory; Steele and Josephs 1990), they suggest that simply activating approach motivational states can produce a narrowing of attentional focus even in the absence of perceived or actual consumption.

Impulsivity and Motivational Intensity

If alcohol-related stimuli acquire approach-motivational properties, it stands to reason that individuals who possess poor inhibitory control should be most affected by such cues. Many theorists argue that deficits in executive control functioning facilitate addictive behaviors (e.g., Koob 2013; Madden and Bickel 2009), and that the incentive-motivational properties of alcohol-related stimuli will be enhanced for those who have difficulty controlling their impulses (e.g., Coskunpinar and Cyders 2013). For example, trait impulsivity, a personality characteristic

associated with executive control, describes the tendency to act with less forethought, and predisposes an individual towards rash, unplanned reactions without regard to negative consequences and with a disregard to more rational long-term choices for success (International Society for Research on Impulsivity 2013). Not surprisingly, impulsivity is strongly linked to addictive behaviors generally, and alcohol use and misuse specifically (e.g., Bickel et al. 2012; Gould 2010; Leeman and Potenza 2012). Based on the MIM, we predict that impulsive individuals should demonstrate an increased narrowing of attention following alcohol cue exposure due to heightened approach motivation in response to such cues.

Research has shown that, like trait impulsivity, narrowed attentional scope leads individuals to focus on the "here and now" as opposed to thinking about the long-term goals and evokes greater approach-motivation to appetitive cues (Gable and Harmon-Jones 2011), suggesting a strong link between these two variables. As an initial test of this idea, this study will directly test whether alcohol cues will narrow attentional scope for impulsive individuals. This prediction is indirectly supported by a recent meta-analysis showing a significant relationship between impulsivity and measures of substance-related attentional biases (Coskunpinar and Cyders 2013). Importantly, however, while this meta-analysis shows that impulsivity is associated with the type of stimuli people focus on, research has yet to examine whether impulsivity also contributes to a general narrowing of attention following exposure to alcohol-related incentive cues.

Of course not all impulsive individuals value the effects of alcohol consumption. As such, it is unclear whether impulsivity will activate approach motivational states following alcohol cue exposure for individuals who do not strongly value the rewarding properties of alcohol consumption (for a similar rationale see Fleming and Batholow 2013). In the present

study, we specifically test whether alcohol use moderates the proposed link between impulsivity and attentional narrowing. Participants were exposed to either alcohol or neutral cues before completing a measure of attentional scope. We predicted that impulsive individuals would demonstrate a narrowing of attentional scope following exposure to alcohol cues, and explored whether alcohol consumption would moderate this effect.

Methods

Participants

Three hundred and ninety two students (66% female) enrolled in an introductory psychology course participated for partial completion of course credit. Participants reported a median age of 18 years old (M = 18.62; SD = .92) and were predominantly White (78.1%) and non-Hispanic (79.8%). Sixty one participants reported to have never had a drink of alcohol before and were thus excluded from all analyses (see Krueger et al. 2004); however, the results for the primary analyses remained significant when these abstainers were included.

Measures

Alcohol cues and attentional scope task. A within-participants procedure was used for the present study (adapted from Gable and Harmon-Jones 2010a). Participants viewed 32 images of alcoholic beverages and 32 neutral images of rocks (from Hicks et al., 2012). On each trial, a single image was displayed for 3 s following a 500 ms fixation cross. After each picture, another fixation cross appeared for 500 ms followed by an image of a Navon (1977) letter that was presented until the participant responded or 5 s elapsed. The inter-trial interval varied between 6 s to 11 s depending on how quickly participants responded to the target image.

To assess attentional breadth, we used an established measure of global/local processing (Navon 1977) in which large letters composed of smaller letters are presented (see Figure 2).

Each vertical and horizontal line of a large letter was made up of five closely spaced smaller letters (e.g., a T made up of Ls). Participants indicated as quickly as possible whether the picture contained the letter T or the letter H, by pressing the "Z" key or the "/" key, respectively. Global targets were those in which a T or an H was composed of smaller Ls or Fs. Local targets were those in which a large L or F was composed of smaller Ts or Hs. Faster responses to the local (vs. global) targets indicate a narrowed attentional scope. Thirty-two local and 32 global targets were presented in random order (see Table 1 for means for each type of trial).

Impulsivity. To assess impulsivity, participants completed the Barratt Impulsiveness Scale -11 (BIS-11; Patton et al., 1995). The BIS-11 is a 30 item questionnaire. Items are on a 4-point scale (1 = rarely/never to 4 = almost always/always). The BIS-11 consists of three sub-factors (motor impulsiveness, nonplanning impulsiveness, and attentional impulsiveness). For our main analyses, we summed all items to create a total impulsivity score.[1] Higher total scores reflect greater impulsivity (M = 64.78, SD = 9.56).[1]

Alcohol use and covariates. Participants first indicated whether they had consumed alcohol at least once in their lives. Those who answered yes to this questions (n = 331) then completed 2 items to assess their alcohol consumption in the past 30 days. One item assessed the number of times they drank in the past month (M = 5.39, SD = 6.45), and a second item assessed the average quantity of drinks per drinking episode (M = 3.40, SD = 2.52).The product of the monthly frequency and quantity variables was used as our measure of alcohol use (M = 24.96, SD = 41.44).

[1]We report the total impulsivity scores for all of the analyses reported in the text. We also ran separate analyses for each of the DVs testing the independent effects of the three subscales of the BIS-11 measure. The results of each of these analyses mirrored those reported in the main text. Each of these regression analyses revealed a marginal or significant effect of the interaction terms (p's = .003, .043, 081, .006, .007, .025).

Secondary analyses controlled for sex of the participant and general approach motivation. To assess dispositional approach motivation, participants completed the Behavioral Approach/Inhibition Scale (BAS/BIS; Carver and White 1994). Research has shown that facets of trait approach motivation (e.g., BAS Drive) are linked to narrowed attention following general appetitive cues (Gable and Harmon-Jones 2013) and alcohol-related cues, specifically (Hicks et al. 2012). Further, theorists have posited that the BAS Drive and Reward Responsiveness subscales reflect a type of impulsivity called Reward Drive (Dawe and Loxton 2004; Dawe et al. 2004; see also Franken and Muris 2005; Franken et al. 2006; Gray 1987), unique to "rash impulsivity" captured by BIS-11 scores. We therefore explored the contribution of this subscale on secondary analyses. Five items assessed Reward Responsiveness (e.g., "It would excite me to win a contest") and 4 items assessed Drive (e.g., "I go out of my way to get things I want"). All items were rated on a scale from 1 (*not at all true*) to 7 (*extremely true*). The 2 subscales were aggregated to create a total Reward/Drive score ($M = 4.95$, $SD = .78$).

Procedure

Upon arrival to the lab, participants were escorted to visually isolated computers and first completed the attentional breadth task. Participants then completed a survey containing the measures of alcohol use followed by the impulsivity measure and BIS/BAS scale. Finally, they were probed for suspicion and thoroughly debriefed.

Results

Correlation analyses revealed that impulsivity was associated with alcohol use *(*$r = .195$; $p < .01$) and trait approach motivation ($r = .126$; $p = .039$). Trait approach motivation was also significantly associated with alcohol use ($r = .114$; $p = .039$).

Dependent Variables

Researchers have assessed attentional narrowing using this paradigm in one of two ways. We did not have specific predictions for these two variables, and, therefore, report analyses for each variable (see Simmons et al. 2011). For each of these dependent variables, response times on the composite letter task were transformed logarithmically to compensate for skew. Trials with incorrect responses or those in which the RT was more than 3 SDs from the mean for that stimulus were excluded from the analyses (Fazio 1990). For our first dependent variable, we computed a difference score between the global target RTs and local target RTs following alcohol pictures. For this indicator, higher scores demonstrate greater attentional narrowing. Previous research has also revealed a general global bias on the Navon letter task, indicating that participants typically respond faster to the global targets compared to the local targets. Following Gable and Harmon-Jones (2008), we therefore computed a second dependent variable that represented the difference score between the global-alcohol and the global-neutral RTs. For this score, a slower RT to the global-alcohol trials compared to the global-neutral trials would demonstrate alcohol-cue induced attentional narrowing.

Primary Analyses

Hierarchical multiple regressions were used to test our main hypothesis. The standardized BIS-11 scores and alcohol use scores, along with the global-local difference score to the neutral stimuli to control for individual differences in response times (Robinson , 2007), were entered on the first step. These variables produced a significant change in R^2 (R^2=.155, p <. 001), with the neutral difference score significantly predicting the dependent variable (β = .40, p < .001). Importantly, however, the alcohol use × impulsivity interaction term, entered on the second step, also produced a significant change in R^2 (R^2_{change} = .020, p = .005, β = .15 for the interaction term). Inspection of the simple slopes for each group supported our hypothesized effect, showing

that impulsivity ratings were more positively associated with attentional narrowing for people who drank more heavily (β = .17, p = .005) compared to lighter drinkers (β = -.093, p = .26; see panel A of Figure 1).A subsequent analysis revealed that the interaction effect remained significant after controlling for trait approach motivation and sex of the participant (p = .005).

In the second analysis, the impulsivity scores and the alcohol use variables were regressed on the second dependent variable. These variables contributed to a significant change in R^2 (R^2=.024, p = .018) with alcohol use positively predicting increased attention narrowing (β = .13, p = .020). Notably, the interaction effect, entered on the second step, also produced a significant change in R^2 (R^2_{change} = .025, p = .003, β = .17 for the interaction term), again showing that impulsivity scores were a stronger predictor of attentional narrowing for heavier drinkers (β = .22, p = .001) compared to lighter drinkers (β = -.07, p = .442; see panel B of Figure 1). This interaction effect also remained significant when the covariates were entered in the analyses (p = .004).

Overall, these results support the notion that cues high in incentive value constrict attentional focus for impulsive individuals. Although there were not consistent main effects of drinking status or trait impulsivity on attentional focus (see discussion for more on this unexpected finding), the interaction effect revealed that trait impulsivity was strongly associated with narrowed attention for heavier drinkers.

General Discussion

Based on contemporary and classic models linking incentive cues to automatic approach motivation (e.g., Robinson and Berridge 1993; Gable and Harmon-Jones 2008), we predicted that rewarding stimuli would produce narrowed attentional focus for impulsive individuals. The current research supported this prediction utilizing an alcohol-cue exposure task, revealing a

significant link between trait impulsivity and attentional focus for heavier drinkers. These findings are the first to demonstrate an association between impulsivity and attentional breadth and have important implications for research on substance use.

Over 4 decades of research demonstrate that trait impulsivity is associated with alcohol use and misuse (e.g., Bjork et al. 2004; Rubio et al. 2008). Such an association makes strong conceptual sense given that impulsive individuals are more focused on attaining immediate rewards without thinking about the negative consequences of their actions. Our findings suggest that narrowed attentional focus may be one cognitive mechanism influencing alcohol misuse for some impulsive individuals. Like impulsivity, narrowed attention is thought to reflect a focus on the "here and now" (Förster and Dannenberg 2010). Perhaps then, in the presence of alcohol cues, the narrowed attention of impulsive, heavy drinkers helps facilitate a tenacious focus on goal attainment (i.e., drinking) even when other factors might normally impede the initiation of alcohol consumption. Future research should test this possibility in a laboratory setting, as well as the provocative possibility that past drinking and impulsivity do not simply exert main effects on alcohol-related outcome variables, but converge to contribute to maladaptive alcohol use. These findings will help uncover whether narrowed attention in this context simply delineates certain types of heavy drinkers, or if narrowed attention directly contributes to the development of substance-related problems (cf. Field et al. 2006).

The current research is the first to explicitly investigate the role of automatic approach motivational responses as a possible contributor to the link between impulsivity and alcohol use. While these findings have implications for research on alcohol use and abuse, we believe that our findings support a more general model explaining the mechanisms underlying the relationship between impulsivity and a host of other behaviors (e.g., eating behaviors, abuse of other

substances, gambling). Our findings support that idea that incentive cues elicit a heightened approach motivational response for impulsive individuals, in part, because of their difficulty to control their impulses.

Of course, one limitation to the current findings is that we didn't directly assess whether impulsive heavy drinkers actually had increased difficulty controlling their impulses after exposure to alcohol cues. While it is possible that the alcohol cues produce an automatic narrowing of attention for these individual that would render it difficult to assess this underlying mechanisms, future research should assess measures of impulse control (e.g., the Impaired Control Scale; Heather, Booth, & Luce, 1998), or assess neurological markers of impulse control to directly test this claim.

One unexpected finding was the lack of consistent main effects of drinking status and impulsivity on our indicators of attentional narrowing. One might expect that heavy drinkers, for example, who presumably highly value the rewarding properties of alcohol, would demonstrate narrowed attentional focus following alcohol-cue exposure regardless of their level of impulsivity. One possible reason from this null finding is that some of the heavy drinkers in the current study consumed alcohol for reasons that were not exclusively approach-related (e.g., Cooper 1994). This possibility raises two clear limitations to the present research. First, the sample consisted of younger college students who were relatively light drinkers. In order to substantiate the clinical significance of the current finding, future studies need to recruit individuals who have had a history of heavy alcohol and/or alcohol dependence. One problem with drawing strong inferences based on the present findings alone is that students often possess divergent reasons for drinking (e.g., Cooper, 1994). For example, some students' alcohol use might be influenced by peer pressure, while other might drink heavily because they strongly

enjoy feeling inebriated. Further, some younger college students might not drink heavily only because they do not access to alcohol. These possibilities undermine our claim the heavy (light) drinkers in our study highly value (do not value) the rewarding properties of alcohol. In order to better understand the associations between these variables, future studies should recruit a sample heavy drinkers and assess their motives for drinking.

Two aspects of the study design are potentially problematic as well. First, we assessed alcohol use using a two item measure assessing past month frequency and typical quantity of use. Future research should consider using a well validated measure of alcohol use such as the Timeline Followback method (Robinson, Sobel, Sobel, & Leo, 2012). Second, the neutral images in the current study were composed of images low in incentive value (i.e., rocks). While previous research did not find differences between moderate (i.e., images of juice) and low (i.e., images of rocks) incentive cues (Hicks et al., 2012), using only the non-appetitive cues makes it difficult to rule out whether the effects are specific to alcohol images, or whether any appetitive cue would also narrow attention for impulsive, heavy drinkers individuals.

Additionally, research should examine how other indicators of impulsivity interact with drinking status to influence attentional responses to alcohol cues. For example, some behavioral measures of impulsivity (e.g., delay discounting tasks) are similarly associated with substance use but are not necessarily highly correlated with self-reports of impulsivity (e.g., Krishnan-Sarin et al. 2007; Reynolds et al. 2004). Assessing these other measures will help test whether differences between self-report and behavioral measures, as well as different dimensions of impulsivity (e.g., Reynolds et al. 2008), influence the constriction of attentional scope in this context.

Despite these limitations, these findings suggest that impulsive individuals demonstrate heightened approach-motivated cognitive processing styles when incentive relevant (and perhaps familiar) stimuli are present in the environment. Although many questions remained unanswered, the current results suggest that this narrowed attentional focus may serve a role in the maintenance of alcohol use and misuse for impulsive individuals.

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Table 1.
Mean Reaction Times, in Milliseconds, Transformed Logarithmically

	Global Trials	Local Trials
Alcohol Cues	2.90 (.106)	2.92 (.112)
Neutral Cues	2.91 (.107)	2.92 (.114)

Note. Standard deviations for each mean are provided in parentheses. Supporting evidence of a global attentional bias, participants were faster to respond to the global trials compared to the local trials (p's $< .001$). No other comparisons were significant.

Figure 1. Attentional narrowing following alcohol cue exposure as a function of monthly alcohol use and trait impulsivity. Panel A reflects responses times to global stimulus trials minus local stimulus trials following alcohol cue exposure. Panel B reflects responses times to global stimulus trials following alcohol cues minus global stimulus trials following neutral cues. Predicted values are plotted at ± 1 SD from the means of impulsivity and alcohol use.

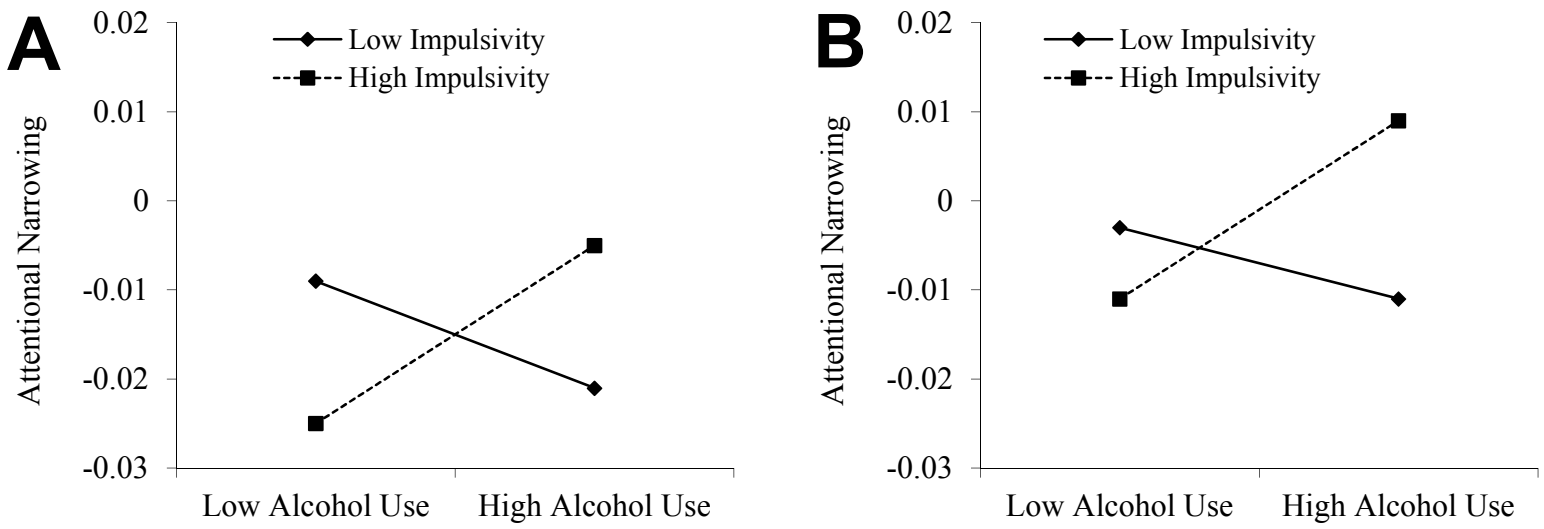

Figure 2. Stimuli for global and local responses.