

Emotional and Behavioral Consequences of Alcohol-Impaired Cognitive Processing

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ABSTRACT

Affect disruption is pivotal to many theories of alcohol use, yet the mechanisms by which alcohol alters emotional response are poorly understood. In the case of threatening stimuli, there are indications that alcohol may attenuate fear by compromising cognitive processes necessary for appraisal of fear cues (Lang, Patrick, & Stritzke, 1999). This experiment further advanced understanding about alcohol effects on fear by providing concurrent measurement of fear reactivity and fear cue processing in complex contexts demanding simultaneous attention to competing stimuli.

Participants received either alcohol (0.08g/100 ml) or no alcohol. They then viewed words from two semantic categories: animals and body parts. Words from one category (CUE+) were followed by electric shocks, whereas no shocks followed words from the other category (CUE-). Words were presented in blocks of 20. Blocks were either "Shock Only" (participants simply attended to the words) or "Task & Shock" (word cues were colored either red or green, with the color serving as the discriminative stimulus for a speeded Go/Stop task). Fear-potentiated startle (FPS) to acoustic probes delivered after cue onset was used to assess fear. P3 and CNV provided online indices of fear cue and task processing respectively. Task performance was also measured.

FPS was observed to CUE+ words, with the magnitude of the effect varying by beverage and task conditions, such that the greatest reduction in fear occurred in intoxicated participants during divided attention (Task & Shock blocks). This diminished fear reactivity was accompanied by a reduction in fear cue processing as indexed by P3 and lesser RT interference on GO trials involving CUE+ words.

These results suggest that alcohol interfered with cognitive functions necessary for processing of fear stimuli in a complex context requiring attention to multiple cues. Coincident RT effects point to behavioral consequences deriving from this cognitive-emotional effect.

MULTILEVEL MODEL OF ALCOHOL EFFECTS ON EMOTION

- Emotional states involve activation of "action dispositions" that prepare an organism to act.
 - Emotional response represents activation of two subcortical primary motivation systems: Appetitive and aversive motivation systems.
 - Reciprocal connections exist between these subcortical primary motivation systems and higher level cortical structures.
 - Alcohol does not directly affect emotion at the level of these primary motivation systems but instead influences emotional response by its impact on higher level cortical structures.
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SPECIFIC AIMS

- Examine effects of acute alcohol intoxication on fear response to threat cues presented in two distinct conditions: Simple focused attention vs. Divided attention conditions.
 - Replicate results from Curtin et al., (1998), demonstrating a selective effect of alcohol on fear response, specific to conditions requiring complex cognitive processes such as the division of attentional resources.
 - Provide online measurement of task and threat cue processing concurrent with fear response across beverage and cognitive load conditions. Such data will allow the examination of possible differential alcohol effects on competing stimuli in conditions of divided attention, and an initial assessment of possible cognitive mediation of the alcohol-fear response relationship.
 - Examine behavioral consequences of alcohol-induced attenuation of fear response.
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METHODOLOGY

Participants

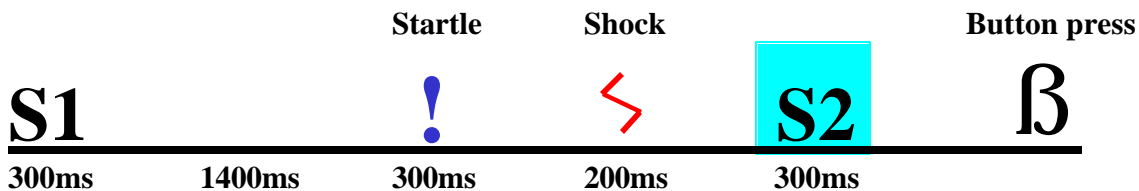
- 48 social drinkers (24 male/24 female) assigned to 2 beverage groups
- Alcohol (peak blood alcohol level of 0.080 g/100 ml)
 - No-Alcohol

Description of Paradigm

32 blocks of trials (see figure below)

- 8 "Shock Only" blocks: Cues (S1) were from 2 word categories (CUE+ and CUE-). CUE+ trials could result in shock administration. Cue color was constant.
- 8 "Task Only" blocks: Cues (S1) were presented in 2 colors (Green/GO and red/STOP). GO trials required a motor response to S2. Word category was constant.
- 16 "Task & Shock" blocks: Cue word category and color varied simultaneously. Task processing was prioritized.

Trial Structure



S1

- Shock Only: **Animal** or **Body-part**
 - Task Only: **XXXXX** or **XXXXX**
 - Task & Shock: **Animal/Body-part** or **Animal/Body-part**
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DEPENDENT MEASURES

- ❖ **Overall Cognitive Speed/Flexibility**: A Digit Symbol test was administered pre- and post-beverage manipulation to assess possible global deficits in cognitive speed and flexibility resulting from alcohol intoxication.

 - ❖ **Fear Response**: Fear potentiated startle indexed fear response to threat cues in Shock Only and Task & Shock blocks. Fear potentiated startle was calculated as the difference in startle reflex magnitude to auditory probes presented after CUE+ vs. CUE- word cues.

 - ❖ **Task Processing**: CNV differentiation in the S1-S2 interval indexed attentional resource allocation to task processing. CNV differentiation was calculated as the difference in the CNV component of the event related potential waveform to GO vs. STOP trials.

 - ❖ **Threat Cue Processing**: P3 differentiation indexed attentional resource allocation to threat cue processing. P3 differentiation was calculated as the difference in the P3 component of the event related potential waveform to CUE+ vs. CUE- word cues.

 - ❖ **Task Performance**: Reaction time to CUE+ and CUE- GO trials in Task & Shock blocks was assessed to examine alcohol intoxication effects on "shock interference" (a slowing in RT on CUE+ relative to CUE- GO trials).
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HYPOTHESES

Fear Response

Differential alcohol effects on fear potentiated startle (FPS) across attentional load conditions

- Reduced FPS in alcohol group in divided attention (Task & Shock) blocks
- No beverage group effect on FPS in simple focused attention (Shock Only) blocks

Task Processing

Main effect of attentional load on CNV differentiation

- Reduced task processing in divided attention condition vs. simple focused attention
- As task processing was prioritized for participants, the attentional load effect is not expected to interact with beverage group (i.e., alcohol is not predicted to affect processing of stimuli which are the direct focus of attention)

Threat Cue Processing

Differential alcohol effects on P3 differentiation across attentional load conditions

- Reduced processing of threat cues in divided attention (Task & shock) blocks
- No beverage group effect on threat cue processing in simple focused attention (Shock Only) blocks

Task Performance

Differential "shock interference" effects across beverage groups

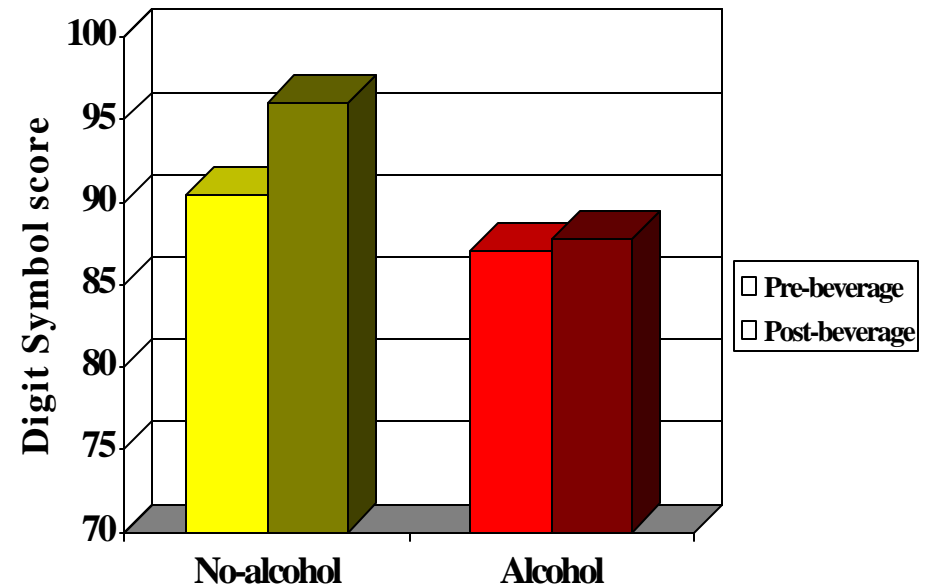
- Reduced interference of shock on task performance in Task & Shock block for alcohol group
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RESULTS

Individual Differences

Measure	No-Alcohol	Alcohol
Age (years)	23.5 (3.9)	22.4 (2.0)
Drinks/week	8.8 (10.7)	8.4 (7.6)
SMAST scores	0.8 (1.0)	1.2 (1.4)
Fear Survey	2.0 (0.4)	2.0 (0.6)
Trait Anxiety	30.4 (6.2)	28.6 (6.9)
Shock Aversiveness	3.3 (0.8)	3.2 (0.8)
Task Prioritization	3.4 (0.8)	3.3 (1.0)

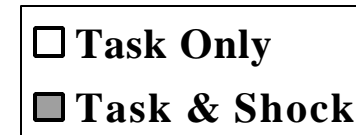
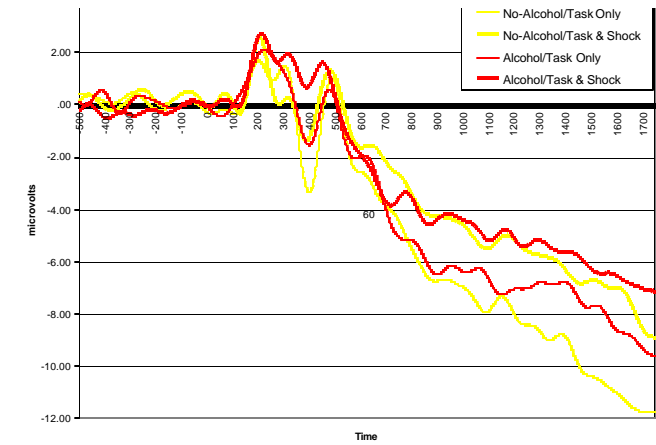
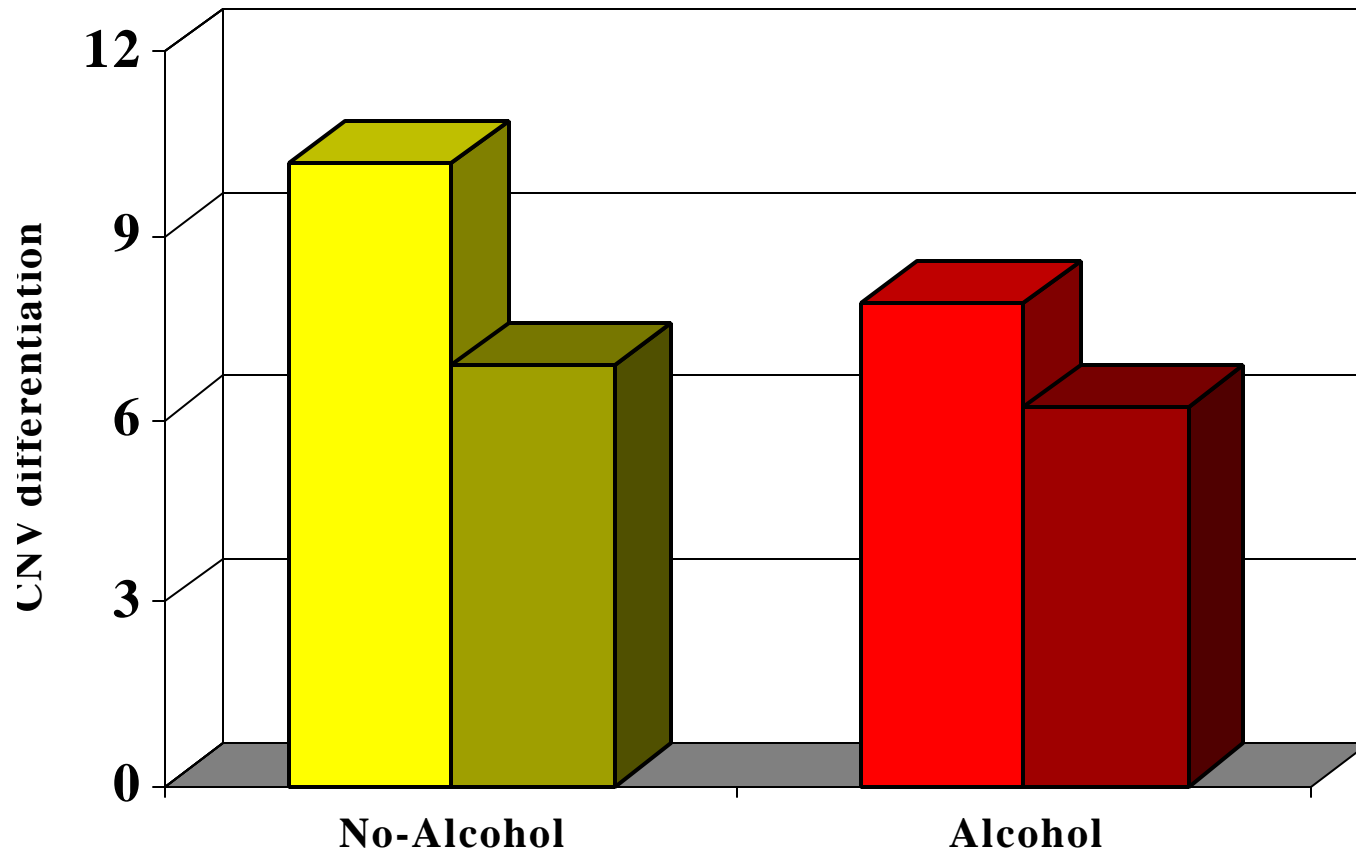
Cognitive Speed/Flexibility



No significant beverage group differences were observed for demographics, drinking history and problems, trait fearfulness/anxiety, and ratings of shock aversiveness and task prioritization.

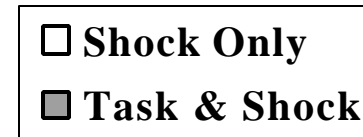
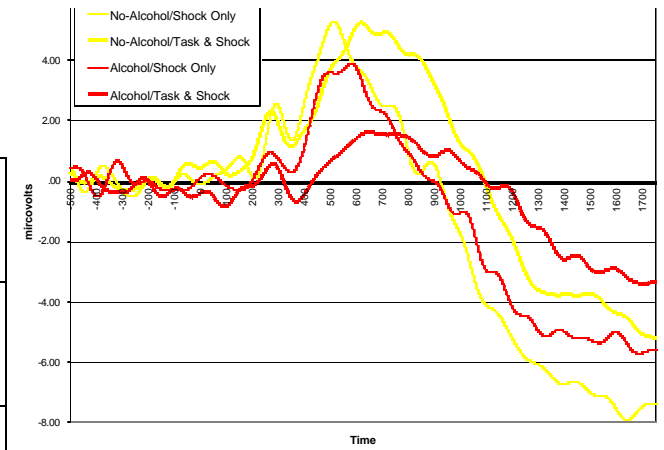
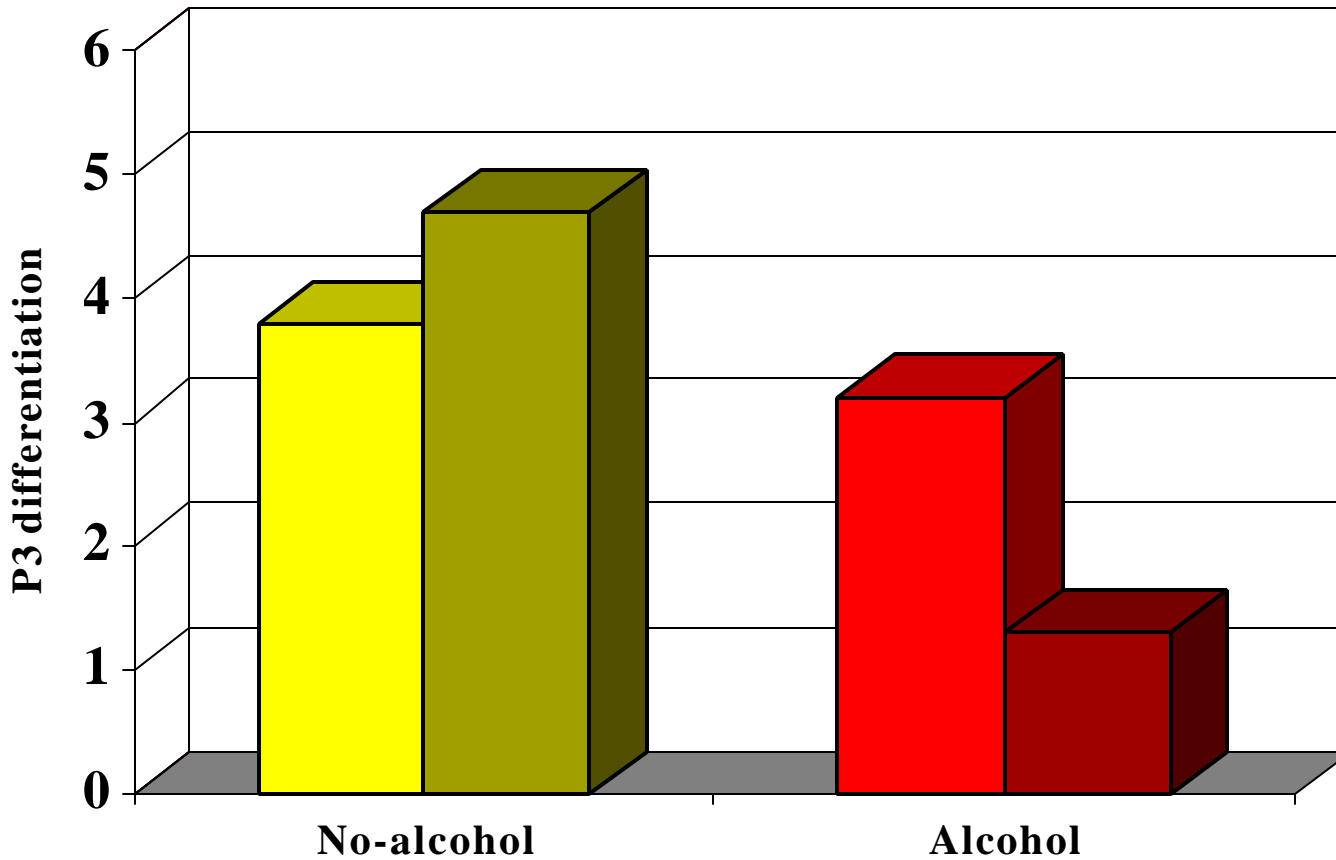
A significant Beverage X Time interaction was observed, $F(1,39) = 4.29$, $p = .045$. Beverage groups were not different at pretest. However, intoxicated participants exhibited significantly lower Digit Symbol scores post-beverage administration, $t(41) = 2.14$, $p = .039$, suggesting a reduction in overall cognitive speed and flexibility.

Task Processing



CNV differentiation was analyzed within a Beverage (Alcohol vs. No-alcohol) X Block Type (Task Only vs. Task & Shock) repeated measures ANOVA. A significant main effect of block type was observed with greater CNV differentiation in Task Only vs. Task & Shock blocks, $F(1,44) = 23.73$, $p < .001$. This effect indicates that the integrity of task processing was reduced when division of attentional resources was required. However, this block type effect did not interact with beverage group, suggesting that alcohol intoxication did not exacerbate this divided attention deficit in processing of prioritized task-related cues.

Threat Cue Processing



P3 differentiation was analyzed within a Beverage (Alcohol vs. No-alcohol) X Block Type (Shock Only vs. Task & Shock) repeated measures ANOVA. In contrast to CNV results, a significant Beverage X Block Type interaction was observed for P3 differentiation, $F(1,44) = 5.15$, $p = .028$. Simple effect tests revealed no beverage group differences in P3 during Shock Only blocks. In contrast, P3 was significantly lower for intoxicated participants in divided attention Task & Shock blocks, $t(46) = 3.55$, $p = .001$. In addition, within beverage simple effect tests indicated that the reduction in P3 differentiation in Task & Shock vs. Shock Only among intoxicated participants was also significant, $t(23) = 2.94$, $p = .007$.

Integration of CNV and P3 results indicates that alcohol had a differential impact on task-related vs. threat cue processing. Alcohol intoxication did not degrade processing of the prioritized task-related cues. However, processing of more peripheral threat cue information was particularly sensitive to alcohol effects in conditions of divided attention.

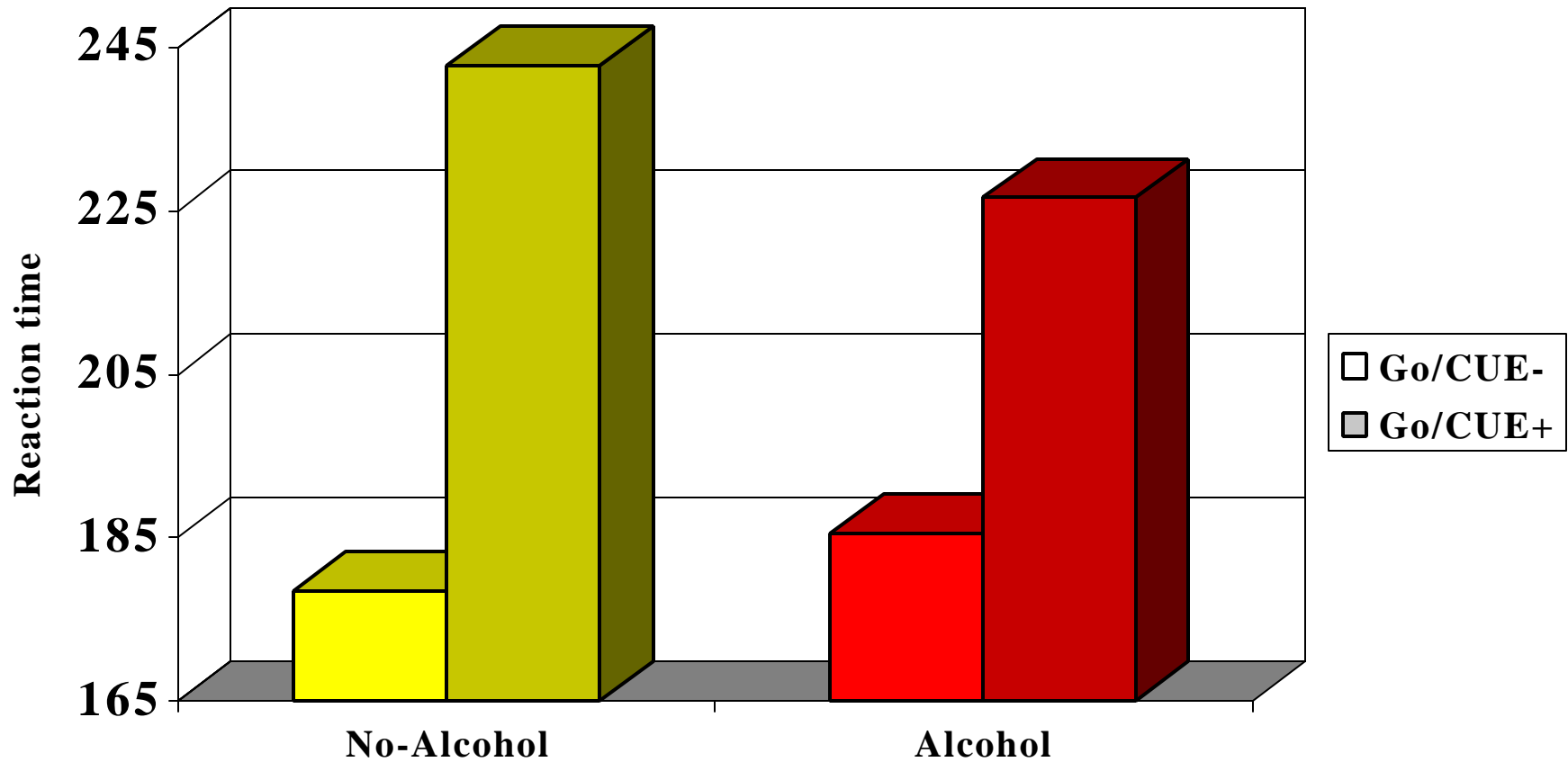
Fear Response



Fear potentiated startle (FPS) was analyzed within a Beverage (Alcohol vs. No-alcohol) X Block Type (Shock Only vs. Task & Shock) repeated measures ANOVA. The pattern of results for fear potentiated startle (FPS) mirrored deficits in threat cue processing indexed by P3 differentiation (see previous figure). A significant Beverage X Block Type interaction was observed for FPS, $F(1,44) = 8.88$, $p = .005$. Simple effect tests revealed no beverage group differences in FPS during Shock Only blocks. However, FPS was significantly reduced among intoxicated participants in the divided attention Task & Shock blocks, $t(46) = 2.36$, $p = .023$. In addition, within beverage simple effect tests indicated that the reduction in FPS in Task & Shock vs. Shock Only among intoxicated participants was also significant, $t(23) = 2.07$, $p = .050$.

FPS results indicate that alcohol selectively reduced fear response only when participants were required to divide attention between competing stimuli. Reference to P3 results reveals that comparable selective deficits in threat cue processing in divided attention conditions co-occurred with this reduction in fear response.

Task Performance



Reaction time in Task & Shock blocks was analyzed in a Beverage (Alcohol vs. No-alcohol) X Cue Type (CUE+ vs. CUE-) repeated measures ANOVA. As expected, a significant main effect of cue type, $F(1,44) = 93.80$, $p < .001$, demonstrated that participants did experience shock interference on task performance with RTs significantly longer on CUE+ trials than on CUE- trials. However, more interestingly, beverage group significantly interacted with this cue type effect, $F(1,44) = 4.61$, $p = .037$, indicating that the "shock interference effect" (i.e., cue type effect) was greater in the no-alcohol group than in the alcohol group.

CONCLUSIONS

- **Alcohol intoxication produced a global deficit in cognitive speed/flexibility.**
 - **In divided attention conditions, alcohol-induced global deficits in cognitive processing resulted in impaired processing of peripheral threat cues. In contrast, alcohol intoxication did not negatively impact processing of "prioritized" task-related cues.**
 - **Intoxicated participants exhibited a selective deficit in fear response to threat cues only when required to divide attentional resources between these threat cues and processing of competing task-related information. This deficit in fear response co-occurred with impairment in threat cue processing, strongly suggesting cognitive mediation of this alcohol effect on fear.**
 - **Alcohol intoxication reduced the impact of "shock interference" on task performance. Specifically, intoxicated participants exhibited less reaction time slowing in conditions of shock threat than did sober participants, suggesting that intoxication facilitated task performance in this stressful environment.**
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FUTURE DIRECTIONS

- **Parametric study of stimulus processing competition when intoxicated (e.g., Stroop paradigm)**
 - **Examination of the nature of intoxicated processing deficits (e.g., "all or nothing" vs. consistent deficit)**
 - **Investigation of neural sites of alcohol effects (e.g., subliminal processing paradigm, fMRI)**
 - **Exploration of moderating role of individual differences**
 - **Application of analogous models to the examination of other intoxicated behavior and other psychopathology**
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