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Research Report

Centrally-mediated sensory information processing is impacted with increased alcohol consumption in college-aged individuals

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ABSTRACT

Alcohol consumption can have an impact on a variety of centrally-mediated functions of the nervous system, and some aspects of sensory perception can be altered as a result of long-term alcohol use. In order to assess the potential impact of alcohol intake on sensory information processing, metrics of sensory perception (simple and choice reaction time; static and dynamic threshold detection; amplitude discrimination with and without pre-exposure to conditioning stimulation) were tested in college-aged subjects (18 to 26 years of age) across a broad range of levels of alcohol consumption. The analysis indicated no detectable associations between reaction time and threshold measures with alcohol consumption. However, measures of adaptation to short duration (0.5 s) conditioning stimuli were significantly associated with alcohol consumption: the impact of a confounding conditioning stimulus on amplitude discriminative capacity was comparable to values reported in previous studies on healthy controls (28.9 ± 8.6) for light drinkers while the same adaptation metric for heavy drinkers (consuming greater than 60 drinks per month) was significantly reduced (8.9 ± 7.1). The results suggest that while some of the sensory perceptual metrics which are normally impacted in chronic alcoholism (e.g., reaction time and threshold detection) were relatively insensitive to change with increased alcohol consumption in young non-alcoholic individuals, other metrics, which are influenced predominantly by centrally-mediated mechanisms, demonstrate a deviation from normative values with increased consumption. Results of this study suggest that higher levels of alcohol consumption may be associated with alterations in centrally-mediated neural mechanisms in this age group.

Abbreviations: 2AFC, two-alternative forced-choice; AD, amplitude discrimination; AUDIT-C, alcohol use disorders identification test (consumption); DL, difference limen; DPM, drinks per month; GABA, γ-aminobutyric acid; NMDA, *N*-methyl-D-aspartate; RAPI, Rutgers alcohol problem index; RT, reaction time; SSA, single-site adaptation; TLFB, timeline follow back

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1. Introduction

Previously, we reported that the ability of an individual to perceive the difference between two simultaneously-delivered vibratory stimuli to the skin can be impacted significantly by relatively brief (0.2 to 2 s) periods of pre-exposure to conditioning stimuli (Folger et al., 2008; Francisco et al., 2011; Tannan et al., 2006, 2007, 2008; Tommerdahl et al., 2007a, 2007b, 2010a; Zhang et al., 2008, 2009, 2011a, 2011b). The measure that we currently use to describe the impact that conditioning stimuli have on some aspect of sensory discriminative capacity – but most often amplitude discriminative capacity – is the *adaptation metric*, a value which has been demonstrated to be relatively constant across a large age spectrum of healthy controls (Zhang et al., 2011b). However, the adaptation metric for a number of neurological conditions has been demonstrated to be reduced or below normative values. Observations from a number of studies have demonstrated substantial decreases in adaptation metrics: subjects with autism (Francisco et al., 2011; Tannan et al., 2008; Tommerdahl et al., 2007a), mild NMDA receptor block (Folger et al., 2008), a number of types of chronic pain (Tommerdahl et al., 2010b; Zhang et al., 2011a), and concussion (Tommerdahl et al., 2010b). These findings suggest that the method could be viewed as a potential indicator or marker of systemic cortical alterations, as adaptation, at this short duration time scale, is impacted by a number of factors. In particular, these factors include GABA and NMDA receptor-mediated neurotransmission, and neuron–glial interactions (for discussion, see (Folger et al., 2008; Francisco et al., 2008; Tannan et al., 2007, 2008; Tommerdahl et al., 2007a, 2010a, b; Zhang et al., 2009, 2011a, 2011b). A central theme of these observations – discussed in each of the aforementioned reports – is that the adaptation metric, at these relatively short durations (for review of dynamic mechanisms involved, see Tommerdahl et al., 2010a), is impacted by alterations that are predominantly centrally-mediated.

A number of studies have demonstrated that alcohol use can lead to peripheral sensory impairment and/or altered central processing of sensory information. Sensory assessments of individuals with alcoholism, in particular assessments of vibration thresholds, thermal sensitivities, and pain tests, have provided useful metrics in detecting and describing alcoholic peripheral neuropathy (Hilz et al., 1994, 1995; Jochum et al., 2010; Sosenko et al., 1991; Yarnitsky and Zaslansky, 1998). Additionally, impairment in central neural mechanisms in individuals with alcohol use disorders has been implicated by studies describing abnormal inhibition of sensory gating; reports have demonstrated that thalamocortical feed-forward interactions modulate sensory information processing (Wang et al., 2010), as well as disinhibition of sensory evoked potential recovery patterns (Marco et al., 2005; Mochizuki et al., 2004). These previous evaluations provided rationale for analyzing sensory percepts of college students, a population with high prevalence of moderate to heavy binge drinking (Grant et al., 2004; Wechsler et al., 2002; Wechsler and Nelson, 2001). Moderate-to-heavy alcohol consumption in this age group has been shown to impair a variety of centrally-mediated functions of the nervous system inclusive of, but not limited to, spatial memory judgment and decision-making, mood and behavior, motor performance, learning, executive functioning, and rate of information processing (Courtney and Polich, 2009). Taken together, the above-described studies would suggest that a centrally-mediated metric of sensory information processing, such as the adaptation metric, may be significantly impacted by heavy alcohol use by college-aged students.

In this study, standard screening methods of alcohol consumption were paired with metrics of sensory perception in order to assess potential sensory information processing changes in college-aged individuals who consumed alcohol on a regular basis. The results of the study suggested that, although some of the sensory perceptual metrics (in particular, reaction times and detection thresholds) were relatively insensitive to change with increased alcohol consumption, adaptation metrics were significantly lower in the group of subjects who consumed higher quantities of alcohol.

2. Results

2.1. *Increased alcohol consumption does not have an impact on reaction time or threshold measures in 18–26 year olds.*

As Fig. 1 illustrates, both simple and choice reaction times demonstrated little variation across the range of alcohol consumption. The mean simple reaction times (247.6 ± 12.3 ms) across all levels of consumption were consistently faster than choice reaction times (405.9 ± 11.6 ms) ($n=87$; $*p \ll 0.01$).

Static and dynamic detection threshold assessments were also independent of consumption as shown in Fig. 2. The mean dynamic thresholds (10.0 ± 0.5 μm; $n=84$) were consistently higher than those of static thresholds (16.2 ± 0.5 μm; $n=87$) across all quantities of consumption ($*p \ll 0.01$).

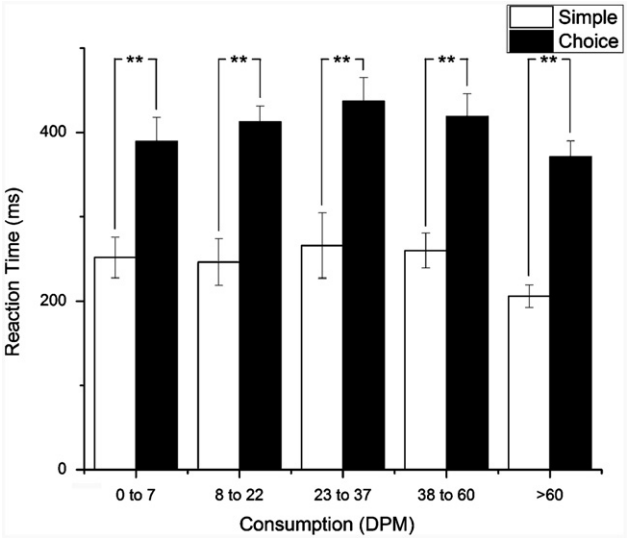

Fig. 1 – Impact of alcohol consumption on simple and choice reaction times. The reaction times (ms) are not affected over increases in alcohol consumption reported as drinks per month ($n=87$; $**p \ll 0.05$).