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Cognitive manifestations of drinking–smoking associations: Preliminary findings with a cross-primed Stroop task

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ABSTRACT

Background: Despite tremendous growth in research examining the role of cognitive bias in addictive behaviors, scant consideration has been paid to the close association between smoking and drinking behavior. This study sought to determine whether an association between smoking and drinking could be observed at an implicit level using a novel cognitive bias task, as well as characterize the relationship between performance on this task and clinically relevant variables (i.e., heaviness of use/dependence).
Methods: Individuals ($N = 51$) with a range of smoking and drinking patterns completed a modified Stroop task in which participants identified the color of drinking, smoking and neutral words that were each preceded by drinking, smoking or neutral picture primes. Participants also provided information regarding the heaviness of their smoking and drinking behavior and completed self-report measures of alcohol and nicotine dependence.
Results: Response times to smoking and drinking words were significantly slowed following the presentation of either smoking or drinking picture primes. This effect did not differ across subgroups. However, the strength of the coupling between smoking and drinking prime effects was greater among heavier drinkers, who also exhibited a concordant looser coupling of the effects of smoking and drinking primes on smoking words.
Conclusions: Associations between smoking and drinking can be observed at an implicit level and may be strongest for heavier drinkers.

1. Introduction

There exists a close linkage between alcohol and tobacco use across numerous levels of analysis (Funk et al., 2006; McKee and Weinberger, 2013). Research exploring the factors responsible for this association have identified many potential candidates, including shared genetic risk and neural circuitry (Connor et al., 2007; Li et al., 2007), common experiences and personality traits (Elliott et al., 2014; Jackson et al., 2002; VanderVeen et al., 2013), as well as the impact of combined alcohol and nicotine on mood, cognition and substance use motivation (Braun et al., 2012; Oliver et al., 2013; Ralevski et al., 2012). Once a pattern of dual alcohol and nicotine use is established, associative conditioning processes may contribute to its maintenance (Drobes, 2002). Notably, these factors do not necessarily represent competing explanations. Indeed, each likely plays a contributing role in driving the association between alcohol and tobacco use, as do a number of other factors that have yet to be discovered.

Although research supports the presence of cognitive associations between alcohol and tobacco use among dual users (Monti et al., 1995), there has been comparatively little research in this area. This is particularly surprising given the increasing attention being given to information processing biases in recent theoretical accounts of addiction (Franken, 2003; McCusker, 2001; Ryan, 2002). A central component of these theories is the notion that repeated exposure to drugs of abuse increases their salience, resulting in cognitive systems prioritizing the processing of drug-related stimuli over alternatives (Berridge and Aldridge, 2008; Robinson and Berridge, 2008). Extensive efforts have been undertaken to understand this cognitive processing bias in both alcohol and nicotine dependence (Bradley et al., 2004; Ehrman et al., 2002; Field et al., 2013; Munafò et al., 2003; Townshend and Duka, 2001). These biases appear to have relationships with numerous other constructs relevant to addictive behavior, including craving (Field

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et al., 2009) and impulsivity (Coskunpinar and Cyders, 2013). It has also been suggested the relationship between attentional bias and craving may be mutually excitatory (Franken, 2003). That is, attentional bias may enhance craving by drawing attention to drug cues in the environment that would otherwise pass unnoticed and/or delaying attentional disengagement from drug cues once established. In turn, this enhanced craving may increase attentional bias (Smeets et al., 2009). Furthermore, attentional bias may promote the cognitive elaborations that have been both theoretically and empirically linked to drug use (Kavanagh et al., 2005; May et al., 2014). Indeed, attentional bias has also been shown to predict treatment outcome in both alcohol and nicotine dependence (Cox et al., 2002; Powell et al., 2010; Waters et al., 2003b). Accordingly, interventions designed to directly modify attentional bias have been developed and some have shown promise for helping to promote abstinence (e.g., McGeary et al., 2014; Schoenmakers et al., 2010).

A variety of laboratory tasks have been modified in order to study cognitive biases in drug-cue processing, including visual probe (Ehrman et al., 2002), flicker change blindness (Jones et al., 2003), N-back (Evans et al., 2011), visual search (Oliver and Drobes, 2012) and attentional blink paradigms (Chanon et al., 2010). Perhaps the most widely used task has been the addiction Stroop task (Cox et al., 2006). This task is a modified version of the classic Stroop paradigm (Stroop, 1935), in which individuals must identify the color of both addiction-relevant words and words derived from a "neutral" control category, with the assumption that slower responses to addiction relevant words is due to unintended processing of substance-related information (i.e., an inability to ignore the semantic content of the word). Its utility for measuring cognitive processes relevant to addiction is well-established (Field and Cox, 2008) and it appears to carry psychometric advantages over other measures (Ataya et al., 2012).

Examinations of cognitive biases to multiple types of drugs within the same study have been rare, but are necessary to fully understand the nature and specificity of drug-related cognitive biases (McCarthy and Thompsen, 2006). Similarly, there is evidence suggesting patterns of cognitive bias may differ among dual users (e.g., Cohn et al., 2014), but studies rarely report on the presence of co-occurring addictions. The present study sought to build on the attentional bias literature by explicitly seeking to examine cognitive associations between drinking and smoking through further modification of an addiction Stroop task. The modified version included both smoking and drinking words, as well as words from a neutral category. In addition, each word was preceded by a drinking, smoking or neutral image designed to activate cognitive schema relevant to that substance and potentially cause further delay in response time due to increased processing of salient words (i.e., a priming effect). The use of primes for this purpose has been studied extensively within traditional, affective and addiction Stroop tasks (Kramer and Goldman, 2003; Segal and Gemar, 1997; Stewart et al., 2002). The inclusion of both alcohol and smoking primes and target words enables examination of implicit associations between alcohol and tobacco. We hypothesized that relative to neutral primes, drinking and smoking primes would slow response times on both same-drug (i.e., drinking prime/drinking word and smoking prime/smoking word) and cross-drug (i.e., drinking prime/smoking word and smoking prime/drinking word) trials, but would not impact response time to neutral word trials. We also conducted a number of exploratory analyses aimed at determining: (1) whether effects differed as a function of substance dependence or usage patterns, (2) the correlation between the effects of same-drug and cross-drug primes, and (3) whether this correlation differed as a function of substance dependence or usage patterns.

2. Methods

2.1. Participants

Individuals ($N = 51$) who were current users of both alcohol and cigarettes were recruited from the local community as part of a larger study designed to examine the combined effects of alcohol, nicotine and cues on motivation to smoke and drink. The present sample includes only those individuals who completed a modified addiction Stroop task (described below) as part of their baseline session for the study. At the time of scheduling, participants had to report consuming between 1 and 50 drinks per week and smoking at least one cigarette on four or more days per week. All participants were between the ages of 21 and 55, had been smoking regularly for the past two years with a stable smoking pattern in the most recent year, were not actively attempting to quit smoking, and were not regular users of alternative tobacco products.

2.2. Procedures

The session began with informed consent procedures, followed by breath alcohol (BrAC) and carbon monoxide level (CO) readings. BrAC was required to be zero for participation. As light/non-daily smokers were eligible for inclusion, there were no requirements imposed regarding CO level. Next, participants provided a urine specimen that was subjected to a toxicology screen (required to be negative for all drugs except marijuana), cotinine test (required to be >0) and pregnancy test (females only; required to be negative). A brief medical exam was conducted, including a blood draw for liver enzyme analysis. As the primary study included laboratory sessions involving alcohol administration, participants whose liver enzymes were outside normal limits were excluded from further participation. Similarly, a brief psychological diagnostic interview to assess for current depressive episodes, manic episodes, panic disorder, psychosis, alcohol dependence and drug dependence (SCID-I; First et al., 2012) was conducted and participants who met criteria for any disorder besides alcohol dependence were excluded. Lastly, participants completed a brief interview to assess their recent alcohol use, as well as a battery of self-report measures and computer tasks. Additional details on measures/tasks relevant to the present study are provided below.

2.3. Self-report and interview measures

Single-item questions were used to assess basic demographic information (e.g. age, race, income). A single item asked participants to identify their preferred type of alcohol beverage (beer, liquor, wine) for purposes of tailoring the images and words used in the Stroop task (see below). An abbreviated medical history was also obtained to confirm the absence of exclusionary medical conditions. A detailed smoking history (e.g., cigarettes per day, age at initiation) was obtained; including a brief self-report of nicotine dependence—the Fagerström Test for Nicotine Dependence (FTND; Heatherton et al., 1991). Alcohol dependence was assessed using the full 25-item version of the Alcohol Dependence Scale (ADS; Skinner and Allen, 1982) but was scored according to the reduced 9-item version developed for community samples (Kahler et al., 2003). In this latter scoring method, 9 items from the original ADS are recoded into binary (yes/no) outcomes and then summed, resulting in a 0–9 scale in which higher numbers reflect greater alcohol dependence. The internal consistencies of both the FTND and the 9-item ADS were in the acceptable range (α's = 0.72–0.74). Additional details regarding participants' recent drinking behavior was collected via a Timeline Followback interview (TLFB; Sobell and Sobell, 1995) that assessed alcohol use over the previous 30 days, though drinking statistics were computed based on only the