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Combined Alcohol and Energy Drink Use: Hedonistic Motives, Adenosine, and Alcohol Dependence

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Abstract

Consumption of alcohol mixed with energy drinks (AmED) has been associated with both short and long-term risks beyond those observed with alcohol alone. AmED use has been associated with heavy episodic (binge) drinking, risky behaviors, and risk of alcohol dependence. Laboratory research has demonstrated that AmED beverages lead to greater motivation to drink versus the same amount of alcohol consumed alone. However, the reason consumers find AmED beverages particularly appealing has been unclear. A recent report by Droste and colleagues (2014) is the first study to investigate motivations related to AmED consumption and to determine which motives predict AmED consumption patterns, experience of drinking-related harms, and risk of alcohol dependence. The findings of this study significantly enhance our understanding of why AmED consumption is related to the risk of alcohol dependence and change our understanding of why consumers chose AmED beverages. The authors report that hedonistic motives strongly predicted AmED use and the harms associated with use. While intoxication-reduction motives predicted self-reported accidents and injuries, these motives did not predict AmED consumption patterns and risk of dependence. The risk of alcohol dependence may arise from repeated experiences when drinking alcohol is more pleasurable when energy drinks are consumed with the alcohol. This commentary will focus on why energy drinks might increase the rewarding properties of alcohol in social drinkers. In addition, discussion is provided explaining why more research on the neurotransmitter, adenosine, may actually inform us about the mechanisms contributing to the development of alcohol dependence.

Keywords

Alcohol; Dependence; Energy Drinks; Caffeine; Adenosine

A recent report by Droste and colleagues (2014) examined the motivations related to alcohol mixed with energy drinks (AmED) consumption. The investigators wished to determine which motives predicted AmED consumption patterns, experience of harms, and risk for alcohol dependence. Despite widespread global use of AmED beverages, the motives for use by consumers remained poorly understood until this study. Using a large Australian sample, the results of an anonymous survey were used to examine how hedonistic, social, energy/endurance, and intoxication-reduction motives related to AmED use and its associated

problems. The results present an interesting, and somewhat unexpected, pattern of data. Hedonistic (i.e., pleasure-seeking) motives for AmED use significantly predicted a variety of drinking-related harms including increases in AmED consumption, risk for alcohol dependence, and experiencing harm. Participants reported that they were motivated to choose AmED because they perceived that drinking alcohol was a more pleasurable experience when energy drinks were consumed with the alcohol. Further, the authors found that intoxication-reduction motives (i.e., drinking AmED to reduce perceptions of drunkenness) only significantly predicted actual self-reported harm from accidents or injuries. In simple terms, consumers are primarily motivated to choose AmED beverages because they make drinking more pleasurable. This motivation is associated with greater drinking in the short-term and alcohol dependence in the long-term. If consumers are motivated to choose AmED to reduce feelings of intoxication, they are likely to experience an accident or injury since energy drinks do not alter blood alcohol concentrations.

Before this study, many researchers might have thought that intoxication-reduction motives were the primary reason for choice of AmED beverage and the underlying reason why so many problems are associated with AmED use. Droste and colleagues' findings suggest many new directions for scientists to address, which will not only inform us about issues related to AmED use, but also potentially inform the field about the mechanisms that underlie the development of alcohol dependence problems in general.

To place this study in context, the use of high-caffeine energy drinks as a mixer for alcohol has been a recent global phenomenon, particularly in underage and young adult drinkers. Until November 2010 in the U.S., alcoholic beverages were available premixed with energy drinks. The risks of AmED use were first noticed in the U.S. when these premixed beverages were on the market. An increased number of highly intoxicated underage and young adult AmED drinkers were admitted to emergency rooms, prompting concerns about these products. After the available scientific data was reviewed, the U.S. Food and Drug Administration (FDA) determined that caffeine was an unsafe food additive when combined with alcohol (U.S. FDA, 2010). This determination was based in part on laboratory observations that consumption of AmED (or alcohol with caffeine) resulted in lower perceived intoxication and other altered subjective responses to alcohol such as heightened perceived stimulation when compared to alcohol alone (Ferreira et al., 2006; Marczinski & Fillmore, 2006). These subjective changes occurred even though caffeine or energy drinks do not alter objective blood alcohol levels.

Even though prepackaged AmED are no longer available in the U.S., they are available in other countries. Moreover, the popularity of combining energy drinks with alcohol has continued to increase as consumers and bartenders mix their own AmED. These drinks tend to be most appealing to underage and young adult drinkers. In the U.S., the Monitoring the Future (MTF) Survey examines licit and illicit drug use in high school students, college students, and young adults using a nationally-representative sample. Data from the 2012 MTF survey revealed that approximately 26% of 12th graders, 34% of college students, and 37% of young adults (ages 19-28) reported consuming at least one AmED during the past year (Johnston et al., 2013a,b). Hazards associated with AmED use continue to be observed

in the U.S. as emergency department visits and calls to poison control centers related to AmED consumption continue to rise (SAMHSA, 2014; Seifert et al., 2013).

As the problems with AmED become evident, research that has examined if, and why, AmED might be more risky than alcohol alone continues to be of widespread interest. The weight of the scientific evidence to date reveals that AmED use has been associated with greater risks of heavy episodic (binge) drinking, risky behaviors (including risky sexual behavior and driving while under the influence), and risk of alcohol dependence, when compared to alcohol consumption alone (for a review, see Marczinski & Fillmore, in press). Interestingly, a substantial proportion of published studies emphasize that the harms and hazards associated with AmED (when compared to alcohol alone) occur because consumers feel less intoxicated when drinking AmED. Droste and colleagues did find that intoxication-reduction motives significantly predicted actual self-reported harm outcomes. They also found that hedonistic motives for using AmED underlie most heavy drinking and other problems that have been observed to be associated with AmED use in the literature. Their results suggest that the use of AmED lead to both short and long term problems because the use of AmED is more pleasurable than the use of alcohol alone.

Two recent laboratory-based studies have demonstrated that energy drinks (or caffeine) increase the reinforcing properties of alcohol (Heinz et al., 2013; Marczinski et al., 2013). Participants given a small dose of AmED (or alcohol) report a subsequent desire to drink more alcohol (i.e., alcohol priming). However, the desire to drink alcohol persists for a longer period of time when AmED is consumed when compared with the same dose of alcohol. These laboratory observations coincide with Droste and colleagues' findings that consumers are motivated to consume AmED beverages to increase pleasure from drinking. If the experience of drinking alcohol is more rewarding and enjoyable when combined with energy drinks, the consumer is likely to drink more alcohol. The fact that AmED beverages are more rewarding and/or reinforcing than alcohol alone is not surprising when one considers what is known about caffeine, the primary psychoactive stimulant drug found in energy drinks. Caffeine is known to increase the preference and consumption of nonalcoholic beverages (Temple et al., 2012). It is consistent to observe that adding caffeine-containing energy drinks to alcohol increases the preference and consumption of that alcohol. It should be noted that the assertion that AmED leads to greater desire to drink when compared to alcohol alone is controversial. It has been argued that the caffeine doses involved are low and should not increase the reinforcing properties of alcohol, among other concerns, prompting calls for replication (Griffin, 2013; Peacock & Bruno, 2013; Verster et al., 2013). Droste and colleagues' results provide another piece of evidence suggesting that AmED are more rewarding to consumers than alcohol alone.

The reason why AmED are more rewarding than alcohol alone remains to be elucidated. However, enhanced stimulation and/or reduced sedation are commonly observed outcomes in laboratory studies that have compared subjective state for AmED to alcohol alone (Marczinski et al., 2011, 2012; Peacock et al., 2013). Drug-induced stimulation is a desired outcome of psychoactive drug use, and drug-induced stimulation is associated with rewarding effects (Newlin & Thomson, 1999). Thus, the risks of drinking alcohol may be

higher with consumption of AmED when compared to alcohol alone because the perceived stimulation is enhanced with an energy drink mixer.

The sedative effects of alcohol which typically are experienced later in a drinking episode when blood alcohol is declining are regulated by increases in the neurotransmitter adenosine. When alcohol is consumed, alcohol blocks the reuptake of adenosine, which leads to an elevation in adenosine activity. Caffeine is an adenosine antagonist drug. Caffeine is most effective when adenosine activity is high and the individual is feeling very sedated or sleepy. As such, there is a direction central nervous system interaction between the caffeine in energy drinks and the adenosine activity resulting from alcohol consumption (for a review, see Marczinski & Fillmore, in press).

Energy drinks may alter the effects of alcohol through changes to adenosine. In addition, both alcohol and caffeine alter dopamine activity. Activation of adenosine receptors (particularly the A2A receptors) inhibits dopamine transmission. Given that elevated dopamine activity underlies a reinforcing property of alcohol, increased adenosine activity that occurs with alcohol consumption will inhibit dopamine activity, thus keeping drinking within a safer range. At a practical level, sleepiness in an alcohol consumer can be an important outcome because it may limit the continued consumption of alcohol. Caffeine with alcohol antagonizes adenosine receptors, preventing adenosine levels from rising. Thus, dopamine levels during drinking episodes should increase when caffeine is on board thus increasing the reward experienced from the alcohol and contribute to the continued consumption of alcohol (for a review, see Marczinski & Fillmore, in press).

Dysregulation of adenosine activity has recently been implicated in alcohol use disorders. Individuals dependent on alcohol have a substantial history of drinking, which means many episodes where alcohol is consumed resulting in increased adenosine activity. Over time, tolerance to these alcohol-induced increases in adenosine activity will develop as the body learns to compensate for those changes. Upon detoxification, it is common for individuals to experience disrupted sleep in part because the adenosine system is not functioning normally (Nam et al., 2012). Not all consumers of AmED will become dependent on alcohol. However, at the neurotransmitter level, it remains to be determined if repeated suppression of adenosine action or the resulting increases in dopamine activity (or both) following many episodes of consuming AmED would increase the likelihood that dependence will occur.

In sum, the findings of Droste and colleagues reveal that hedonistic motivations play the most important role in why consumers choose AmED beverages. Consumers of AmED are more likely to be dependent on alcohol. These outcomes suggest that adenosine dysregulation may play an important role in the development of alcohol use disorders. Could medications be developed that enhance adenosine activity and keep drinking in a safer range? At this time, the literature on AmED and Droste and colleagues' recent findings would suggest that the role of adenosine during drinking warrants closer examination as we endeavor to better understand the underlying mechanisms that contribute to the development of alcohol dependence.

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