Alcohol and Energy Drinks: Motivations, Drinking Behaviours and Associated Risks

by

Kristina Brache
M.Sc., University of Victoria, 2009

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ABSTRACT

Introduction: Consuming alcohol mixed with energy drinks (AmED) has become a growing and popular trend among young adults worldwide. Although there have been some mixed findings, generally AmED use is associated with heavy drinking, risky behaviours and more negative outcomes, compared to alcohol use alone. Little research has been done outside of college samples and few researchers have investigated motivations for consuming AmED. **Purpose:** The purpose of the current research was to expand on previous research by investigating motivations for AmED use and the associations between AmED use and heavy drinking, alcohol use disorders, risky behaviours, and negative outcomes in community samples, while controlling for potentially important third variables, like sensation seeking. **Methods:** Using multivariate regression analyses the associations between AmED use and other variables were investigated in a randomly selected Canadian sample (n = 13,615) and a Canadian community young adult sample (n = 456). As well, an in-depth qualitative investigation of university students' (n = 465) reported motivations for AmED and energy drink use was investigated using content analysis. **Results:** Compared to alcohol only, AmED use was found to be associated with heavy alcohol use, increased risk for alcohol use disorders, and increased risky behaviours and negative consequences (e.g., being a passenger in a vehicle with a drunk driver; drinking and driving; being involved in physical aggression; having harmful effects on relationships, health, employment) in both the Canadian and community samples. More frequent AmED use (e.g., weekly or more) was associated with ever having had a sexually transmitted infection. These relationships

remained significant even after controlling for demographic variables and sensation seeking personality in the Canadian community sample. The most commonly reported motivations for AmED use were due to the taste of the beverage, enjoyment of a particular AmED (e.g., Jagerbomb), for increased stimulation (e.g., wakefulness, energy, alertness) while drinking, to facilitate "partying" or staying out late when drinking, to counteract the depressant effects of alcohol, for social purposes, and because of ease of availability (e.g., purchased by others/ given for free). **Conclusions:** This research has contributed to a better understanding of the relationships between AmED use and personality traits, drinking behaviours, and risk behaviours in two relatively large community samples. It has contributed to a better understanding of the motivations for AmED use and how these motivations may be related to heavy drinking and risky behaviours. Taken together, this research indicates that there may be something about AmED use which puts people at an increased risk of drinking heavily, engaging in risky behaviours, and experiencing harms, compared to alcohol use alone. Along with the accumulating research in this area, the current research could be valuable for directing and planning future research studies which are designed to investigate causative relationships and for formulating effective policies and intervention programs.

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Introduction

In recent years the consumption of energy drinks has become popular for young adults in North America and internationally (Heckman, Sherry, & Gonzalez de Mejia, 2010). Energy drinks are caffeinated beverages that are designed to provide a burst of energy and/or enhance alertness. The principle stimulant ingredient in energy drinks is caffeine, although they may or may not include high doses of sugar (or a sugar substitute), and they generally include B vitamins, an amino acid (e.g. taurine or l-carnitine), and plant/herbal extracts (e.g. ginseng, milk thistle, ginko biloba). Energy drinks come in different sizes and have varying amounts of caffeine and other ingredients. Notably, energy drinks do not seem to be a transient trend in the beverage market. The popularity of this type of beverage is evident by their impressive growth of more than 240% in the US from 2004-2009 (Heckman et al., 2010). The US energy drink industry was expected to more than double and reach $19.7 billion in 2013 (Heckman et al., 2010). This is an expected 160% increase from 2008, which speaks to the enormity of this industry. Within the energy drink industry it appears that there are a few energy drink brands which hold the majority of the market share. Red Bull holds the highest market share (42.6%), followed by Monster (14.4%), Rockstar (11.4%), Full Throttle (6.9%), and Amp (3.6%) (Heckman et al., 2010). Overall, the energy drink industry is extremely profitable, is anticipated to continue expanding, and generally targets adolescents and young adults as a means to increase consumption.

Adolescents and young adults represent the majority of energy drink consumers and appear to be the target population for marketing (Heckman et al., 2010). The increased popularity of energy drinks among adolescents and young adults is not

surprising given the aggressive and questionable marketing strategies to this population (Heckman et al., 2010; Jones, 2011; Jones & Barrie, 2009; Simon & Mosher, 2007). Along with the increased consumption of these beverages, reports have been made linking energy drink use with high risk drinking behaviour, other risky behaviours, harmful physical outcomes (resulting in emergency room visits), group hospitalizations, and even deaths (Brache, Thomas, & Stockwell, 2012; O'Brien et al., 2008; Pennay, Lubman, & Miller, 2011; Siegel, 2011; Simon & Mosher, 2007; Substance Abuse and Mental Health Services Administration, 2011; Woolsey, 2010). Health risks associated with energy drinks include an increased heart rate, irregular heart rate and palpitations, increased blood pressure, sleep disturbances, dieresis, and hyperglycemia (Tropy & Livingston, 2013). Consequently, it is an opportune time to conduct more health and safety research on energy drink use and associated behaviours.

It appears that as energy drinks have grown in popularity, so has the consumption of alcohol mixed with energy drinks (AmED) (Brache, Thomas, & Stockwell, 2012; O'Brien et al., 2008; Simon & Mosher, 2007). Marketing by energy drink companies that promotes mixing alcohol and energy drinks appears to target young drinkers, conveying that caffeine will offset the sedating effects of alcohol and enhance alertness (Howland et al., 2010). The combined use of alcohol and energy drinks can come in the form of hand-mixed varieties, where a drinker or bartender will manually mix alcohol with an energy drink. For example, these beverages come in the form of Red Bull mixed with vodka or a "Jägerbomb," which is a cocktail that is mixed by dropping a shot of Jägermeister into a glass of Red Bull. Capitalizing on the popularity of combining alcohol with energy drinks, companies have created beverages that are alcoholic energy drinks which are pre-

mixed beverages (e.g. Rockstar with vodka). These beverages are packaged and marketed similarly to energy drinks and can often be mistaken for non-alcoholic versions (Simon & Mosher, 2007). Research from a university student survey indicates that the consumption of the hand mixed variety is more common than the pre-mixed versions (Brache & Stockwell, 2010).

The consumption of AmED has continued despite warning labels on energy drinks to not consume with alcohol, media reports of adverse outcomes, and government warnings about the risks associated with combined consumption (Attwood, 2012; Health Canada, 2005; Seetharaman, 2009; U.S. Food and Drug Administration, 2010). It is reported that Health Canada experts have called for specific research into the health and safety implications of AmED use (Schmidt, 2011). Over the past few years researchers have begun to investigate some of the health and safety implications of AmED use, but large gaps remain in our knowledge of AmED health and safety and there exists plenty of disagreement among researchers regarding the conclusions of the current data. After several group hospitalizations following the consumption of a pre-mixed alcoholic energy drink (Four-Loko), the American Food and Drug Administration announced that caffeine is considered an "unsafe food additive" to alcoholic beverages and effectively made "premixed" alcoholic energy drinks prohibited for sale in the US (Arria & O'Brien, 2011; Siegel, 2011). Unfortunately, premixed alcoholic energy drinks consumption reflect a small minority of the AmED use, which is primarily hand mixed (Berger, Fendrich, & Fuhrmann, 2013).

The research which has been conducted to date (summarized below) indicates that there is likely cause for concern, showing evidence of negative health and safety

implications with AmED use. Nevertheless, more work is needed in this area to address methodological limitations and expand the investigation of health and safety implications. Research on this type of beverage consumption is now crucial as the use of AmED is increasing sharply and policy changes and regulations to the energy drink industry are being considered (Brache, Thomas, & Stockwell, 2012; Howland et al., 2010; Schmidt, 2011). Additionally, further research in this area is particularly important as alcohol is one of the leading causes of death, and disability among young Canadians (Lea et al., 2009).

Literature Review

As AmED use has increased, research investigating energy drink use and AmED use has quickly grown. Since the proposal of the current research, many studies have been published on AmED use, adding greatly to the body of knowledge on AmED use and associated variables. A few important factors have influenced the growth of this literature. Most importantly energy drink companies, such as Red Bull, have provided financial support to some researchers who have conducted their own research on AmED use and critically reviewed other published research in this area (e.g., Verster, Alford, & Scholey, 2013). Their research has been successfully published in peer reviewed journals. Several researchers have responded to their reviews (e.g., Marczinski & Fillmore, 2013) and provided their own take on how these industry-funded researchers may be shaping the research field (Miller, 2013b). For example, industry-funded researchers have been allegedly influencing the dissemination of research on AmED through their industry-funded attendance at alcohol and drug conferences (Miller, 2013b). Additionally, those receiving samples from Red Bull GmbH may need to have their investigative designs

approved by Red Bull prior to receiving samples, which further blurs the definition of independent, non-industry funded or influenced research (Miller, 2013b).

In addition to the critical review research in this area has received from industry funded researchers, other scientific researchers have also relatively frequently critically reviewed other non-industry research in frequent "letters to the editor" and published commentaries (Marczinski, 2011b; Rossheim, Suzuki & Thombs, 2013). Consequently, even after published peer review, research on AmED use is receiving ample attention and critique from all sides. This has resulted in a very active and quickly growing body of research on AmED use. It has also resulted in many published reviews of the relatively smaller body of empirical research on AmED use. Due to all of this critique, and different reviews of the same evidence, multiple conclusions have been drawn and published regarding AmED use and associated variables such as drinking behaviours, risk for alcohol use disorders, risky behaviours, and negative consequences. Consequently, it is difficult to draw firm conclusions due to the differing opinions, conflicts of interest, and limitations in the current literature.

Below is a review of the relevant literature to date on AmED use and associated drinking behaviours, risk behaviours, alcohol-related consequence, laboratory investigations, and motivations for use. In the review I will clearly identify when discussing research literature which has been funded by the energy drink industry and literature which has been heavily criticized or questioned by other research colleagues. AmED use also appears to be common drinking behaviour on college campuses (Brache & Stockwell, 2011; O'Brien et al., 2008; Snipes and Benotsch, 2013). Consequently, it is important to note when reading the literature that the majority of available published

literature on AmED use has primarily focused on college samples, mainly from convenience samples using survey methodology.

For the literature review below a comprehensive literature search was conducted using the search terms of "energy drinks" and "alcohol," "energy drinks mixed with alcohol," "alcoholic energy drinks," and "caffeinated alcoholic beverages." Summon 2.0, a fast, powerful, and comprehensive search engine, was used to search the University of Victoria's library collections. It searches through the University of Victoria's collection of books, scholarly journals, newspaper articles, e-books, dissertations, and manuscript collections. Rather than searching in separate databases, Summon 2.0 provides a single unified search box to search databases. Some frequently used databases searched by Summon 2.0 as part of the literature review include Web of Science, Academic Search Complete, JSTOR, Science Direct, PsychINFO and Social Sciences Index. Abstracts of search results were screened for investigations into the use of AmED. Results from investigations of AmED use are summarized below.

Prevalence.

Research with U.S. college students indicates that about 24% of current drinkers had consumed AmED in the past 30 days (O'Brien et al., 2008). Miller (2008a) found that 26% of university students reported past 30 day AmED consumption. Snipes and Benotsch (2013) found that 19% of their undergraduate sample consumed AmED monthly and that 30% of those who drank alcohol consumed AmED. In a sample of US psychology undergraduate students Marczinski (2011a) found that 44% reported ever trying AmED and 9.3% reported using AmED in the past two weeks. Other research with U.S. college students found a lower prevalence of use, where 14.9% of students reported

consuming energy drinks mixed with alcohol in the past month (Velazquez et al., 2012). This lower prevalence rate, compared to other college samples, may be partly due to the student population sampled. Students were first year college students with an average age (18.7 years), well under the legal drinking age of 21. Additionally, a smaller proportion of the students surveyed reported consuming alcohol in the past month (46.7%) compared to other college surveys on AmED use (e.g., 68% in O'Brien et al., 2008; 88% in Brache & Stockwell, 2011), thereby making them less likely to have combined alcohol and energy drinks in the past month.

Thombs et al. (2010; 2011) conducted two alcohol field studies where patrons in a U.S. college bar district were interviewed leaving the bar. They found that 6.5% of participants in the first study, and 4.7% in the second study, had consumed AmED in the prior 12-hour period.

Research on college populations outside the US has found similar past month AmED use. Research at a western Canadian university found that 26% of current drinkers had consumed AmED in the past 30 days (Brache & Stockwell, 2011). Researchers at an eastern Canadian university surveyed 72 students who were past-month energy drink users (Price et al., 2010). They reported a lifetime prevalence of 76% for AmED use, with 19% consuming AmED in the past week. Twenty two percent of participants reported using alcohol during their most recent use of energy drinks. International research with Italian university students has reported a somewhat higher prevalence of 48.4% who have reported using AmED in the past month (Oteri et al., 2007). Other research with university students from Turkey found that 37.2% of students who had ever used energy drinks, reported that they had consumed AmED (Attila & Cakir, 2011). A

national survey of Brazilian college students found that 25.6% of students surveyed consumed AmED in the past year (Eckschmidt et al, 2013).

Some research has been conducted on a nationally representative sample of 36,155 Canadian high school students (Azagba, Langille, & Asbridge, 2013). Approximately 20% of participants reported using AmED in the past year. They found that the prevalence was the highest among those in higher grades and those who were older, "Aboriginal (33.8%) and black (25%)" students, and those residing in British Columbia (25.8%) and Nova Scotia (25.6%). They found that students who currently smoke, were involved in past year heavy drinking, past year marijuana use, were absent from school, participated in school team sports, and had $40 or more weekly spending money, were more likely to consume AmED in the past year. Students who felt more connected to school and who had an academic average of 70% or higher were less likely to consume AmED.

One study has investigated AmED use in a US community sample (Berger et al., 2011). They found that 6% of respondents were past-year AmED users. Past year AmED users were more likely to be White, young adults (18-29 years old), single, and have higher household incomes ($60,000+), compared to past year energy drink users only. Importantly, this study is among the first that has expanded beyond college students and examined energy drink use in a broader population. Unfortunately, they did not compare AmED users to alcohol only drinkers.

Another study which has investigated a community sample was conducted by Peacock, Bruno, and Martin (2013) in an Australian community sample. A total of 1,336 were recruited for the survey via media reports, social networking, and notices at local

venues. After excluding data from participants for various reasons their final sample consisted of 963 Australians ages 18-35. Of the final sample, 42% reported consuming (a) alcohol and energy drinks in the same drinking session in the preceding 6 months, and (b) typically consuming the two constituents simultaneously rather than successively. It is interesting that the authors have specified that the beverages must have been mixed simultaneously as the effects of alcohol or energy drinks consumed successively in a drinking occasions could be argued to have similar physical and potential psychological effects to simultaneous consumption. Interpretation of their prevalence data is also difficult due to an exclusion of those who withdrew prior to completion (n = 224), where no analyses appeared to be conducted in order to determine whether those who withdrew differed on AmED use and related variables compared to those who completed the study. The sample was generally young adults (mean age = 23.1) who were well-educated and had a high employment rate. Their demographics were not compared to the demographics of the typical Australian young adults. The majority of the sample reported consuming AmED relatively infrequently with three quarters reporting that less than half of all drinking sessions involved AmED use and one quarter stated that at least half of all drinking sessions involved AmED use. Participants reported consuming approximately 2.4 standard energy drinks in a typical AmED session and 7.0 standard alcoholic drinks. The majority of their sample (83%) reported using Red Bull as their energy drink brand for mixing with alcohol.

One study has also investigated AmED use in a national survey of the Taiwan working population (n=22,085) (Cheng et al., 2012). They found that approximately 5.3% of those aged 25-35 consumed AmED on a regular basis (defined as more than once

a week). Certain occupational groups reported relatively high prevalence of regular AmED use, such as skilled manual workers (17%) and movers, packers, and laborers (17.8%).

The use of energy drinks in general, as well as in the form of AmED, has been identified using survey methodology as being more frequent in men, in athletes, in younger adults, and in White students (Levy and Tapsell, 2007; Miller, 2008a; Miller, 2008b; O'Brien et al., 2008; Velazquez et al., 2012). Despite this, several studies have not found a gender difference in AmED consumption among college students and high school students (Azagba, Langille, & Asbridge, 2013; Brache & Stockwell, 2012; Snipes et al., 2014; Snipes and Benotsch, 2013). Using field-based data focusing on a range of New York nightlife scenes, it was found that men, younger individuals, Latinos, and sexual minorities had a higher prevalence of recent energy drink use (Wells et al., 2013). They found that younger individuals, men, and those recruited in gay venues reported a higher prevalence of AmED use.

Generally, investigations into the prevalence of AmED use have largely focused on college samples. More investigations into AmED use in community samples and in different regions will aid in understanding regional patterns of use and may be informative for future policy considerations.

Drinking Patterns.

Research on AmED has consistently found that college students who use AmED tend to consume more alcohol and consume alcohol more often, compared to students who consume alcohol alone (Brache & Stockwell, 2011; Eckschmidt et al, 2013; O'Brien et al., 2008; Price et al., 2010; Thombs et al., 2010; Woolsey, Waigandt, & Beck, 2010).

This has generally been the case when comparing drinking behaviour across groups (those who combine vs. those who only consume alcohol) and within the individual (drinking occasions that involve AmED use vs. those that do not). One exception to these findings was identified by Woosley and colleagues, (2010) where they found that AmED users drank more alcohol than those who used only alcohol, but, within the individual, combined users reported drinking less alcohol when mixing with energy drinks compared to their use of alcohol alone. Unfortunately, the authors did not address the potential reasons for this finding, particularly as it is contrary to previous research. Further research is needed using within subject comparisons for drinking behaviours when using AmED or alcohol alone.

Importantly, research has indicated that the association between AmED use and increased alcohol use remains significant after controlling for intrinsic risk taking tendency (Brache & Stockwell, 2011), a variable that is considered important as a potential causal third variable (Howland et al., 2011). Correspondingly, researchers have estimated that Red Bull has increased alcohol sales by 20% in pubs and clubs in Britain (as cited in Kuhns, Clodfelter, & Bersot, 2010).

There is also evidence for increased consumption of energy drinks, when energy drinks are used in combination with alcohol. For example Malinaukas et al. (2007) found that the majority of energy drink users in their sample reported consuming one energy drink in most situations, whereas it was common to drink more energy drinks when consuming with alcohol while drinking socially. In a social drinking situation 49% of energy drink users reported consuming three or more energy drinks with alcohol. Woolsey, Waigandt, and Beck (2010) also found that students who consumed AmED

consumed energy drinks more often and in greater amounts when using alcohol. When combining, 61% of their sample consumed 3 or more energy drinks. When not using alcohol, 32% of their AmED sample reported consuming 3 or more energy drinks. Consequently, it appears that the amount of caffeine ingested when consuming AmED is higher than when energy drinks are consumed alone, and it is beyond what is recommended as daily intake levels (Health Canada, 2005).

Woolsey (2010) investigated gender differences in AmED users' drinking behaviour. He found that men consumed higher amounts of alcohol when consuming alcohol alone and when using AmED, compared to females. He also found that men consumed more energy drinks when consuming energy drinks alone and when consuming AmED, compared to females.

Given the association between AmED use and increased alcohol consumption, of interest is the potential for this group to experience higher levels of alcohol use disorders (Woolsey, 2010). Researchers investigating the relationship between energy drink consumption and alcohol use in college students have found that past month and past week energy drink consumption were significantly associated with alcohol use, heavy drinking, and increased likelihood of AmED use (Velazquez et al., 2012). They also found that greater energy drink consumption was significantly associated with a higher quantity of alcohol consumed during a single event. Other researchers investigating energy drink consumption and alcohol dependence in college students have found that higher frequency energy drink users were at a significantly greater risk for alcohol dependence, relative to non-users or low frequency energy drink users (Arria et al., 2011). This investigation received a variety of criticisms from Skeen and Glenn (2011)

regarding the lack of evidence to imply that energy drinks "cause" alcohol dependence, the self-report nature of the data, contradictory statistical associations, group division, response rate, and jumping to conclusions. It was not indicated whether Skeen and Glenn (2011) were researchers funded by the energy drink industry. Arria (2011) responded to these criticisms in a letter to the editor clarifying response rate, arguing that self-report data is considered widespread and acceptable in substance use research, and addressing statistical and methodological concerns. Arria (2011) particularly focused on the accusation of "extensively manipulating data" reporting that they aimed to identify categorization that would have practical relevance to energy drink users for low and high-frequency users. They provided a distribution of energy drink use in their sample. In post-hoc analyses responding to the criticisms they found that regardless of the method of deriving a cut-off, using the raw frequency, or using the logged frequency, they continued to observe a statistically significant association between energy drink use and alcohol dependence, even when holding constant demographics, alcohol consumption, and other covariates from the original model.

Several more recent publications have replicated Arria et al.'s (2011) findings. Researchers investigating energy drink use in an Alaskan college population found that greater energy drink use was significantly associated with greater hazardous drinking (as measured by the Alcohol Use Disorder Identification Test), alcohol consequences, and alcohol dependence symptoms (Skewes, Decou, & Gonzalez, 2013). A limitation to this research is that they failed to investigate AmED use, and its association with heavy alcohol use and dependence, which may be important given the altered drinking behaviour in groups that simultaneously combine alcohol and energy drinks. Several

other researchers have investigated the association between AmED and alcohol use disorders. In Brazilian college students, researchers have found that AmED users had higher risks of developing alcohol dependence compared to alcohol only users as measured by the ASSIST-WHO (Eckschmidt et al, 2013). A US community survey found that past year AmED users were more likely to be hazardous drinkers, as measured by a score of 4 or higher on the AUDIT-C scale (which assesses past year frequency and quantity of alcohol use in standard drink units) (Berger et al, 2011). Importantly, their analyses did not appear to take into account other potentially confounding variables or full criteria for alcohol use disorders. In a Taiwan working population male workers who consumed AmED on a weekly basis were at a higher risk for alcohol abuse as measured by a score of two or more on the CAGE, compared to those who did not use any energy drinks (Cheng et al., 2012).

Taken together, there appears to be a need for more research on the associations between AmED use and alcohol use disorders, where an alcohol only group is used as a comparison group. There is a need to use more comprehensive measures for alcohol use disorders, rather than simple screeners that do not assess several alcohol use disorder variables. Additionally, these relationships should be investigated in community samples in order to understand what type of impact this may be having on the population as a whole, outside of college campuses.

Risk behaviours and alcohol-related consequences.

Not only do college students who mix alcohol and energy drinks appear to be consuming more alcohol and energy drinks, the majority of research indicates that they also have a significantly higher prevalence of alcohol-related consequences. For example

O'Brien and colleagues (2008) found that AmED users, compared to alcohol only users, had higher odds of being taken advantage of, or taking advantage of another student, sexually; riding in an automobile with a driver under the influence of alcohol; being hurt or injured; and requiring medical treatment, after adjusting for the amount of alcohol consumed (O'Brien et al., 2008). This adjustment is important given AmED users reported higher alcohol use. Spierer, Blanding, and Santella (2014) found that in a U.S. college sample more frequent energy drink consumption (three times or more per week) was significantly related to drinking alcohol to intoxication and driving, and riding with a drunk driver, engaging in "extreme sports," and taking anabolic steroids, compared to less frequent energy drink consumers. They did not find energy drink consumption to be related to sports-related risks, tobacco use, illegal drug use, engaging in unprotected sex, or use of prescription drugs. In a national survey of Brazilian college students, AmED users were found to be at increased odds of being involved in high-risk traffic behaviours (e.g., driving without a seatbelt, driving at high speeds, drinking and driving, driving after binge drinking, riding with an intoxicated driver, and being involved in a traffic accident where someone was hurt) when compared to alcohol only users (Eckschmidt et al, 2013). After controlling for demographic variables and drinking variables (e.g., frequency of alcohol use; amount of alcohol consumed in a typical drinking occasion in the past 12 months; involvement in binge drinking; engagement in "hazardous use of alcohol" according to the ASSIST-WHO score), the odds that AmED users drove at high speeds and drove after binge drinking was almost 3 times the corresponding odds for alcohol only users.

Snipes and Benotsch (2013) found that participants reporting AmED use were significantly more likely to report engaging in high-risk sexual behaviours, including unprotected sex, sex while under the influence of drugs, and sex after having too much to drink, even after controlling for demographic factors and other substance use. Other recent research by Snipes and colleagues (2014) investigated gender differences in the association between AmED and risk of sexual victimization among college students (253 men and 545 women). They found that AmED was associated with several forms of sexual victimization among men, and with physically forced sexual victimization among women. After controlling for demographic variables and collapsing all categories of sexual victimization, AmED was only associated with sexual victimization among men.

Woolsey, Waigandt, and Beck (2010) examined differences in reported risk taking and negative consequences when using alcohol only compared to when students consumed AmED. They found that there was an increase in risk taking and negative consequences with AmED use, as measured by student's expectations for particular effects to happen while under the influence. This included an expected increase in likelihood to act aggressively, drive a motor vehicle, feel dizzy, be clumsy, not sleep well, be nervous or jittery, and experience a rapid heartbeat. Woolsey (2010) also investigated gender differences in reported risk taking and negative consequences after AmED use. Overall, males scored higher on risk taking than females for all risk taking variables with significant differences on enjoying sex more, acting more aggressively, likelihood of driving a motor vehicle, and likelihood of fighting. Overall, there were no significant gender differences for reported negative consequences from AmED use, albeit the females consumed considerably less AmED than men.

Berger, Fendrich, and Fuhrmann (2013) investigated AmED use and negative consequences in 606 college students. They found that 75.2% of students engaged in lifetime AmED use and 64.7% engaged in past year AmED use. Past year hazardous drinkers (as determined by scores of 5 or more on the AUDIT-Consumption) were more likely than past year non hazardous drinkers to be past year AmED users. They split the participants into three categories (1) nonhazardous drinkers (34.6%); (2) hazardous drinkers (12.3%), and; (3) hazardous drinkers who also engaged in AmED use (53.1%). These categories appear to be somewhat confusing as they did not identify a category of AmED users who are nonhazardous drinkers. It is unclear but the authors may have grouped non hazardous AmED users in with other nonhazardous drinkers who do not consume AmED. Berger, Fendrich, and Fuhrmann (2013) found that past year hazardous drinkers were significantly more likely than past year nonhazardous drinkers to have driven a car under the influence, been hurt or injured, and had unprotected sex. Past year hazardous drinkers who consumed AmED were significantly more likely than past year hazardous drinkers to have unprotected sex, but not more likely to have driven a car under the influence, been hurt or injured, or experienced unwanted sexual contact. These findings are different than previous research that has found AmED use to be associated with increased risk of driving a car under the influence, and being hurt or injured (Brache and Stockwell, 2009; O'Brien et al., 2008; Thombs et al., 2010). It is possible that the difference in the findings here may be partly due to the way AmED use was measured (e.g., past year use as opposed to past 30 days), which may select a larger group of students who have tried AmED use in the past year but who may not be more frequent users and therefore may be less likely to experience the possible negative consequences

associated with AmED use. This is particularly important as previous research has shown that more frequent AmED users are more likely than less frequent users to experience negative consequences (Brache & Stockwell, 2009). A further limitation could be that the AmED group was not simply compared to alcohol only users (with level of hazardous drinking used as a control variable) and instead they compared hazardous drinkers who had consumed AmED to hazardous drinkers who did not consume AmED use.

Importantly, research by Brache and Stockwell (2011) found that associations between frequency of AmED use, and higher rates of alcohol-related negative consequences (e.g. driving home after drinking, riding home with a driver who had been drinking, being hurt or injured) remained significant after controlling for the individual's propensity to take risks. This suggests that consumption of AmED use may increase risk over and above what would be expect based on a person's general proclivity to engage in risky behaviours.

Using different methodology to investigate the association of AmED use and risk, Thombs et al. (2010) conducted an alcohol field study where patrons in a U.S. college bar district were interviewed, surveyed, and administered a breath alcohol concentration test when leaving the bar. This is one of the only studies to date that has examined event-level connections between AmED use and risky driving behaviour, as opposed to other associational analyses (e.g. O'Brien et al., 2008). Their results revealed that compared to other drinking patrons, patrons who had consumed AmED were at a 3 fold increased risk of leaving a bar highly intoxicated, as well as a 4 fold increased risk of intending to drive.

In a later study they conducted secondary analyses from 2 nighttime field studies that collected anonymous information from 413 randomly selected bar patrons in 2008

and 2010 (Rossheim & Thombs, 2011). They were investigating whether alcohol mixers that contain an artificial sweeteners and caffeine (diet cola) resulted in increased blood alcohol level, potentially due to increased gastric emptying following diet cola consumption. They found that caffeinated alcohol mixers were consumed by 33.9% of patrons and cola caffeinated mixers were more popular than energy drinks. They found that diet cola mixed drinks had a significant association with patron intoxication, after controlling for the number of drinks consumed. They did not find an association with intoxication in those who combined alcohol with regular cola or energy drinks. The authors concluded that caffeine's effect on intoxication may be most pronounced when mixers are artificially sweetened as they lack sucrose which slows gastric emptying of alcohol. They also reported that researchers investigating AmED may be overlooking the risks that have existed in consuming alcohol with caffeinated sodas.

There were a number of important limitations to note in this study which likely affected their conclusions. Importantly, the number of AmED only participants was relatively small compared to the number of other cases. The mean breath alcohol content of the AmED-only group was not significantly different than the diet cola-only group, and caffeine consumption could not be quantified so the data could not be used to estimate the respective influences of sweeteners and caffeine on alcohol intoxication. Perhaps most importantly, the analyses controlled for the number of alcoholic drinks consumed the day of the study. Due to the design of the analysis and the study, it should not be expected that AmED use be associated with greater intoxication after controlling for number of alcoholic drinks, compared to alcohol use alone, because many laboratory studies have found that breath and blood alcohol concentration is not altered after AmED

intake compared to alcohol alone after ingestion of a set amount of alcohol/kg (Alford, Hamilton-Morris, & Verster, 2012; Ferreira et al., 2006; Marczinski et al., 2012; Marczinski et al., 2011; Marczinski and Fillmore, 2006). It is possible that the general associations that have been found between AmED and greater alcohol intoxication is due to changes in drinking patterns rather than increased intoxication due to increased gastric emptying from each beverage. Therefore after controlling for number of beverages consumed one would not expect there to be differences in breath alcohol concentrations between AmED use and alcohol alone. Also of importance, the study did not compare beverages with artificial sweeteners to those that do not contain artificial sweeteners, which may explain why after controlling for number of alcoholic drinks consumed, only the diet cola-caffeinated group was significantly associated with level of intoxication (possibly due to gastric emptying related to artificial sweeteners). Clearly more laboratory research could be used in this area and has been called for to compare gastric emptying time for alcoholic beverages mixed with artificially sweetened vs. sucrose sweetened caffeinated drinks and possible gender differences, particularly as diet-energy drinks and sugar free varieties are now available (Marczinski, 2011a).

Negative physical symptoms.

Presentation to the emergency department after consumption of a specific pre-mixed alcoholic energy drink (Four Loko) was investigated in a case series looking at patients younger than 25 years old presenting to a US emergency department from July to November 2010 (Cleary, Deborah & Hoffman, 2012). This beverage had recently been in the media for being involved in several hospitalizations of groups of young adults after its consumption at different college parties. In its original formulation it was a malt beverage

that contained 12% alcohol and 156 mg of caffeine. Due to governmental warnings, subsequent to the group hospitalizations, caffeine was removed as an ingredient in this beverage in early 2011. Of the 11 identified emergency department admissions, the median age was 16.4 years, where 90.9% were under the legal drinking age. Seven of the admissions were male patients. Four patients were found in high-risk settings (e.g., with an altered mental status on subway tracks), two patients had blood alcohol concentrations greater than 200mg/dL, six patients had emesis, one patient had seizures and another had persistent tachycardia.

Data on the presentation of 2005-2009 drug-related U.S. emergency department visits was collected by the Drug Abuse Warning Network (DAWN) who also investigated energy drinks and AmED admissions (Substance Abuse and Mental Health Services Administration, 2011). They found that between 2005 and 2008-2009 there had been a sharp (tenfold) increase in the number of energy drink related emergency department visits, with the majority of visits made by young adults ages 18-25, followed by those 26-39. Of the visits to the emergency departments, 56% were following the consumption of energy drinks alone, and 44% were involving the combination of energy drinks and other drugs. Sixteen percent of energy drink related emergency department visits involved the administration of AmED. AmED related visits were more likely in those aged 18 to 25 and in males. Of all energy drink-related visits, reasons for the visit included adverse reactions (67%) and misuse or abuse of drugs (34%). Among those who combined energy drinks with other drugs adverse reactions was the reason for 30% of visits and misuse or abuse were reasons for 57% of visits. For energy drink only admissions, 92% related to adverse reactions and 8% related to misuse or abuse.

Of students sampled at a Western Canadian university who reported ever consuming AmED, 46% reported experiencing negative physical symptoms in the past 12 months after combining alcohol and energy drinks (Brache, Thomas, & Stockwell, 2012). Of those who reported negative physical symptoms, the most common symptoms experienced were dehydration (71.6%), a bad hangover (68.8%), and vomiting (34.8%).

Due to previous anecdotal reports that energy drinks in combination with alcohol and exercise could cause sudden cardiac death, Wiklund et al., (2009) investigated the influence of AmED on post-exercise heart rate recovery and heart rate variability in ten healthy volunteers. After baseline screening, they performed four tests with 1-3 months between each test. The four conditions involved the administration of (1) energy drinks (equivalent to 3 cans of Red Bull totaling 3000mg of taurine and 240mg of caffeine), (2) energy drinks mixed with vodka (corresponding to a 0.4 g of ethanol per kg of body weight) and a maximal bicycle ergometer exercise 30min later, (3) energy drinks and a maximal bicycle ergometer exercise 30min later; and, (4) maximal bicycle ergometer exercise after 30 minutes of rest. They found that no subject developed clinically significant arrhythmias, but that post-exercise recovery in heart rate and heart rate variability was slower after subjects consumed AmED before exercise, than after exercise alone. An important limitation to this research is the small sample size and that the authors did not compare AmED to alcohol use alone, as previous research indicates that acute alcohol ingestion can affect heart rate variability (Romanowicz et al., 2011). Overall, the authors concluded that individuals predisposed to arrhythmia could have an increased risk for malignant cardiac arrhythmia in similar situations after AmED use.

Peacock et al., (2014) also investigated self-reported physiological (using the Somatic Symptom Scale) and psychological (using the Profile of Mood States) side-effects of an acute alcohol and energy drink dose. They used a single-blind, placebo-controlled, crossover design, with 28 adults who completed four sessions where they were administered (i) 0.50 g/kg alcohol (ii) 3.57 mL/kg energy drinks, (iii) AmED, and (iv) placebo. They found no interactive alcohol and energy drink effects on psychological outcomes. They found no interactive physiological effects with the exception of a trend for a moderate magnitude decrease in heart palpitation ratings following alcohol, relative to AmED use. As discussed by the authors, the low dose of energy drink and alcohol provided in the study (approximately one standard 250 mL of energy drinks and 3.5 standard alcoholic drinks) is less than what typical Australian consumers report using (2.4 standard 250 mL energy drinks and 7.1 standard alcoholic drinks) during an AmED drinking session. The authors recommend that future research extend into these higher doses to increase ecological validity and to inform guidance at a policy level. Another limitation of the study was that the authors use a target sample size that would be able to detect moderate effect sizes (Cohen's f= .30) as they believed that smaller effect sizes would not have practical meaningful effects. Alternatively, others have found significance for smaller effect sizes (Alford, Hamilton-Morris & Verster, 2012). Similar limitations were present for the study summarized next.

Using the same design as in Peacock et al., (2014), Peacock et al. (2013) investigated the impact of AmED consumption on intoxication (using the Biphasic Effects Scale and a Subjective Effects Scale) and risk-taking behavior (using the Balloon Analogue Risk Task). They found that a moderate alcohol dose (mean BrAC 0.064%) did

not alter risk taking behavior nor did the interaction of AmED. Limitations with regard to their choice of measurements, the dose of alcohol, and the lack impact for alcohol alone on risk taking, likely impacted these results. They found no interactive effects of alcohol and energy drinks for perceived sedation, impairment, mental fatigue, ability to drive, and intoxication. They found that after 30 minutes the AmED condition had significantly higher stimulation ratings than the alcohol only condition. They conclude that their findings support previous research (Attwood et al., 2012; Marczinski et al., 2011, 2012) regarding increased stimulation with AmED. They proposed that energy drinks may enhance alcohol-induced stimulation thereby heightening the reinforcing effect of alcohol and increasing alcohol intake.

In an attempt to understand risk-taking outcomes of AmED consumption relative to alcohol consumption for AmED users Peacock, Bruno, and Martin (2012) surveyed 403 Australians aged 18 to 35 who had consumed AmED and alcohol only in the preceding 6 months. The survey investigated patterns of independent and combined energy drink and alcohol use, motivations for AmED use, many physiological, psychological, and behavioural outcomes of acute alcohol and AmED intoxication, licit and illicit drug use, demographics and trait impulsivity. For physiological and psychological side effects they clustered those reporting “never” and “less than half of the time” to be absent, and “half the time” or more often to be present. They used Comprehensive Meta-Analysis Version 2 to determine the relative likelihood of each outcome during AmED and alcohol sessions, with alcohol sessions functioning as a reference category. They found that the frequency of AmED ingestion (typically monthly or less) occurred less often than independent alcohol (once every two weeks to 3 times

per week) and energy drink ingestion (weekly to monthly). They found that the typical number of standard alcoholic drinks was greater with AmED use than alcohol alone, although it is noted that caution should be exercised in interpretation due to time reference periods. They found that reported risk-taking behavior was higher across all categories of alcohol sessions relative to AmED sessions in the preceding 6 months, where participants had significantly lower odds of engaging in all 26 risk behaviours in AmED sessions relative to alcohol sessions. Interestingly, the authors asked participants to attribute whether their engagement in risk behaviours during AmED sessions was due to consuming energy drinks with alcohol. When not hampered by small sample sizes, less than one-fifth attributed their risk taking behavior to co-ingestion of energy drinks with alcohol. The risk behaviours with the highest attributions of risk taking due to AmED use was for being in a speeding vehicle (22%); being passed out (19%); being physically hurt or injured (17%), drinking more alcohol than planned (16%), acting on a dare and causing harm (16%), and acting in a humiliating manner (16%). They found that after AmED use there were higher odds of experiencing heart palpitations, enduring sleep difficulties, having tremors, general psychomotor agitation, "jolt and crash episodes," and increased speech than after using alcohol only. In AmED use occasions the odds of experiencing nausea, slurred speech, and impairment in walking and vision was significantly less relative to alcohol only sessions. After an AmED session, participants had higher odds of experiencing alertness, energy, stimulation, feeling "on edge," and feeling irritable than alcohol only sessions. After an AmED session participants had lower odds of feeling confused, exhausted, sad, calm, carefree, outgoing, friendly, sociable, and disinhibited than in alcohol only sessions. The authors concluded that

AmED use sessions appeared to be associated with lower odds of sedation effects and higher odds of experiencing stimulatory mood states. They conclude that odds of engaging in all assessed risk behaviours are significantly lower during AmED sessions relative to alcohol sessions.

There are several very important limitations to Peacock, Bruno, and Martin's (2012) research which are key to the conclusions of their study. Rossheim, Suzuki, and Thombs (2013), summarize these limitations in a letter to the editor. They argue that Peacock, Bruno, and Martin's (2012) conclusions and analyses comparing AmED and alcohol only risk behaviours are incorrect as the authors failed to account the relative frequencies of each type of drinking session in their analyses, where AmED sessions were far less frequent than alcohol only drinking sessions. Consequently, there were more opportunities for risk behaviours in alcohol only sessions in the past 6 months, than AmED session. The odds ratios were calculated using just the proportion of individuals who engaged in a risk behavior at least once during an AmED/alcohol-only drinking episode in the past 6 months, which failed to account for frequency of sessions. Consequently, Rossheim, Suzuki, and Thombs (2013) argue that the odds ratios presented cannot be interpreted in the context of a particular drinking session. With their own crude analyses, they provide an example of increased risk behaviours in the AmED use occasion vs. alcohol only, when taking frequency of sessions into account. They also discussed limitations in the quick response time of participants, the validity of respondents' ability to correctly attribute their involvement in risk behaviours, the dichotomization and frequency issues with physiological and psychological outcomes, and issues with recall bias when frequencies of AmED and alcohol sessions are different.

Overall, the healthy critical debate in the literature should help shape the importance that might be put on Peacock, Bruno, and Martin's (2012) findings.

Varvil-Weld and colleagues (2013) have taken a "person-centered approach" in order to prospectively identify college students who may be more likely to experience greater AmED use, heavy episodic drinking, and alcohol-related consequences based on their AmED expectancies, attitudes, and both descriptive and injunctive peer norms. They recruited a random sample of incoming university students (n = 387) who completed measures of AmED use, AmED-specific expectancies, attitudes, and normative beliefs, drinking quantity, and alcohol-related negative consequences on two occasions: spring semester of first year and fall semester of second year in university. Latent profile analyses identified four subgroups of individuals: occasional AmED (53.7%), anti-AmED (30.5%), pro-AmED (5.2%), and strong peer influence (10.6%). Occasional AmED users reported neutral expectancies, attitudes, and injunctive normative beliefs about AmED. Anti-AmED users had highly negative expectancies, attitudes, and injunctive norms. Pro-AmED users had the most positive attitudes and injunctive norms, with neutral expectancies and moderate descriptive norms. The *strong peer influence* group had moderately negative expectancies and attitudes and moderately positive injunctive norms and relatively high perceived descriptive norms. They found that participants in the pro-AmED and *strong peer influence* profiles reported significantly more weekly AmED use than participants in the anti-AmED profile. The associations between profile and AmED use remained significant after controlling for heavy drinking and typical weekly drinking, indicating that AmED may be a high-risk behavior distinct from drinking. They found that the pro-AmED profile was associated with heavier

drinking than participants in the anti-AmED profile. Participants in the occasional and pro-AmED profiles reported significantly more weekly drinks than the anti-AmED profile. Members of the anti-AmED and *strong peer influence* profiles reported significantly fewer consequences than the pro-AmED profile. The association between profile membership and consequences was no longer significant after controlling for heavy drinking, typical weekly drinking, and AmED use.

Overall, Varvil-Weld and colleagues (2013) results indicated that students in profiles characterized by positive expectancies and attitudes for AmED use were at the greatest risk of AmED, heavy episodic drinking, and related consequences. Those who perceived strong AmED-specific normative influences were also more likely to be AmED users, but not necessarily higher alcohol users than lower-risk profiles. Ultimately, Varvil-Weld et al. (2013) conclude that their findings emphasize the complex and interrelated nature of drinking, AmED use, and related risk behaviours. The occurrence of different profiles makes research in this area difficult and likely contributes to the mixed results found in the current literature. Future research looking at how expectancies are related to heavy drinking and AmED drinking habits may benefit from using a more extensive list of expectancies (rather than the 4 item scale used in Varvil-Weld and colleagues' (2013) study, possibly developed from in-depth research on motivations for use.

Recently Patrick and Maggs (2014) published a study which appears to have one of the best within-subjects research designs implemented to date to investigate the associations between AmED use, alcohol behaviours, and negative consequences (e.g., have a hangover, get in trouble) in college students (n = 508). They used a longitudinal

measurement-burst design (14-day bursts of daily surveys in four consecutive college semesters) in order to capture within-person variation across occasions and between-person differences across individuals. They found that 30.5% of the students used energy drinks and alcohol on the same day at least once across sampled days. On days that students used energy drinks, they also used alcohol on 31.6% of days. Using Hierarchical Linear Modelling they found that on days when students consumed energy drinks and alcohol, compared to days when they drank alcohol only, they drank more alcoholic drinks, reached a higher estimated blood alcohol content, had a greater likelihood of subjective intoxication, and experienced more negative consequences of drinking that day. AmED use was also associated with a trend toward more hours spent drinking, than when using alcohol alone. After controlling for the estimated blood alcohol content, AmED use was still associated with a greater number of reported alcohol-related negative consequences, but no longer predicted subjective intoxication, compared to alcohol use alone. They concluded that their findings do not support differences in subjective intoxication after AmED use but that given the increase of alcohol consumption on days with energy drinks their findings may support the process of alcohol priming (i.e. where energy drinks or AmED use may increase motivations to drink more alcohol). Important limitations to this research include the generalizability of the sample, the limited sensitivity of the subjective intoxication measure, the estimation of blood alcohol contents and that they did not collect the time of day of energy drink consumption.

As seen above, much of the research in this area has focused on the association between AmED use, risk behaviours, and alcohol related consequences, with some studies considering the negative physical effects experienced after AmED consumption

(Woolsey, Waigandt, & Beck, 2010). The majority of this research has shown that in college populations AmED use appears to be associated with higher risk-taking behavior, and greater alcohol-related negative consequences and physical symptoms, when compared to alcohol only users. There continues to be some equivocal findings regarding certain risk behaviours (e.g., sexual risk behaviours). There have been mixed findings regarding the association between AmED use and risky behaviours or negative outcomes when comparing AmED use occasions vs. alcohol only use occasions within participants. The differences in findings are likely due to the differences in research methodologies, and differences in frequency of AmED and alcohol only use occasions, which likely affect recall. More recent studies using more appropriate methodologies (e.g., Thombs et al., 2010; Patrick & Maggs, 2014) have found associations between increased risk behaviours and harmful consequences after AmED use occasions. Some have argued that the differences in findings in between vs. within subject comparisons are potentially due to the personality differences between AmED and alcohol only users, where AmED users may experience more harms due to sensations seeking or risk taking personalities which would be influencing findings from between subject comparisons (Verster & Alford, 2011). They argue than in some within-subject designs, which take personality traits into account, AmED use occasions do not appear to be associated with increased risk-taking or negative consequences. Despite this, and as noted above, more methodologically sound within-subject research has also found AmED use to be associated with increased risk-taking and negative consequences compared to alcohol use alone.

It is clear that with the equivocal findings in this area more methodologically sound research needs to be completed which take into account personality variables, such

as sensation seeking. Additionally, investigations into AmED use and associated consequences should be extended beyond college samples. Also, additional research on the association between AmED, risk behaviours, and harms is being called for, particularly with a focus on increased risk for violent offending and victimization (Kuhns, Clodfelter, & Bersot, 2010).

Laboratory investigations.

Some laboratory investigations have been conducted in an attempt to understand whether AmED use should be considered risky and in what ways AmED use affects cognitions and behaviours. Laboratory research has also been used to investigate the associations between AmED use and subjective intoxication, drinking behavior, and risk taking. The results of earlier investigations have suggested that the stimulant effects of energy drinks attenuate some of the negative effects of alcohol (Ferreira et al., 2006; Marczinski and Fillmore, 2006), therefore, possibly leaving drinkers of AmED believing they are less intoxicated and more able to drive or do other activities. These findings sparked a variety of laboratory investigations in an attempt to replicate these findings, and to see which areas of functioning or subjective intoxication, are attenuated by AmED use, compared to alcohol use alone. Several of these subsequent laboratory investigations were completed by energy drink funded researchers (which will be noted below). These researchers likely had a goal of minimizing any risk that AmED use might have. They also appeared to want to refute the claim that AmED use leads to reduced subjective intoxication.

Cognitive, behavioural, and psychological effects of AmED.

Ferreira and colleagues (2006) investigated whether a dose of AmED use (vodka 37.5%v/v and Red Bull 3.57 mL/kg), compared to alcohol or energy drink use alone, would reduce the depressant effects of alcohol. Twenty-six young healthy volunteers were randomly assigned to two groups that received 0.6 or 1.0g/kg of alcohol, respectively. They all completed 3 experimental sessions in random order, 7 days apart: alcohol alone, energy drink alone, or AmED. They evaluated participant's breath alcohol concentration (BrAC), subjective sensations of intoxication, objective effects on motor coordination, and visual reaction time. They found that consumers of AmED had positive subjective effects from AmED use, such as a significant reduction in perception of intoxication including headache, weakness, dry mouth, and impairment of motor coordination, compared to the ingestion of alcohol alone. Importantly, despite subjective feelings, Ferreira and colleagues (2006) found that the ingestion of energy drinks did not reduce the deficits caused by alcohol on objective measures of motor coordination and visual reaction time. In addition, it did not alter the participant's breath alcohol concentration.

Previously, researchers have found attenuation in certain areas of functioning, but not in others when investigating caffeine's effect on alcohol. For example, Marczinski and Fillmore (2003) found that caffeine antagonizes alcohol's effect on response execution but has no effect on inhibitory control. Their subsequent findings also indicated that caffeine co-administration with alcohol does counteract some aspects of performance that are impaired by alcohol (i.e. response speed) but not others (i.e. response accuracy) (Marczinski & Fillmore, 2006). They concluded that these findings could indicate that "tasks which rely on activational aspects of behavioural control might be more likely to

show caffeine antagonism of alcohol induced impairment compared with tasks that rely on inhibitory aspects of control" (Marczinski & Fillmore, 2006, p.234). Other research has also found deficits in cognitive performance with AmED consumption where combined use negatively influenced a global measure of cognitive functioning, specifically visuospatial/constructional and language performance scores, compared to participants who consumed caffeine only (Curry and Stasio, 2009). Unfortunately, this study did not have an alcohol only group to compare their results.

Marczinski and colleagues (2011) investigated whether the consumption of AmED alters neurocognitive and subjective measures of intoxication compared to the consumption of alcohol alone. Participants (n = 56) attended 1 session where they were randomly assigned to receive one of 4 doses (0.65g/kg alcohol; 3.57 ml/kg energy drink; AmED; or a placebo beverage) and were administered cued go/no-go tasks to measure response inhibitory and activational mechanisms of behavioural control. They also provided subjective ratings of stimulation, sedation, impairment and level of intoxication. Consistent with their previous research, they found that AmED use counteracted some of the alcohol-induced impairments in response activation (as measured by change in reaction time), but not response inhibition. They also found a trend signifying that AmED use increased self-reported stimulation, but had similar ratings of other subjective effects compared to alcohol alone. It appears that the addition of energy drinks to alcohol alters some objective and subjective impairing effects of alcohol, but not others. The authors postulated that the mix of impaired behavioural control and enhanced stimulation with AmED use may make its consumption riskier than alcohol alone. There are several limitations to this research with the most important being the unclear presentation and

conclusions regarding the findings, particularly when it appears that their findings were largely non-significant with regard to AmED and alcohol only comparisons. This may be due to the limitations regarding small sample size and a dose of AmED combination which is not representative of typical drinking occasions.

Marczinski and colleagues (2012) also investigated the effects of energy drinks mixed with alcohol on information processing, motor coordination, and subjective reports of intoxication. They administered four test sessions to 18 participants where they received one of four doses in random order (0.65g/kg alcohol, 3.57 ml/kg energy drink, AmED, or a placebo beverage) and were administered dual-task information processing tests, the Purdue pegboard (simple and complex motor coordination), and subjective measures of stimulation, sedation, impairment and level of intoxication. They found that alcohol induced impairment was not altered by energy drink co-administration on dual-task information processing and simple or complex motor coordination. They found that on subjective ratings, AmED reduced perceptions of mental fatigue and enhanced feelings of stimulation compared to alcohol alone. Marczinski and colleagues (2012) suggested that AmED use may increase risk for drinkers as they continue to experience behavioural impairment but may experience reduced fatigue and increased stimulation, possibly erroneously leaving consumers to perceive themselves as better able to function than is actually the case.

Mixed findings regarding caffeine's attenuation of alcohol-related performance deficits appears to be common and task-dependent in other research teams investigating AmED use. For example Attwood et al. (2012) examined the combined effects of alcohol and caffeine on measures of behavioural control and perceived intoxication in 28 social

alcohol drinkers and light caffeine consumers in Bristol, UK. They found that caffeine attenuated alcohol-related performance deficits on accuracy in a stop-signal task, but had no effect on go-no-go performance deficits, and worsened accuracy on the Stroop task. Overall, they concluded that there is mixed-support for compensation for alcohol-induced performance deficits on inhibitory control tasks, with attenuation, no effect, and worsened performance being found across three behavioural control tasks. Regarding perceived intoxication, they found no absolute changes in perceived intoxication but a suggestion that caffeine may have changed the nature of intoxication with increases in stimulation. Consequently, caffeine may alter the nature of intoxication without altering the perceived degree of intoxication (Attwood et al., 2012). Other research looking into the use of energy drinks to reduce the depressant effects of alcohol by Ferreira et al. (2004b) found that AmED use did not alter physiological indicators, improve performance on a maximal effort test, or reduce alterations induced by alcohol ingestion.

Researchers have also investigated the effect of caffeine on alcohol-induced driving impairment using a variety of reaction time, psychomotor, cognitive, and driving simulation tests (Liguori & Robinson, 2001). They found that after administration of alcohol and two doses of caffeine capsules (200, 400 mg caffeine), both caffeine doses comparably counteracted alcohol impairment of brake latency but not choice reaction time or "body sway." Of note, brake latency with the alcohol-caffeine combination remained significantly longer than with placebo, but was significantly better than alcohol alone. Performance on the Stroop test and critical flicker fusion tests were not affected by any drug condition. Their results suggested that caffeine may improve reaction time after alcohol use, but does not completely counteract alcohol impairment in a driver.

Importantly, the use of caffeine pills as opposed to energy drinks may differ in their effects due to the differences in composition of energy drinks beyond caffeine alone.

There have been several laboratory investigations done by researchers funded by Red Bull. Alford, Hamilton-Morris and Verster (2012) investigated AmED use on subjective intoxication and objective performance. They used a balanced order, placebo-controlled, double blind design looking at the effects of alcohol versus placebo at two alcohol doses (0.046 and 0.087% breathalyzer alcohol concentration), alone and in combination with an energy drink (80 mg of caffeine) in 20 participants. Tests they used included objective measures of performance (reaction time, word memory and Stroop task) and subjective visual analogue mood scales. They found impairments in reaction time and memory after alcohol consumption (vs. no alcohol condition). They found that performance on the Stroop task was improved after the AmED condition (vs. placebo energy drink plus alcohol combination). When examining the graphical plots they found that AmED, compared to placebo energy drink with alcohol, showed lower levels of impairment at the higher dose of alcohol on multiple tasks (i.e. critical flicker fusion threshold, total reaction time, recognition reaction time, and a reduction in Stroop errors and completion time). They did not find a reduction with memory tasks. They found that neither BAC nor subjective measures showed significant differences between the AmED and placebo energy drink mixed with alcohol conditions. They concluded that relative reductions in alcohol-induced impairment after co-administration of energy drinks suggests some possible antagonism by energy drink constituents. Their data and findings are likely limited by the small sample size which may have contributed to some small effect size ($d \geq 0.2$) differences not being statistically significant. They are limited by

findings that alcohol did not consistently cause significant impairment on their performance measures (therefore making it difficult to assess whether energy drink attenuated that impairment), and that energy drinks did not consistently show overall significant differences in subjective visual analogue measures (therefore making it difficult to assess whether energy drinks attenuated alcohol impairment when the energy drink dose did not generally change subjective experience alone). Interestingly, the same authors in a criticism of other laboratory research argue that co-administering caffeine in amounts less than 300 mg generally does not significantly alter performance impairment caused by alcohol, nor does it alter mood or perception of intoxication (Verster, Alford and Scholey (2013). Therefore one must question why these authors chose to conduct laboratory experiments using caffeine less than 300mg when they had already concluded and argued elsewhere that it should not have an attenuating effect. Due to obvious conflicts of interest, the design and findings of their research has been criticized (Miller, 2013b).

Another laboratory investigation funded by the energy drink industry investigated the effects of AmED on subjective intoxication in 52 male volunteers using an 18-item Visual Analogue Scale 9 (Ulbrich et al., 2013). They used a randomized, double-blinded, controlled, four treatment cross-over trial after the consumption of a (i) placebo, (ii) alcohol (vodka 37,5% at a dose of 46.5 g of ethanol), (iii) alcohol in combination with caffeine at a dose of 80mg (equivalent to one can of energy drink), and (iv) alcohol in combination with one 250ml can of energy drink. Of note, the amount of caffeine provided in this study may not be sufficient to answer the research question in an ecologically valid manner, but the authors noted that they chose this dose as that is what

Ferreira et al. (2006) used in their study and it is "within the range of doses usually ingested on a single occasion." This is an interesting choice given that the authors of the article were heavily criticizing Ferreira et al.'s (2006) research and there is other research to indicate that this is not a dose which is usually ingested on a single occasion when consuming with alcohol (Malinaukas et al., 2007; Peacock, Bruno, and Martin, 2013). They found no statistically significant differences between the AmED or alcohol and caffeine groups, compared to the alcohol only groups on any of the variables assessed. Ultimately Ulbrich and colleagues (2013) reported that they did not replicate Ferreira et al (2006) findings of the "masking" of intoxication effect when combining caffeine or energy drinks with alcohol compared to alcohol alone. Ulbrich and colleagues (2013) did not discuss the limitations of their own research, but it is likely that their findings are limited by their choice of a low dose of alcohol and energy drinks. Their findings may also be limited by the lack of inclusion of variables that look at subjective stimulation, something which has been more consistently considered altered after AmED consumption vs., alcohol alone (Attwood et al., 2012; Marczinski et al., 2011, 2012; Peacock et al, 2013; Peacock, Bruno, & Martin, 2012).

Overall, research on the cognitive and psychomotor effects of energy drinks on alcohol intoxication has resulted in equivocal findings. The majority of research in this field has found attenuation of alcohol's effects in some tasks, but not others. Generally, it appears that when attenuation is found it occurs in simple response activation tasks (as measured by change in reaction time), with more equivocal findings regarding response inhibition tasks (Attwood et al., 2012; Liguori & Robinson, 2001; Marczinski et al., 2011). With regard to subjective intoxication, it appears that the majority of findings do

not support the idea that AmED use has a broad attenuation of subjective intoxication, but that it may alter some aspects of intoxication, such as the sensation of stimulation while being intoxicated. Perhaps Attwood and colleagues (2012) describe it best when saying that caffeine may alter the nature of intoxication without altering the perceived degree of intoxication. Clearly, more well-designed research conducted by objective researchers is needed to continue the investigation on the effects of AmED on subjective intoxication and cognitive and psychomotor aspects of intoxication.

Drinking behaviour and AmED use.

Research on the association between AmED and increased alcohol use has sparked interest and speculation regarding the mechanisms by which energy drinks may alter drinking behavior. In an attempt to study possible mechanisms, Marczinski and colleagues (2013) conducted a laboratory experiment to investigate whether the consumption of AmED would alter alcohol priming (i.e., increasing ratings of wanting another drink) compared to alcohol alone. Energy drinks are anecdotally used at pre-drinking events to prepare for a night out. Participants (n = 80) were randomly assigned to receive 1 of 4 beverages (vodka, energy drink, vodka mixed with energy drink (AmED) or a placebo beverage). They subsequently completed a Desire for Drug questionnaire which was aimed to assess alcohol-induced priming of the motivation to drink. They found that the priming dose of alcohol (0.91 ml/kg vodka) increased the subjective ratings of "desire" for more alcohol, which is consistent with previous research on alcohol priming. They found that higher desire ratings over time were observed with AmED compared with alcohol alone, where AmED desire ratings were significantly higher than baseline for 10, 20, 40, and 60 minutes after the priming dose of alcohol.

Alternatively, desire to drink in the alcohol only group was higher than baseline at 10 and 20 minutes but not afterwards. Importantly, when using independent samples t-tests they did not find statistical differences between the alcohol and AmED groups in "desire to drink," but found higher trend ratings for AmED use versus alcohol alone at 40 minutes. They did not find differences in ratings of subjective "liking" or "feeling" the drink, intoxication, stimulation or sedation between the groups. They concluded that an energy drink may elicit increased alcohol priming and therefore greater motivation to drink versus the same amount of alcohol consumed alone. They suggested that it is possible that this may explain why consumers of AmED are more likely to become alcohol dependent as drug wanting produces addictive behaviour. Additionally, since AmED users are likely to be high in risk-taking (Brache & Stockwell, 2011), this combined with drug wanting may also contribute to alcohol dependence risk. Strengths of this study included their fairly comprehensive demographic analyses for comparing possible differences between groups. Limitations include that the small amount of energy drink consumed by participants (2:1 energy drink/vodka ratio which is a common ratio in bars, where some practices resemble more of a 5:1 ratio as a standard 1½ oz. shot of vodka or Jagermeister is mixed with an entire 250 ml can of Red Bull), the relatively low alcohol dose for priming, and the lack of significant t-tests comparing AmED and alcohol alone groups.

In response to Marczinski et al.'s (2013) research, Red Bull funded researchers published a letter to the editor to discuss Marczinski and colleagues (2013) findings and conclusions. Verster, Alford and Scholey (2013) argued that their findings and conclusions are premature due to them finding no significant effects in between-group

comparisons, using a placebo energy drink vehicle which may not closely enough resemble Red Bull, and using within-group comparisons to make between group inferences (which may be highly influenced by baseline differences). Despite the very valid criticism's made by the Verster, Alford and Scholey (2013), they also make their own mistakes in their commentary (e.g., that the control decaffeinated soda had the third lowest "desire for alcohol" baseline score when, according to the original article it had the second highest), and subsequently making unsupported arguments (e.g., that the most interesting findings of the article regard the control decaffeinated soda). They argue for critical review of proposed research by granting agencies and state probable levels (less than 300mg) in which co-administration of energy drinks generally does not alter performance impairment, mood, or perception of intoxication (based on their own potentially biased review). Peacock and Bruno (2013) also published a paper noting the limitations of Marczinski and colleagues (2013) findings and conclusions.

In response to the criticism, Marczinski & Fillmore (2013) provided additional details and data analysis. They argued that their analyses were correct in order to determine whether AmED itself led to longer desire to drink compared to alcohol alone, and, because social drinkers tend to differ in baseline ratings, making within-subject comparison of change over time they determined was most appropriate. Further, Marczinski and Fillmore (2013) reanalyzed their data using analysis of covariance (ANCOVA) with baseline desire for alcohol ratings as a covariate. They argued that this may have been better than the original analyses and expressed regret for not having done this originally. In their new analyses using ANCOVA they observed an alcohol by energy drink interaction. In these follow-up analyses they found a moderate to large effect where

alcohol vs. AmED was significant. They concluded that given this, and the higher desire for alcohol ratings in AmED group, AmED resulted in increased desire for alcohol for a longer period of time compared to the same amount of alcohol alone.

Kutcher and colleagues (2011) investigated the formation of alcohol preference and behavior in rats after "long-term" caffeine and alcohol intake. They found that a long-time intake of caffeine, ethanol, and their combination led to the increase of alcohol preference in rats, with higher alcohol preference formed in female rats. They also found that alcohol preference was formed earlier in rats who consumed caffeine with ethanol and later in rats who consumed ethanol alone. The authors hypothesized that perhaps rats receiving caffeine combined with alcohol experienced more rapid tolerance to alcohol, and as a consequence experience increased alcohol preference. More research is clearly needed in this area, particularly regarding the use of energy drinks and alcohol. Researchers looking at whether energy drinks reduce the depressant effects of alcohol have also used mice to investigate locomotor activity (Ferreira et al., 2004a). They found that at higher doses of ethanol, energy drink use (equivalent to 3 cans of 250 ml by a 70-kg individual) antagonized the depressant effects of alcohol.

In general, although there are mixed results, the idea that energy drinks fully attenuate the negative effects of alcohol has not been supported in the research literature, despite subjective perceptions of positive effects (Attwood, 2012; Ferreira et al., 2004b). Importantly, experimental studies have tended to administer single doses of caffeine/alcohol that are different to the general pattern of sustained drinking that occurs in social settings (Attwood, 2012). For example, Attwood et al., 2012, administered a relatively low dose of caffeine (2.0mg/kg) which is "close to the amount" they claim is

"usually contained in real-world" AmED. They reported purposely choosing this dose to assess whether a dose consistent to a normal energy drink serving could elicit relevant changes in alcohol-related performance. Most importantly, there is a recognized need to investigate the dose response curve with regard to AmED and performance benefits as some suggest that caffeine may decrease alcohol-related physical and cognitive impairment when blood alcohol levels are low, but not when they are high (Attwood et al., 2012). This highlights an important limitation of laboratory studies regarding their ability to assess the effects and risks of AmED consumption, as hospitalization reports suggest that the negative consequences are experienced after large consumptions of alcohol and caffeine. As a result, it has been suggested that the negative consequences of AmED consumption are likely to increase with the number of drinks consumed; therefore, laboratory studies can only provide information regarding specific research questions, which may not be indicative of real world effects (Attwood et al., 2012). Laboratory studies are also designed in order to assess the pharmacological effects of alcohol and caffeine combinations, but they limit the influence of expectancy which could be an important factor in the effects of AmED use (Attwood et al., 2012).

In sum, some effects of alcohol intoxication may be attenuated with AmED consumption, but overall impairment still exists, signifying an inability to conduct complex tasks that involve significant motor and cognitive capabilities, such as driving. More research is necessary to clarify the nature of the alcohol and energy drink relationship on perceived intoxication, alcohol priming, and attenuation of physical and cognitive impairments cause by alcohol. In general, it appears that AmED may increase

desire for alcohol and AmED use may alter the subjective intoxication by increasing sense of stimulation.

Energy drink industry funded reviews of the literature.

In response to the publication of scientific literature on AmED consumption and its consequences, energy drink companies have recently funded academic researchers to conduct their own research on AmED use and to critique the methodology and findings of published AmED research. The findings of these energy drink funded researchers will be discussed here, in this separate section, so readers may interpret these findings with the understanding that the authors had a clear conflict of interest, where they may have been biased towards the safety of energy drink use as they were being funded by energy drink companies. Nonetheless, these researchers have discussed valid criticisms of the AmED literature, some of which apply to the research methodologies used in the following studies conducted as part of this dissertation. Importantly, all research, including their own, has its limitations and these should be acknowledged.

Verster and Alford (2011) wrote an editorial which briefly outlined their concerns regarding energy drink research. They primarily focused on giving a simplistic understanding of the differences between correlation and causation, and how correlation studies should not claim causation. They called for better controlled prospective surveys and controlled experimental studies. They argued that differences in personality, impulsivity, and sensation seeking may exist which limit the ability to draw conclusions from comparing AmED users to alcohol only users. They called for more within-subject research and discussed research which supports their hypotheses that within subjects research designs will not find increased alcohol use on AmED occasions, compared to

alcohol only use occasions. They also argue that researchers who have drawn different conclusions from the data are "mainly speculative" and do not consider the full body of available scientific literature. Ultimately, they argue that the current research conclusions have raised "unsubstantiated concerns among consumers about the use of energy drinks" and may trigger "unjustified regulations."

The researchers funded by Red Bull conducted a review of the AmED literature (Verster, Aufricht, & Alford, 2012). In their review of the published literature they point out the limitations in the current studies and draw conclusions from the evidence. Their search for articles on energy drinks yielded 23 research articles which they reviewed. They specifically focused on studies examining whether energy drinks antagonize alcohol-induced performance impairment in both recovery from physical exercise and cognitive testing. Verster et al. (2012) noted significant limitations in some of these studies where alcohol was not tested alone in two studies, thereby not allowing for sufficient comparison. After reviewing the evidence, in the body of the paper they conclude that "there is mixed evidence that energy drink consumption antagonizes some performance effects caused by alcohol intoxication but not others" but in their abstract they more strongly conclude that there is "little evidence that energy drinks antagonize the behavioural effects of alcohol." When investigating whether AmED use changes a drinker's perception of intoxication, Verster and colleagues (2012) note that studies showing this have questionable control comparisons (e.g., using baseline as opposed to alcohol only groups) and that there is mixed evidence of changes in perception of intoxication, with some scales showing differences between AmED and alcohol only groups, and others not. Consequently, they conclude that there is "no consistent evidence

that energy drinks alter the perceived level of intoxication of people who mix energy drinks with alcohol." They conclude in their abstract that no "clinically relevant" cardiovascular or other adverse effects have been reported for healthy subjects consuming AmED, although they do not appear to have investigated this in the body of their study.

Verster and colleagues (2012) also investigated whether energy drinks enhance alcohol consumption. Their main criticisms of the majority of surveys is that there is no data which can make causal attributions, that energy drink use was often investigated as opposed to AmED use, that the groups likely significantly differ in risk perception and risk taking propensity, and that the AmED groups tended to have a relatively small prevalence in some samples which limited the ability to make conclusions. In the body of their paper they summarize the literature and conclude that the specific nature of the relationship between energy drink consumption and alcohol consumption cannot be established from the current surveys. They conclude that there is no "direct" or "reliable" scientific evidence that AmED use increases alcohol consumption, or initiates drug and alcohol dependence or abuse, only associational analyses. Verster and colleagues (2012) argue that a personality with higher levels of risk taking may be the primary reason AmED use is associated with increased alcohol and drug abuse, where AmED use is one of the many expressions of a high risk lifestyle and personality. They argue that within-subject analyses are necessary to establish whether there is an actual difference in AmED and alcohol only drinking occasions. Importantly, as summarized above, several research studies have been published since this review was conducted which have investigated the variables of interest using a variety of methodologies.

Reasons for Use.

The majority of research on AmED consumption has focused on laboratory findings of cognitive and motor functioning, drinking behaviour, risky behaviours, and negative consequences. Little research has been done on the reasons for AmED use, despite its importance in understanding the phenomenon and potentially preventing harm (Woolsey, 2010). Importantly, more recent investigations have focused on the motivations for AmED and their potential influence on increased use and negative outcomes.

The research to date on motivations for use has shown that consuming AmED while drinking socially, or "partying," is a common reason reported among college students for consuming energy drinks, where researchers have identified that 54% of college students who consume energy drinks reported using for this purpose (Malinauskas et al., 2007). AmED users in a Canadian sample have also endorsed a wide variety of reasons for use in survey responses (see Figure 1) (Brache, Thomas, & Stockwell, 2012). The most common reasons reported were because they enjoyed the taste (35%) and to get an energy boost (27.7%). Other reasons, that appear to be more troubling in terms of health safety, include: (1) to stay awake when drinking (20.2%), (2) to party longer (18.4%) and (3) to get a buzz quicker (9.5%). Similar to rationales reported for AmED use in Canada, research conducted in Australia found that young adults consume AmED to extend their nights out, to have more energy, to party longer, and because they are considered "cool" to drink while in a club (Jones & Barrie, 2009). This research also identified the role of social image in AmED use, specifically noting that AmED are used as a group bonding experience and to make nights out more "fun."

Marczinski (2011a) investigated motivations for AmED use in a small survey of undergraduate college students who were past two week users of AmED (n=66). These regular AmED users endorsed more highly the following reasons for AmED use: it is a common alcoholic drink, AmED use allows one to get drunk faster, it can help one drink more alcohol, and one does not feel as tired after AmED use. Other important reasons they identified for drinking AmED is to socialize, to get drunk, to celebrate, and because they enjoyed the taste. Of the larger college student sample (including those who did not consume AmED in the past two weeks), 78% agreed that AmED appeal to underage drinkers. Marczinski (2011a) called for more research to investigate the motivations for AmED consumption in general, for more research into why taste of the beverage appears to be important, and for researchers to use more clearly worded motivations for AmED use. An important limitation of Marczinski's (2011a) research is that it focused on common motivations for students who frequently combined AmED, which may be different from less frequent users.

Ballistreri and Corradi-Webster (2008) surveyed a convenience sample of 211 fourth-year Argentinean physical education students regarding their patterns of energy drink consumption. Of the students surveyed, 64.9% had previously consumed energy drinks. The majority (87.6%) of those students had also consumed AmED. In total, 56.9% of their student sample had previously consumed AmED. Participants responded to the question of "what do you want when you drink these beverages?" Of the students who reported consuming energy drinks, 54% did so in order to improve the taste of alcoholic drinks, 27.7% to enjoy an all-night party, 13.9% to improve sports performance, 9.5% for stimulation, 8.8% enjoy the taste, 6.6% for curiosity and 4.4% to

be able to study longer. When describing occasions where energy drinks were consumed, 75.2% did so in night clubs, 48.9% at parties, 38.7% in bars, 15.3% before practicing sports, 5.8% after practicing sports, 4.4% for studying, 3.6% for working and 3.6% for driving vehicles. Limitations for this research is that if focused solely on motivations for energy drinks use and not AmED use.

Peacock, Bruno, and Martin (2013) investigated motivations for AmED use in an Australian community sample (described above). They developed questions based on a literature review and extraction of recurrent themes from two 30-min focus group sessions with six AmED users. Participants indicated on a 5-point Likert scale how frequently 30 reasons motivated them to consume AmED. These responses were clustered into motivation absent (never and less than half of the time) and motivation present (half the time or more). They used exploratory factor analysis to determine grouping of motivations. They found that seven factors provided a good fit to the data with an interpretable factor structure. They labeled the seven factors as (a) functional motives (e.g., to feel more energetic), (b) intoxication/impairment motives (e.g., so I could drink more), (c) taste and sensation motives (e.g., because I like the taste of alcohol and energy drinks together), (d) illicit "high" motives (e.g., as a legal alternative to illicit drugs), (e) situational motives (e.g., because there was a discount drink special), (f) hedonistic motives (e.g., to have more fun), and , (g) sociability motives (e.g., to feel more sociable). Their results indicated that improved functionality motives were a primary motive for co-ingestion with 70% of the sample reporting use for energetic purposes and 54% for extending their stay at drinking venues. Taste and sensation motives were also highly endorsed (69%). Situational motives (e.g. sharing AmED with

drinking companions, AmED availability, and price discounting) were also a predominant factor. Specifically 72% endorsed the motivation to consume AmED due to having a preference for a specific drink (i.e. Jagerbomb). With regard to hedonistic motives, 53% reported motives to "have more fun" and 32% reported using to "get more drunk." Of note, to "get more drunk" may also be considered an intoxication motive. They found less endorsement for intoxication and impairment, illicit "high," and sociability motives. The majority or participants did not endorse using in order to feel less intoxicated. The authors concluded that only a small subset reported positioning themselves in a situation of increased risk by attempting to increase alcohol intake, heightened alcohol-induced impairment, and/or experience a "high" similar to illicit drug use.

Strengths to this study include the use of a community sample, the wide variety of motives which were surveyed, and the use of factor analysis in an attempt to organize such motives. Limitations include discussion about whether these motives put individuals at increased risk. For example, some may assume that enjoying the taste of a beverage (endorsed by 69% of the sample) does not put one at increased risk of harm and that using AmED so that one could "drink more" (endorsed by 20%) of the sample might put one at increased risk of harm. Alternatively, it could be argued that enjoying the taste of a beverage actually puts one at increased risk of consuming more of that beverage, and increased consumption of AmED beverages could be considered risky for a variety of reasons. Consequently, investigators of motivations for consuming AmED should be cautious when discussing whether certain motives are more risky than others, as it may not be so easily determined by the nature of the motivation and further investigation is

likely needed in order to determine how "risky" one motivation for drinking is compared to another. Additionally, even with factor analysis, the clarity by which motivations should fall under certain categories is unclear. For example 32% reported using "to get more drunk" as an AmED motive. This motive was classified as a hedonistic motive and not an intoxication or impairment motive. This categorization may wrongly influence people and the authors to make conclusions that motivation for AmED related to impairment or intoxication motives is not highly endorsed when "to get more drunk" simply fell under a different factor.

Jones (2011) investigated adolescent (ages 12-17) Australians' perceptions, and consumption, of alcoholic energy drinks through a multi-method study including survey data (n = 1263) and focus groups (n = 95). Of note, the study was about "ready-to-drink" beverages more generally so the questions did not always specifically refer to alcoholic energy drinks. Pre-mixed alcoholic energy drinks, where the alcohol is already mixed with the energy drink in a "ready-to-drink" beverage container, are a relatively new entry to the ready-to-drink market in Australia. From the focus groups, they found that the premixed alcoholic energy drinks were popular drinks that participants would choose to drink, particularly among females. Participants commented on the similarities in physical appearance and taste of the alcoholic energy drink to non-alcoholic energy drinks, to the point where others may be unaware that they are consuming alcohol. Female participants mentioned the sweet taste of the premixed alcoholic energy drink, although a small number of participants did not like the taste. Male participants described the energy benefits received from these beverages while allowing them to feel the effects of alcohol.

Participants also mentioned that energy levels and "fun" are increased when drinking these beverages, in comparison to other alcohol products.

Jones, Barrie and Berry (2012) recently conducted a small-scale qualitative investigation of the perceptions of, and experiences with, premixed alcoholic energy drinks among 21 students (ages 18-25). The key themes they identified in focus group discussions were that students consumed pre-mixed alcoholic energy drinks when "drinking to get drunk," when "drinking to be part of the crowd," and for "convenience." Under the "drinking to get drunk" theme, participants reported drinking the premixed beverages in order to remain awake and alert so that they could keep drinking and socializing longer, both during the night, and at the beginning of the night in order to provide an initial energy boost for the night ahead. The authors' interpreted these reasons for consumption as demonstrating the desire for drinking to intoxication. Alternatively, the quotes given could be interpreted differently, simply as participants seeking energy or wakefulness for the night, in order to help them enjoy the night, as opposed to drinking for intoxication. Other reasons given for consumption include (1) the higher alcohol content of pre-mixed alcoholic energy drinks, compared to other ready-to-drink beverages on the market, perhaps offering cost incentives, (2) the sweetness of the energy drink components which mask the taste of alcohol and made them more palatable, (3) the excitement of having an added psychoactive ingredient to an alcoholic beverage (e.g. stimulants), and, (4) having a sense of added feelings of control or invincibility while consuming alcohol. Under the "drinking to be part of the crowd" theme, participants reported consuming premixed alcoholic energy drinks as they were a "cool" drink to have, and that the consumption of self-mixed alcoholic energy drinks was a form of

social bonding activity. Finally, participants reported drinking the premixed alcohol energy drinks as they are "convenient" where they can be easy to obtain, carry and conceal. Important limitations to this research was the small sample size and the focus on premixed alcoholic energy drinks as opposed to consuming AmED in a variety of forms (e.g. self-mixed).

Attila and Cakir, (2011) conducted a cross-sectional study investigating reasons for energy drink use in 439 Turkish university students. They found that the main reasons for trying energy drinks was curiosity of its taste/effects (48.3%), for energy (15.9%), to boost performance during exercise (14.9%) and to mix with alcohol (11.9%). Among "current" users (of note the authors did not indicate how they defined or determined "current" users), the most common reasons endorsed for using energy drinks were for energy (24.2%), to boost performance during exercise (21.4%), for taste (17%), to use in cocktails, mixed with alcohol (15.2%), to concentrate while studying (8.9%), and to stay awake (7.6%). They noted that one third of "current" users consumed energy drinks in bars. Importantly, the methodology of this study was not well described, particularly with respect to how the students' reasons for energy drink use were queried. In the discussion, the authors discussed findings that they had not stated in the results, namely that 10% of their participants stated that they use energy drinks to mix with alcohol, to make alcoholic beverages taste better, or to decrease the depressive effects of alcohol. Interpretation of these findings is difficult given the lack of information regarding the survey methodology and the development of the survey questions, specifically regarding motivations, and the lack of clarity in describing the reasons for use in both the results and discussion of the research article.

Skewes, Decou, and Gonzalez (2013) investigated whether frequency of energy drink use was associated with different motives for drinking alcohol in 298 Alaskan college students. Using the Drinking Motives Questionnaire-Revised, they found that greater energy drink use was associated with drinking for enhancement motives (e.g., to increase enjoyment or have fun) and drinking to cope with negative affect (e.g., to forget one's problems). The researchers noted a need for more investigations into AmED motives and motives for energy drink use independent of AmED use in order to help understand how these associations or motives may impact drinking behavior and related consequences.

Researchers are now calling for further research in exploring positive motivations for AmED use in order to better understand how users expect energy drinks to positively impact their alcohol drinking experience (Pennay, Lubman, & Miller, 2011; (Skewes, Decou, & Gonzalez, 2013; Woolsey, 2010). Previous research on consuming alcohol and caffeine in combination has shown that individual differences in expected effects can predict individual differences on psychomotor performance (Fillmore & Vogel-Sprott, 1995). It was found that regardless of whether caffeine was actually received, those who expected the most impairment from the combination of alcohol and caffeine performed the most poorly. Understanding expectancies may help better predict future drinking and behavioural choices (Woolsey, 2010). Additionally, Varvil-Weld and colleagues (2013) research (summarized above) indicated that students in profiles characterized by positive expectancies and attitudes for AmED use were at the greatest risk of AmED use, heavy episodic drinking, and related consequences. They used a limited number of motivations/expectancies for AmED use to determine profile characteristics so future

research could expand on their findings on motivations to help understand how motivations and expectancies are related to alcohol use, heavy drinking, risk behaviours and negative consequences.

Overall, there appears to be a variety of reported motivations for AmED use, with more highly endorsed reasons being enjoying the taste, to get an energy boost, to party longer, to stay awake when drinking, for social bonding, because it is a common drink (e.g., Jagerbombs), to get drunk faster, to help one drink more alcohol, and to have fun. The current literature in this area is limited by small sample sizes, specific samples (e.g., frequent users), limited investigations (e.g., only motivations for pre-mixed beverages; only motivations for energy drinks), and limited choices of motivations in quantitative research. I also believe that investigations which attempt to group motivations may be limited due to attempting to group a potentially more complex phenomenon which ultimately leads to confusion in making conclusions. Future research should investigate larger samples, use qualitative methodology, use a greater variety of motivations in quantitative research, and have study designs which allow for causal interpretation with regard to whether motivations are associated with certain behaviours such as increased drinking or risk-taking.

Understanding the Relationships

Several mechanisms have been proposed to explain the increased risk of heavy drinking and harm from AmED use (Brache, Thomas, & Stockwell, 2012; Pennay, Lubman, & Miller, 2011). These include a (1) decreased subjective awareness of intoxication, or a change in the nature of intoxication, thereby increasing the likelihood of alcohol poisoning and risky behaviours. This could be due to a reduced sensitivity to the

signs of alcohol use; (2) caffeine masking the depressive effects of alcohol leading to longer and more active drinking sessions; (3) AmED use facilitating greater alcohol consumption, leaving consumers more intoxicated; (4) dehydration from alcohol and caffeine use leading to a variety of negative physical effects (e.g. vomiting, increased heart rate, severe hangover), and, (5) mixed messages to the nervous system resulting in cardiovascular problems (Pennay, Lubman, & Miller, 2011).

As summarized above, individuals who have used AmED have been found to have decreased perception of intoxication but continued deficits in motor coordination and visual reaction time, compared to alcohol use alone (Ferreira et al., 2006). The majority of findings seem to support that AmED use may alter some aspects of intoxication, such as the sense of stimulation while being intoxicated (Attwood et al., 2012; Marczinski et al., 2011, 2012; Peacock et al, 2013; Peacock, Bruno, & Martin, 2012). The positive subjective effects of being more "stimulated" while drinking could lead to increased alcohol consumption as consumers of AmED may feel less intoxicated or more stimulated. Consumers may also be more likely to participate in risky behaviours, like drinking and driving, because they have a subjective sense of being "stimulated," "awake" or less intoxicated due to feeling less of the depressant effects of alcohol (Pennay, Lubman, & Miller, 2011).

Although the laboratory research appears to have mixed findings regarding the attenuation of alcohol's effect, some research suggests that the stimulant effects of caffeine attenuate some negative effects of alcohol like locomotor activity (Ferreira et al., 2004a; Marczinski and Fillmore, 2006). Increased stimulation has been argued to potentially blunt interoceptive intoxication cues resulting in a misperception of ability to

consume further alcohol quantities and a decreased sense of mental fatigue, subsequently extending a drinking period (Peacock & Bruno, 2013). This attenuation may explain the increased risk of harm as the caffeine may mask the depressant effects of alcohol, potentially leading to longer and more active drinking sessions. Investigations into motives for AmED use also supports the idea that AmED use leads to extended and more energetic drinking sessions (Peacock, Bruno, & Martin, 2013). This could lead the consumer to ingest alcohol in higher quantities and be more active while drinking despite being intoxicated and experiencing impairment in other areas of functioning (Pennay, Lubman, & Miller, 2011). With increased activity, and similar levels of alcohol impairment, drinkers could be more likely to attempt activities demanding motor skills, like fighting or driving, than if they had only consumed alcohol.

Research on AmED has frequently found that drinkers tend to ingest more alcohol when consuming in combination with energy drinks (Brache & Stockwell, 2011; O'Brien et al., 2008; Price et al., 2010; Thombs et al., 2010). One way in which increased alcohol use may be facilitated by AmED use is that energy drinks may help mask the flavor of alcohol and remove taste barriers that slow alcohol intake (Peacock & Bruno, 2013). Research on motivations appears to consistently report consumption of AmED use due to the taste of the beverage, or a certain desired beverage type (e.g., Jagerbombs) (Peacock, Bruno, & Martin, 2013). Finally, it is also possible that AmED consumption enhances consumer's desire for further alcohol, in particular leading to a longer desire to drink after AmED use than alcohol use alone (Marczinski et al., 2013). This increased alcohol consumption likely leads to increased risk of harm. Alcohol consumption, at heavier doses, is associated with decreased activity level, lowered inhibition, and slowed

response speed (Ferreira et al., 2006; Marczinski and Fillmore, 2006; Marczinski and Fillmore, 2003). It is also associated with increased disposition to take risks (Cherpitel, 1999). The use of energy drinks when drinking alcohol may increase energy and decrease subjective intoxication leading to an increased activity level and increased alcohol consumption. This increased energy and activity level, increased intoxication from additional alcohol use, and an increased disposition to take risks, could explain why increased risk-taking behaviour and harms are associated with AmED use.

Other possible mechanisms by which AmED could lead to physical harms is through the dehydration from the consumption of alcohol and caffeine, which may lead to a variety of negative physical effects (e.g. vomiting, increased heart rate, severe hangover) which have been described by consumers (Pennay, Lubman, & Miller, 2011). Additionally, negative cardiovascular effects could be derived from the potential mixed messages to the nervous system from AmED use (Pennay, Lubman, & Miller, 2011).

Others have described that the "situational specificity of tolerance" phenomenon may be related to the negative effects associated with AmED use (Siegel, 2011). Siegel (2011) reported how the administration of drugs and alcohol, like AmED, have been shown to have a greater effect when administered in the presence of unusual cues rather than in the presence of typically associated cues. He defined unusual cues to include environmental cues and flavour cues, which have been shown to have an effect on experience of alcohol and caffeine administration (Siegel, 2011). He argued that pre-mixed AmED and possibly hand-mixed AmED beverages are separated from the usual smells, taste, and presentation of alcohol thereby possibly causing an exaggerated effect as they provide alcohol in an unusual flavor context. He argues that group

hospitalizations after the consumption of the pre-mixed alcoholic energy drink beverage Four Loko may be due to increase intoxication due to a novel context for alcohol administration, where alcohol tolerance acquired in the context of different cues, may not have been exhibited in the context of Four Loko cues (Siegel, 2011), and possibly other AmED beverages. Not mentioned by Siegel (2011), but another possible altered consumption cue is that Four-Loko was sold in large 23.5-oz cans which contained the equivalent of 3 to 4 beers and 1½ cups of coffee in one can (Cleary, Levine, & Hoffman, 2012). Consuming the equivalent to this many drinks when only opening and drinking one can, may also significantly alter consumption cues. Relatedly, Four Loko has been referred to by users as "blackout in a can" (Cleary, Levine, & Hoffman, 2012).

Finally, energy drink funded researchers have argued that the associations between AmED use and heavy drink, risk behaviours, and negative consequences are potentially due to personality variables which are associated with all behaviours. Verster and colleagues (2012) argue that a personality with higher levels of risk taking or sensation seeking may be the primary reason AmED use is associated with increased alcohol abuse and risk taking, where AmED use is one of the many expressions of a high risk lifestyle and personality. Some research which has attempted to account for risk-taking tendency continued to find associations between AmED use and heavy drinking, risk behaviours, and negative consequences (Brache & Stockwell, 2011). There have been mixed results in within-subjects comparisons of heavy drink, risk behaviours, and negative consequences after AmED use and alcohol use alone (Brache & Stockwell, 2011; Patrick & Maggs, 2014; Woosley et al., 2010). Further research is needed in this area to help clarify the role of personality and AmED use.

Personality Variables

AmED researchers have proposed that certain personality variables, such as sensation seeking and impulsivity, may explain the relationship between AmED use, risk taking, and harmful outcomes (Howland et al., 2011). The relationships between these variables has been speculated to be the result of selection effects; specifically, sensation seeking individuals, impulsive individuals, or individuals with a high risk taking tendency, may be drawn to energy drinks, heavy alcohol consumption, and risky behaviours (Miller, 2008a; O'Brien et al., 2008). Research has shown that impulsivity and sensation seeking are associated with energy drink use and risk taking tendency is associated with AmED use (Arria et al., 2010; Brache & Stockwell, 2011). Impulsivity and sensation seeking are associated with high risk behaviours, injury, and alcohol use (Cherpitel, 1993; Howland et al., 2011). High caffeine consumption among university students is also associated with impulsivity and sensation seeking (Jones & Lejuez, 2005). Additionally energy drink use and AmED use is associated with a number of risky behaviours including heavy alcohol use, drug use, sexual risk taking (e.g., unprotected sex, sex while under the influence of drugs, and sex after having too much to drink), fighting, seatbelt-use omission, and taking risks on a dare (Arria et al., 2010; Arria et al., 2011; Miller, 2008a; Snipes & Benotsch, 2013). Due to these associations, it has been speculated that the heavy alcohol use, risks, and harms associated with AmED use could be explained by a causative personality trait of impulsivity, sensation seeking, or risk taking tendency (Howland et al., 2011; Verster et al., 2012), as opposed to the causal influence of AmED consumption. As a result, research regarding the association between

AmED, alcohol use, harms, and risk-taking behaviours should take personality traits into account.

In addition to the within-subject research designs discussed above, three research studies have taken into account some of these personality variables (Arria et al., 2010; Arria et al., 2011, Brache & Stockwell, 2011). Two of these studies investigated the relationship between energy drink use and subsequent drug and alcohol use, taking into account impulsive sensation seeking using the Zuckerman-Kuhlman Personality Questionnaire Short Form (Arria et al., 2010; Arria et al., 2011). When controlling for impulsive sensation seeking, they found that energy drink use was significantly associated with later non medical use of prescription analgesics (Arria et al., 2010), and with alcohol dependence (Arria et al., 2011). These studies did not investigate the relationship between AmED use and risky behaviours. Only one between-subjects study has investigated the relationship between AmED use and risk taking, controlling for personality variables (Brache & Stockwell, 2011). In this study, student's risk taking tendency was measured by a slightly adapted measure of risk taking tendency which had been previously developed and used in predicting substance use and injury (McLeod et al., 2003; Thorson and Powel, 1987). After controlling for risk taking tendency, AmED use was associated with heavy drinking, risky behaviours, and negative consequences from AmED use (e.g. drinking and driving, being hurt or injured).

This limited research provides some support that the association between AmED use, drinking behaviours, and negative consequences, is not fully accounted for by personality traits. Limitations in this small body of research include the failure of some studies to consider the relationship between AmED use and risky behaviours (by only

considering energy drink use) (Arria et al., 2010; Arria et al., 2011), the use of limited personality traits as covariates (e.g. only risk taking tendency), and the use of a personality scale with limited research support (Brache & Stockwell, 2011). As called for in the literature (Howland et al., 2011; Verster et al., 2012), more research is needed investigating personality traits (e.g. sensation seeking, impulsivity, risk taking tendency) and their relationship to AmED use and risk behaviours in order to increase understanding of the mechanisms by which AmED use may increase risk.

A Theoretical Model of AmED use, Personality Traits, and Outcomes

Figure 2 is a theoretical model created to help conceptualize the relationships between AmED use, personality traits, demographic variables, drinking behaviours, and other outcomes. It illustrates how these variables could be causally related and how AmED use may remain causally related to drinking behavior and negative outcomes even after accounting for personality traits and demographic variables. Regarding AmED use and negative outcomes there are three causal mechanism postulated: (1) the risk of negative outcomes is increased because of greater alcohol and energy drink consumption with AmED use, (2) the risk of negative physical outcomes is increased due to the combined physical effects of energy drinks and alcohol, and (3) even after accounting for the increase in alcohol consumption, energy drinks consumption possibly increases risk-taking behavior subsequently leading to increased negative outcomes. The following is a description of the relationships in the model and draws from the current research literature, as summarized above, in order to support these proposed relationships.

Individuals with personality traits such as sensation seeking, impulsivity, and risk taking tendency are speculated to be drawn to energy drink use, heavy alcohol

consumption, and risky behaviours (Miller, 2008a; O'Brien et al., 2008). Energy drinks are heavily marketed in association with extreme sporting events, purposely aligning themselves with individuals who appear to take risk such as motorcross and car racing (Simon & Mosher, 2007). Their products are also named so as to appeal to risk taking and sensation seeking individuals (e.g. DareDevil, Cocaine, Rockstar). Research has shown that, among university students, impulsivity and sensation seeking are associated with high caffeine consumption and energy drink use, and, risk taking tendency has been associated with AmED use (Arria et al., 2010; Brache & Stockwell, 2011; Jones & Lejuez, 2005). Additionally impulsivity and sensation seeking are associated with high risk behaviours, injury, and alcohol use (Cherpitel, 1993; Howland et al., 2011). Consequently, these enduring personality traits appear to predict transitory behaviours including AmED use, drinking behaviours, risk behaviours, and resulting injury.

Other demographic variables such as age and gender appear to be related to AmED use where energy drink use in general, as well as in the form of AmED, has been identified as being more frequent in men, and in younger adults (Levy and Tapsell, 2007; Miller, 2008a; Miller, 2008b; O'Brien et al., 2008). This may be due to the specific marketing tactics used to target these groups (Simon & Mosher, 2007) and for the general tendency for younger adults, especially males, to engage in risky substance use (Kashdan, Vetter & Collins, 2005).

As described in detail above, AmED use has been associated with heavy drinking behaviours (Brache & Stockwell, 2011; O'Brien et al., 2008; Price et al., 2009; Thombs et al., 2010; Woolsey, Waigandt, & Beck, 2010). The increased drinking behaviour with AmED consumption may be due to a decreased subjective sense of intoxication after

combined consumption (Ferreira et al., 2006), thereby, leading to more alcohol consumption to achieve the desired level of intoxication. Additionally, the added energy from energy drinks and the antagonization of some of the depressant effect of alcohol with AmED use (Attwood et al., 2012; Marczinski et al., 2011, 2012; Marczinski & Fillmore, 2006; Peacock et al, 2013; Peacock, Bruno, & Martin, 2012) may lead to more active drinking session. These effects and others (e.g., increased stimulation; alcohol priming) likely account for the increased alcohol use among AmED users, compared to alcohol only users, even when controlling for personality traits (Brache & Stockwell, 2011). It has also been found that AmED use is associated with increase energy drink use, compared to energy drinks use alone (Malinaukas et al., 2007; Woolsey, Waigandt, & Beck, 2010). Consuming the AmED in larger amounts when co-administering may be independently predictive of negative physical effects due to their potential combined effects on the body (e.g., severe dehydration; mixed nervous system effects) (Pennay, Lubman, & Miller, 2011).

AmED use has also been associated with other negative outcomes such as increased risk of drinking and driving, being hurt or injured, heavy drinking, and engaging in risky sexual behaviours (Arria et al., 2011, Brache & Stockwell, 2011, O'Brien et al., 2008, Thombs et al., 2010). Energy drink use is associated with a number of risky behaviours including drug use, sexual risk taking, fighting, seatbelt-use omission, and taking risks on a dare (Arria et al., 2010; Arria et al., 2011; Miller, 2008a). It is possible that these associations are due to personality traits (as described above) or heavy drinking behaviour, particularly as heavy drinking is associated with injuries, and other risky behaviours (Bond & Macdonald, 2009; Ye & Cherpitel, 2009). Despite this,

research has found that AmED use continues to predict negative outcomes such as injury and risk behaviours after accounting for personality traits and drinking behaviour (Brache & Stockwell, 2011; O'Brien et al., 2008), although, more research is needed in this area to reproduce and support these findings using different methodology and populations. The continued predictive ability of AmED use on negative outcomes may be related to its effects on response execution where energy drinks have been found to antagonize some of alcohol's behavioural effects (Marczinski & Fillmore, 2003). Energy drinks have been found to counteract some aspects of performance that are impaired by alcohol, such as response speed but not response accuracy (Marczinski & Fillmore, 2006). Consequently, AmED consumers may be more likely to engage in risky behaviours and experience negative outcomes due to activational aspects of behavioural control, which are more likely to show caffeine antagonism of alcohol induced impairment, while remaining impaired in other aspects important for behavioural functioning and safety such as inhibitory aspects of behavioural control (Marczinski & Fillmore, 2006). For example, compared to alcohol only users, AmED consumers may be more likely to engage in a fight, or other risky physical behaviours, due to faster response speeds and activation of their behavior than they may experience if only consuming alcohol, particularly as their ability to inhibit aspects of their behavior remain as impaired as if they were only consuming alcohol.

Overall, Figure 2 illustrates the potential causal relationships between personality traits, AmED use, drinking behavior, and negative outcomes, as described above, while specifying that AmED use theoretically predicts drinking behaviour and negative outcomes independent of personality traits and demographic variables.

Gaps in Knowledge/Future Directions

The research on alcohol and energy drinks is relatively limited, partly due to the recency of this phenomenon. As such, there are many gaps in the literature, with three main areas needing to be addressed. These areas are (1) investigating novel samples (non-university students) and larger samples, (2) including personality variables in between-groups analyses of AmED use, and (3) getting a better understanding for motivations for use.

First, upon review of the research literature there appears to be limited peer-reviewed research investigating the consumption of alcohol and energy drinks in samples outside of university students. The research literature to date has shown that AmED use is associated with a variety of problematic behaviours including heavy drinking and other risk behaviours (e.g. drinking and driving, physical aggression). The large majority of this research has focused on non-probability samples of college students, with the exception of some community surveys which are limited in their investigations of associated risky behaviours (e.g., Peacock, Bruno, & Martin, 2013), have serious methodological limitations (e.g., Peacock, Bruno, & Martin, 2012) and have failed to compare AmED users to drinkers of alcohol alone (Berger et al, 2011). As a result, we are largely unaware of the level of AmED consumption, drinking behaviours, or risk relationships outside of a university samples. Given that the actions of policy makers in this area are affecting the entire population, more research is needed on community and national samples.

Second, there is a clear demand for research in this area to account for personality traits such as risk taking tendency, sensation seeking, and impulsivity (Howland et al.,

2011). Many investigations into the associations between AmED and risk taking have not taken such variables into account. It is important for future research to account for personality variables when investigating risk relationships and to use different methodologies to account for these (e.g., within-subjects designs).

Lastly, most of the research in this area has focused on risk relationships and laboratory studies regarding cognitive and motor functioning. There is limited research on the motivations for consuming AmED. In order to better understand the risk relationships and consumption behaviours of AmED users, the motivations for consumption should be more thoroughly investigated. Understanding these motivations may better inform decision making regarding policy, behaviour change, and reducing risk.

The Current Study

The current study will address some of the aforementioned gaps in the literature through a series of investigations. Three separate data sets will be used in order to gain a better understanding of AmED use. The first data set is the 2010 Canadian Alcohol and Other Drug Use Monitoring Survey (CADUMS). The CADUMS is a Canada wide survey asking Canadians about their experience with alcohol, drugs and other substances. The 2010 data is the first to include questions on alcohol and energy drinks. It will allow the investigation of AmED use in a national sample. It will also allow the investigation of the relationship between AmED use, drinking behaviour, alcohol use disorders, and risk behaviours within a large sample. The second data set is the University of Victoria's Healthy Youth Survey. The Victoria Healthy Youth Survey (VHYS) is a longitudinal survey of Victoria, BC, adolescents and young adults. Prior to the fourth wave of data

collection in 2009, Dr. Stockwell and I added questions regarding energy drink and alcohol use. This Canadian community sample will allow us to investigate the associations between AmED use and drinking behaviour, risky behaviours, negative consequences, and personality traits. The third data set is a 2009/2010 University of Victoria Student Survey (UVSS) on alcohol and energy drink use conducted by Dr. Stockwell and myself. This data set will be used to investigate the self-reported reasons for combining energy drinks and alcohol. It may help clarify possible reasons for the associations between AmED use, heavy drinking, and possible risk behaviours.

Research Questions and Hypotheses.

With these investigations, I would like to answer the following research questions:

1. **Is AmED use associated with risky behaviours and negative outcomes in a Canadian and young adult community samples?**

   Specifically,

   a. **Is AmED use associated with increased and risky drinking behavior and alcohol use disorders?**
   b. **Is AmED use associated with engagement in other risky behaviours (e.g. drinking and driving, sexual risk taking)?**
   c. **Is AmED use associated with increased likelihood of experiencing negative consequences (e.g. injury)?**

   These research questions investigate the relationships (illustrated in Figure 2) between AmED use and outcome variables including drinking behaviours, and other outcomes. I hypothesized that, similar to university samples, AmED use will

be associated with risky drinking behaviour, alcohol use disorders, risky behaviours, and negative consequences in a Canadian and young adult sample.

2. **Is AmED use associated with heavy drinking behaviours, alcohol use disorders, risky behaviours, and negative consequences after controlling for sensation seeking?**

   This research question investigates the relationships (illustrated in Figure 2) between personality traits, AmED use and outcome variables including drinking behaviours, and other outcomes. Based on previous research, I expect that sensation seeking will be related to AmED use, drinking behaviour, risky behaviour and negative consequences. Nonetheless, I hypothesize that sensation seeking will not fully account for the association between AmED use and drinking behaviours, other risk behaviours, and negative outcomes (Figure 2). This is based on support from previous research findings (e.g. Brache & Stockwell, 2011) and the notion that there is something risky about AmED use, due to its physical and mental effects, which place people at increased risk above and beyond certain personality traits.

3. **What are the self-reported reasons for consuming AmED, and are these reasons related to increased drinking behaviours and risky behaviours?**

   The self-reported reasons for consuming AmED will be used to help understand the relationship between AmED use and risky behaviours and negative consequences. Accordingly, I expect that participants will report reasons for consuming AmED that involve encouraging drinking behaviour, longer and more

active drinking sessions, and decreased negative sensations of alcohol intoxication.

The CADUMS and VHYS data sets will be used to address the first research question. The VHYS will be used to address the second research question, as it contains measures of personality traits. Finally, the UVSS will be used to answer the third research question.

Canadian Alcohol and Other Drug Use Monitoring Survey (CADUMS) – 2010

Present Study

Research to date shows that AmED use is associated with a variety of problematic behaviours including heavy drinking and other risky behaviours (e.g. drinking and driving, physical aggression). One major limitation of the existing research is that the large majority has focused on non-probability samples of college students, with the exception of several community surveys which are limited in their investigations of associated risky behaviours (e.g., Peacock, Bruno, & Martin, 2013), have serious methodological limitations (e.g., Peacock, Bruno, & Martin, 2012) and have failed to compare AmED users to drinkers of alcohol alone (Berger et al, 2011). The current study fills this gap by focusing on a large community-based probability sample of Canadians aged 15 years and older. The goal of the current research is to investigate whether AmED use is associated with heavy drinking and other risk behaviours in the general population using a Canadian population sample. Another limitation of previous research on AmED use is the limited research investigating the relationship between AmED use and alcohol use disorders, despite the consistent identification of increased hazardous drinking patterns associated with AmED use. Consequently, the current investigation will explore whether AmED use is associated with alcohol use disorders.

Methods

Procedures and Participants

The Canadian Alcohol and Other Drug Use Monitoring Survey (CADUMS) is an on-going Canada wide survey asking Canadians about their experiences with alcohol, drugs and other substances. The CADUMS is conducted by the Controlled Substances

and Tobacco Directorate, Health Canada. Health Canada contacts at least 10,000 Canadians aged 15 years and older every year to interview them about their experience with alcohol, drugs and other substances. The purpose of this survey is (1) to investigate the prevalence, incidence, and frequency of Canadian alcohol and other substance use, and (2) to measure the extent of harms which are associated with the use of alcohol and other substances. Random digit dialing of selected households was used for participant recruitment. The sampling frame was based on an electronic inventory of all active toll phone area codes and exchanges in Canada. The surveyor asked to speak with the person living in household who is 15 years or older and who had the next birthday. Participation was voluntary. The sampling approach was designed to produce maximum precision of estimates when reporting the provincial level by sex and at the national level by sex and major age groups. A technical guide for the 2010 data set, describing the specific survey methodology, population coverage, and questionnaire design is available online (Health Canada, 2012).

Canadians randomly selected, stratified by province, were surveyed, with approximately 1000 respondents surveyed per province where an equal number were surveyed each month. The 2010 CADUMS data is the first to include questions on alcohol and energy drink use. Consequently, this data was used in the current study to investigate AmED use in a national sample. Specifically, the current investigation focused on the relationships between AmED use, drinking behaviours, alcohol use disorders, and risk behaviours (e.g. drinking and driving, physical aggression). For the 2010 survey Health Canada collected 13,615 responses. The base size sample consisted

of 10,760 Canadians. The youth sample (15-24 years) was increased to 3,989, resulting in the final sample.

Measures

The CADUMS is based on three prior national alcohol and drug use surveys. Health Canada modified these surveys to use the most current and standard measures for examining alcohol and drug use and abuse. The questionnaire was developed in collaboration with an expert working group with membership from departments and organizations that specialize in substance use and addiction research. Core content of the CADUMS questionnaire included questions on: general health and well-being, smoking status, alcohol use and harms, energy drink use, AmED use, pharmaceutical use, cannabis use and harms, other illicit drug use and harms, alcohol and cannabis use in driving, pregnancy and substance use, and demographics.

To investigate AmED use, past 30 day drinkers were asked whether they consumed an energy drink mixed with alcohol in the past 30 days. The results of this question were used to identify a group of past 30 day drinkers who did not consume AmED (Non-AmED) and a group of drinkers who did consume AmED in the past 30 days. The groups were then used to investigate whether the consumption of AmED was associated with increased levels of risky behaviours compared to the use of alcohol alone.

Alcohol use was investigated using questions assessing drinking status, quantity and frequency of alcohol use in the past 12 months, quantity and frequency of alcohol use in the past 30 days, usual number of drinks on days when drinking, volume of alcohol consumed in standard drinks in the past 12 months, heavy monthly alcohol use (as defined by the gender-specific measure of four or more alcoholic beverages for females

and five or more alcoholic beverages for males in a single sitting), heavy weekly alcohol use, and exceeding the Canadian low risk drinking guidelines for weekly and daily sex specific limits. At the time, these guidelines recommended that men and women limit weekly alcohol intake to no more than 14 and 9 standard drinks, respectively. Also, alcohol intake on any day should not exceed 2 standard drinks[1].

The risk for alcohol use disorders was measured by the Alcohol Use Disorders Identification Test (AUDIT). The AUDIT was developed by the World Health Organization as a simple method of screening for excessive drinking and to assist in brief assessment (Babor et al., 2011). The AUDIT helps to identify alcohol dependence and some specific consequences of harmful drinking. A cut-off value of 8 points was determined as an indicator of hazardous and harmful alcohol use, as well as possible alcohol dependence (Babor et al., 2011). Other indicators of alcohol use disorders included questions regarding past 12 month harmful consequences from alcohol use. These consequences included social, family, physical health, work, financial, legal, housing, and learning problems. Finally, participants were also asked whether they felt as though they needed help for their alcohol use in the past 12 months. Other risky behaviours investigated included past 12 months impaired driving (among valid drivers), defined as driven a motor vehicle within 1 hour of drinking 2+ drinks, being a passenger in a motor vehicle with an impaired driver, having been in a motor vehicle accident when driving, and having been involved in an incident which involved physically aggression. Demographic variables that were of interest included age, gender, marital status, ethnicity, household income, and the highest level of education completed.

[1] In November 2011 the Canadian low-risk drinking guidelines were changed, now recommending that men and women limit weekly alcohol intake to no more than 15 and 10 standard drinks, respectively. Also, alcohol intake on any day should not exceed 3 standard drinks for women and 4 standard drinks for men.

Data analysis

Descriptive statistics are provided for AmED use among past 30 day drinkers and the total population aged 15+ on each covariate. Chi-Square tests were used to indicate whether there were significant differences in AmED use for each covariate. These estimates were adjusted for design effect using weighting variables. Separate multivariate regression analyses were used to investigate the relationships between AmED use and each outcome variable (i.e. drinking behaviour; alcohol use problems; harmful consequences; and risky behaviours). Using AmED as a dichotomous predictor, we compared individuals who consumed AmED in the past 30 days to those who only consumed alcohol in the past 30 days (Non-AmED), in order to understand the additional implications of adding energy drinks to alcohol. Age, sex, income, marital status, and education were used as covariates in the analyses. Where indicated, the volume of alcohol consumed in the past 12 months was also used as a covariate. Weighted data were not used for the regression analyses because the relationships *between* the variables were of interest, not estimating population prevalence. Additionally, a sample of 1,000 individuals from a province may not be that representative of the entire province, even when weighted. As a result, the analyses for this study aimed to understand the relationship between the variables of interest for the *individuals that were surveyed*. The objective of the analyses was to understand relationship between AmED use and drinking behaviour, alcohol use disorders, and risk behaviours within a large Canadian sample. Specifically, the analyses aimed to understand whether AmED use is associated with heavy drinking behavior, alcohol use disorders, and risky behaviours (e.g., driving after drinking).

Results

Demographics

A total of 13,615 participants completed the 2010 CADUMS. Of the 2010 CADUMS participants, 55% (n = 7,498) reported drinking alcohol in the past 30 days. Of these drinkers, 2.28% (n = 265) reported consuming AmED in the past 30 days (see Table 1). Of young adult (aged 18-24) past 30 day drinkers, 10.85% reported consuming AmED in the past 30 days. Estimates of other covariates were also investigated using weighted data in order to adjust for design effects. Rates of AmED use in past 30 day drinkers varied significantly by gender, age group, educational status, and marital status. After adjusting for the other covariates, participants who were male, between the ages of 18-24, had completed high school or some post-secondary education, or had a household income of $80,000+ were more likely to have consumed AmED in the past 30 days (see Table 2).

Drinking Behaviour

In multivariate linear regression analyses, the consumption of AmED was strongly associated with measures of drinking quantity, frequency, and volume, where the group who consumed AmED engaged in more drinking, more often, than past 30 day drinkers (see Table 3). Compared to past 30 day drinkers, participants who reported consuming AmED drank significantly more alcohol in the past 12 months, reported a higher number of days consuming alcohol in the past 30 days, and reported typically consuming more drinks on drinking occasions in the past 30 days and in the past 12 months.

In multivariate logistic regression analyses, the consumption of AmED was also strongly associated with risky drinking behaviours, where the group who consumed AmED engaged in more risky drinking behaviours than past 30 day drinkers (see Table 4). AmED consumers had increased odds of having five or more drinks in a single sitting once a month or more often and once a week or more often. Compared to past 30 day drinkers, those who had consumed AmED in the past 30 days had increased odds of typically consuming five or more drinks on days when drinking. They had increased odds of monthly and weekly heavy drinking, as defined by the gender-specific measure of four or more alcoholic beverages for females and five or more alcoholic beverages for males in a single sitting. Additionally, they had increased odds of exceeding the Canadian low risk drinking guidelines for weekly and daily sex specific limits. Overall, the results reveal that the consumption of AmED was associated with higher levels of alcohol use and risky drinking behaviours, compared to past 30 day drinkers who did not consume AmED.

Alcohol Use Disorder Indicators

Multivariate logistic regression analyses revealed that the consumption of AmED use was strongly associated with several indicators of alcohol use disorders. The group who consumed AmED had increased odds of exceeding a high-risk cut-off score of 8+ on the AUDIT and experiencing harms due to alcohol use, compared to those who only consumed alcohol in the past 30 days (see Table 5). Even after controlling for the volume of alcohol consumed in the past 12 months, those who had consumed AmED had increased odds of experiencing harms in the past 12 months from their alcohol use, than those who only consumed alcohol. We did not control for past 12 month volume of

alcohol use for the AUDIT scores as the AUDIT contains questions regarding alcohol consumption patterns. Finally, those who had reported consuming AmED were also significantly more likely to report feeling as though they needed help for their alcohol use in the past 12 months.

Risky Behaviours

Multivariate regression analyses revealed that those who had consumed AmED in the past 30 days, compared to past 30 day drinkers, had increased odds of being a passenger in a vehicle with a drunk driver, and driving after drinking, where the drivers had consumed 2 or more drinks in the previous hour (see Table 6). This relationship remained significant even after controlling for the volume of alcohol consumed in the past 12 months. Despite this, consumers of AmED in the past 30 days were not at increased risk of having experienced a motor vehicle accident when driving in the past 12 months compared to past 30 day drinkers. Finally, consumers of AmED had increased odds of having been in an incident involving physical aggression in the past 12 months, compared to past 30 day drinkers. Again, this remained significant after controlling for volume of alcohol consumed in the past 12 months.

Discussion

In this large Canadian community sample, approximately 2% of past 30 day drinkers had consumed alcohol and energy drinks in the past 30 days. This estimate is lower than what has been reported in another community survey (6%), although this other community survey was conducted in a community characterized by a relatively high prevalence of alcohol-related problems (Berger et al., 2011). The estimated prevalence of AmED use varied by age group, with young adults (ages 18-24) having the highest

prevalence of AmED use, where approximately 11% of past 30 day drinkers reported consuming AmED in the past 30 days. This is lower than estimates from North American college samples (24-26%) (Brache & Stockwell, 2011; Miller, 2008a; O'Brien et al., 2008), indicating that the college community may be at higher risk for AmED use. This could be related to the aggressive marketing strategies used by energy drink companies with this population (Heckman et al., 2010; Jones and Barrie, 2009; Simon and Mosher, 2007). The prevalence differences may also be due to different sampling techniques, and the possibility of college samples biased towards AmED users due to sampling techniques. AmED users were more likely to be male, between the ages of 18-24, never married, completed high school or have some post-secondary education, and have a higher household income. This is similar to what was found in the other community survey and other surveys of college students (Berger et al., 2011; Levy and Tapsell, 2007; Miller, 2008a; Miller, 2008b; O'Brien et al., 2008).

We found that AmED users consumed more alcohol, more often, than past 30 day drinkers who did not combine alcohol and energy drinks. AmED users also had increased odds of engaging in risky and heavy drinking in the past 12 months, compared to past 30 day alcohol only drinkers. We are among the first to have investigated the relationship between AmED and heavy drinking in a community sample where AmED users are compared to alcohol only users. These findings are similar to studies of college students, where AmED use was associated with higher levels of alcohol consumption, compared to past 30 day drinkers (Brache & Stockwell, 2011; O'Brien et al., 2008; Price et al., 2009; Thombs et al., 2010; Woolsey, Waigandt, & Beck, 2010). It appears that across samples, the use of AmED is associated with increased drinking and risky drinking behaviours,

compared to alcohol only drinkers, suggesting that there may be something about the addition of energy drinks to alcohol that increases risk of heavy alcohol use.

We also found that AmED use, compared to alcohol use alone, was associated with an increased risk of alcohol use disorders, as measured by several indicator variables. Importantly, this relationship remained significant even after controlling for volume of alcohol consumed in the past 12 months. To our knowledge, we are among the first to have investigated this significant relationship, where we specifically compared AmED use to past 30 day drinkers, and investigated more comprehensive symptoms of alcohol use disorders in community samples. Our results indicate that consuming AmED may increase one's risk of an alcohol use disorder, even after controlling for the amount of alcohol consumed. This may be due to an increased risk of experiencing problems or negative consequences when consuming AmED, potentially because of possible physiological effects (e.g., altered feelings of intoxication, increased motor coordination, quicker response speed) which might thereby increase the likelihood of alcohol poisoning and risky behaviours (Pennay, Lubman, & Miller, 2011). It may also be due to the increased risk of experiencing a variety of negative physical effects (e.g., severe hangover possibly affecting subsequent work productivity or driving performance, nausea/vomiting, fatigue, increased heart rate, heart palpitations, disturbed sleep) from dehydration or nervous system impairment after AmED use (Pennay, Lubman, & Miller, 2011). With regards to screening and intervention, our findings indicate that those who consume AmED should be screened for alcohol use disorders and the need for intervention.

Finally, we found that AmED use is significantly associated with risky behaviours such as driving after drinking, being a passenger in a vehicle with a drunk driver, and being involved in an incident involving physical aggression, compared to alcohol use alone. This is similar to relationships found in college samples (Brache & Stockwell, 2011; O'Brien et al., 2008; Thombs et al., 2010). Importantly, these relationships remained significant after controlling for volume of alcohol consumed, indicating that there may be something about the addition of energy drinks to alcohol that puts one at increased risk. Perhaps AmED users are more likely to participate in risky behaviours, like drinking and driving, because they have a subjective sense of being stimulated or less intoxicated (Ferreira et al., 2006). We did not find a significant difference between groups in the odds of having been in a motor vehicle accident when driving in the past 12 months. This is contrary to what might be expected, which is that the AmED group would have significantly higher odds of being in a motor vehicle accident, given their increased odds of driving after drinking. There could be several explanations for this including the low frequency with which motor vehicle accidents occurred in both groups giving us less power to detect differences. Nevertheless, perhaps some of the negative effects of alcohol which impair driving are attenuated by drinking energy drinks (Ferreira et al., 2004a; Marczinski and Fillmore, 2006; Marczinski and Fillmore, 2003), thereby reducing the risks of a motor vehicle accident compared to the use of alcohol alone, even if one is drinking and driving more frequently. Despite this, adding energy drinks to alcohol could also worsen one's ability to drive as it is associated with increased alcohol consumption and increased risk taking. As described above, the data regarding the attenuation of the negative effects of alcohol with AmED consumption are mixed

(Ferreira et al., 2006; Ferreira et al., 2004a; Ferreira et al., 2004b; Marczinski and Fillmore, 2006; Marczinski and Fillmore, 2003) and more evidence is necessary regarding driving capabilities when consuming AmED.

Several mechanisms have been proposed to explain the increased risk and harm from AmED use (Brache, Thomas, & Stockwell, 2012). These include a (1) decreased subjective awareness of intoxication; (2) caffeine masking the depressive effects of alcohol leading to longer and more active drinking sessions and (3) AmED use facilitating greater alcohol consumption, leaving consumers more intoxicated and perhaps more likely to experience alcohol use disorder symptoms. Individuals who have used AmED have been found to have decreased or altered perception of intoxication but continued deficits in motor coordination and visual reaction time, compared to alcohol use alone (Ferreira et al., 2006). The positive subjective effects of altered intoxication could lead to increased alcohol consumption as consumers of AmED may feel less intoxicated or more stimulated. Consumers may also be more likely to participate in risky behaviours, like drinking and driving, because they have a subjective sense of being less intoxicated or drowsy (Pennay, Lubman, & Miller, 2011).

Although the laboratory research appears to have mixed findings regarding the attenuation of alcohol's effect, some research suggests that the stimulant effects of caffeine attenuate some negative effects of alcohol like locomotor activity (Ferreira et al., 2004a; Marczinski and Fillmore, 2006). This attenuation may explain the increased risk of harm as the caffeine may mask the depressant effects of alcohol, potentially leading to longer and more active drinking sessions. This could lead the consumer to ingest alcohol in higher quantities and be more active while drinking despite being intoxicated and

experiencing impairment in other areas of functioning (Pennay, Lubman, & Miller, 2011). With increased activity, and similar levels of alcohol impairment, drinkers could be more likely to attempt activities demanding motor skills, like fighting, driving, or going to the bar to order another drink, than if they had only consumed alcohol.

Strengths and Limitations

Strengths of this study include the use of a large, community-based sample. To our knowledge, this study is one of the few that have investigated AmED use in a community sample. It also appears to be one of the first to investigate the relationships between AmED use and drinking behaviors, alcohol use disorders, and risky behavior, compared to alcohol use alone in a community sample. This allows us to gain a better understanding of whether the addition of energy drinks to alcohol increases risk for community populations in addition to college samples. It is important to understand whether the relationships between AmED use and alcohol problems found in college student populations are also occurring in community samples in order to help direct and devise interventions to reduce risk. Policies regarding alcohol and energy drinks would likely affect the use of these beverages for the entire population, which is why it is important to conduct research on AmED use outside of college samples.

The data is limited by its self-report nature and therefore may underestimate the prevalence of more risky or negative behaviors, however efforts were made to minimize this as the survey was anonymous. The data is also limited as only household landlines were eligible, thereby, leaving out important populations such as cell phone only households, individuals who are homeless, and individuals living in private and public institutions. The data is stratified by province, where some provinces with lower

populations had a larger proportion of their population represented in this survey. This limits the generalizability of the results, particularly for provinces where a smaller proportion of their population was surveyed. The data is also limited as only 1,000 individuals were surveyed from each province. Despite the attempt to have a sample representative of the Canadian population, the survey likely did not fully succeed in doing this as many populations may be left out and the proportion of Canadians surveyed is relatively low, although the use of data weighting was used in order to address these concerns. Finally, the cross-sectional design of this study does not allow causal relationships to be drawn about whether or not AmED use contributes to heavy drinking, risky behaviours, negative outcomes, and alcohol use disorders.

In conclusion, our study indicates that AmED use, compared to alcohol use alone, is associated with increased odds of heavy drinking, experiencing symptoms of an alcohol use disorder, and engaging in other risky behaviours (e.g. drinking and driving). These relationships appear to be similar to what has been previously found in studies investigating college students. We also found that AmED users were more likely to be male, between the ages of 18-24, never married, completed high school or have some post-secondary education, and have higher household incomes. These findings should be used to inform interventions and policy responses where differential information messages may depend on the subgroups being targeted. Future studies are needed to confirm and add to these findings. Of particular usefulness in terms of guiding interventions would be some additional research on motivations for AmED use.

Victoria Healthy Youth Survey

Methods

Procedures

The Victoria Healthy Youth Survey (VHYS) was collected at the Centre for Youth and Society in Victoria, British Columbia in the spring of 2003, 2005, 2007 and 2009. The VHYS was designed to contribute to the knowledge base concerning youth, health risks, and injuries. The survey was administered in-person by trained interviewers who met with individual youth either in their home, or in a location that provided a safe environment in which to respond. Informed consent was obtained from either the parents or guardians and from the youth. The VHYS included items on socio-demographics, family, peer, and school environments and substance use. Youth answered a two-part questionnaire; part one was administered and recorded by the interviewer and part two was read aloud by interviewers and recorded by the youth to ensure confidentiality regarding potentially sensitive issues such as use of illegal substances and sexual behaviour. Youth received a $25 gift certificate to a movie theatre, sporting goods, music or food store for their participation (Jansson, Mitic, Hulten and Dhami, 2006).

Participants

The participants were chosen from a random sample of 9500 private telephone listings. Of these listings 1036 households with an eligible youth (between the ages of 12 and 18 years) were identified. At Time 1, complete data were available for 664 youth between age 12 and 19 (M=15.5 years, SD = 1.93 years); 321 (48.3%) males and 343 (51.7%) females); with an overall response rate of 64% which is comparable to other national surveys (i.e. Canadian substance use survey; Health Canada, 2005). Further, this

randomly selected population was considered a representative sample of British Columbia adolescents. The living situation, parental education, and ethnicity reported by the youth in the sample were almost identical to that of the population from which the sample was drawn (Albrecht, Galambos & Jansson, 2007). Time 2 (2005) had an 87% response rate with 580 youth aged 14-20 (*M* =17.6 years, *SD* = 1.94 years); 273 (47.1%) males and 307 (52.9%) females. These youth were re-interviewed two years later. Time 3 (2007) had an 81% response rate with 540 youth aged 16-23 (*M* =19.5 years, *SD* = 1.95 years); 245 males (45.4%) and 294 females (54.4%).

The current analyses primarily used data collected at Time 4 (2009) as the questions regarding energy drinks were added for this fourth wave of data collection. Time 4 had a 69% response rate with 456 youth aged 18-26 (*M* = 22.3 years, *SD* = 1.97 years); 205 males (44.5%) and 255 females (55.3%). Analyses indicated that of the original Time 1 participants, participants who responded at Time 4 were significantly more likely to be female. The original participants had similar ethnic composition as Time 4 respondents. Compared to participants who did not participate at Time 4, analyses indicated that respondents at Time 4 did not have significantly different sensation seeking scores at Time 2 (when sensation seeking was first measured), and they did not have significantly different past week alcohol use at Time 1. Consequently, due to the response rate and some differences in the proportion of respondents at Time 4, this sample may not continue to be a representative community sample.

Measures

The current investigation used a subset of questions from the VHYS in order to investigate the relationship between AmED use, personality traits, and drinking

behaviour, alcohol use problems, harmful consequences, risky behaviours, and negative physical symptoms. Demographic variables of interest for the current study were age, gender, post-secondary attendance, ethnicity, and the personality variable of sensation seeking. Sensation seeking was measured with the widely used Zuckerman Kuhlman Personality Questionnaire for sensation seeking (Zuckerman, 1994). The Cronbach's alpha for this scale using the 2009 data was 0.76 which is considered to be good. Importantly, as described below, some measures of alcohol use, heavy drinking, alcohol use disorders, risky behaviours, and negative consequences, were different in the VHYS than the CADUMS survey. As a result the variables are operationalized differently in each survey and this should be considered when interpreting and comparing the results.

The respondents were asked the following questions in order to investigate their alcohol and energy drink use: (1) "How often do you consume energy drinks mixed with alcohol?" Response options were: never; once or twice a month; weekly (about 4 times per month); more often than once a week; and daily, and; (2) "After consuming energy drinks mixed with alcohol have you ever experienced the following: vomiting; insomnia, a bad hangover, shaking, dehydration, heart pain?" For each symptom, response options included: never; some of the time; half of the time; almost all of the time; always; unsure; N/A.

Several different measures of drinking behaviour were used in the current study. The number of drinks in the last 7 days was measured by a weekly schedule. Respondents were asked "Starting yesterday and looking back over the last 7 days, how many drinks of alcohol did you have each day?" To measure typical drinking behavior, respondents were asked "In the past 12 months, how many drinks did you usually have on one

occasion?" To measure the frequency of drinking, respondents were asked "How often in the past 12 months have you had a drink of beer, wine, liquor or any other alcohol beverage?" To measure frequency of heavy drinking, respondents were also asked "How often in the past 12 months have you had 3 or more drinks on one occasion?" They were also asked the same question for having "5 or more drinks." Response options for all three frequency questions were never; a few times/year; a few times/month; once a week; more than once a week. For the purposes of the current analyses responses for frequency of drinking were categorized into those who reported consuming a drink once a week or more frequently vs. those who reported consuming less frequently. The responses for frequency of heavy drinking were categorized into those who reported consuming "3 or more" or "5 or more" drinks a few times a month or more often. The use of proportional odds modeling was investigated for these variables but was not used due to different odds for each drinking frequency. Finally, heavy drinking was also measures by the question "In the past 12 months, have you had 3 or more alcoholic drinks, -within a 3 hour period, - on 3 or more occasions?" Response options were yes or no.

Alcohol use disorder indicators were measured using a variety of measures. The CAGE, a widely used screening test for problematic alcohol use, was used as a measure of alcohol use problems (Ewing 1984). It consists of four questions asking participants if they felt that they should "cut down" on their drinking, whether people had "annoyed or criticized" them on their drinking, whether they felt "bad or guilty" about their drinking, and whether they had a "drink first thing in the morning to steady nerves or get rid of a hangover." Response options were "yes" or "no." Two or more "yes" responses were considered to meet CAGE criteria for "suspected alcohol abuse." The Harmful Effect of

Alcohol Scale was also used in the current analyses. This scale is an adaptation of alcohol problem use scale used by CAMH (http://notes.camh.net/efeed.nsf/feedback) and also used by Alcohol Help Center, (http://www.alcoholhelpcenter.net). For this scale respondents were asked "was there ever a time that you felt your alcohol use had a harmful effect on your…(a) friendships or social life; (b) physical health; (c) outlook on life (happiness); (d) home life or marriage; (e) work, studies or employment; (f) financial opportunities?" Response options were "yes or no"; and if yes then, "yes or no" in the past 12 months. The scale score is the sum of "yes" responses for the past 12 month harmful effect of alcohol questions. For an earlier version of this scale see (Hilton, 1987). Other questions regarding diagnostic criteria for alcohol abuse and dependence were taken from the MINI International Neuropsychiatric Interview (M.I.N.I.). The scales can be used to help determine diagnostic status. The M.I.N.I. was designed as a brief diagnostic structured interview for the major Axis I psychiatric disorders in DSM-IV and ICD-10. It has been validated against other widely used structured interviews (e.g. SCID-P; CIDI) and has similar reliability and validity, but can be administered in a much shorter period of time (Lecrubier et al., 1997; Sheehan et al., 1997). For the current analyses, responses on the MINI regarding abuse and dependence criteria were used in both scale format (i.e., number of symptom criteria endorsed), and categorically (i.e. meeting diagnostic criteria for abuse or dependence).

Potential harmful consequences and risky behaviours that were investigated in the analyses are the experience of a serious injury in the past 12 months, and whether alcohol was involved in this serious injury. A serious injury was defined as "serious enough to limit your normal daily activities" and examples such as broken bones, bad cuts, or

sprains were given. Other risky behaviours included participants having "started a fight and struck someone" in the past year, past 30 day frequency of driving a car or other vehicle after drinking, and past 30 frequency of riding in a car or other vehicle driven by someone, including parents, who had been drinking alcohol. Sexual risk-taking was also investigated. Participants were asked "Do you use some form of contraception or birth control to guard against pregnancy when having sexual intercourse?" The same question was asked for use of "protection against sexually transmitted infections (STIs)." Examples were provided. Response options were never; sometimes, or; always. For the purposes of the current analyses those reporting "never" using were compared to those reporting "sometimes or always." Participants were also asked if they had ever been told by a doctor or nurse that they had a STI. Response options were "yes" or "no" and examples of STIs were provided.

Data Analysis

Demographic statistics are provided for past 12 month drinkers and the total sample. Chi-Square tests and independent samples t-tests were used to explore differences in demographic variables among participants using AmED and between those using AmED in the past month and those who did not. Multiple logistic regression analyses were used to investigate differences between drinkers who used AmED in the past month and those who did not, in order to understand the additional implications for those who add energy drinks to alcohol. Separate multivariate logistic regression analyses were completed for each investigated drinking behavior, alcohol use disorder indicator, and risky behavior. For these analyses AmED was entered as a dependent variable and the drinking behavior, alcohol use disorder indicator, and risky behavior were entered as

independent variables. This allowed the presentation of the associations to be simpler (e.g., not needing separate linear and logistic regression tables) and helped address concerns regarding violations to assumptions of normality that would be problematic for linear regression analyses. Since the data for all variables were collected at the same time point, for the current analyses we can only determine significant associations and not determine causality. For these reasons, it is appropriate to conduct logistic regressions with AmED as a dependent variable, as we are not determining whether AmED is a causal predictor of each variable or behavior.

A final set of separate multivariate logistic regression analyses were included where frequency of AmED use (entered as the independent variable) was investigated as a predictor of engagement in risky behaviours or experience of negative outcomes (dependent variables). AmED was split into three categories: none used in the past 30 days; AmED used once or twice a month in the past 30 days, and; AmED used weekly or more often in the past 30 days. This was included in order to investigate whether more frequent AmED use was associated with each risky behavior or negative outcome.

For each variable of interest several models were run controlling for (1) demographic variables (age, sex, education), (2) sensation seeking, and, where appropriate, (3) typical alcohol use (calculated as the number of drinks consumed in the past 7 days). Typical alcohol use was included in a third model in order to investigate whether the relationship between AmED and each variable remained significant after controlling for typical alcohol consumption, as the alcohol consumption between AmED and non-AmED groups tends to differ and may account for differences in the alcohol use disorder indicators or engagement in risky behaviours.

Finally, a table summary and graph of reported negative physical symptoms experienced after AmED use was provided.

The objective of the analyses was to understand the relationship between AmED use and drinking behaviour, alcohol use disorders, risk behaviours, and negative consequences after controlling for sensation seeking. Specifically, the analyses aimed to understand whether AmED use is associated with heavy drinking behavior, alcohol use disorders, risky behaviours (e.g., driving after drinking), and negative outcomes (e.g., serious injury).

Results

Demographics

A total of 456 participants completed the 2009-2010 Victoria Healthy Youth Survey. Of the 2009-2010 participants, 95% (n = 436) reported drinking alcohol in the past 12 months. Of these drinkers, 43.6% (n=190) reported consuming AmED in the past 30 days (see Table 7). Rates of AmED use in past year drinkers varied significantly by gender, age, and sensation seeking. It did not vary significantly by educational attainment or ethnicity. Participants who were male, were younger, and had higher levels of sensation seeking were more likely to have consumed AmED in the past 30 days.

Drinking Behaviour

In separate multivariate logistic regression analyses, the consumption of AmED was strongly associated with measures of drinking quantity, frequency, and volume, where the group who consumed AmED engaged in more drinking, more often, than drinkers who did not consume AmED in the past 30 days (see Table 8). Compared to alcohol only drinkers, participants who reported consuming AmED drank significantly

more alcohol in the past week, reported a higher frequency of weekly alcohol use, and reported a higher number typical drinks consumed per drinking occasion. These differences remained significant even after controlling for sensation seeking. With regards to risky drinking behaviours, the consumption of AmED was strongly associated with engagement in risky drinking practices. Those who consumed AmED in the past 30 days were more likely than non-AmED drinkers to have had "three or more" and "five or more" drinks per occasion with a frequency of a few times a month or more often. AmED users were also more likely than alcohol only drinkers to have had three or more drinks within three hours on three or more occasions in the past year. The significant association between AmED use and all heavy drinking variables remained significant after controlling for sensation seeking. Overall, the results reveal that the consumption of AmED was associated with higher levels of alcohol use and risky drinking behaviours, compared to past 12 month drinkers who did not consume AmED, even after controlling for demographic variables and sensation seeking.

Alcohol Use Disorder Indicators

Separate multivariate logistic regression analyses revealed that the consumption of AmED use was significantly associated with several indicators of alcohol use disorders. After controlling for demographic variables and sensation seeking, the use of AmED use was significantly associated with higher scores on the CAGE, harmful effects of alcohol scale, MINI alcohol abuse scale, and the MINI alcohol dependence scale (see Table 9). AmED use was also significantly associated with meeting criteria for suspected alcohol abuse on the CAGE, alcohol abuse on the MINI, and alcohol dependence on the MINI. After controlling for typical weekly alcohol consumption, AmED remained

significantly associated with three variables: meeting criteria for alcohol abuse on the MINI alcohol abuse scale, meeting criteria for alcohol dependence on the MINI alcohol dependence scale, and having higher scores on the MINI alcohol dependence scale than alcohol only drinkers.

Risky Behaviours/Negative Outcomes

In separate multivariate logistic regression analyses, when controlling for demographic variables and sensation seeking, AmED use was significantly associated with starting a fight and striking someone in the past 12 months, an increased frequency of drinking and driving, and an increased frequency of being a passenger in a vehicle where the driver had been drinking (see Table 10). When controlling for past week alcohol consumption, frequency of drinking and driving was no longer significantly associated with AmED use. AmED use, compared to alcohol only use, was not significantly associated with never using birth control or protection from sexually transmitted infections, ever having had a sexually transmitted infection, serious injury in the past 12 months, or alcohol-related serious injury in the past 12 months.

In another set of analyses, using separate multivariate logistic regression analyses, frequency of AmED use was investigated as a predictor of risky behaviours/negative outcomes in order to determine whether increased frequency of AmED use was associated with a different level of risk, when compared to alcohol only drinkers (see Table 11). Starting a fight and striking someone was significantly associated with once or twice monthly, and weekly or more AmED use, even after controlling for demographic variables, sensation seeking, and past week alcohol use. Weekly or more frequent, but not

once or twice monthly, AmED use was significantly associated with having ever had a sexually transmitted infection, even after controlling for all covariates.

Negative Physical Symptoms

Participants provided frequency of experiencing negative physical symptoms after AmED use (see Figure 3). The majority of participants had never experienced insomnia, shaking, heart pain or vomiting after AmED use. Despite this, an important minority had experienced heart pain (10.2%), insomnia (20.8%) and shaking (26.1%) with differing frequencies after AmED use (see Table 12). Over a third of participants (35.6%) reported having experienced vomiting (with differing frequency) after AmED use. The majority of participants reported having experienced some frequency of a "bad hangover" (69.3%) and dehydration (70.0%) after AmED use. Of those investigated, these appeared to be the most commonly endorsed negative physical side effects after AmED use.

Discussion

In this young adult community sample, approximately 44% of drinkers had consumed AmED in the past 30 days. This prevalence appears to be much higher than the past 30 day prevalence in young adults (11% in Canadians aged 18-24) found in the CADUMS data reported previously. The prevalence appears to be closer to college samples, where researchers have reported finding a range of prevalence (e.g., 24-48%) of AmED use among student samples (Brache & Stockwell, 2011; Miller, 2008a; O'Brien et al., 2008; Oteri et al., 2007). Similar to previous research, AmED users were more likely to be male, younger, and higher in sensation seeking, but unlike some samples there were no differences in current school enrolment or ethnicity (Brache & Stockwell, 2011;

Berger et al., 2011; Levy and Tapsell, 2007; Miller, 2008a; Miller, 2008b; O'Brien et al., 2008).

We found that AmED use was associated with increased drinking and increased heavy drinking compared to alcohol only users. This is similar to previous research in college samples (Brache & Stockwell, 2011; O'Brien et al., 2008; Price et al., 2009; Thombs et al., 2010; Woolsey, Waigandt, & Beck, 2010). Importantly, the current research, adds to previous research, by supporting that the association between AmED use and heavy drinking is not limited to convenient college samples (which has been a previous criticism of that research). The current study's findings indicate that not only is AmED use relatively prevalent among a young adult community sample, but that the associations found in college samples between AmED use and increased heavy drinking are also prevalent in a community sample. Importantly, our findings indicate that this is the case even after controlling for sensation seeking, a variable which is widely cited as a potential explanation for this association.

Similar to some more recent research findings (Berger et al., 2011; Cheng et al., 2012; Eckschmidt et al., 2013), our results found that AmED use is associated with a variety of measures used to indicate alcohol abuse, alcohol dependence, and other harmful effects from alcohol use. Importantly, meeting the criteria for alcohol abuse and alcohol dependence on the MINI alcohol use disorder scales was significantly associated with AmED use even after controlling for demographic variables, sensation seeking, and past week alcohol use. These findings go beyond previous research as they investigated sensation seeking and used more comprehensive measures of alcohol use disorder criteria. As noted previously, this association may be due to an increased risk of

experiencing problems when consuming AmED because of a possible reduced sensitivity to the signs of alcohol thereby increasing the likelihood of alcohol poisoning and risky behaviours (Pennay, Lubman, & Miller, 2011). With regards to screening and intervention, our findings indicate that those who consume AmED should be screened for alcohol use disorders and the possible need for intervention. Importantly, our findings indicate that some current screening tools, such as the CAGE, appear to capture only a small portion of the individuals consuming AmED as being suspected for alcohol abuse (13.2%), whereas other tools such as the MINI scales indentified higher proportions of AmED users as meeting criteria for alcohol abuse (43.7%) and alcohol dependence (35.3%). There is evidence that the CAGE does not have good validity as a screen for heavy drinking and drinking problems in Canadian general population surveys as it does not discriminate well between heavy and non-heavy drinkers or present a good sensitivity, a good specificity, and a good positive predictive value (Bisson, Nadeau, & Demers, 1999). The CAGE is likely not the most sensitive measure due to its few items, the lack of assessment of a variety of negative consequences or harms from drinking, and the influence that the social climate and cultural expectations regarding drinking have on one's answers to the CAGE questions even when one's drinking is not necessarily abusive (Bisson, Nadeau, & Demers, 1999). Perhaps asking about AmED use may be used in addition to the CAGE, or another more valid screening tool, as a quick screener for alcohol use problems in a young adult population, with more questions to be asked as follow-up.

Finally, we found that AmED use is significantly associated with risky behaviours such as being a passenger in a car where the driver has been drinking and being more

likely to have started a fight and striked someone in the past year, when controlling for sensation seeking, and past week alcohol use. This indicates that there may be something about the addition of energy drinks to alcohol that increases their risk of injury from engaging in such behaviours. This is similar to relationships found in college samples (Brache & Stockwell, 2011; O'Brien et al., 2008; Thombs et al., 2010). Drinking and driving was found to be associated with AmED use when controlling for demographic variables and sensation seeking, but it was no longer significant after controlling for past week alcohol use. We did not find significant relationships between AmED and other risky behaviours or negative outcomes such as never using birth control, never using protection from STI's, ever having a STI, being seriously injured in the past 12 months, or having a serious injury involving alcohol in the past 12 months. These findings are somewhat different than previous studies (O'Brien et al., 2008; Snipes & Benotsch, 2013), although there have been mixed findings regarding AmED and sexual risk taking (e.g., Snipes et al., 2014; Spierer, Blanding, & Santella, 2014). Differences may be due to the nature of the questions regarding sexual behavior and seriousness of an injury.

Despite increased odds of risky behaviours (e.g., drinking and driving, fighting), we did not find significant differences between groups in the odds of having had a serious injury or alcohol-related serious injury in the past 12 months. This is contrary to what might be expected, which is that the AmED group would have significantly higher odds of being seriously injured, given their increased odds of driving after drinking, being a passenger in a vehicle where the driver had been drinking, and starting a fight. There could be several explanations for this including the potential low frequency with which a motor vehicle accidents occur. Nevertheless, perhaps some of the negative effects of

alcohol which impair driving are attenuated by drinking energy drinks (Ferreira et al., 2004a; Marczinski and Fillmore, 2006; Marczinski and Fillmore, 2003), thereby reducing the risks of a motor vehicle accident compared to the use of alcohol alone, even if one is drinking and driving more frequently. Despite this, adding energy drinks to alcohol could also worsen one's ability to drive as it is associated with increased alcohol consumption and increased risk taking. As described above, the data regarding the attenuation of the negative effects of alcohol with AmED consumption are mixed (Ferreira et al., 2006; Ferreira et al., 2004a; Ferreira et al., 2004b; Marczinski and Fillmore, 2006; Marczinski and Fillmore, 2003) and more evidence is necessary regarding driving capabilities when consuming AmED.

To further investigate the association between AmED use and risky behaviours, particularly the potential for a causal relationship, the frequency of AmED use and its association to risky behaviours or negative outcomes was investigated. Our result indicated that any frequency of past month AmED use was significantly associated with starting a fight, compared to those who only consumed alcohol. Our findings also indicated that weekly or more users of AmED use, but not 1-2x/monthly users, was associated with ever having been diagnosed with a STI. These findings provide some preliminary evidence on how frequency of AmED use may be differentially associated with risk outcomes. They may also provide insight into the potentially mixed research findings regarding AmED use and sexual risk taking/ negative outcomes, which may be related to frequency of AmED use. This area is important to explore in future research.

Finally, we investigated the frequency with which participants experienced negative physical symptoms after consuming AmED. Having a "bad hangover" and being

"dehydrated" were the more commonly reported physical symptoms, and were reported to occur more frequently compared to other physical symptoms after AmED use. Dehydration is known to occur with alcohol and energy drink use due to the diuretic properties of both caffeine and alcohol (Pennay, Lubman, & Miller, 2011). More infrequently reported but concerning symptoms include heart pain, shaking, and vomiting. Some of these symptoms (e.g., heart pain) may be related to physical or biochemical changes from frequent energy drink or AmED use (Ugwuja, 2014). These may be related to changes in plasma potassium or plasma triglyceride levels which can lead to cardiac abnormalities, as evidenced by energy drink and AmED research in rats (Ugwuja, 2014). Unfortunately, our data are limited as we did not assess the occurrence of negative physical symptoms after consuming alcohol alone; therefore, we are unable to determine the relative frequency of negative AmED symptoms compared to the relative frequency of the same symptoms after consuming alcohol alone. Despite this, heart pain may be a physical symptom that does not commonly occur after alcohol use alone, but was experienced "some of the time" or more often in 10% of participants. Although this is a minority of experiences, it is likely still an important area for further investigation given the nature of the symptom.

Overall, the results indicate that sensation seeking personality does not seem to be that influential of a variable in explaining the associations between AmED use and heavy drinking, potential alcohol use disorders, risky behaviours, and negative outcomes. Although sensation seeking is predictive of AmED use, it does not fully explain the links between AmED use and associated variables. This may be due to the existence of other possible third variables which explain the associations between AmED and heavy

drinking, risk behaviours, and negative consequences. Other third variables could be other personality traits (e.g., impulsivity), non-measured demographic variables, contextual variables (e.g., influence of staying in a drinking venue for longer hours, type of drinking venue, peer influences, marketing messages), or expectancies and motivations. The results could also indicate that there may be something about the combination of energy drinks with alcohol that could put individuals at increased risk of heavy drinking, alcohol use problems, engaging in risky behaviours, and experiencing other negative outcomes, independent of sensation seeking, and demographic variables. Importantly, some of these relationships remained significant after controlling for volume of alcohol consumed, indicating that there may be something about the addition of energy drinks to alcohol that puts one at increased risk, independent of the potential for increased alcohol consumption with AmED use. These associations could be due to the physiological effects of AmED use (e.g., altered sense of intoxication, attenuation of some alcohol-related deficits such as response speed, priming alcohol use), changes in drinking patterns and associated behaviours that may occur due to AmED use (e.g., staying in a drinking venue for longer), and the possibility that AmED use may have an effect on momentary decision making leading to increased risk behaviours, which may be greater than the effect of general sensation seeking personality on decision-making. It is possible that the relationship between AmED use and heavy drinking, risk behaviours, and negative consequences is determined by multiple influences, rather than simply accounted for by differences in sensation seeking personality. Due to the complex nature of human behavior and decision making, it is probably more likely that decisions and behaviours associated with AmED use and risk behaviours are multi-determined. Future

research should continue to investigate sensation seeking and other personality variables, as there is a need to both replicate these findings and a need to use multiple methodologies (e.g., within subject designs). Also, future research should consider more variables which may explain the associations between AmED use and heavy drinking, risk behaviours, and negative consequences. Understanding how much of these associations are derived from different factors has been called for in future AmED research (Miller, 2013a).

Strengths and Limitations

Strengths of this study include the use of a relatively large, community-based sample thereby allowing the investigation of relationships between AmED use and alcohol related problems outside of a college sample. It is important to understand whether the relationships between AmED use and alcohol problems found in college student populations are also occurring in community samples in order to help direct and devise interventions to reduce risk. To our knowledge this is one of the few community based samples investigating AmED use. It is also one of the few samples which measures and controls for sensation seeking, a potentially important personality variable when investigating AmED use. Another strength of this study includes the use of well-established research tools to examine sensation seeking, alcohol use, alcohol abuse, and alcohol dependence.

Despite the strengths of this research, the data are limited in a variety of ways. This survey data was self reported and may therefore underestimate the prevalence of more risky or negative behaviors. Consequently, anonymity was enhanced by having portions of the interview that contain sensitive material to be collected anonymously on a

self administered portion of the survey. Questions about energy drink use, alcohol use, sexual behaviour, and personality were asked in this confidential self-administered portion. The survey was designed to be a representative community survey of Victoria adolescents and young adults. Our data is limited due to the 69% response rate for the Time 4 wave of data collection used for this study. Despite this, our analyses suggest that most variables of interest (e.g., sensation seeking, typical alcohol use) did not differ significantly between participants who completed Time 4 and those who completed previous waves of the survey. One significant difference was that females were more likely than males to complete Time 4 of the study. As a result the current data may underestimate the prevalence of AmED use in this community sample, as males were more likely to use AmED and they may be underrepresented in the current wave of data. Due to these differences there may also be limitations in our ability to generalize to the community as a whole. Despite this, the survey data allowed for the investigation of the relationships between AmED use and the other variables of interest, which did not appear to differ between participants who did or did not complete Time 4 of the study. Further limitations include the cross-sectional design of this study which does not allow causal relationships to be drawn about whether or not AmED contributes to heavy drinking, risky behaviours, negative outcomes, and alcohol use disorders.

The data analyses were also limited to between subject comparisons. Having between subject and within subject comparisons of alcohol consumption with and without energy use could offer better support for increased alcohol use when combining AmED. The possibilities of within subject analyses were originally planned for the study. Unfortunately in the final stages of preparation of the survey questions a member of the

overall research team altered some of the energy drink questions in an apparent attempt to simplify them, consequently changing the nature of the question. This change was not caught prior to the completion of the interviews by participants. As a result, within-subject analyses investigating differences in drinking patterns when using alcohol alone vs. combining alcohol with energy drinks were not possible with the current data set. Another limitation of the data was only having reported negative physical symptoms of AmED use, and not of alcohol use alone, for possible within-subject comparisons. This is an important area for future research in this field due to the current variability in within and between subject research findings on AmED use.

In conclusion, our study indicates that AmED use, compared to alcohol use alone, is associated with increased odds of heavy drinking, experiencing symptoms of an alcohol use disorder, and engaging in other risky behaviours (e.g. starting a fight). These relationships appear to be similar to what has been previously found in studies investigating college students. We also found that AmED users were more likely to be male, younger, and to have higher levels of sensation seeking. These findings should be used to inform interventions and policy responses where differential information messages may depend on the subgroups being targeted.

University of Victoria Student Survey 2009/ 2010

Methods

Procedures

Students at the University of Victoria were recruited from November, 2009 until February, 2010 by posters and recruitment emails to complete an online survey about alcohol and energy drinks. The posters were in all buildings on campus and the emails were sent to all faculty secretaries on campus in order to widely sample the university student population. Faculty secretaries were directed to forward the recruitment email, which contained a link to the survey, to all students in their faculty. All participants who responded to the posters on campus were emailed a link to the online survey. Informed consent was given for participation in the research. Students were compensated $10 for their participation in the study. This research was approved by the University of Victoria Research Ethics Board.

Participants

All of the 19, 244 students attending the university were eligible to complete the survey until a maximum number of 501 survey responses were collected. A total of 501 participants began the online survey, with 465 participants (93%) fully completing the survey with valid data. Of those who began the online survey 31 participants (6%) did not fully complete the survey, therefore, they were not included in the analyses for the present study. Completers did not differ significantly from non-completers on age, sex, and past 30 day consumption of AmED, however, non-completers were less likely than completers to have consumed alcohol in the past 30 days (75% vs. 88%). Four participants reported that they were not students at the University of Victoria and, as a

result, their data was removed. One participant's data was removed as they were inconsistent regarding whether they had consumed alcohol in the past 30 days.

Measures

The survey was comprised of questions relating to student's alcohol consumption, energy drink consumption, and their combined alcohol and energy drink consumption over the past 30 days. The assessment of AmED consumption included the consumption of premixed alcoholic energy drinks (e.g. "Rockstar with vodka") and, the more common phenomenon, of manually mixing an energy drink with alcohol (e.g. where an individual or bartender would mix Red Bull with Jägermeister) (Berger, Fendrich, & Fuhrmann, 2013). Other variables surveyed included their past year stimulant substance use, risk taking tendency, harmful consequences, and risk taking behaviours when combining alcohol and energy drinks (e.g. drinking and driving, injury). The relationships between these variables have been previously investigated and published (see Brache & Stockwell, 2011).

The survey also comprised of questions regarding motivations for combining alcohol and energy drinks. Participants were asked "why do you mix energy drinks with alcohol?" They were given specific response options and were instructed to mark all that apply. Please see Figure 1 and Brache, Thomas, & Stockwell (2012) for a look at those options and the endorsement by participants in this survey. Participants were also asked "What are your main reasons for drinking energy drinks?" and "What are your reasons for drinking energy drinks mixed with alcohol?" After each question participants were given space to enter their own written response. Of interest for this investigation is analyzing the participant's qualitative responses to these two questions.

Data Analysis

Each participant's answers to the two questions identified above underwent an extensive content analysis. Content analysis is "a technique used to extract desired information from a body of material by systematically and objectively identifying specified characteristics of the material" (Smith, 2000, p.314). Through content analysis a large body of qualitative information can be reduced to a smaller more manageable form of representation. First, all answers were thoroughly read. Following this, an extensive list of codes was created that was subsequently used to classify the information. Some examples of codes specific to reasons for combining these substances would be for "taste," continued partying, and/or social bonding. For an extensive listing of the codes used for the current content analysis see Table 13 and Table 14. After creating a list of codes, each participant's answers were coded using this list of codes. Where necessary, additional codes were added to the coding list. The list of codes was sufficiently detailed to make all necessary distinctions, but sufficiently abstract to be applicable to an unlimited number of novel responses (Bartholomew, Henderson, & Marcia, 2000). The codes came from both *a priori* (the categories are specified from previous research) and empirical (the categories emerged from the material to be analyzed) approaches (Smith, 2000).

The codes and themes from the participant's responses were summarized in descriptive and numerical displays (see Table 13 & 14). The results of the analyses are presented below using many participants' quotes to represent the different codes/themes for motivations for use. The quotes were chosen to be ones that were representative of the overall motivations for combined use. The analyses and summary below have attempted

to understand how different AmED and energy drink variables (patterns of use, contexts of use, associated harms, and risk-taking behaviours) may be related to the participant's motivations for use. Despite this, I have attempted to remain cautious to not overly speculate whether certain motivations are associated with increased risk over others. The analyses below attempt to describe a relationship pattern between these variables. This was done with the objective of gaining an understanding of what constellations of factors put people at risk for harm when combining alcohol and energy drinks.

Additionally, participants' reasons for using energy drinks alone were analyzed and compared to their reasons for using energy drinks in combination with alcohol. This could enable a greater understanding of when these reasons may overlap, and when they may differ. This may allow us to gain insight into what contributes to the combined use of alcohol and energy drinks, as opposed to the use of energy drinks alone.

Overall, the objective of the qualitative analyses was to gain a better understanding of the self-reported reasons for combining energy drinks and alcohol. Additionally, the analyses aimed to help clarify possible reasons for the associations between AmED use, heavy drinking, and possible risk behaviours.

Results

Motivations for AmED Use

In response to the open question "What are your reasons for drinking energy drinks mixed with alcohol?" 188 participants (40% of the sample) gave motivations for AmED use. As described below, students reported a wide variety of reasons for use, with some reasons being reported much more frequently than others. The reasons for use will

be described below and many quotes from participants will be provided in order to illustrate the participant's varied motivations for use.

Taste.

By far, the most common reason given for AmED use was an enjoyment of the taste of the beverage and the variety of ways energy drinks can be mixed with alcohol in order to enhance the taste of an alcoholic beverage. Many participants simply reported that they enjoyed the taste of the AmED beverage. One participant described that when combining alcohol and energy drinks,

"They create a unique flavour that nothing else replicates."

Participants described how energy drinks are a good mixer with alcohol as they provided an attractive beverage flavour:

"It mixes well (tastes good and I can taste the alcohol less)."

"It's just a mixer for alcohol that I don't want to drink straight, or it makes a cocktail that tastes better than the sum of its parts."

"It's a great chase and perfect mixer"

"I like the taste of the combination (chasing alcohol with something)"

Participants also reported a particular liking to a certain energy drink and alcohol combination commonly referred to as a Jagerbomb. Jagerbombs are drop shots which are mixed by dropping a shot of Jagermeister into a glass of Red Bull. Some participants responded to the survey question by simply writing that their reason for combining AmED is "Jagerbombs." Others provided more of an explanation regarding the attraction to this particular beverage, specifically referring to its good taste. Several of the

participants also described how consuming a Jagerbomb may be the only occasion where they consume AmED:

"Jagerbombs are amazing and taste like candy."

"They are tasty (ok I have to admit it, I LOVE the taste of a Jagerbomb)"

"Because Jagerbombs taste better than most other shots."

"You can't have a Jagerbomb without the Redbull."

"On occasion, I will have a few Jagerbombs because they taste good."

"Something to mix Jager with, purely for taste"

"I only have energy drinks when I am drinking Jagermeister."

"Jagerbombs is pretty much the exclusive reason."

"Jagerbombs taste good, that is the only reason or case where I mix the two. Otherwise, I don't drink energy drinks mixed with alcohol"

"I rarely do it; the hype of a Jagerbomb is the only reason. They also taste quite delicious."

"I only drink energy drinks with alcohol when I am drinking Jagermeister, because they seem to go well together."

Participants also reported consuming AmED as the combination would hide the flavour or taste of alcohol, thereby making the drinks more attractive.

"To hide the flavour of the alcohol. The only times I have drank it with alcohol the purpose has been to use it as a mix for the alcohol."

"It completely overpowers the taste of the alcohol."

"tastes good, disguises the taste of alcohol pretty well, easy cocktail to mix"

"tastes good, masks the taste of alcohol"

Overall, the most commonly reported reason for consuming AmED was due to the attractive taste, whether it is the taste in general, due to a specific beverage, or because it hides the flavour of alcohol. It is likely that enjoying the taste of the beverage or hiding the undesirable taste of alcohol could contribute to increased alcohol use.

Stimulant effects.

After taste, the most commonly reported reasons for consuming AmED was for the desired stimulant effects including wakefulness, alertness, increased arousal, and increased energy.

Wakefulness.

Participants often reported consuming AmED in order to help them stay awake, feel more awake, or stay up later when drinking:

> "If I'm going to a show and I'm drinking, I often get sleepy. Thus, I drink energy drinks to stay awake longer."
>
> "To give me a lift when I'm tired before going out or going to a party. Also to stay awake later at night while drinking."
>
> "If I am tired before partying I will choose to mix alcohol with energy drinks so that I can stay awake and party longer and have fun."
>
> "It's an easy drink to mix and helps me stay awake longer (if I am feeling tired) than when I am simply drinking alcohol alone."
>
> "It tastes good, and keeps me awake to party"
>
> "They keep me awake while drinking and it tastes really good"
>
> "Restoring wakefulness while drinking"

"to not feel as sleepy, to get more energy, to get rowdy fun- instead of pass out drunk"

"Alcohol makes me sleepy sometimes, even if it is only one or two drinks. Mixed energy drinks help keep me awake so I can have fun with my friends or family during late nights."

"Staying awake to party longer, tastes good."

"Keeps me going after working all day so I don't get sleepy at 10pm"

"Keeps you awake / full of energy"

Increasing wakefulness was a key motivation for using AmED for many participants. They described using AmED to increase wakefulness in order to stay out longer and to party longer. They also describe using it in order to attenuate some of the depressant effects of alcohol. Some participants specifically referred to desiring the stimulant effects of the caffeine in order to enhance their level of wakefulness when drinking alcohol:

"It gives me a caffeine buzz with the alcohol, and it's a good way to start the night, or to stay awake if I'm getting tired."

"Give me a boost of caffeine when I know I will be up late drinking."

Increased alertness.

Several participants stated that one of their reasons for consuming AmED was a desire to feel more alert when consuming alcohol:

"It helps make you feel more alert when you are tired and tastes good."

"Increased alertness & buzz"

"I like Jagerbombs. Keeps more alert if I'm drinking, or want to take the edge off a little while studying."

Increased energy.

Participants also commonly reported using AmED in order to gain increased energy while drinking. They often referred to receiving an energy boost from AmED use:

> "It gives me an energy boost and helps me stay up longer when I'm going to be out all night (alcohol makes me feel sleepy sometimes)."
>
> "It tastes great and it gives me more energy when binge drinking"
>
> "Energy boost while drinking. Stay up longer."
>
> "Because you get energy, and retard your thought processes at the same time."
>
> "If I'm going to mix hard liquor with something, why not add something with a little energy attached to it."

Participants also reported that this energy boost was something they may seek before going out drinking:

> "good way to get the energy boost of caffeine plus the effects of alcohol. ex. if you're about to go out and want to start drinking but you're feeling tired you can have mix the two for efficiency"
>
> "to get amped, especially when tired before a night of drinking or when hungover"
>
> "I drink them beforehand and only for energy"

Relatedly, participants also reported using AmED as they were seeking more energy for "partying:"

> "it tastes good and usually when I drink alcohol without energy drinks I get fairly tired feeling and laid back. When I add energy drinks I am energetic and feel like partying more and dancing."
>
> "It tasted good. And I needed energy to get into a party mood."

"like the way it tastes and gives me more energy to party"

"so that I can keep partying and partying and partying..."

"to give me more energy so I can stay out longer/dance more"

"to avoid crashing while partying."

"I would say that it allows me to party longer"

Many participants' motivation for AmED use was to increase stimulating effects, often with the goal of helping them stay awake longer and to have more energy to party longer. They appeared to be motivated to help them stay our longer on drinking occasions. Being in drinking venues longer and feeling more stimulated is likely to be associated with increased alcohol use.

Pre-drinking.

Participants reported consuming AmED, or energy drinks alone, prior to a night of drinking. This theme can also be observed in many of the quotes provided above. Pre-drinking traditionally involves drinking alcohol before going out to an event where the goal is often to maximize one's fun while spending less money on pricey alcoholic beverages. In the case of consuming AmED, or energy drinks alone, prior to a drinking occasion, it appears that consuming these types of beverages provided the added benefit of the stimulant effects prior to going out. AmED use may also be related in increased priming for alcohol (Marczinski et al., 2013), and subsequently potentially more alcohol use. Thus, participants reported being motivated to consume AmED and energy drinks alone as a form pre-drinking in order to enhance their later drinking and partying experience.

"I will have [an energy drink] on occasion before going out for a big night or having people over for drinks."

"I don't mix them, but I sometimes drink them within an hour or so of each other. I drink Redbull sometimes so I have more energy for the night."

"I don't generally mix, I have a redbull before I start drinking."

"if I am tired before drinking, the energy drink helps stimulation"

"to feel revved up and buzzed before heading to a party"

"it is a good start to the night and goes great with shots."

"Taste delicious and good for in the car on the way to the bar or when you're walking somewhere"

To counteract the depressant effects of alcohol.

As can be seen in the quotes below, and several of the quotes above, participants reported being motivated to consume AmED in order to counteract some of the depressant effects of alcohol, whether it was to increase wakefulness, feel more sober, or to feel more in control:

"Drinking just alcohol makes me feel really tired after a few hours, so I mix vodka with Monster energy drink to get buzzed and keep me energized throughout the night. I especially drink this mix before going clubbing."

"I like the taste, and to counter the effects of a depressant (alcohol)"

"they taste good, it helps to keep you more in control and less drunk"

"I like the taste and it can have a better feel (less groggy/less drunk) than alcohol alone."

> "When feeling tired but still want to drink with friends; to counteract the drowsiness of alcohol"
>
> "hides the alcoholic taste, and won't be as drunk"
>
> "keeps you from getting drowsy when drinking"

Overall, many of the motivations reported for consuming AmED involved seeking some desired stimulant effects while consuming alcohol, prior to consuming more alcohol, and while out partying or out with friends. These often included seeking a sense of wakefulness, increased alertness, increased energy, and counteracting the depressant effects of alcohol, including the sense of intoxication. It appears that AmED users are purposefully combining in order to alter their drinking experience or type of intoxication.

Availability through others.

When participants gave reasons for their AmED use, the availability of these beverages appeared to be of importance. Participants reported using them when they were given for free, passed out to the group at parties or at the bar, and after being purchased by others for consumption:

> "I think that I have had an energy drink with alcohol maybe one time and I drank the drink because the Red Bull was already with the drink. I did not intend to have the Red Bull (bought for me)."
>
> "They are bought for me. Many people drink them."
>
> "I have only done it 3 times and each time was only because someone else bought me the drink."

"It was my first time having a mixed drink and my friends wanted me to try it out. I ended up really liking it but I knew it was REALLY bad for my heart so I stopped drinking after a few....I probably shouldn't have even had that many."

"I don't, unless someone else buys it"

"I drank one once at a stagette. It was bought for me by another stagette attendee (she bought a round without asking us) and I felt it would make the situation more uncomfortable if I did not drink it."

"It was a mixed drink, made by someone other than myself that added the energy drink for flavor"

"I only drink energy drinks when they are mixed with alcohol, and someone else is buying the drink for me."

"Friends most often purchase these drinks"

"I have only had them a few times - mainly when a friend buys a round of drinks that are Jagerbombs, for example. I have never ordered them for myself."

"I've occasionally had Jagerbombs at parties or at bars, mainly because someone was ordering or making a round for a group of people."

"While I rarely do this, it is when someone buys a Jagerbomb and therefore I drink it also."

"I have only ever had Bailey's and coffee a few times (which I don't think counts) and one Jagerbomb because my friend bought it for me. I wouldn't choose it on my own. However, it did help me party longer."

It appears that this form of availability supports the consumption of AmED in a group of individuals who do not identify as regular consumers of AmED, but who instead may

consume them occasionally with a friend or a group of friends who are also consuming the beverage. As some participants described, they may be facing some sense of social pressure to consume the beverage, either because the whole group is drinking the beverage, or because the beverage was bought for them.

Convenience.

Relatedly, the convenience of an energy drink, often as an available mixer, was noted by several participants as a reason for AmED use.

"If it's the only mix available, I use it"

"tastes good and it's convenient that it provides a mixer and more energy."

"I don't usually mix them with alcohol, when I do it is usually out of convenience or because I am feeling really tired"

"I drink them on occasion because they are convenient and sugary, if that is what I'm in the mood for. Plus it doesn't make me feel as bloated and full as beer does."

"They taste good, and are convenient"

"They taste good, and are sometimes convenient; you don't have to mix your own drink"

Cost-savings.

Additionally, the availability of AmED as a cheaper drink is a motivation for consuming AmED as it can provide cost-savings when drinking alcohol:

"They taste good. They are cheap."

"Enjoy the taste of Jagerbombs. Cheap at the clubs compared to other mixed drinks."

"drink specials"

"On the one occasion that I drank alcoholic energy drinks, it was only because they were the cheapest available drink at the pub I was at."

"if it's on a deal I used to buy it, haven't bought it recently as it affects me badly, rapid heart rate etc."

"I have drank Revs twice only because they were cheap, I don't drink energy drinks with alcohol on a regular basis."

As with other alcoholic beverages, drink specials on AmED appear to provide incentives for consumption, even in those consumers who do not report regular consumption of AmED. Cheaper drink prices may also influence increased consumption of alcohol.

Increased fun.

As can be seen in several of the quotes above, and those provided below, participants reported consuming AmED as they are fun. They described how AmED consumption can increase the fun of a drinking occasion in general. Furthermore, participants described how certain mixed alcohol and energy drink beverages are simply fun drinks to consume. Some referred to Jagerbombs, (drop shots) as being particularly fun. When multiple shots are ordered, these shots can be set up as a "train" of dropped shots which creates a domino effect causing each shot glass to fall into a glass of Red Bull. It is a theatrical method for preparing drinks when multiple Jagerbombs have been ordered. There are many videos on the internet illustrating examples of these "trains" and competitions for having the longest Jagerbomb train. Overall, consuming AmED appears to add a sense of excitement and fun to a drinking occasion:

"It tastes good, gets you fired up and excited, makes drinking alcohol more fun."

"To have fun at parties."

"drunk + energy = fun"

"It was fun, and if you mix it right, it tastes good."

"I have only had them once or twice. Both times it was just a random mixed drink that we decided to have for fun. It contained redbull and Jack Daniels. I think they called it a "Chuck Norris" When that whole "Chuck Norris" thing was supposed to be funny... I dunno."

"Jagerbombs are fun - they take away the dopey effects of alcohol (especially if you have been drinking beer all night) and compliment the high energy of clubs well."

"I have only ever done it with red-bull and Jager typically. Once was at a red-bull party, and other times it's because the drop shots are fun and it tastes good."

"Tastes good, Jagerbombs are a fun way to drink too."

"Mostly because Jagerbombs are a fun drink."

"Having Jagerbombs at the bar is fun to do with friends."

"Jagerbombs. Taste good, and are a fun drink."

Social.

The use of AmED also appeared to be motivated by the social aspects of consuming the drink. Again, some described the specific aspects of Jagerbombs, while others spoke more generally about the social environment or the personal effect of the alcohol and caffeine combination:

"Largely the social act of drinking Jagerbombs with friends; it works as a rallying and uniting tool for everyone that's drinking that night. Along with the rallying

aspect they provide a kick of energy that results in enthusiasm before we head out the door. They taste delicious as well."

"Like I said, I will sometimes do Jagerbombs because they are a fun drink to do with a group and they taste good."

"Though I don't do it often, I usually do so at parties to be more sociable, as I'm fairly antisocial when sober. Under the influence of alcohol and caffeine, I tend to be very talkative and stoked about everything. Also, the high is superior (in my opinion) to that of alcohol or caffeine alone."

"I have had a "Jagerbomb" maybe three times in my life. It was always because that's what my friends were ordering as a round at the bar."

"I rarely do, I have had the mix when friends get a round of Jagerbombs."

"Social and to wake up if tired"

"Partying with my friends"

Less Common Reasons for AmED Use

In addition to the more common reasons for AmED use, which are described above, the following reasons were mentioned by a small number of participants.

Experiment.

A few participants reported consuming AmED in order to simply try the beverages:

"I've had sips of friends' Rockstar and vodka because I wanted to try it."

"Tried it to see if it covered the taste of alcohol."

"I typically don't do this. I did in the past however mostly because others were doing it and I wanted to try it."

> "I have done such things less than I can count in one hand. I simply wanted to try the variety of these drinks once. Since they are legally sold by most businesses, I believe that having one drink as a dessert after dinner wouldn't be too bad so long as I don't have more than one drink per occasion."

Decrease alcohol consumption.

Two participants described being motivated to consume AmED as they believed it helped decrease their overall alcohol consumption:

> "sometimes I'll order a vodka/red bull because I know I can slowly drink it.... whereas other drinks are probably going down too quickly."

> "so that I don't need to drink as much alcohol."

Increase alcohol consumption.

Another participant reported that AmED use aided in consuming more alcohol:

> "To be able to drink more alcohol."

Increased intoxication.

Others felt as though AmED use helped increase their level of intoxication:

> "To get drunk faster and stronger, and be energetic while partying."

> "get drunk faster"

When hungover.

A few participants were motivated to consume AmED in order to reduce hangovers:

> "gives me an energy burst, seems to reduce the hangovers"

Drink in public.

Some reported consuming AmED in public. Both refer to a pre-mixed alcoholic energy drink on the market, named Rockstar with Vodka, whose packaging is very similar to

their non-alcoholic versions. One may be motivated to consume these AmED beverages in public as they can be easily mistaken for the non-alcoholic energy drink, and therefore, one may be less likely to be identified as drinking alcohol in public.

> "Because the Rockstar with Vodka looks like a normal Rockstar and thus a person can walk around town drinking it and look less suspicious."

> "If it's the only mix available I use it, and if I need to bring a can somewhere (road trip, movie theater, etc...) I will get Rockstar vodka's because I hate beer."

Sexual performance.

One participant reported using AmED to help sexual performance on a night when drinking. Energy drink companies have previously used marketing tactics which target college populations and imply improved sexual performance.

> "It helps give an energy boost before playing a show (I play guitar and sing) or having sex on a drinking night."

Replace illegal drugs.

Interestingly, one participant even reported using it to help stay awake without the need to use illegal substances.

> "Helps to stay up late into the night without illegal drugs."

Fewer calories.

Finally, one individual reported how some energy drinks can provide low calorie alternatives to other potential mixers:

> "Hide the flavour of the alcohol, sugar free energy drinks with fewer calories than other mixes, to wake me up."

Although these less common reasons were not reported by many participants, they do illustrate the wide variety of reasons that college students may choose to consume AmED, including motivations which may reduce harm, increase harm (e.g., public drinking; increased intoxication), enable desired functioning, or ease the use of alcohol.

Motivations for Energy Drink Use Alone

To offer a comparison with regard to motivations for AmED use, responses were analysed in response to the open question "What are your main reasons for drinking energy drinks alone?" 265 participants (57% of the sample) gave motivations for energy drink use alone (without alcohol). As described below, students reported a wide variety of reasons for energy drink use, with some reasons being reported much more frequently than others. The reasons for use will be described below and many quotes from participants will be provided in order to illustrate the participant's varied motivations for use.

Stimulant effects.

Participants commonly reported consuming energy drinks for their desired stimulant effects including wakefulness, alertness, increased arousal, and increased energy. Out of all of the reasons given for consuming energy drinks, the most commonly reported reason was for increased wakefulness.

Wakefulness.

Participants often reported consuming energy drinks in order to help them stay awake, feel more awake, or stay up later:

"I drink energy drinks to be more awake on days that I don't get much sleep"

"For countering the effects of fatigue"

"Staying awake while having a long night."

"to feel more awake; to take in place of coffee"

"To stay awake if coffee is not available."

"trying to stay awake after an all-nighter of studying"

"To combat fatigue, and give me a bit of a boost on the odd occasion."

"When I'm lazy or tired, it wakes me up"

"wake me up in the morning at work or school if I did not get enough sleep"

"I have only had them a couple times in the past and it was to combat fatigue"

"to maintain awareness while studying or to curb tiredness before staying out late"

"When I drink those (which I do often) it is almost always to stay up late to study and/or write a paper. Sometimes it is when I am tired because of a lack of sleep in the morning and I need a boost to work on schoolwork or when I am hungover. Occasionally, I will drink one before going out if I feel tired."

"To combat fatigue and stay awake, mostly while studying."

Stay awake to be social.

Participants also reported consuming energy drinks in order to increase wakefulness while being social:

"I rarely drink them, but I will buy them occasionally mostly with friends if we're staying up late."

"I would drink an energy drink in order to stay up later to hang out with friends"

Stay awake when driving.

Driving was another important activity where energy drinks would be used in order to increase wakefulness:

"typically to stay awake when driving long distances"

"Long road trips to stay awake while driving."

"Taste good and when driving late at night."

"Very rarely if I have to stay up late, but will have to drive, and if they are the only thing available, I might drink one"

"if I'm not drinking and am the designated driver I drink energy drinks to be able to stay awake and be more aware while driving my friends home."

"Once in a blue moon I buy them at convenience stores when I am travelling by car."

"On rare occasions that require me to be alert. On long drives in the evening for example."

"I have only had energy drinks a couple of times - to study and for driving on a road trip."

"If I am tired and I need to drive and I don't feel like coffee, or if I am playing sports and I am tired."

The desire to increase wakefulness generally, and during different activities, was the most common reason participants reported for consuming energy drinks alone. Importantly, consuming energy drinks for increased wakefulness was most commonly reported for use when studying or conducting other school activities (e.g., exams). See below for several quotes regarding wakefulness and studying.

Study.

Consuming energy drinks for the purpose of studying or other school activities was the second most common reason for energy drink consumption:

"I very rarely drink energy drinks, when I have it was during long study or project work sessions."

"Study purposes: focus, long study periods"

"I have only had an energy drink 1-2 times and I think I drank the drink for studying."

"I used to drink energy drinks when studying to keep alert. I do not drink them anymore because they have so much sugar and I prefer coffee (as I notice less side effects like shaking or heart racing)."

"Those end of term cram sessions"

"The caffeine and sugar help me to focus when researching and writing."

"Taste's good, and to help study for exams (for boring courses)"

"To ensure that I complete my school exams within the allotted period."

"When writing exams for school."

"Usually I drink them at the university during exam period."

"tastes good, allows me to study, usually just grab some coffee though"

Wakefulness while studying.

As stated above, participants commonly reported drinking energy drinks in order to increase wakefulness while studying:

"To help me study or stay awake when cramming for midterms or writing papers."

"To stay awake when studying for school or doing essays late into the night. I drank a lot during midterms and finals last semester."

"I don't, generally. Only when I have to pull an all-nighter studying, or the morning after an all-nighter when I need it just to get through my classes. I think they taste horrible, so I rarely drink them."

"I use them to keep me awake and alert, especially during the exam period. They work faster and are stronger than coffee and sometimes I need the extra boost."

“to stay awake while out partying or studying.”

“to stay awake while studying, to stay awake in class”

“To help me stay awake on night shifts and during exam periods. Also, if required to stay up all night to write papers.”

“I don't really drink them often, just occasionally when I am studying, or sometimes when I go to the bar. It helps keep me awake.”

“I used to drink them to stay awake in early classes after late night studying.”

“When taking 6 classes, and there are many final exams in a row eg., 7 exams in 7 days or 4 exams in 4 days. It is impossible to do anything but cram and stay up all night studying to achieve the grade I want. Coffee also works but is usually unavailable at school during the night. This is usually (95% of the time) when I drink them is when I am studying for final exams when I have more than 2 in a row, it seems to be the only way sometimes.”

“I have only drank energy drinks to stay up later while studying when I didn't have coffee.”

“to pull all nighters with studying for tests or writing papers. Also when I want to stay awake when I’m already really tired and have something to do/ someone to see. Also, they taste pretty good.”

“To stay awake for longer periods of time, especially when writing or studying.”

“To pull an all nighter for studying or homework”

“to restore mental alertness or wakefulness when experiencing fatigue or drowsiness. Actually :) usually when I’m working on something late (getting a paper done)”

> "I don't usually drink energy drinks on their own. If I do, I do to stay awake while I am studying, but it usually doesn't help because energy drinks make me feel shaky."
>
> "To help me study longer without getting tired."
>
> "Increased alertness for studying. As a replacement for coffee in the morning as I do not enjoy the taste of coffee. Staying up late and productive when deadlines for project work are near."
>
> "Taste awesome and are good energy source when studying or need a couple extra hours of staying up"
>
> "Only on very extreme nights of procrastination and I have a lot to do before the next morning."

As illustrated by these quotes, participants were motivated to consume energy drinks in order to increase wakefulness while studying, particularly when needing to work late into the night. Not surprisingly, the most commonly reported reasons for consuming energy drinks (for increased wakefulness and in order to study) were reasons that were very commonly reported together, as shown in these quotes.

Other stimulant effects.

Following wakefulness and seeking stimulant effect for study purposes, participants commonly reported consuming energy drinks for other desired stimulant effects including increased energy, alertness, and focus.

Energy boost.

Participants reported drinking energy drinks in order to gain increased energy in general and to provide energy during different activities such as partying, being social, staying

out late, playing sports, and when studying. Many participants reported consuming energy drinks to increase their energy levels in general:

"To give me energy. lol. Why else?"

"To provide energy and alertness."

"To get energized and feel more awake"

"so that I can keep going and going and going..."

"To feel energized/hyper"

"to provide an energy boost when I'm tired"

"The energy boost they give you. The rush."

"Good "energy" high"

"Get energy when I am lacking energy and a simple coffee or tea is not enough."

"Good way to boost energy in the morning after experiencing insomnia."

"Sometimes I stay up late studying, so I need to get more energy since I didn't get enough sleep."

"to get a boost of energy, or at least that's what I think I'm doing by drinking energy drinks"

"to have more energy to do what you want to do"

"Usually for a short-term boost in physical energy and cognitive focus, especially prior to activities (work-related or recreational) in which increased mental focus is required."

"because they give a small boost that can be helpful on a hard day of work once in a while"

"To allow me to function for 20 hours a day instead of the norm, allowing me to work harder faster, and longer, enabling me to accomplish more."

"I don't normally. A couple years ago I worked as a landscaper and would often consume 2 or 3 Red Bulls at lunch. That made me kinda sick of them. But at the time, my reason was actually that I needed a lot of energy."

"To be able to have the energy to do things during the day. I would otherwise be too tired for, grocery shopping for example, to study, to have more energy while playing sports working out."

"1. Mental alertness when studying or working long hours. 2. Excess energy when playing sports 3. Excess energy when having sex"

Energy to stay out late.

Participants reported using energy drinks in order to stay up longer:

"To have more energy, especially when I'm staying out late."

"Taste good. Give me energy to get through the night"

Energy to party and be social.

Participants reported using energy drinks for partying and social purposes:

"Increasing alertness and attention mostly for studying, or keeping energy up for a long night of partying."

"To help me stay awake and energized at parties. So I can be more outgoing and social.

"To get more energy to be able to study or hang out with friends."

Energy for sports.

Consuming energy drinks in order to gain energy for sports was also reported by participants.

"I like the taste. It gives me energy for sports or staying awake."

"For a temporary source of energy, when feeling groggy or when engaging in sports."

"before a hockey game that is late at night to get an extra boost."

"If I'm tired and have a lot of studying to do, or a paper to write, the caffeine kick helps keep tiredness at bay. Or if I'm tired before a sports game, I'll also drink one for an extra boost"

"Sometimes I drink them before a field hockey game when I'm feeling tired because it wakes me up."

Energy to study.

Participants also reported consuming energy drinks in order to gain energy for studying and other school activities.

"They taste really good and give me a good enough burst of energy to start whatever I am setting out to do. (e.g., before study or class)"

"To give me a quick boost if I'm really tired but need to complete a task - like studying."

"Staying awake to study. It is practically the only time I ever drink energy drinks and it is normally a Starbucks Doubleshot. This way when I need the energy that I don't have, I know how to get it."

"energy boost during exams, or for work"

"energy boost while studying after I'm sick of drinking coffee"

"to keep high energy during exams"

Overall, participants reported consuming energy drinks in order to give them energy in a variety of settings and for various activities.

Increase alertness.

Another stimulant effect that was sought by participants was the sense of increased alertness after consumption of energy drinks. Participants reported desiring increased alertness generally and while performing certain activities (e.g., exams).

"To stay awake!!! and be more alert."

"to wake me up when I need to be alert and awake"

"I do not drink energy drinks regularly and have only tried them on occasion to have more energy/stay alert."

"It helps me stay alert at work when I'm tired from lack of sleep."

"Get more energy when I'm tired, mental alertness"

"In order to feel more awake and alert."

"To make me feel alert during exam time if I don't want more coffee"

"To stay alert. Being a full time student, I'm finding myself tired quite often and I like the effect that an energy drink gives me (that is being able to be alert for a longer period of time)"

"Mental alertness, more energy. Unfortunately they usually just make me jittery and don't help me concentrate at all. They are also diuretics and will help dehydrate you."

"I usually do not drink energy drinks, but on rare occasions I will for mental alertness."

"When necessary, to maintain alertness when tired."

"I drink energy drinks because it keeps my mind more alert - compared to other forms of caffeine - and helps me stay awake longer when I need to (this is only when I drink energy drinks alone and not mixed with alcohol)"

"Without alcohol consumption, only before a test if I haven't slept well the night before for mental alertness."

"To be more mentally alert and to have more energy."

"I don't like doing it very often - as I believe they're bad for you. But when I do it's because I need to stay alert for cramming for an exam or for another sort of all night event (such as a movie marathon). Often it backfires, making me more tired. Some of them taste good, too."

"To be more mentally alert when I'm feeling tired. Same reasons as drinking coffee or other beverages with caffeine."

Focused.

Participant's also reported consuming energy drinks for another stimulant property, in order to increase focus:

"They taste good (I particularly enjoy Monster and Talon's Blood Red Punch), and if I need to get work done, it usually helps me stay focused a bit longer (studying, moving furniture around, organizing my papers, keeps me awake while driving home…if it's late out)"

"Stay alert, focused, awake. Like the taste."

"Increase Alertness and focus."

Caffeine.

Some participants specifically referred to desiring caffeine, and the effects of caffeine, obtained in an energy drink. Caffeine is one of the main stimulant ingredients in energy drinks and the caffeine content may be one of the main selling features for these products, as consumers appear to desire the stimulant properties:

> "for the caffeine ie. for mental alertness/to stay awake"
>
> "Quick burst of sugar and caffeine"
>
> "To get the caffeine buzz."
>
> "Energy and alertness, or caffeine content."
>
> "Consuming the caffeine"
>
> "I hardly ever do, but the few times I've tried them it's been mostly for the caffeine to perk me up in the morning,"

Overall, participant's motivations for consuming energy drinks alone often involved the gaining desired stimulant effects from these beverages. These included desiring wakefulness, alertness, increased arousal, and increased energy for a variety of activities. Consuming energy drinks for their desired stimulant properties was often reported as a way to help complete required school activities, like exams or studying.

Taste.

Participant's reported consuming energy drinks as they enjoyed the taste of these beverages. Of note, many more students reported consuming energy drinks combined with alcohol due to the taste, than did students consuming energy drinks alone.

> "To get energy and they taste awesome."
>
> "For taste and for the caffeine (I don't like coffee)."
>
> "They taste good and give me an energy boost."

"Usually taste good. Need to stay awake"

"They taste good"

"I find the many varieties of drinks available fun to try. Though at first I found it weird, or maybe even bitter, I find that I love the unique flavour that the energy drinks have. And, I'm definitely one who has had enough that now I crave them."

"I like how some of them taste, and I use them as something different than coffee once in a while."

"I like the taste"

"I enjoy the taste"

"On occasion I drink a Red Bull because I like the taste and it is refreshing"

Experiment.

Several participants reported consuming energy drinks in order to try the beverages, to try different varieties, and to experiment with the effects of the beverages.

"I usually don't drink energy drinks, and the few time that I've tried them it's just to see if I like them, but usually I don't drink them because there's too much sugar in them for me."

"I tried Redbull to see what the big attraction was and I felt so horrible after two hours of drinking it I'll never have another one."

"Twice. Once because it was a free sample and I had no money for food. Once to taste a new kind my friend was drinking."

"I have only tried it, to simply discover that they are too sweet and taste horrible."

"I rarely drink energy drinks. I once had a red bull to try it. Same with some nutrition/energy drink being handed out at clubs and course union days, which was a bad idea to have on an empty stomach."

"I only wanted to try it once"

"Haven't drank much 'cause they taste awful. I was just curious what all the hooplah was about. I guess I felt a bit more alert, but nothing I would say is very noticeable."

"I've only tried them once, just to see how it would feel."

Purchased by others or given for free.

A few participants reported consuming energy drinks as they were purchased by others or provided for free:

"I don't drink energy drinks on a regular bases, the only time I have when not with alcohol was once when it was free at a basketball game."

"I have never bought an energy drink; I only ever drink them when they're given out free as samples."

"I do not drink energy drinks. I tried one once as it was offered to me for free but I found it did not improve my energy level."

"I have only drank energy drinks in my life when people offered me them on occasion as a refreshment and when I have been bought drinks by others at bars."

Energy drink companies are known for providing free samples of their beverages at different events, and on campuses, as part of their marketing strategies.

Less Common Reasons for Energy Drink Use

In addition to the more common reasons for energy drink use, described above, the following reasons were mentioned by a few participants.

Convenient/Available.

Several participants reported consuming energy drinks due to the availability of the beverage, and as a convenient method for caffeine consumption:

"I don't drink them very much. Maybe two a year? If so, I tend to drink it because it's the only thing available."

"My fiancé drinks them occasionally, so if they are in the house I may have one instead of a coffee because it's easier."

Thirsty/Refreshment.

Drinking energy drinks as a refreshment and to quench thirst was reported:

"extremely thirsty and exhausted"

"make me feel refreshed"

As an alcohol alternative.

Interestingly, several participants reported consuming energy drinks as an alcohol alternative, particularly in social situations and at parties.

"I don't drink alcohol so I feel it helps keep me going in social situations where others are drinking alcoholic drinks."

"I only occasionally drink energy drinks when I am tired and do not want to drink alcohol."

"If I don't want to consume alcohol when out at a party."

"They taste good and can be a good substitute if you don't want to drink alcohol"

Craving.

A few participants reported that they may consume energy drinks because they crave them:

> "On some occasions I drink them because of cravings caused by mild addiction after heavy usage (i.e. exam period)."
>
> "to stay awake and get more work done. Basically relieve drowsiness and fatigue. Cravings."

Increased fun.

Some reported consuming energy drinks in order to have fun:

> "I don't drink them very often (less than once a month), usually just to have fun."
>
> "it's fun to have lots of energy"

Fight stress.

Fighting stress was one reason that a few participants gave for consuming energy drinks:

> "I drink and am a sales rep of XS energy drinks, which have no sugar, no carbs and only 8 calories. The main ingredients are B vitamins, antioxidants, and adaptogenic herbs which help fight stress."
>
> "study, deal with stress"

Sexual performance.

A few participants reported using energy drinks as an aid for sexual performance. Interestingly, energy drink companies have previously used marketing tactics targeting college populations which imply improved sexual performance after consumption. Due to the personal nature of such a reason, I would not expect many participants to report it, particularly without "sexual performance" being specifically prompted by the researcher as a reason for use.

"replenishment after workouts, or late night boost for sex."

Cost savings.

One participant reported that they consumed energy drinks as they were priced cheaper than other beverages:

"I've had one at an airport because it was cheaper than juice and once or twice in hopes to study later."

Leisure.

A participant reported consuming energy drinks as a leisure drink.

"Drink it as a leisure drink... like soda or something"

Increase mood.

Finally, one participant reported consuming energy drinks as they helped to increase their mood.

"I used to drink energy drinks to increase my mood. I stopped about 6 months ago because the energy crash was too intense, and replaced it with green tea. Occasionally I'll have an energy drink, but it has been a long time since I had one."

Discussion

The participant's responses provide a rich picture of the varied reasons why individuals may choose to consume AmED or energy drinks alone. The significance of "taste" as a motivator for consuming AmED was evident throughout participant's responses. This is similar to previous research which has identified taste as an important variable (Ballistreri & Corradi-Webster, 2008; Peacock, Bruno & Martin, 2013). Obtaining the stimulating effects from AmED use was also found to be a strong motivator to consume AmED. This appeared to be due to the ability of AmED to enhance a drinking occasion by putting one in a more desired mental or physical state (e.g., increased wakefulness, increased energy), something which is also supported by previous research (Ballistreri & Corradi-Webster, 2008; Peacock, Bruno & Martin, 2013). AmED use also appeared to enhance group drinking experiences by providing a "fun" way to consume alcohol. In other contexts, the usefulness of consuming energy drinks alone for their stimulating properties was also a prime motivator for students, as it appeared to aid them to function academically (e.g., studying, exams, attend morning classes) and socially. As to be expected, the consumption of AmED and energy drinks alone was reportedly influenced by the availability of these products, particularly if they are provided through others or provided for free. This appeared to largely influence first time users and irregular users of AmED and energy drinks alone. Marketing techniques by energy drink companies have often focused on providing energy drinks for free and enhancing availability of their products through low pricing and ample availability at drinking establishments. These efforts appear to be successful in motivating some individuals to consume their beverages.

The participant's qualitative responses regarding their reasons for using AmED were similar to their quantitative responses provided (Figure 1) (previously published in Brache, Thomas, & Stockwell, 2012). The most common quantitative reasons reported were because they enjoyed the taste (35%) and to get an energy boost (27.7%). Other common reasons included to stay awake when drinking (20.2%), party longer (18.4%), to hide the flavor of alcohol (18.1%), for mental alertness (10.1%), to get a "buzz" quicker (9.8%), and for refreshment (9.1%).

Previous quantitative research has found that students report similar reasons for the consumption of AmED and energy drink use alone. The motivations of AmED use reported by students in the current study are similar to other quantitative research with college students, where AmED use occurred for drinking socially or "partying" (Malinauskas et al., 2007). Similar to Ballistreri and Corradi-Webster (2008) participants reported using energy drinks in order to improve the taste of alcoholic drinks, to enjoy an all-night party, to improve sports performance, for stimulation, because they enjoy the taste, for curiosity, for studying, for working, and for driving. Using energy drinks for sports performance is concerning because, despite the common misperception that energy drinks are helpful for sporting activities, energy drinks are not recommended during physical activity (Attila & Cakir, 2011). Attila and Cakir (2011) identified several reasons that their participants noted for "trying" energy drinks alone including curiosity of its taste/effects, for energy, and to boost performance. Their "current" energy drinks users reported that they use energy drinks to get energy (24.2%), boost performance during exercises (21.4%), for taste (17%), to use in cocktails, mixed with alcohol (15.2%), to concentrate while studying (8.9%), and to stay awake (7.6%). Additionally,

one third of their "current" energy drink users reported consuming energy drinks in bars. Similar to the current study's findings, the student respondents reported consuming AmED in order to make alcoholic beverages taste better and to decrease the depressive effects of alcohol. The current study generated many more reasons for AmED use and energy drink use alone, than reported in Attila and Cakir's research. But, it is difficult to compare the studies as the methodology used to generate reasons for use in Attila and Cakir's (2011) research is unclear, and the reported reasons for consuming AmED use is limited. Furthermore, the author's presentation regarding reasons for AmED use was confusing as some reasons for use found in their discussion were not presented in their research results. Attila and Cakir's (2011) research also largely focuses on the reasons or motivations for energy drink use alone rather than AmED use.

Similar motivations were identified in the current qualitative investigation as were identified in Peacock, Bruno and Martin (2013). Similar to their research, functional motives were commonly reported for using AmED (e.g., more energy, stay out later, increased alertness), taste was highly endorsed, and the enjoyment of the particular Jagerbomb beverage was also highly endorsed. Somewhat different in the current qualitative investigation compared to Peacock, Bruno, & Martin's (2013) investigation is that fewer participants specifically endorsed using AmED to "get more drunk" but rather reported AmED use to enhance the experience of drinking or prolong their attendance at drinking events, which ultimately may lead to increased intoxication and drinking. The student's reported motivations for seeking stimulant effects while intoxicated may also be related to the desire to become intoxicated, but perhaps in a different way.

Similar to rationales reported for AmED use in the current study, qualitative research conducted in Australia found that young adults consume AmED to extend their nights out, to have more energy, to party longer, and because they are considered "cool" to drink while in a club (Jones & Barrie, 2009). This research also identified the role of social image in AmED use, particularly that AmED are used as a group bonding experience, and to make nights out more "fun." Other research conducted by Jones (2011), using focus groups, found that premixed alcoholic energy drink use was desired for their similar packaging to non alcoholic versions, their sweet taste, and the increased "fun" or energy levels that coincide with its use. Also investigating premixed alcoholic energy drinks, Jones, Barrie and Berry's (2012) small-scale qualitative investigation (n = 21) found that students consumed pre-mixed alcoholic energy drinks in order to remain awake and alert so they may keep drinking and socializing longer, both during the night, and at the beginning of the night in order to provide and initial energy boost for the night ahead. Students also consumed premixed alcoholic energy drinks in order to be part of the crowd (i.e., social bonding activity, "cool" drink), for convenience, for the higher alcohol content of pre-mixed alcoholic energy drinks, the sweetness of the energy drink components which mask the taste of alcohol, the excitement of having an added psychoactive ingredient to an alcoholic beverage (e.g. stimulants), and having a sense of added feelings of control or invincibility while consuming alcohol. Although their research solely focused on reasons for using premixed alcoholic energy drinks, the reasons for use reported by their students align with the reasons reported by the current study participants for all forms of AmED use. Finally, Pennay and Lubman (2012), in a small qualitative study (n = 10), found that participants consumed AmED for

wakefulness and energy, taste, counteracting the drowsy effects of alcohol, facilitating alcohol intoxication, and social bonding. They also noted the popularity of Jagerbombs and the possibility that energy drinks could be used as a substitution for illicit stimulants when consuming alcohol. Importantly, the current research findings support these previous findings, provide a wider variety of motivations for use, and provide more details and examples of previously identified reasons for AmED use, from a considerably larger sample than previous qualitative investigations.

Subjective Intoxication

Our qualitative findings may provide some insight into the debate in the literature regarding whether AmED use alters subjective intoxication. The participants clearly described being motivated to consume AmED as it reportedly increased their level of wakefulness, energy, and alertness when consuming alcohol, while also counteracting some of the depressant effects of alcohol. These were some of the most commonly reported reasons for consuming AmED. Given this, it appears that students are motivated to consume AmED in order to purposefully alter their experience of intoxication, where they aim to increased stimulation, compared to the use of alcohol alone, and/or to reduce the depressant effects of alcohol, potentially altering the extent to which they feel intoxicated. Although laboratory studies have found mixed result on whether subjective intoxication is altered after AmED use compared to alcohol use alone, the motivations for use provided in this study and others can offer added insights to this debate, where AmED users report purposefully using in an attempt to alter their experience of alcohol intoxication. Important for future research, AmED users expectations regarding subjective intoxication after AmED use should be considered as they may alter their

experience of intoxication, something well-designed laboratory studies may attempt to address. Perhaps some of the measures used in the laboratory studies have failed to find consistent results regarding subjective intoxication as they may be using measures which tap into overall symptoms of intoxication, rather than symptoms of intoxication which energy drinks appear to alter (e.g. drowsiness). As others have suggested (Attwood et al., 2012) it may be that the type of intoxication is altered (e.g., wide-awake-drunk) rather than the overall subjective level of intoxication. Our results provide some hypotheses regarding the desired sense of intoxication (e.g., alert; non-drowsy; energetic) that is pursued with AmED use, which should be investigated in future research.

Risky Behaviours and Negative Consequences

Importantly, understanding the participant's motivations for use can provide insight into the nature of the relationships between AmED use and increased alcohol consumption, increased energy drink consumption, engagement in risky behaviours, and negative consequences. Several of the reasons for use reported by participants appear to be associated with an increased likelihood of consuming alcohol, and an increased likelihood of consuming energy drinks. The primary reason reported for consuming AmED was due to the attractive taste of the beverage. Of note was both the popularity of the "Jagerbomb" beverage and the desire to hide the taste of alcohol. Enjoying the taste of the alcoholic beverage and hiding the unwanted flavor of the alcohol in the alcoholic beverage could be expected to be related to increased consumption of AmED beverages. Consequently, individuals consuming AmED for these reasons, likely consumed more alcohol and more energy drinks when consuming AmED, than when consuming alcohol without the energy drinks, as previous research has indicated (Malinaukas et al., 2007).

The motivation to consume AmED for the various stimulant effects would also likely contribute to an increased consumption of alcohol and energy drinks. The increased consumption when using AmED could result from the increased energy and wakefulness reportedly experienced when drinking, thereby aiding drinkers in having extended and more active drinking occasions. As was also described by participants, the consumption of AmED or energy drinks alone (prior to a night of drinking) would appear to provide individuals with the energy to attend a party or drinking event in the first place. It may also have a priming effect for alcohol (Marczinski et al., 2013). Participants also described how consuming AmED would counteract the depressant effects of alcohol. This altered state of intoxication could have led to increased consumption of alcohol as drinkers may not be experiencing the depressant effects of alcohol to the same extent, and therefore consider themselves to be less intoxicated, or to have more physical energy or ability to continue drinking alcohol and engage in risky behaviours. Other factors such as increased convenience, availability, and cost-savings of the beverages may lead to increased alcohol and caffeine consumption, potentially increasing the likelihood of negative physical effects.

The reported motivations for AmED use also provide some insight into why consumers may be at increased risk for engaging in risky behaviours and experiencing alcohol-related consequences, compared to when consuming alcohol alone. For one, the increased consumption of alcohol, with AmED use, is likely to increase the chances that one will engage in risky behaviours due to increased intoxication. Secondly, consumers may be more likely to engage in risky behaviours as they feel stimulated and consequently feel as though they have the physical energy or mental stimulation to

engage in activities that they may not otherwise participate in when intoxicated. This could include activities such as driving, engaging in a physical or verbal altercation, or engaging in sexual activity. It is possible that consumers are more physically active when consuming AmED and are therefore more at risk of being injured as a result of engaging in some form of physical activity while intoxicated. Such physical activities may not be inherently risky, such as walking or dancing, but instead risky if highly intoxicated. As consumers of AmED may be more likely to engage in such activities while highly intoxicated (potentially as they feel physically stimulated), they may also be at increased risk of getting injured.

Strengths and Limitations

Strengths of the current research includes the large sample size, particularly in comparison to previous research, and the option for participants to report on their own reasons for energy drink use alone and AmED use. The survey design allowed for open responses where participants could report their reasons for energy drink and AmED use, as opposed to having preselected responses. This resulted in a wide variety of reported reasons for AmED use and energy drink use alone, which has expanded on current knowledge of motivations.

Despite these strengths, the research is not without limitations. The survey data was self-reported and may therefore underestimate the willingness to report certain reasons for engaging in potentially risky behaviours. For example, participants may be unwilling to report motivations to consume AmED which involve driving home after drinking. Although this may have occurred, efforts were made to minimize this as the survey was anonymous and web-based so the participants could complete it in private.

The sample cannot be ensured to be a random sample due to biases in response to the email and poster recruitment. Graduate students were more highly represented in this sample, compared to University of Victoria student population, which limits the generalizability of our results. This may have been due to an unintended sampling bias in email recruitment or a bias where underage drinkers could have been less likely to complete the survey. Additionally, the survey findings may have limited generalizability to non-university samples. Having qualitative responses also limit the ability to identify associations of AmED with other behaviours (e.g., increased alcohol use; risk behaviours) unless specifically stated by participants. As such, some speculation is included, where noted, on how participant's motivations for use may be related to these behaviours.

Conclusions

Overall, students appear to have a wide variety of reasons for consuming energy drinks alone and in combination with alcohol. The reported reasons for use in the current study are similar to other student's reasons, as evidenced in previous investigations. Importantly, the current research adds to previous research by identifying a great variety of motivations for use obtained from a large student sample. These results help clarify that it is insufficient to investigate motivations for AmED use using a few predetermined response options. Finally, the current research helps to elucidate the potential connections between AmED use and increased alcohol and energy drink consumption, altered subjective intoxication, increased risky behaviour, and increased risk of injury.

General Discussion

The current research studies add to the quickly growing body of literature on AmED use. The VHYS and the CADUMS data provide information on AmED use and associated drinking behaviours and consequences in Canadian community samples, as opposed to college samples. These data provide an example of what is occurring outside college campuses, both in regard to prevalence of use and associated variables. This can provide more representative information, particularly as Canadian health officials consider policy recommendations regarding energy drinks which could affect the entire Canadian population. The VHYS adds to previous literature by incorporating and controlling for sensation seeking, a personality variable which has frequently been considered to explain the connection between AmED use and associated risk behaviours and consequences. Finally, the University of Victoria student survey, adds to previous investigations regarding students' motivations for using energy drinks and combining energy drinks with alcohol. The student survey gathered in-depth qualitative responses regarding motivations for use. This adds to previous research which has largely focused on collecting only quantitative data on reasons for use, was limited to a smaller number or questionably worded reasons for use, and was limited to qualitative studies with small sample sizes.

With regards to the first and second research questions, the quantitative investigations found that in the CADUMS survey AmED use was associated with increased amount of alcohol use, increased days of alcohol use, increased heavy drinking, increased risk of an alcohol use disorder, and an increased risk of experiencing a variety of harmful consequences from alcohol use (even after controlling for typical alcohol use),

compared to those who consumed alcohol alone. Those who reported consuming AmED, compared to those who consumed alcohol alone, had increased odds of driving after drinking, being a passenger in a vehicle where the driver had been drinking, and being involved in physical aggression. They did not experience significantly increased odds of being in a motor vehicle accident. With regards to the VHYS, we found that consuming AmED in the past month was associated with increased alcohol use, increased heavy alcohol use, and increased risk of alcohol use disorders, even after controlling for sensation seeking personality. We also found that AmED users, compared to alcohol only users, were associated with increased driving after drinking, being a passenger in a vehicle where the driver had been drinking, and starting a fight and striking someone, after controlling for sensation seeking personality. We did not find AmED use to be associated with having experienced a serious injury or reported risky sexual practices, except, weekly or more AmED use was associated with ever having a sexually transmitted infection, compared to alcohol use alone. This indicates that AmED use may be associated with some negative outcomes, only for more frequent users. More research should investigate a possible dose-response relationship related to AmED and negative outcomes. Finally, VHYS participants reported relatively high frequencies of a "bad hangover," and "dehydration" after AmED use and some experience of "heart pain." Unfortunately, these were not compared to experiences after alcohol use alone.

Taken together, the CADUMS and VHYS data indicate that, compared to alcohol us alone, in Canadian community samples AmED use is associated with increased alcohol use, risky alcohol use, increased alcohol use disorders, driving or riding with a driver after drinking, and physical aggression, even after controlling for sensation seeking

in the VHYS respondents. For CADUMS respondents, AmED use is also associated with harmful consequences of alcohol use on a variety of life areas (e.g., social life, home life, physical health), even after controlling for typical alcohol use. AmED use was not associated with serious injury or being in a motor vehicle accident, compared to those who used alcohol alone. This may be partly due to the limited frequency of these events.

Regarding the third research question, qualitative responses from the University of Victoria student survey, found that the most common motivations for energy drink use alone (without alcohol) were to stay awake or stay up late, to study or take exams, to boost energy, to increase alertness, and for the taste of the beverage. The most common motivations for AmED use was for the taste, to stay awake or up late when drinking, for an energy boost while drinking, because they were purchased by others or given for free, for energy to "party," to increase the fun when drinking, and to counteract the depressant effects of alcohol. Some of the reasons for AmED use appear to encourage increased alcohol consumption (e.g., taste; increase fun while drinking), longer and more active drinking sessions (e.g., stay awake or up late when drinking), and to decrease negative sensations related to alcohol intoxication (e.g., energy boost when drinking; counteract the depressant effects of alcohol). Most importantly, the University of Victoria student survey responses revealed a wide variety of reasons of use of energy drinks alone and AmED. These findings indicated that it may not be appropriate to only include a small number of reasons in quantitative studies when investigating reasons for use. They also indicate the importance of appropriate wording regarding reasons for use, which could be taken from the quotes of those who use AmED.

Strengths of the Current Research

Using a variety of methods and different survey populations the current studies investigated AmED prevalence and associated variables in community samples. Many studies on AmED consumption fail to investigate the potential effects of sensation seeking personality on the relationship between AmED and high-risk behaviours, despite discussing its importance for understanding their research findings (e.g., Snipes & Benotsch, 2013). Using the VHYS, the current investigation looked further into the relationships between AmED us, sensation seeking, and high-risk behaviours. The current studies also use a variety of methodologies and research samples to investigate AmED use, including an extensive qualitative investigation into the motivations for AmED use and how they may be associated with increased alcohol use or risky behaviours.

Limitations of the Current Research

There are limitations to each sample's survey methodology and research investigations. These have been individually discussed with regards to each survey. In general, due to the survey methodology it is possible that participants may have over or under reported certain behaviours. As much as possible anonymity was provided in order to minimize this potential. There may have also been a sampling bias in all samples with regard to those who chose to respond to the surveys or participate in another wave of data collection for longitudinal studies. Most importantly, the current survey results are limited to associational analyses and do not allow causal conclusions to be drawn from the data. This is a significant limitation as it limits the ability for the research to support policy action by concerned government bodies.

Understanding the Link: Reflecting on the Model

Given the current research studies, in association with previous research, it appears that certain personality traits (such as sensation seeking), and other demographic variables (e.g., being younger) are associated with increased AmED use. Importantly, while controlling for these variables AmED use is associated with increased alcohol consumption, and increased energy drink consumption (Brache & Stockwell, 2011). AmED use is also associated with increased risk behaviours (e.g., heavy drinking, being in a car where the driver has been drinking, driving after drinking, and experiencing negative effects of alcohol on different areas of life) even after controlling for sensation seeking, demographic variables, and typical alcohol consumption. AmED use has previously been associated with injury (but not in the current studies) (Brache & Stockwell, 2011; O'Brien et al., 2008), and has been repeatedly been shown to be associated with physical altercations, even after controlling for sensation seeking, demographic variables, and typical alcohol consumption. AmED use has also been associated with some sexual risk behaviours in previous research (O'Brien et al., 2008; Snipes & Benotsch, 2013; Snipes et al., 2014). We did not find that it was associated with the sexual risk behaviours we investigated, but heavier (weekly +) AmED use was associated with lifetime experience of a sexually transmitted infection.

A common limitation with most research investigating these relationships is that the conclusions which they are able to be drawn from their data are associational, not causal. Importantly, the majority of objective research evidence in this field has found AmED use to be associated with increased alcohol consumption, risky behaviours, and negative outcomes. Also, a variety of methods have been employed to investigate these links and potential third variables including event-level analyses (Thombs et al, 2010)

and prospectively designed studies (Varvil-Weld et al., 2013), which provide further support for a specific link between AmED use and increased heavy drinking, risky behaviours, and negative outcomes, independent of sensation seeking, demographic variables, and typical alcohol intake. Dose-response relationships also support the existence of a potentially causal relationship between AmED use and related risky behaviours. The frequency and experience of negative physical reactions following AmED use has been documented in several emergency department investigations (Cleary, Deborah & Hoffman, 2012; Substance Abuse and Mental Health Services Administration, 2011) and AmED survey studies (Brache, Thomas, & Stockwell, 2012; Woolsey, 2010). These provide further evidence supporting negative consequences after AmED use. More controlled studies are clearly needed to investigate whether the frequency of these negative outcomes and nature of these outcomes are above what would be expected from alcohol use alone.

Other research methods, such as qualitative investigations, can aid in the understanding of the relationships between AmED use and drinking behaviours, other risk behaviours, and negative consequences. To date, qualitative investigations have found that reasons for use often involve facilitating increased alcohol consumption, engaging in longer and more active drinking sessions, and to decrease negative sensations related to alcohol intoxication. These motivations for use support the idea that consumers are purposefully using AmED for reasons that may increase their risk of heavy alcohol use and related negative consequences, beyond the risk of alcohol use alone.

Despite this converging research evidence, there remain many limitations and gaps in the current research knowledge in order to unequivocally determine whether the

associations between AmED use and heavy drinking, alcohol use disorders, risky behaviours, and negative consequences are due to causal relationships. As noted previously, there appears to be some within-subject research which indicates that AmED users may use less alcohol on AmED use occasions than occasions when they use alcohol alone (e.g., Woolsey, 2010). There is also within subject research indicating the opposite (Brache & Stockwell, 201; Price et al., 2010). The design of research studies investigating AmED use could be improved to help further investigate the potential of causal associations. Although several laboratory investigations have attempted to understand these associations, ambiguous research findings from a variety of investigations have made it difficult to drawn clear conclusions regarding the potential mechanisms by which AmED use may increase alcohol consumption and engagement in other risk behaviours. Further studies will be needed to investigate these links.

Limitations in AmED Research

Many AmED studies are correlational and therefore cannot determine the direct effects of AmED consumption on behavior. Importantly, different survey methodologies are being used to address these concerns in more recent research. Other limitations include biased research conducted by energy drink funded researchers, and their potential influence on research dissemination and research review. Laboratory research appears to be limited due to administration of energy drink and alcohol amounts that do not appear to be representative of the quantities consumed in drinking venues, as reported by AmED users. They are also limited as their investigations of direct pharmacological risks may fail to take into account how motivations (e.g., achieve high intoxication), expectancies, and situations associated with AmED use may increase risk (Attwood, 2012). The

research to date has limited well-designed within-subject AmED use research. More studies with this design may help tease apart differences between AmED and alcohol only use occasions for consumers and whether these occasions are related to relatively heavy drinking and risk taking on AmED use days compared to alcohol only days. A well designed study is needed to account for differences in frequency of each type of use and potential recall biases related to frequency of use.

Investigations into motivations of use are also limited due to their use of few reasons and different wording of these reasons as opposed to allowing consumers to report their reasons for use in a qualitative manner, or supplying an extensive enough list of motivations.

Future Research

As the published research on AmED use quickly grows, researchers have been urged to remain attentive to the variety of unanswered questions regarding the associations between AmED and other health-risk behaviours. Miller (2013a) summarizes two key unanswered questions, "how much of this relationship derives from the physiological effects of caffeine/alcohol co-administration (particularly as they interact with alcohol expectancy effects), how much from demographic or psychosocial selection effects (such as gender or sensation-seeking personality trait), and how much from environmental contexts (such as drinking venues, peer influences, marketing messages, or polysubstance use)?" Importantly, AmED expectancies and motivations for use appear to have potentially important influences on understanding this relationship as well. Secondly, Miller (2013a) identifies the questions "what are the policy implications of these findings?" as another important future research questions of interest in the field.

This question appears to be somewhat more difficult to attack, given the equivocal laboratory and limited "causally attributable" findings regarding the associations between AmED and different outcomes. Policy implications may also be difficult to address as we currently have an unclear understanding with regard to whether a specific amount of AmED use or frequency of AmED use is related to such outcomes.

In order to answer some of these research questions different research designs will have to be employed. Future research should be designed to investigate the possible mechanisms and temporal association by which caffeine or energy drinks may play in the propensity for heavy alcohol use, addiction, engagement in risky behaviours, and negative outcomes (Arria & O'Brien, 2011). Different research approaches may be helpful such as identifying the environmental factors associated with the use of AmED that may facilitate problem drinking and engagement in risk behaviours (Miller, 2013a; Wells et al., 2012). It appears that within-subjects designs will also add a great deal to this field of research to allow for comparison of alcohol only and AmED use (Patrick and Maggs, 2014). Researchers should begin and continue to investigate more diverse samples, outside of the college student population in order to replicate the current findings and create research that can be used to support policy changes. It is clear from the debate and limitations of current laboratory research, future research is needed investigating the effects of energy drinks on subjective intoxication, and objective performance for a variety of alcohol and energy drinks doses. Additionally, more laboratory research should investigate if a priming dose of AmED use on desire for alcohol (Peacock & Bruno, 2013).

Motivations and expectancies of AmED use appear to be important areas for future study, particularly as they may influence consumption behaviours, expected effects, and possible risk behaviours (Varvil-Weld et al., 2013). Several researchers have mentioned the possibility of an expectancy effect associated with AmED consumption, where those who consume AmED perceive themselves to be more likely to take risks based on previous encounters with both alcohol and energy drinks (Attwood, 2012; Snipes & Benotsch, 2013). Risk taking and negative consequences may be higher due to the combination of feeling stimulated, reduced motor impairment, and a greater propensity to take risks (Snipes & Benotsch, 2013). This should be further investigated in both ecological and laboratory studies in order to understand how expectancy and motivation influence behavior. Others have described that consumers of AmED may have unexpected physical effects due to altered alcohol consumption cues (Siegel, 2011). These should also be investigated, particularly how they might relate to increased alcohol consumption.

Perhaps most importantly, some have argued that although public health concerns on AmED may be justified, careful attention should be paid to not divert attention from the more pressing issue of harmful alcohol consumption (Attwood, 2012). Consequently more research on the public health impact of AmED vs. alcohol alone is needed. Despite this, the current research in addition to other research on AmED suggests that AmED consumption is a new risk factor for heavier and harmful alcohol consumption (Patrick & Maggs, 2014).

With regard to future research in this area, it is important for researchers to use rigorous research methods and to limit the conclusions of their research to that which

their analyses and data can support. The peer review process appears to be an important time for scrutiny of research published in this area. It should focus on encouraging more clear presentation of data and research findings for both university, public, and energy drink-funded researchers so that higher quality research is published with less potential of unsubstantiated claims and the accusations of using improper research methods. The responsibility for thoughtful peer review and publication will likely fall on the shoulders of journals publishing research in this area and the researchers being asked to conduct peer reviews. There is a need for more clear statements regarding conflicts of interest which should be noted (potentially repeatedly) in the body of the research, as well as a description of how such conflicts may have impacted the authors' research designs and conclusions (Miller, 2013b). This should also extend to conference presentations and other dissemination of the literature (Miller, 2013b). Conference organizers should take care to invite researchers who are not funded by industry to also present on their research. In general, researchers in this area should strive to use more rigorous research methods and support more thorough peer-review.

Implications for Interventions

Given that much of the AmED consumption appears to be from consuming hand-mixed energy drinks with alcohol, potential regulations on energy drinks and their availability in drinking venues could be an area for policy consideration. Unfortunately, the quick accumulation of research studies on AmED use and the wide-variety of findings from industry and non-industry funded researchers makes drawing overall conclusions regarding AmED associations or cause and effect statements very difficult. More methodologically sound and unbiased reviews of this literature are needed to help

inform and educate policy-makers in effective strategies that can reduce harms associated with AmED use. Clearly, more research that is intended to guide regulatory agencies is still needed (Arria & O'Brien, 2011). Policy interventions may be based on research into whether a scientifically validated upper limit on the amount of caffeine a manufacturer can include in a single serving of a beverage (or alcoholic beverage) and a possible limit to how many "servings" a non-resealable beverage container may contain (Arria & O'Brien, 2011). Further considering energy drinks as a food product, as opposed to a natural health care product in Canada, may result in similar maximum allowable limits for caffeine amounts in beverage products.

While waiting for this research to be available, some have suggested considerations for interventions. Arria and O'Brien (2011) suggested that heath care professionals inform their patients of associated risks with energy drinks, the public should educate themselves on the risks of energy drinks (and mixing them with alcohol), and the alcohol industries should voluntarily and actively caution consumers against mixing energy drinks with alcohol. They argue that this should occur both on product labels and in their advertising material. Of note, this may be a big shift for energy drink advertising as energy drink advertising is very prevalent in drinking venues in Canada, and perhaps elsewhere. Additionally, a determination by health officials of who is or should be responsible for ensuring ethical advertising and product availability by energy drinks companies could help in moving forward in proactively protecting the public. One example would be requesting energy drinks companies to not advertise or sell energy drinks in drinking venues when the product itself warns to not consume with alcohol.

As described by Varvil-Weld et al. (2013), AmED research findings suggest that information about AmED use should be assessed and included as part of comprehensive alcohol intervention efforts in college students. As identified by their different AmED profiles, some users may benefit from interventions addressing AmED expectancies and attitudes may be appropriate, whereas others may benefit from addressing normative misperceptions. An analysis and intervention regarding students' motives for use may also be included in such intervention efforts. Some efforts appear to be underway on campuses as information has been gathered and released to begin helping campus professionals address AmED concerns (Traue & Stahlman, n. d.). Their recommendations include educating themselves and students about AmED, developing campus policies regarding advertising and availability of energy drinks on campus, working with community stakeholders, and engaging community leaders. Additionally, some AmED researchers who found school connectedness to be related to lower AmED use have suggest that school connectedness is most amenable to change and could be targeted (Azagba, Langille, & Asbridge, 2013). At the policy level, approaches could involve a flat or variable tax (reflective of caffeine content) on energy drinks, similar to what has been proposed and conducted with alcohol in certain Canadian jurisdictions (Azagba, Langille, & Asbridge, 2013). Harm-reduction approaches could be utilized to encourage youth to not consume AmED, or to limit their consumption.

In order to help inform communities beyond the campus communities, policy reports for policy makers and information for the public can be created and advertised. Several examples of these have occurred in the Canadian setting (e.g., Brache, Thomas, & Stockwell, 2012; Health Canada, 2005).

Conclusions

In conclusion, this research has contributed to a better understanding of the relationships between AmED use and personality traits, drinking behaviours, and risk behaviours. It has contributed to a better understanding of the motivations for AmED use and how these motivations may be related to risky behaviours. Along with the accumulating research in this area, the current research could be valuable for directing and planning future research studies and for formulating effective policies and intervention programs.

References

Albrecht, A. K., Galambos, N.L. & Jansson, S. M. (2007). Adolescents' internalizing and aggressive behaviors and perceptions of parents' psychological control: A panel study examining direction of effects. *Journal of Youth and Adolescence. 36*(5), 673-684.

Alford, C., Hamilton-Morris, J., & Verster, J. C. (2012). The effects of energy drink in combination with alcohol on performance and subjective awareness. *Psychopharmacology, 222*(3), 519-532.

Arria, A., M. (2011). A response to the letter to the editor my Michael P. Skeen. *Alcoholism: Clinical and experimental research, 35*(8), 1377-1378.

Arria, A. M., & O'Brien, M. C. (2011). The "high" risk of energy drinks. *The journal of the American medical association, 305*(6), 600-601.

Arria, A. M., Caldeira, K. M., Kasperski, S. J., O'Grady, K. E., Vincent, K. B., Griffiths, R. R., & Wish, E. D. (2010). Increased alcohol consumption, nonmedical prescription drug use, and illicit drug use are associated with energy drink consumption among college students. *Journal of Addiction Medicine, 4*(2), 74-80.

Arria, A., Caldeira, K., Kasperski, S., Vincent, K., Griffiths, R. & O'Grady, K. (2011). Energy drink consumption an increased risk for alcohol dependence. *Alcoholism: Clinical & Experimental Research. 35*(2), 365-375.

Attila, S., & Cakir, B. (2011). Energy-drink consumption in college students and associated factors. *Nutrition, 27*(3), 316-322.

Attwood, A. S., (2012). Alcohol and caffeine. Caffeinated alcohol beverages: A public health concern. *Alcohol and Alcoholism, 47*(4), 370-371.

Attwood, A. S., Rogers, P. J., Ataya, A. F., Adams, S., & Munafo, M. R. (2012). Effects of caffeine on alcohol-related changes in behavioural control and perceived intoxication in light caffeine consumers. *Psychopharmacology, 221*(4), 551-560.

Azagba, S., Langille, D., & Asbridge, M. (2013). The consumption of alcohol mixed with energy drinks: prevalence and key correlates among Canadian high school students. *Canadian Medical Association Journal,* E19-E26.

Babor, T. F., Higgins-Biddle, J. C., Saunders, J. B., & Monteiro, M. G. (2001) The Alcohol Use Disorders Identification Test: Guidelines for use in primary care (2ed). *World Health Organization, Department of Mental Health and Substance Dependence.*

Ballistreri, M. C., Corradi-Webster, C. M., (2008). Consumption of energy drinks among physical education students. *Rev Latino-am Enfermagem, 16,* 558-564.

Barnes, G. E., Murray, R. P., Patton, D., Bentler, P. M., & Anderson, R. E. (2000). *The addiction-prone personality.* New York: Kluwer Academic/Plenum Publishers.

Bartholomew, K., Henderson, A., & Marcia, J. E. (2000). Coded semistructured interviews in social psychological research. In H. T. Reis & C. M. Judd (Eds.), *Handbook of Research Methods in Social and Personality Psychology* (pp. 286-312). Cambridge: Cambridge University Press.

BC Liquor Distribution Branch (2009). Sales data for alcoholic energy drink "Rockstar with Vodka."

Berger, L., Fendrich, M., & Fuhrmann, D. (2013). Alcohol mixed with energy drinks: Are there associated negative consequences beyond hazardous drinking in college students? *Addictive Behaviours, 38*(9), 2428-2432.

Berger, L. K., Fendrich, M., Chen, H.Y, Arria, A. M., & Cisler, R. A. (2011). Sociodemographic correlates of energy drink consumption with and without alcohol: Results of a community survey. *Addictive Behaviors, 36* (5), 516-519.

Bisson, J., Nadeau, L., & Demers, A. (1999). The validity of the CAGE scale to screen for heavy drinking and drinking problems in a general population survey. *Addiction, 94*(5), 715-722.

Brache, K., Thomas, G., & Stockwell, T. (2012). *Caffeinated Alcoholic Beverages in Canada: Prevalence of Use, Risks and Recommended Policy Responses*. Ottawa, ON: Canadian Centre on Substance Abuse. Accessed at: http://www.ccsa.ca/Eng/Priorities/Alcohol/Caffeinated-Alcoholic-Beverages-in-Canada/Pages/default.aspx

Brache K., & Stockwell, T. (2011). Drinking patterns and risk behaviors associated with combined alcohol and energy drink consumption. *Addictive Behaviors, 36* (12), 1133-1140. doi: 10.1016/j.addbeh.2011.07.003

Brache, K., & Stockwell, T. (2010). Unpublished survey data on alcohol and energy drink use among college students at a western Canadian university.

Brache, K. (2009). Alcohol and cocaine simultaneous polysubstance use: A qualitative investigation. *Masters Thesis.* Accessed on April 20, 2010 at http://hdl.handle.net/1828/1436

Brache, K., & Stockwell, T. (2008). Patterns, settings, and functions of simultaneous use of alcohol and psychostimulants: a literature review. Paper presented at the 34th Annual Alcohol Epidemiology Symposium of the Kettil Bruun Society for Social and Epidemiological Research on Alcohol, Victoria, Canada.

Cheng, W. J., Cheng, Y., Huang, M. C., & Chen, C. J. (2012). Alcohol dependence, consumption of alcoholic energy drinks and associated work characteristics in the Taiwan working population. *Alcohol and Alcoholism, 47*(4), 372-379.

Cherpitel, C. J. (1999). Substance use, injury, and risk-taking dispositions in the general population. *Alcoholism: Clinical and Experimental Research, 23*(1), 121-126.

Cherpitel, C.J. (1993) Alcohol, injury, and risk-taking behavior: Data from a national sample. *Alcoholism: Clinical and Experimental Research 17*(4): 762-766.

Cleary, K., Levine, D. A., & Hoffman, R. S. (2012). Adolescents and young adults presenting to the emergency department intoxicated from caffeinated alcoholic beverage: A case series. *Annals of Emergency Medicine, 59* (1), 67-69.

Curry, K. & Stasio, M. J. (2009). The effects of energy drinks alone and with alcohol on neuropsychological functioning. *Human Psychopharmacology, 24* (6), 473-481.

Dunlap, L. (2008). Wake up to the facts: Energy Drinks & Alcohol don't mix, *The Journal of the Air and Mobility Command's Magazine, March/April,* 20-21.

Eckschmidt, F., De Andrade, A. G., Dos Santos, B., & De Oliveira, G. D. (2013). The effects of alcohol mixed with energy drinks (AmED) on traffic behaviors among Brazilian college students: A national survey. *Traffic injury Prevention, 14*(7), 671-679.

Éduc'alcool (n.d.) Energy drinks and alcohol: Don't get your kicks from this mix! Accessed on June 14, 2011 at: http://www.educalcool.qc.ca/en/alcohol-and-society/alcohol-and-energy-drinks/index.html

European Commision (2010). Standing committee on the food chain and animal health section on general food law: Summary of record of meeting of April 26, 2010. Accessed on July 25, 2010 at: http://ec.europa.eu/food/committees/regulatory/scfcah/general_food/sum_26042010_en.pdf

Ewing, J. A. (1984). Detecting alcoholism, the CAGE questionnaire. *Journal American Medical Association, 252*(14), 1905-1907.

Ferreira, S. E., de Mello, M. T., Pompeia, S. & de Souza-Formigoni, M. L. O. (2006). Effects of energy drink ingestion on alcohol intoxication. *Alcoholism: Clinical and Experimental Research, 30*(4), 598-605.

Ferreira, S. E., Hartmann Quadros, I. M. H, Trindade, A. A., Takahashi, S., Koyama, R. G., Souza-Formigoni, M. L. O. (2004a). Can energy drinks reduce the depressor effect of ethanol? An experimental study in mice. *Physiology and Behavior, 82*(5), 841-847.

Ferreira, S. E., de Mello, M. T., Rossi, M. V., & Souza-Formigoni, M. L. O. (2004b). Does an energy drink modify the effects of alcohol in a maximal effort test ? *Alcoholism: Clinical and Experimental Research, 28*(9),1408-1412.

Fillmore, M. T. & Vogel-Sprott, M. (1995). Behavioural effects of combining alcohol and caffeine: Contribution of drug related expectancies. *Experimental and clinical psychopharmacology, 3*(1), 33-38.

Finnegan, D. (2003) The health effects of stimulant drinks. *Nutrition Bulletin, 28*(2),147-155.

Health Canada (2012) Canadian alcohol and drug use monitoring survey 2010: Microdata user guide. Accessed on April 22, 2014 at http://abacus.library.ubc.ca/bitstream/10573/42656/5/cadums_user_guide_2010_en_rev%202012.pdf

Health Canada (2005). Safe use of energy drinks. Accessed on January 27, 2010 at http://www.hc-sc.gc.ca/hl-vs/alt_formats/pacrb-dgapcr/pdf/iyh-vsv/prod/energy-energie-eng.pdf.

Heckman, M. A., Sherry, K., & Gonzalez de Mejia, E. (2010). Energy drinks: An assessment of their market size, consumer demographics, ingredient profile, functionality, and regulations in the United States. *Comprehensive Reviews in Food and Food Safety*, *9*(3), 303-317.

Hilton, M. (1987). Drinking patterns and drinking problems in 1984: results from a general population survey. *Alcoholism: Clinical and Experimental Research, 11*(2), 167-175.

Howland, J., Rohsehnow, D., Arnedt, J., Bliss, C., Hunk, K., Calise, T., Heern, T., Winter, M., Littlefield, C & Gottlieb, D. (2010). The acute effects of caffeinated versus non-caffeinated alcoholic beverages on driving performance and attention/reaction time. *Addiction*, 106(2):335-341.

Howland, J., Rohsenow, D., Vehige Calise, T., MacKillop, J. & Metrik, J. (2011). Caffeinated alcoholic beverages: An emerging public health problem. *American journal of preventative medicine*, 40(2):268-271.

Jansson, M., Mitic, W., Hulten, T. & Dhami, M. K. (2006). A youth population health survey (pp.59-69). In Leadbeater, B., Banister, E., Benoit, C., Jansson, M.,Marshall, A. & Riecken, T. (Eds.). *Ethical Issues in Community-Based Research with Children and Youth.* Toronto, Ontario: University of Toronto Press.

Jones, S. C., (2011). "You wouldn't know it had alcohol in it until you read the can:" Adolescents and alcohol-energy drinks. *Australian Marketing Journal, 19*(3), 189-195.

Jones, S. C., Barrie, L., & Berry, N. (2012). Why (not) alcohol energy drinks? A qualitative study with Australian university students. *Drug and Alcohol Review, 31*(3), 281-287.

Jones, S. C. & Barrie, L. (2009). Alcohol-energy drinks: Engaging young consumers in co-creation of alcohol related harm. Proceedings of the Australian and New Zealand Marketing Academy Conference. Accessed on June 14, 2011 from http://uow.academia.edu/LanceBarrie/Papers/221182/Alcohol-Energy_Drinks_Engaging_Young_Consumers_In_Co-Creation_of_Alcohol-Related_Harm

Jones, H. A., & Lejuez, C. W. (2005). Personality correlates of caffeine dependence: The role of sensation seeking, impulsivity, and risk taking. *Experimental and Clinical Psychopharmacology, 13*(3), 259-266.

Kashdan, T. B., Vetter, C. J., & Collins, R. L. (2005). Substance use in young adults: associations with personality and gender. *Addictive behaviours, 30*(2), 259-269.

Kuhns, J. B., Clodfelter, T. A., & Bersot, H. Y. (2010). Examining and understanding the joint role of caffeine and alcohol in facilitating violent offending and victimization. *Contemporary Drug Problems, 37*(2), 267-287.

Kunin, D., Gaskin, S., Rogan, F. Smith, B.R. & Amit, Z. (2000). Caffeine promotes ethanol drinking in rats: Examination using a limited-access free choice paradigm. *Alcohol, 21*(3), 271-277.

Kutcher, E., Egorov, A., Filatova, E., Kulagina, K. & Chernikova, N. (2011). Sex influence on the formation of alcohol preference and behavior in rats during the long-term caffeine and ethanol intake. *Journal of behavioral and brain science, 1*(3), 172-180.

Liguori, A. & Robinson, J. H. (2001). Caffeine antagonism of alcohol-induced driving impairment. *Drug and alcohol dependence, 63*(2), 123-129.

Lea, S., Black, K., Asbridge, M. (2009). An overview of injuries to adolescents and young adults related to substance use: data from Canadian emergency departments. *Canadian Journal of Emergency Medicine,11*(4), 330-336.

Lecrubier, Y., Sheehan, D. V., Weiller, E., Amorim, P., Bonora, I., Sheehan, K. H., Janavs, J., & Dunbar, G. C. (1997) The mini international neuropsychiatric interview (MINI). A short diagnostic structured interview: reliability and validity according to the CIDI. *European Psychiatry, 12*(5), 224-231.

Levy, G. & Tapsell, L. (2007). Shifts in purchasing patterns of non-alcoholic, water-based beverages in Australia, 1997–2006. *Nutrition & Dietetics, 64*(4), 268–279.

Malinauskas, B. M., Aeby, V.G., Overton, R.F., Carpenter-Aeby, T. & Barber-Heidal, K. (2007). A survey of energy drink consumption patterns among college students. *Nutrition Journal, 6*(35), 1-7.

Marczinski, C A. (2011a). Alcohol mixed with energy drinks: Consumption patterns and motivations for use in U.S. College students. *International journal of environmental research and public health, 8*(8), 3232-3245.

Marczinski, C. A. (2011b). Commentary on Rossheim and Thombs (2011): Artificial sweeteners, caffeine, and alcohol intoxication in bar patrons. *Alcoholism: Clinical and experimental research, 35*(10), 1729-1731.

Marczinski, C. A., Fillmore, M. T. (2013). Letter to the editor in response to the alcohol mixed with energy drinks debate: Masking the facts! *Alcoholism: Clinical and experimental research, 37*(4), 706-708.

Marczinski, C. A, Fillmore, M. T., Bardgett, M. E. & Howard, M. A. (2011). Effects of energy drinks mixed with alcohol on behavioural control: Risks for college students consuming trendy cocktails. *Alcoholism: Clinical and experimental research, 35*(7), 1282-1292.

Marczinski, C. A., Fillmore, M. T., Henger, A. L., Ramsey, M. A., & Young, C. R. (2013). Mixing an energy drink with and alcoholic beverage increases motivation for more alcohol in college students. *Alcoholism: Clinical and Experimental Research, 37*(2), 276-283.

Marczinski, C. A., Fillmore, M. T., Henger, A. L., Ramsey, M. A., & Young, C. R. (2012). Effects of energy drinks mixed with alcohol on information processing,

motor coordination and subjective reports of intoxication. *Experimental and clinical psychopharmacology, 20*(2), 129-138.

Marczinski, C. A. & Fillmore, M.T. (2006). Clubgoers and their trendy cocktails: Implications of mixing caffeine into alcohol on information processing and subjective reports of intoxication. *Experimental and Clinical Psychopharmacology, 14(*4), *450-458.*

Marczinski, C. A. & Fillmore, M.T. (2003). Dissociative antagonistic effects of caffeine on alcohol-induced impairment of behavioral control. *Experimental and Clinical Psychopharmacology, 11(*3), 228-236.

McLeod, R., Stockwell, T., Rooney, R., Stevens, M., Phillips, M., & Jelinek, G. (2003). The influence of extrinsic and intrinsic factors on the probability of sustaining an injury. *Accident analysis and Prevention, 35*(1), 71-80.

Miller, K. E. (2013a). Commentary: Correlates of concurrent energy drink and alcohol use among socially active adults. *The American journal of drug and alcohol abuse, 39*(1), 1-2.

Miller, K. E. (2008a). Wired: Energy drinks, jock identity, masculine norms, and risk taking. *Journal of American College Health, 56*(5), 481-489.

Miller, K.E. (2008b). Energy drinks, race, and problem behaviors among college students. *Journal of Adolescent Health, 43*(5), 490-497.

Miller, P. (2013b). Personal view: Energy drinks and alcohol: research supported by industry may be downplaying harms. *BMJ, 347,* f5345.

O'Brien, M.C., McCoy, T.P., Rhodes, S. D., Wagoner, A., & Wolfson, M. (2008) Caffeinated cocktails: Energy drink consumption, high-risk drinking, and alcohol-

related consequences among college students. *Academic Emergency Medicine, 15*(5), 453-460.

Oteri, A, Salvo, F., Caputi, A. P. & Calapi, G. (2007). Intake of energy drinks in association with alcoholic beverages in a cohort of students of the school of medicine of the university of Messina. *Alcoholism: Clinical and Experimental Research, 31*(10), 1677-1680.

Patrick, M. E., & Maggs, J. L. (2014). Energy drinks and alcohol: Links to alcohol behaviours and consequences across 56 days. *Journal of Adolescent Health, 54*(4), 454-459.

Peacock, A., Bruno, R., Martin, F. H., & Carr, A. (2014). Self-reported physiological and psychological side-effects of an acute alcohol and energy drink dose. *Appetite, 76,* 60-65.

Peacock, A., & Bruno, R., (2013). "High" motivation for alcohol: What are the practical effects of energy drinks on alcohol priming? *Alcoholism: Clinical and experimental research, 37*(2), 185-187.

Peacock, A., Bruno, R., & Martin, F. H. (2013). Brief Report. Patterns of use and motivations for consuming alcohol mixed with energy drinks. *Psychology of Addictive Behaviors, 27*(1), 202-206.

Peacock, A., Bruno, R., & Martin, F. H. & Carr, A. (2013). The impact of alcohol and energy drink consumption on intoxication and risk-taking behavior. *Alcoholism: Clinical and experimental research, 37*(7), 1234-1242.

Peacock, A., Bruno, R., & Martin, F. H. (2012). The subjective physiological, psychological, and behavioural risk-taking consequences of alcohol and energy

drink co-ingestion. *Alcoholism: Clinical and Experimental Research, 36*(11), 2008-2015.

Pennay, A., & Lubman, D. I. (2012). Alcohol and energy drinks: A pilot study exploring patterns of consumption, social contexts, benefits and harms. *BMC Research Notes, 5*(1), 369-469.

Pennay, A., Lubman, D. I., & Miller, P. (2011). Combining energy drinks and alcohol: A recipe for trouble? *Australian Family Physician, 40*(3), 104-107.

Price, R., Hilchey, C., Darredeau, C., Fulton, H. & Barrett, S. (2010). Brief communication: Energy drink co-administration is associated with increased reported alcohol ingestion. *Drug & alcohol review*, 29(3):331-333.

Ragsdale, F.R., Gronli, T.D., Batool, N., Haight, N., Mehaffey, A., McMahon, E. C., Nalli, T.W., Mannello, C. M., Sell, C. J., McCann, P. J., Kastello, G.M., Hooks, T. & Wilson, T. (2010). Effect of Red Bull energy drink on cardiovascular and renal function. *Amino Acids, 38* (4), 1193-1200.

Reissig, C. J., Strain, E. C., & Griffiths, R. R. (2009). Caffeinated energy drinks- A growing problem. *Drug and Alcohol Dependence, 99*(1), 1-10.

Romanowicz, M., Schmodt, J. E., Bostwick, J. M., Mrazck, D. A., Karpyak, W. M. (2011). Changes in heart rate variability associated with acute alcohol consumption: current knowledge and implications for practice and research. *Alcoholism: Clinical and Experimental Research, 35*(6), 1092-1105.

Rossheim, M. E., Suzuki, S., & Thombs, D. L. (2013). Letter to the editor in regard to Peacock, Bruno, and Martin (2012): "The subjective physiological, psychological, and behavioral risk-taking consequences of alcohol and energy drink co-

ingestion" misleading results and unjustified conclusions. *Alcoholism Clinical & Experimental Research, 37*(12), 2168-2170.

Rosshein, M. E. & Thombs, D. L. (2011). Artificial Sweeteners, caffeine, and alcohol intoxication in bar patrons. *Alcoholism: Clinical and experimental research, 35*(10), 1891-1896.

Rothman, K.J., & Greenland, S., (1998). *Modern epidemiology* (second edition) Lippincott-Raven Publishers. Philadelphia.

Schmidt, S. (2011). Health Canada ignores recommendation to probe health risks of alcoholic energy drinks. *Montreal gazette.* Accessed on June 13, 2011 at http://www.montrealgazette.com/health/Health+Canada+ignored+recommendation+probe+heath+risks+alcoholic/4934254/story.html

Schmidt, S. (2010). Health Canada strikes an uneasy regulatory balance on alcoholic energy drinks. *Canwest news service.* Accessed on January 16, 2011 at http://www.canada.com/health/Health+Canada+strikes+uneasy+regulatory+balance+alcoholic+energy+drinks/3042092/story.html

Seetharaman, D. (2009). FDA killing buzz on alcohol and energy drinks. *National Post.* Accessed on April 18, 2010 at http://www.nationalpost.com/life/health/story.html?id=ac50aba2-6b6e-4135-a333-cf6ed75cfcbd

Sheeham, D. V., Lecrubier, Y., Sheehan, K. H., Janavs, J., Weiller, E., Keskiner, A., Schinka, J., Knapp, E., Sheehan, M. F., & Dunbar, G. C. (1997). The validity of the Mini International Neuropsychiatric Interview (MINI) according to the SCID-P and its reliability. *European Psychiatry, 12*(5), 232-241.

Siegel, S. (2011). The Four-Loko Effect. *Perspectives on Psychological Science*, *6*(4), 357-362.

Simon, M & Mosher, J. (2007). Alcohol, energy drinks, and youth: a dangerous mix. *Marin Institute: Alcohol Industry Watchdog.* Accessed on June 13, 2011 at https://www.marininstitute.org/site/images/stories/pdfs/energydrinkreport.pdf

Skeen, M. P., & Glenn, L. L. (2011). Imaginary link between alcoholism and energy drinks. *Alcoholism: Clinical and experimental research, 35*(8), 1375-1376.

Skewes, M. C., Decou, C. R., & Gonzalez, V. M. (2013). Energy drink use, problem drinking and drinking motives in a diverse sample of Alaskan college students (2013). *International Journal of Circumpolar Health, 72,* 1-6.

Smith, C. P. (2000). Content analysis and narrative analysis. In H. T. Reis & C. M. Judd (Eds.), *Handbook of Research Methods in Social and Personality Psychology* (pp. 313-335). Cambridge: Cambridge University Press.

Snipes, D. J., & Benotsch, E. G. (2013). High-risk cocktails and high-risk sex: Examining the relation between alcohol mixed with energy drink consumption, sexual behavior, and drug use in college students. *Addictive Behaviours, 38*(1), 1418-1423.

Snipes, D. J., Green., B. A., Javier, S. J., Perrin, P. B., & Bentosh, E. G. (2014). The use of alcohol mixed with energy drinks and experiences of sexual victimization among male and female college students. *Addictive Behaviors, 39*(1), 259-264.

Spierer, D. K., Blanding, N., & Santella, A. (2014). Energy drink consumption and associated health behaviours among university students in an urban setting. *Journal of Community Health, 39*(1), 132-138.

Steinke, L., Lanfear, D. E., Dhanapal, V. & Kalus, J.S. (2009). Effect of "Energy Drink" consumption on hemodynamic and electrocardiographic parameters in healthy young adults. *The Annals of Pharmacotherapy, 43*(4), 596-602.

Streiner, D. L. (2003). Starting at the beginning: An introduction to coefficient alpha and internal consistency. *Journal of Personality Assessment, 80*(1), 99-103.

Substance Abuse and Mental Health Services Administration. (2011). The Drug Abuse Warning Netwrok (DAWN) report: Emergency department visits involving energy drinks. *Centre for behavioural health statistics and quality, Rockville, MD.*

Thombs, D. L., O'Mara, R. J., Tsukamoto, M., Rossheim, M. E., Weiler, R. M., Merves, M. L., & Goldberder, B. A. (2010), Event-level analyses of energy drink consumption and alcohol intoxication in bar patrons. *Addictive Behaviors, 35*(4), 325-330.

Thombs, D., Rossheim, M., Barnett, T. E., Weiler, R. M., Moorhouse, M. D., & Coleman, B. N. (2011). Is there a misplaced focus on AmED? Associations between caffeine mixers and bar patron intoxication. *Drug and Alcohol Dependence, 116* (1), 31-36.

Thorson, J. A., & Powell, F. C. (1987). Factor structure of a lethal behaviors scale. *Psychological Reports, 61*(1), 807-810.

Traue, J. G. & Stahlman, S. (no date). Alcohol mixed with high levels of caffeine: What campus professionals need to know. *ACPA College Student Educators International.* Retrieved from http://www.myacpa.org/files/acpaalcoholcaffeine pdf

Tropy, J. M., & Livingston, E. H. (2013). Energy drinks. *The journal of the American medical association, 309* (3), 297.

Ulbrich, A., Hemberger, S. H., Loidl, A., Dufek, S., Pablik, E., Fodor, S., Herle, M., Aufricht. (2013). Effects of alcohol mixed with energy drink and alcohol alone on subjective intoxication. *Amino Acids, 45*(6), 1385-1393.

Ugwuja, E. I., (2014). Biochemical effects of energy drinks alone or in combination with alcohol in normal albino rats. *Advanced Pharmaceutical Bulletin, 4*(1), 69-74.

U.S. Food and Drug Administration (2010). FDA news release: FDA warning letters issued to four makers of caffeinated alcoholic beverages. Retrieved On January 16, 2011 from http://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm 234109.htm

Varvil-Weld, L., Marzell, M., Turrisi, R., Mallett, K. A., & Cleveland, M. J. (2013). Examining the relationship between alcohol-energy drink risk profiles and high-risk drinking bheaviours. *Alcoholism: Clinical and experimental research, 37*(8), 1410-1416.

Velazquez, C. E., Poulos, N. S., Latimer, L. A., & Pasch, K. E. (2012). Associations between energy drink consumption and alcohol use behaviours among college students. *Drug and Alcohol Dependence, 123*(1-3), 167-172.

Verster, J. C. & Alford, C. (2011). Editorial: Unjustified concerns about energy drinks. *Current drug abuse reviews, 4*(1), 1-3.

Verster, J. C., Alford, C., & Scholey, A. (2013). The alcohol mixed with energy drink debate: Masking the facts! A commentary on “Mixing an energy drink with an alcoholic beverage increases motivation for more alcohol in college students by

Marczinski and colleagues (in press). *Alcoholism Clinical & Experimental Research, 37*(4), 703-705.

Verster, J. C., Aufricht, C., Alford, C. (2012). Energy drinks mixed with alcohol: Misconceptions, myths, and facts. *International Journal of General Medicine, 5,* 187-198.

Weldy, D. (2010). Research letter: Risks of alcoholic energy drinks for youth. *Journal of the American board of family medicine*, 24(4):555-558.

Wells, B. E., Kelly, B. C., Pawson, M., LeClair, A., Parsons, J. T., Golub, S. A. (2013). Correlates of concurrent energy drink and alcohol use among socially active adults. *The American journal of drug and alcohol abuse, 39*(1), 8-15.

Wiklund, U., Karlsson, M., Ostrom, M. & Messner, T. (2009). Influence of energy drinks and alcohol on post-exercise heart rate recovery and heart rate variability. *Clinical Physiological and Functional Imaging*, *29*(1), 74-80.

Woosley, C., Waigandt, A., & Beck, N. (2010). Athletes and energy drinks: Reported risk-taking and conseuqences from the combined use of alcohol and energy drinks. *Journal of Applied Sport Psychology*, *22*(1), 65-71.

Woolsey, C. (2010). Energy drink cocktails: A dangerous combination for athletes and beyond. *Journal of Alcohol and Drug Education*, *54*(3), 41-68.

Woolsey, C. L. & Kensinger, W. S. (2009) Energy drinks: the new gateway drug. Accessed on January 30, 2010 at: http://aahperd.confex.com/aahperd/2010/ preliminaryprogram/abstract_14631.htm

Zuckerman, M. (1994). *Behavioral Expressions and Biosocial Bases of Sensation Seeking.* Cambridge: Cambridge University Press.

Figure 1. University of Victoria Student Survey: Percentage of students endorsing specific motivations for combining alcohol and energy drinks

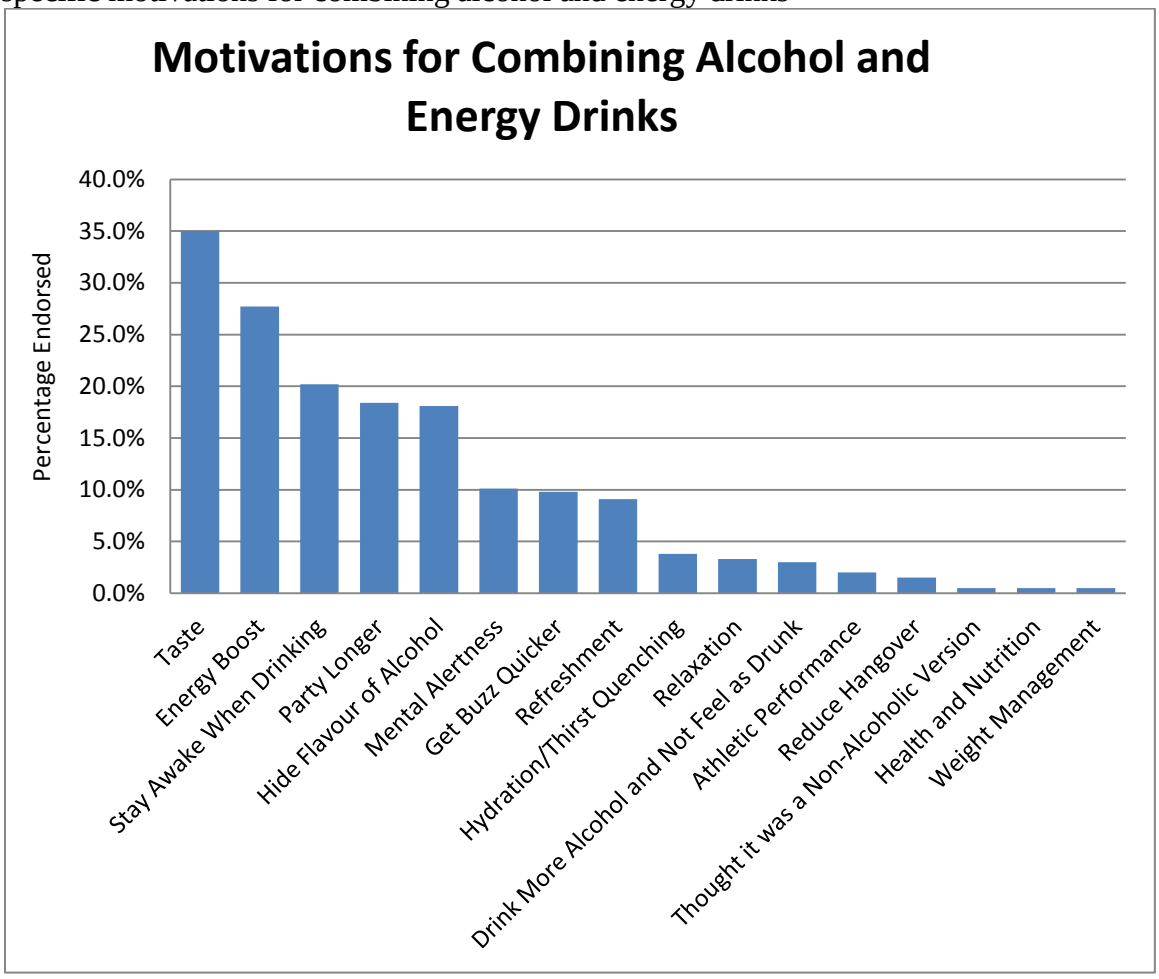

Figure 2. Model of relationships between combined alcohol and energy drink use, personality traits and outcome variables

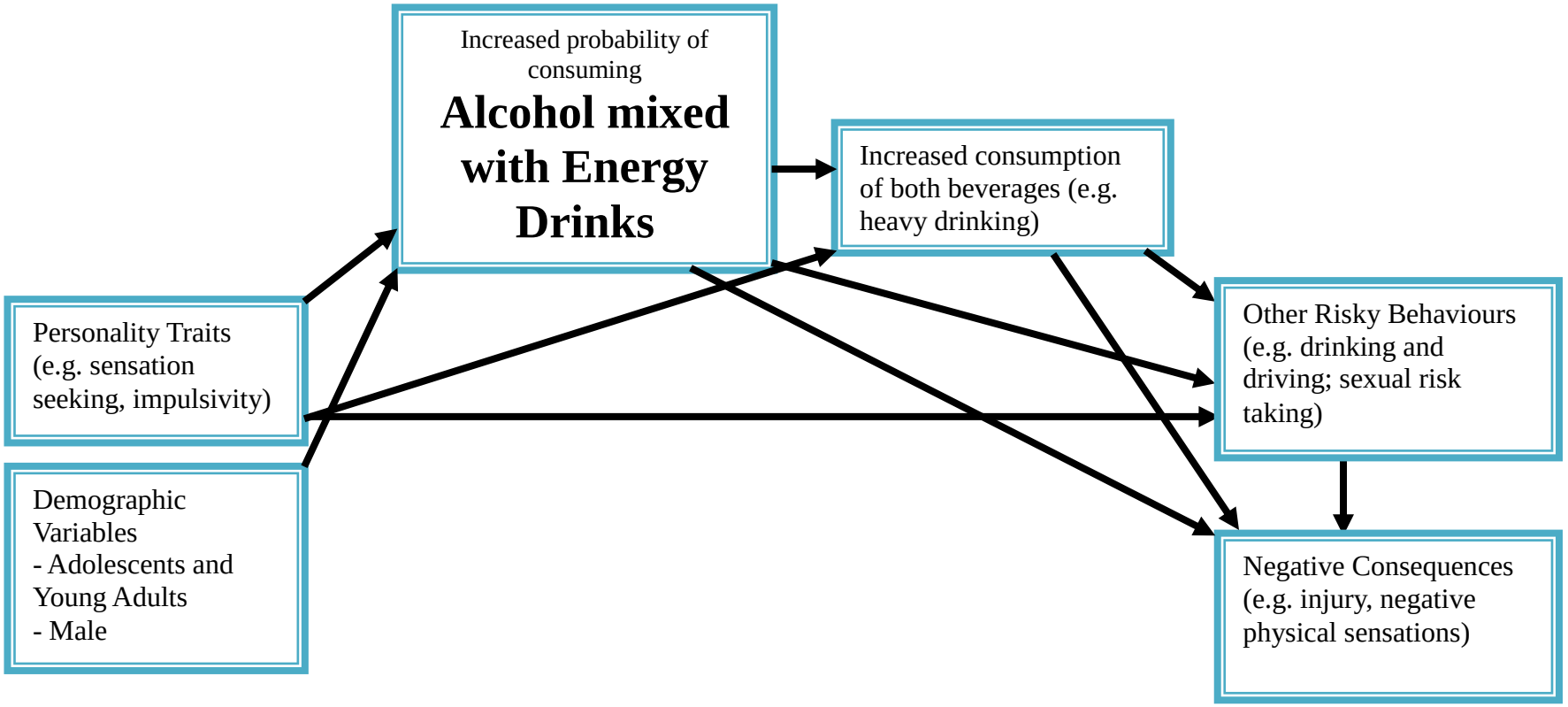

Table 1. CADUMS
Percentage of Canadians aged 15 years and older mixing alcohol and energy drinks in the past 30 days among past 30 day drinkers and the total population aged 15+ in 2010[a]

Demographics	Past 30 Day drinkers			Total Population		
	N/n[b]	%	95% CI	N/n[b]	%	95% CI
Gender	**			***		
Male	3594/173	3.19	2.18-4.20	5807/173	2.16	1.47-2.85
Female	3904/92	1.65 †	1.04-2.26	7543/92	0.94 †	0.59-1.29
Age	***			***		
15-17	421/30	4.92 †	2.43-7.42	1430/30	1.46 †	0.71-2.20
18-24	1445/180	10.85	8.28-13.42	2349/180	6.91	5.23-8.59
25+	5632/55	1.34 †	0.73-1.96	9571/55	0.86 †	0.47-1.26
Education	***			***		
Less than high school	1099/40	1.89	0.87-2.91	3074/40	0.76 †	0.35-1.17
Completed high school	1828/103	3.77	2.52-5.03	3331/103	2.27 †	1.51-3.02
Some post secondary	2436/86	3.32	1.86-4.79	3836/86	2.24 †	1.24-3.23
University	2091/35	0.95	0.44-1.47	2984/35	0.67 †	0.31-1.03
Marital status	***			***		
Married/common law	4039/54	1.55 †	0.81-2.28	6490/54	1.03 †	0.54-1.52
Divorced/separated/ widowed	988/3	s	s	2033/3	s	s
Never married	2427/207	6.13	4.62-7.64	4703/207	3.38	2.54-4.22
Household income	ns			*		
Less than $50,000	1753/40	1.41 †	0.62-2.20	3621/40	0.71 †	0.31-1.11
$50,000 to $79,999	1348/39	2.28 †	0.83-3.73	2042/39	1.56 †	0.56-2.56
$80,000+	2337/107	3.01 †	1.84-4.19	3321/107	2.24 †	1.36-3.12
Don't Know/Refused	2060/79	2.41 †	1.47-3.36	4366/79	1.27 †	0.78-1.77
Ethnicity	ns			ns		
White	6989/238	2.21	1.69-2.72	11957/238	1.48	1.13-1.82
Non-White	509/27	s	0.93-8.43	1393/27	s	s
Total	7498/265	2.28	1.86-3.07	13350/265	1.53	1.15-1.91

[a]The estimates were adjusted for design effects.
[b]N=Sample size and n=Alcohol and energy drinkers.
† The coefficient variation (CV) is between 16.6 and 33.3 and estimates have moderate sampling variability and should be interpreted with caution.
s The CV is 33.3 or larger and estimates are unstable and have been suppressed.
Rao-Scott Chi-Square test: *P<0.05 **P<0.01 ***P<0.001

Table 2. CADUMS
Demographic comparison of Canadians aged 15 years and older mixing alcohol and energy drinks in the past 30 days among past 30 day drinkers and total population aged 15+ in 2010[a]

Demographics	Past 30 day Drinkers		Total Population	
	Unadj OR (95% CI)	Adj OR (95% CI) †	Unadj OR (95% CI)	Adj OR (95% CI) †
Gender				
Male	1.39 (1.09-1.79) **	1.33 (1.03-1.73) *	1.52 (1.18-1.94) ***	1.45 (1.11-1.88) **
Female	1.00	1.00	1.00	1.00
Age				
15-17	1.17 (0.78-1.74)	1.44 (0.80-2.59)	0.69 (0.47-1.02)	1.03 (0.57-1.86)
18-24	2.75 (2.05-3.69) ***	2.01 (1.25-3.22) **	3.48 (2.61-465) ***	2.44 (1.55-3.86)***
25+	1.00	1.00	1.00	1.00
Education				
Less than high school	0.86 (0.54-1.35)	0.66 (0.37-1.19)	0.59 (0.38-0.93) *	0.52 (0.38-0.93) *
Completed high school	1.75 (1.24-2.46) **	1.74 (1.20-2.54) **	1.79 (1.28-2.52) ***	1.72 (1.19-2.48) **
Some post secondary	1.53 (1.02-2.29) *	1.60 (1.02-2.45) *	1.77 (1.18-2.64) **	1.73 (1.10-2.70) *
University	1.00	1.00	1.00	1.00
Marital status				
Married/common law	1.00	1.00	1.00	1.00
Divo/sep/widowed	0.22 (0.07-0.67) ***	0.42 (0.13-1.30)	0.22 (0.07-0.64) ***	0.41 (0.13-1.28)
Never married	4.25 (2.38-7.59) **	1.82 (0.81-4.06)	3.90 (2.19-6.96) **	1.78 (0.79-4.01)
Household income				
Less than $50,000	1.00	1.00	1.00	1.00
$50,000 to $79,999	1.03 (0.61-1.75)	1.19 (0.70-2.05)	1.16 (0.69-1.97)	1.30 (0.77-2.19)
$80,000+	1.37 (0.94-2.02)	1.72 (1.11-2.65) *	1.69 (1.15-2.47) **	1.88 (1.21-2.91) **
DK/Refused	1.10 (0.75-1.61)	0.77 (0.53-1.11)	0.95 (0.65-1.37)	0.73 (0.51-1.04)
Ethnicity				
White	1.00	1.00	1.00	1.00
Non-White	1.47 (0.95-2.28)	1.47 (0.88-2.45)	1.11 (0.72-1.70)	1.11 (0.67-1.85)

[a]The estimates were adjusted for design effects
† Adjusted OR were adjusted for all other demographic variables
Wald Chi-Square test: *P<0.05 **P<0.01 ***P<0.001.

Table 3 CADUMS
Comparison of drinking behaviors between drinkers who mixed alcohol and energy drinks and drinkers who did not[†]

Drinking Behavior	Non-AmED, *M* ± *SD*	AmED, *M* ± *SD*	b[b] (95% CI)
Volume of alcohol consumed in standard drinks in the past 12 months	228.84 ± 6.31	490.81 ± 35.39	0.43 (0.35, 0.50)***
Number of days consuming alcohol in the past 30 days	6.63 ± 0.09	7.10 ± 0.42	0.16 (0.11, 0.20) ***
Typical number of drinks consumed when drinking in the past 12 months	2.90 ± 0.03	5.77 ± 0.22	0.15 (0.12, 0.17)***
Typical number of drinks consumed when drinking in the past 30 days	2.74 ± 0.03	5.57 ± 0.22	0.15 (0.13, 0.18)***

[†]Participants who reported drinking in the past 30 days only
[a] b is the regression coefficient of the log transformed indicator variable comparing AmED to non-AmED drinkers. Separate linear regression analyses adjusting for age, sex, income, marital status, and education
[b] p-value is from comparing AmED vs. non-AmED (reference group) for each drinking behavior (outcome variable)
* $p < 0.05$, ** $p < 0.01$, and *** $p < .001$

Table 4 CADUMS
Comparison of risky alcohol drinking patterns between drinkers who mixed alcohol and energy drinks and drinkers who did not[†]

Risky Drinking Behaviours (past 12 months)	Non-AmED, *N/n*, (%)	AmED, *N/n*, (%)	Adj OR[b] (95% CI)[a]
Five or more drinks in a single sitting once a month or more often	7434/1877, (25.2)	262/202, (77.1)	5.35 (3.90, 7.35)***
Five or more drinks in a single sitting once a week or more often	7434/622, (8.4)	262/103, (39.3)	4.43 (3.33, 5.90)***
Five or more usual number of drinks consumed on days when drinking	7391/1184, (16.0)	255/148, (58.0)	3.03 (2.29, 4.00)***
Heavy monthly alcohol use (5+ drinks for men and 4+ drinks for women)	7429/2280, (30.7)	262/214, (81.7)	5.22 (3.75, 7.27)***
Heavy weekly alcohol use (5+ drinks for men and 4+ drinks for women)	7429/719, (9.7)	262/113, (43.1)	4.65 (3.53, 6.13)***
Exceeding the low risk drinking guidelines for weekly and daily sex specific limits	7045/2044, (29.0)	245/162, (66.1)	3.00 (2.26, 3.98)***

[†]Participants who reported drinking in the past 30 days only
[a] Separate logistic regression analyses adjusting for age, sex, income, marital status, and education
[b]Adjusted Odds Ratio's (OR) from comparing AmED vs non-AmED (referent group) for each alcohol drinking pattern (outcome variable)
* $p < 0.05$, ** $p < 0.01$, and *** $p < .001$

Table 5 CADUMS
Comparison of alcohol use disorder indicators between drinkers who mixed alcohol and energy drinks and drinkers who did not[†]

Alcohol Use Disorder Indicators	Non-AmED, *N/n*, (%)	AmED, *N/n*, (%)	Adj OR[b] (95% CI) Model 1 [a]	Adj OR[b] (95% CI) Model 2 [a]
AUDIT score of 8 and over	7260/1316, (18.1)	250/178, (71.2)	5.13 (3.80, 6.93)***	N/A[c]
Feel as though needed help for alcohol use in past 12 months	7490/65, (0.9)	265/10, (3.8)	2.72 (1.31, 5.65)**	2.54 (1.21, 5.32)*
One or more harms from alcohol use in past 12 months[d]	7446/649, (8.7)	265/92, (34.7)	2.40 (1.80, 3.21)***	1.92 (1.42, 2.60)***
Friendship or social life problems	7486/170, (2.3)	265/28, (10.6)	2.50 (1.58, 3.95)***	2.29 (1.44, 3.63)***
Physical health problems	7481/319, (4.3)	264/39, (14.8)	2.23 (1.51, 3.28)***	2.00 (1.35, 2.96)**
Home life or marriage problems	7485/126, (1.7)	263/17, (3.4)	2.22 (1.26, 3.91)**	2.06 (1.16, 3.64)*
Harmful effect on work, studies, or employment opportunities	7486/146, (2.0)	265/23, (8.7)	1.79 (1.10, 2.91)*	1.65 (1.01, 2.68)*
Harmful effect on financial position	7484/211, (2.8)	265/38, (14.3)	2.07 (1.37, 3.11)**	1.79 (1.18, 2.71)**
Legal problems	7490/37, (0.5)	265/8, (3.0)	2.35 (1.05, 5.27)*	2.10 (0.93, 4.76)
Difficulty learning things	7479/39, (0.5)	265/7, (2.6)	2.57 (1.10, 6.02)*	2.52 (1.08, 5.93)*

[†]Participants who reported drinking in the past 30 days only
[a] Separate logistic regression analyses adjusting for: **Model 1:** age, sex, income, marital status, and education; **Model 2:** age, sex, income, marital status, education, and the volume of alcohol consumed in the past 12 months
[b]Adjusted Odds Ratio's (OR) from comparing AmED vs non-AmED (referent group) for each alcohol use disorder indicator (outcome variable)
[c] This was not adjusted for volume of alcohol as the AUDIT contains questions related to quantity and frequency of alcohol use
[d] Includes harms reported below it in the table which were reportedly experienced because of alcohol use in the past 12 months. It also includes housing problems which was not reported separately due to a limited number of observations.
* $p < 0.05$, ** $p < 0.01$, and *** $p < .001$

Table 6 CADUMS
Comparison of risky behaviours between drinkers who mixed alcohol and energy drinks and drinkers who did not[†]

Risky Behaviours (past 12 months)	Non-AmED, *N/n*, (%)	AmED, *N/n*, (%)	Adj OR[b] (95% CI) Model 1 [a]	Adj OR[b] (95% CI) Model 2 [a]
Passenger in a vehicle with a drunk driver	7428/897, (12.1)	265/124, (46.8)	3.12 (2.38, 4.10)***	2.66 (2.02, 3.51)***
Driving after drinking	7469/673, (9.0)	264/64, (24.2)	2.08 (1.50, 2.88)***	1.88 (1.35, 2.62)***
Motor vehicle accident	7490/470, (6.3)	265/29, (10.9)	1.10 (0.72, 1.69)	1.10 (0.72, 1.68)
Incident involving physical aggression	7488/302, (4.0)	264/50, (18.9)	2.00 (1.39, 2.87)***	1.88 (1.30, 2.70)**

[†]Participants who reported drinking in the past 30 days only
[a] Separate logistic regression analyses adjusting for: **Model 1:** age, sex, income, marital status, and education; **Model 2:** age, sex, income, marital status, education, and the volume of alcohol consumed in the past 12 months
[b]Adjusted Odds Ratio's (OR) from comparing AmED vs non-AmED (referent group) for each risky behaviour (outcome variable)
* $p < 0.05$, ** $p < 0.01$, and *** $p < .001$

Table 7. Victoria Healthy Youth Survey
Demographic variables of participants mixing alcohol and energy drinks in the past month among past year drinkers and the total population

Demographics (Categorical) †	Past 12 month drinkers		Total population	
	N/n[a]	%	N/n[a]	%
Gender	***		***	
Male	189/102	54.0	203/103	50.7
Female	246/88	35.8	255/88	34.5
Current School Enrolment	ns		ns	
Attending High School	5/3	60.0	5/3	60.0
Attending Post Secondary	198/87	43.9	211/88	41.7
Completed some Post secondary	165/72	43.6	171/72	42.1
Not currently in school or completed post secondary	68/28	41.2	72/28	41.6
Ethnicity	ns		ns	
White	375/167	44.5	390/167	42.8
Non-White	61/23	37.7	69/24	34.8
Total	436/190	43.6	456/190	41.7
Demographics (Continuous) ‡	No AmED use *M* ± *SD*	AmED use *M* ± *SD*	No AmED use *M* ± *SD*	AmED use *M* ± *SD*
Age	*		*	
	22.54±1.97	22.08±1.92	22.51±1.98	22.08±1.92
Sensation Seeking	**		**	
	6.54±6.79	8.36±7.40	6.41±6.56	8.36±7.38

[a]N=Sample size and n=past month alcohol and energy drinkers.

†Pearson Chi-Square test: *P<0.05 **P<0.01 ***P<0.001

‡ Independent samples t-test: *P<0.05 **P<0.01 ***P<0.001

Table 8. Victoria Healthy Youth Survey
Comparison of alcohol drinking patterns between drinkers who mixed alcohol and energy drinks and drinkers who did not[†]

Drinking Behaviours	Non-AmED, *N/n,* (%) or *M ± SD*	AmED, *N/n,* (%) or *M ± SD*	Adj OR[b] (95% CI) Model 1[a]	Adj OR[b] (95% CI) Model 2[a]
Total number of drinks in the past week	5.82± *9.08*	12.63± 12.04	1.07 (1.04, 1.10)***	1.07 (1.04, 1.09)***
Typical number of drinks per occasion (past 12 months)	3.82± 3.01	6.31± 3.84	1.24 (1.15, 1.34)***	1.23 (1.14, 1.33)***
Having a drink once a week or more frequently (past 12 months)	246/111 (45.1)	190/142 (74.7)	3.32 (2.17, 5.09)***	3.14 (2.03, 4.84)***
Having 3+ drinks in 3 hours on 3+ occasions (past 12 months)	246/163, (66.3)	190/175, (92.1)	5.14 (2.82, 9.36)***	5.18 (2.81, 9.57)***
Having 3+ drinks/occasion a few times a month or more often (past 12 months)	246/120 (48.8)	190/165 (86.8)	6.46 (3.90, 10.69)***	6.29 (3.79, 10.46)***
Having 5+ /occasion a few times a month or more often (past 12 months)	246/75 (30.5)	190/135 (71.1)	5.13 (3.31, 7.94)***	4.94 (3.18, 7.67)***

[†]Participants who reported drinking in the past 30 days only
[a] Separate logistic regression analyses adjusting for **Model 1**: age, sex, and education; **Model 2**: age, sex, education and sensation seeking
[b]Adjusted Odds Ratio's (OR) from comparing AmED vs non-AmED (dependent variable) for each alcohol drinking behaviour (independent variable)
* $p < 0.05$, ** $p < 0.01$, and *** $p < .001$

Table 9. Victoria Healthy Youth Survey
Comparison of alcohol use disorder indicators between drinkers who mixed alcohol and energy drinks and drinkers who did not[†]

Alcohol Use Disorder Indicators	Non-AmED, *N/n*, (%) or *M ± SD*	AmED, *N/n*, (%) or *M ± SD*	Adj OR[b] (95% CI) Model 1 [a]	Adj OR[b] (95% CI) Model 2 [a]	Adj OR[b] (95% CI) Model 3 [a]
CAGE total score	0.61± *0.98*	0.99± *1.15*	1.40 (1.16, 1.70)***	1.37 (1.13, 1.67)**	1.07 (0.85, 1.34)
CAGE meets criteria for suspected abuse (2+ yes answer)	246/19, (7.7)	189/25, (13.2)	2.17 (1.11, 4.22)*	2.03 (1.03, 4.00)*	0.89 (0.40, 1.96)
Harmful effects of alcohol scale total score	0.85±*1.45*	1.40± *1.71*	1.23 (1.08, 1.40)**	1.21 (1.06, 1.38)**	1.06 (0.91, 1.22)
MINI alcohol abuse scale (total score)	0.31±*0.69*	0.67± *0.95*	1.60 (1.22, 2.10)**	1.54 (1.18, 2.03)**	1.18 (0.88, 1.60)
MINI alcohol abuse (meets criteria for abuse)	246/53, (21.5)	190/83, (43.7)	2.46 (1.58, 3.82)***	2.34 (1.50, 3.66)***	1.69 (1.05, 2.72)*
MINI alcohol dependence scale (total score)	1.17± *1.35*	2.10± *1.57*	1.56 (1.34, 1.80)***	1.53 (1.32, 1.78)***	1.35 (1.14, 1.59)**
MINI alcohol dependence scale (meets criteria for dependence)	246/28, (11.4)	190/67, (35.3)	4.20 (2.51, 7.02)***	3.96 (2.35, 6.67)***	2.51 (1.42, 4.44)**

[†]Participants who reported drinking in the past 30 days only
[a] Separate logistic regression analyses adjusting for: **Model 1**: age, sex, and education; **Model 2**: age, sex, education and sensation seeking; **Model 3**: age, sex, education, sensation seeking, and the number of drinks consumed in the past 7 days
[b]Adjusted Odds Ratio's (OR) from comparing AmED vs non-AmED (dependent variable) for each alcohol use disorder indicator (independent variable)
* $p < 0.05$, ** $p < 0.01$, and *** $p < .001$

Table 10. Victoria Healthy Youth Survey
Comparison of risky behaviours and negative outcomes between drinkers who mixed alcohol and energy drinks and drinkers who did not[†]

Risky Behaviours	Non-AmED, *N/n*, (%) or *M ± SD*	AmED, *N/n*, (%) or *M ± SD*	Adj OR[b] (95% CI) Model 1 [a]	Adj OR[b] (95% CI) Model 2 [a]	Adj OR[b] (95% CI) Model 3 [a]
Frequency of driving after drinking (past 30 days)	*0.33± 1.26*	*0.75± 1.57*	1.25 (1.06, 1.47)**	1.25 (1.06, 1.47)**	1.18 (1.00, 1.39)
Frequency of being a passenger in a vehicle where the driver had been drinking (past 30 days)	0.70± *1.42*	*1.57± 3.04*	1.32 (1.15, 1.51)***	1.30 (1.14, 1.49)***	1.18 (1.04, 1.35)*
Starting a fight and striking someone (past 12 months)	246/16, (6.5)	190/38, (20.0)	3.32 (1.72, 6.41)***	3.15 (1.62, 6.11)**	2.35 (1.17, 4.72)*
Never using birth control when having sexual intercourse	221/13, (5.9)	179/16, (8.9)	1.46 (0.66, 3.25)	1.60 (0.71, 3.64)	1.70 (0.73, 3.95)
Never using protection from sexually transmitted infections when having sexual intercourse	221/53, (24.0)	179/25, (14.0)	0.61 (0.36, 1.06)	0.72 (0.41, 1.26)	0.75 (0.42, 1.35)
Ever having a sexually transmitted infection	223/18, (8.1)	178/18, (10.1)	1.37 (0.66, 2.82)	1.32 (0.64, 2.73)	1.48 (0.70, 3.14)
Serious injury (past 12 months)	246/71, (28.9)	190/58, (30.5)	1.01 (0.66, 1.56)	0.97 (0.63, 1.50)	0.83 (0.52, 1.32)
Serious injury involved alcohol (past 12 months)	71/9, (12.7)	58/14, (24.1)	1.77 (0.65, 4.83)	1.51 (0.54, 4.23)	1.16 (0.39, 3.43)

[†]Participants who reported drinking in the past 30 days only
[a] Separate logistic regression analyses adjusting for: **Model 1**: age, sex, and education; **Model 2**: age, sex, education and sensation seeking; **Model 3**: age, sex, education, sensation seeking, and the number of drinks consumed in the past 7 days
[b]Adjusted Odds Ratio's (OR) from comparing AmED vs non-AmED (dependent variable) for each risky behaviour or negative outcome (independent variable)
* $p < 0.05$, ** $p < 0.01$, and *** $p < .001$

Table 11. Victoria Healthy Youth Survey
Comparison of risky behaviours and negative outcomes in drinkers with different frequencies of alcohol mixed with energy drink use[†]

Risky Behaviours / Negative outcomes	Energy drink and alcohol frequency	Sample yes/ no	Unadjusted[b] OR(95% CI) [a]	Adj OR[b] (95% CI) Model 1[a]	Adj OR[b] (95% CI) Model 2[a]	Adj OR[b] (95% CI) Model 3[a]
Starting a fight and striking someone (past 12 months)	None	16/230	1.00	1.00	1.00	1.00
	1-2x/month	24/113	3.21 (1.62, 6.37)**	2.96 (1.45, 6.07)**	2.93 (1.43, 6.04)**	2.41 (1.15, 5.06)*
	Weekly +	14/39	5.53 (2.47, 12.67)***	4.33 (1.84, 10.19)**	4.29 (1.82, 10.12)**	3.10 (1.26, 7.60)*
Serious injury (past 12 months)	None	71/175	1.00	1.00	1.00	1.00
	1-2x/month	39/98	0.99 (0.63, 1.59)	0.94 (0.58, 1.52)	0.92 (0.57, 1.49)	0.82 (0.50, 1.34)
	Weekly +	19/34	1.43 (0.76, 2.68)	1.22 (0.63, 2.35)	1.18 (0.61, 2.29)	0.97 (0.49, 1.94)
Serious injury involved alcohol (past 12 months)	None	9/62	1.00	1.00	1.00	1.00
	1-2x/month	8/31	1.97 (0.67. 5.74)	1.37 (0.43, 4.34)	1.38 (0.43, 4.46)	1.21 (0.36, 4.03)
	Weekly +	6/13	3.52 (1.04, 11.87)*	2.66 (0.67, 10.52)	2.67 (0.67, 10.60)	1.89 (0.43, 8.26)
Never using birth control when having sexual intercourse	None	13/208	1.00	1.00	1.00	1.00
	1-2x/month	9/117	1.21 (0.50, 2.92)	1.19 (0.48, 2.98)	1.29 (0.51, 3.28)	1.35 (0.53, 3.50)
	Weekly +	7/46	2.43 (0.92, 6.43)	2.19 (0.75, 6.35)	2.44 (0.80, 7.41)	2.65 (0.84, 8.32)
Never using protection from sexually transmitted infections when having sexual intercourse	None	53/168	1.00	1.00	1.00	1.00
	1-2x/month	20/106	0.60 (0.34, 1.06)	0.68 (0.38, 1.22)	0.77 (0.42, 1.40)	0.79 (0.43, 1.45)
	Weekly +	5/48	0.34 (0.13, 0.89)*	0.42 (0.15, 1.14)	0.51 (0.18, 1.43)	0.53 (0.19, 1.52)
Ever having a sexually transmitted infection	None	18/205	1.00	1.00	1.00	1.00
	1-2x/month	9/116	0.82 (0.34, 1.95)	0.93 (0.38, 2.27)	0.93 (0.38, 2.26)	1.07 (0.43, 2.66)
	Weekly +	9/44	2.48 (1.03, 5.92)*	2.62 (1.03, 6.68)*	2.59 (1.01, 6.62)*	3.27 (1.21, 8.88)*

[†]Participants who reported drinking in the past 30 days only
[a] Separate logistic regression analyses adjusting for **Model 1**: age, sex, and education; **Model 2**: age, sex, education and sensation seeking **Model 3**: age, sex, education, sensation seeking, and the number of drinks consumed in the past 7 days
[b]Adjusted Odds Ratio's (OR) from comparing AmED frequency for each alcohol use disorder indicator (indicator variable)
Past month AmED frequency vs none * $p < 0.05$, ** $p < 0.01$, and *** $p < .001$

Figure 3. Victoria Healthy Youth Survey
Percentage of participants who endorsed experiencing physical symptoms after the consumption of AmED

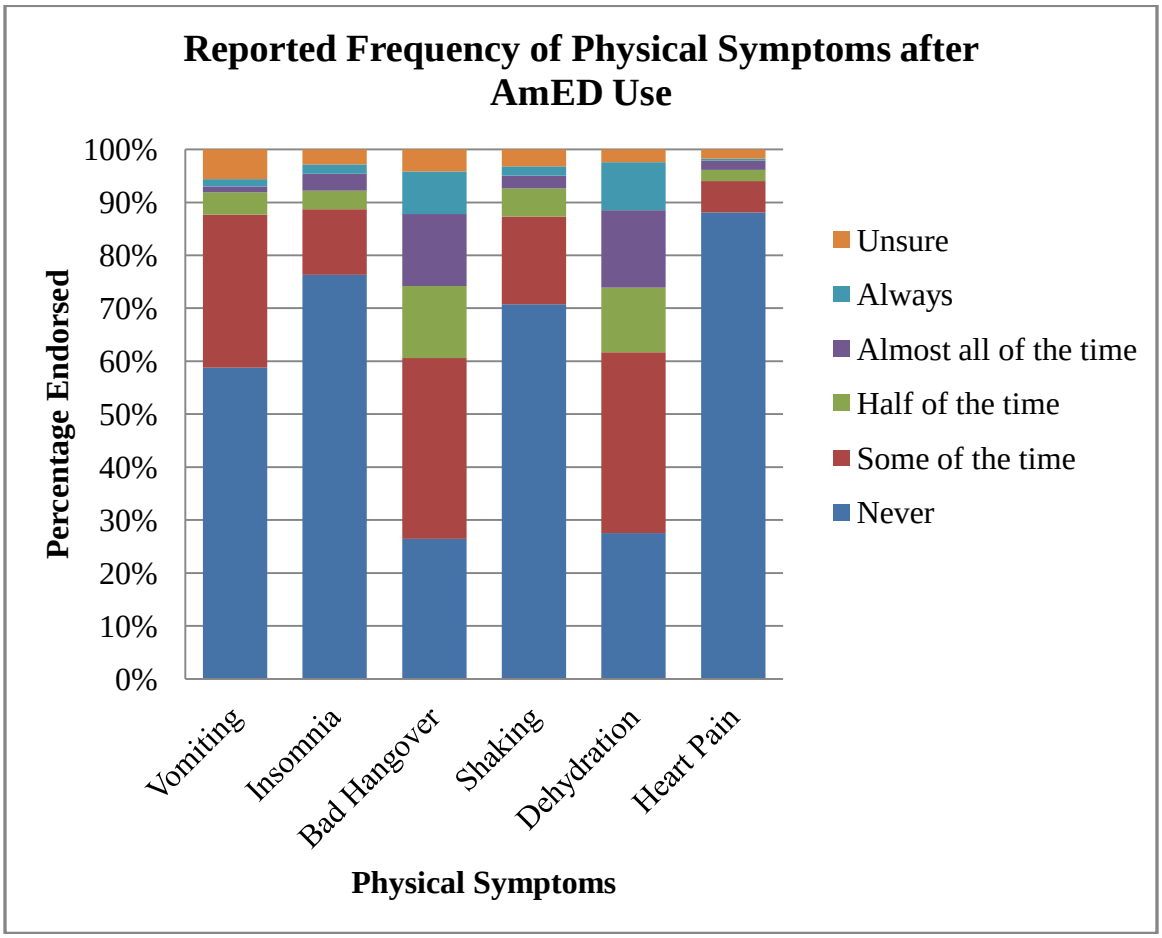

Table 12. Victoria Healthy Youth Survey
Frequency of reported physical symptoms after the consumption of AmED

Frequency	Vomiting	Insomnia	Bad Hangover	Shaking	Dehydration	Heart Pain
	n/N, (%)	*n/N, (%)*	*n/N, (%)*	*n/N, (%)*	*n/N, (%)*	*n/N, (%)*
Never	167/284, (58.8)	216/283, (76.3)	76/287, (26.5)	201/284, (70.8)	79/287, (27.5)	251/285, (88.1)
Some of the time	82/284, (28.9)	35/283, (12.4)	98/287, (34.1)	47/284, (16.5)	98/287, (34.1)	17/285, (6.0)
Half of the time	12/284, (4.2)	10/283, (3.5)	39/287, (13.6)	15/284, (5.3)	35/287, (12.2)	6/285, (2.1)
Almost all of the time	3/284, (1.1)	9/283, (3.2)	39/287, (13.6)	7/284, (2.5)	42/287, (14.6)	5/285, (1.8)
Always	4/284, (1.4)	5/283, (1.8)	23/287, (8.0)	5/284, (1.8)	26/287, (9.1)	1/285, (0.4)
Unsure	16/284, (5.6)	8/283, (2.8)	12/287, (4.2)	9/284, (3.2)	7/287, (2.4)	5/285, (1.8)

Table 13. University of Victoria Student Sample
Frequency counts for each reason for using energy drinks alone[†]

Code #	Name	Count	% of energy drink using participants (n=265)	% of total sample (n=465)
11[a]	Stay Awake, stay up late (alone)	116	43.77	24.95
23[a]	Studying/ exams	82	30.94	17.63
5	Energy boost (alone)	70	26.42	15.05
1	Increase Alertness	38	14.34	8.17
4	Taste	35	13.21	7.53
22	Energy for sports/ sports	13	4.91	2.80
43	Caffeine	9	3.40	1.94
26	Stay awake when driving	9	3.40	1.94
7	Energy to study	8	3.02	1.72
10	Energy to Party	7	2.64	1.51
30	Experiment	7	2.64	1.51
16	Purchased by others, given for free	6	2.26	1.29
2	Attention/ Focus (In general)	5	1.89	1.08
27	Convenient	5	1.89	1.08
29	Thirsty/ Refreshment	5	1.89	1.08
47	As an alcohol alternative	4	1.51	0.86
13	To be social	3	1.13	0.65
9	Energy to stay out late/up longer	3	1.13	0.65
42	Crave them	3	1.13	0.65
18	Increased fun (Alone)	2	0.75	0.43
8	Energy to be social	2	0.75	0.43
25	Fight Stress	2	0.75	0.43
33	Sexual performance	2	0.75	0.43
39	Like them	2	0.75	0.43
44	Health	2	0.75	0.43
14	For cost savings	1	0.38	0.22
38	When hungover/reduce hangovers	1	0.38	0.22
17	Leisure	1	0.38	0.22
21	Increase Mood	1	0.38	0.22

[†]265 participants gave motivations for using energy drinks alone. This is 56.99% of the total sample.
[a] Codes # 11 and 23 commonly occurred together where 47 participants had both of these codes (17.73% of participants, 10.11% of sample).

Table 14. University of Victoria Student Sample
Frequency counts for each reason for mixing alcohol and energy drinks[†]

Code #	Name	Count	% of AmED participants (n=188)	% of total sample (n=465)
4	Taste	94	50.00	20.22
12	Stay awake, stay up later when drinking	37	19.68	7.96
6	Energy boost while drinking	32	17.02	6.88
16	Purchased by others, given for free	24	12.77	5.16
10	Energy to Party	20	10.64	4.30
19	Increased fun when drinking alcohol	17	9.04	3.66
15	Counteract depressant effects of alcohol (e.g. drowsy, sleepy)	16	8.51	3.44
13	To be social	13	6.91	2.80
32	Pre-drinking	13	6.91	2.80
34	Jagerbombs	13	6.91	2.80
27	Convenient	10	5.32	2.15
14	For cost savings	7	3.72	1.51
1	Increase Alertness	6	3.19	1.29
30	Experiment	4	2.13	0.86
43	Caffeine	4	2.13	0.86
46	Chase	4	2.13	0.86
9	Energy to stay out late/up longer	2	1.06	0.43
45	Decrease alcohol consumption	2	1.06	0.43
38	When hungover / to reduce hangovers	2	1.06	0.43
28	Increase intoxication	2	1.06	0.43
37	Drink in public	2	1.06	0.43
31	Retard cognition	1	0.53	0.22
2	Attention/ Focus (In general)	1	0.53	0.22
33	Sexual performance	1	0.53	0.22
41	Replace illegal drugs	1	0.53	0.22
36	Drink more alcohol	1	0.53	0.22
40	Feel good physically	1	0.53	0.22
39	Like them	1	0.53	0.22
44	Health	1	0.53	0.22
23	Studying/ exams	1	0.53	0.22

[†]188 participants gave motivations for AmED use. That is 40.43% of the total sample.