THESIS

EVENT-RELATED POTENTIALS IN COLLEGE-AGED BINGE DRINKERS AND NON DRINKERS

Submitted by

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In partial fulfillment of the requirements

For the Degree of Master of Science

Colorado State University

Fort Collins, Colorado

Summer 2010

COLORADO STATE UNIVERSITY

May 11, 2010

WE HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER OUR SUPERVISION BY BARBARA C. BANZ ENTITLED EVENT-RELATED POTENTIALS IN COLLEGE-AGED BINGE DRINKERS AND NON DRINKERS BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE.

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ABSTRACT OF THESIS

EVENT –RELATED POTENTIALS IN COLLEGE-AGED BINGE DRINKERS AND NON DRINKERS

Recent research has begun investigating whether there are neurophysiological differences in individuals who drink heavily compared to those who do not drink. Research has shown significantly reduced P3 amplitudes in response to neutral but not alcohol-related stimuli in alcoholics and their children. The purpose of this study was to further investigate this phenomenon comparing event-related potentials (ERP) of high drinkers to non drinkers when presented positive, negative and alcohol related images.

Participants were categorized as a drinker or non drinker based on the Alcohol Use Disorders Identification Test (AUDIT), a self report measure of alcohol use. Group comparisons were made based on differences in amplitude and latency of the P2 and the late positive potential (LPP), a component believed to be more evaluative in nature. This data indicated significant difference in the amplitude of the P2, meaning initial attention is greater in the binge drinkers compared to the non-drinking group. No differences were found in LPP amplitudes between drinkers and non-drinkers. These results suggest that there may be neurophysiological indices for binge drinking which may be useful for identifying individuals who are either at risk or currently abusing alcohol.

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INTRODUCTION

Overview

Since the drinking age was changed to twenty-one years, Americans have seen a decrease in binge drinking, except for college students where the drinking rate for males has remained the same and the rate for females has increased (Grucza, 2009). This has caused the popularity of studying young adults with alcoholism or other alcohol related issues to increase in recent years. One group of particular interest is college-aged binge drinkers. Though this group does not necessarily have the classic dependence that is associated with alcoholism or alcohol dependence, it is still a serious issue that affects a wide variety of individuals. Young adults who binge drink are an important population to study for two reasons. The first is that it is important to investigate what effects, if any, excessive drinking during the adolescent period may have on the developing brain, on behavior and possibly on the development of alcohol use disorders (AUDs) in the future. The second reason focuses on prevention and identification of those individuals who may be at risk for developing alcoholism.

Research focusing on excessive alcohol use in college students has primarily focused on individuals classified as "binge drinkers". The term "binge drinkers" was introduced within the past two decades to characterize individuals who consume five or more drinks, for males, and four or more drinks, for females, per occasion at least once within the two weeks prior to the time they are surveyed (Wechsler & Austin, 1992). Data suggest a longitudinal consistency within the college population in regards to the

percent of students who endorse binge drinking. In 1997, 17.7% of male and 15.4% of female college-aged students reported that they had engaged in between 1-11 heavy drinking days (defined as five or more drinks on an occasion) during the past year, while another 22.9 and 7.6%, respectively, endorsed 12 or more heavy drinking days during that period. When this drinking behavior was reassessed in 2008, the males remained the same at 17.7% while the numbers increased to 17% of females reporting between 1-11 heavy drinking days and 25.6 and 11.4%, respectively reporting 12 or more days (National Institute of Alcoholism and Alcohol Abuse, 2009). Given these trends, it appears reasonable to assume that this pattern of behavior will either remain stable or continue to increase in to the future, unless effective intervention methods are introduced (Wechsler, Lee, Kuo, & Lee, 2000).

The importance of these findings is amplified when one realizes that these binge drinking trends may be beginning even earlier than college. Specifically, recent studies suggest that an equally high percent of students begin drinking in high school, although the rates of binge drinking are not quite as severe in this population. Miller and colleagues have reported that approximately 45% of high school students endorse drinking within the 30 days prior to survey and that approximately 30% of these individuals endorsed binge drinking (Miller, Naimi, Brewer, & Jones, 2007). While the prevalence of binge drinking is not as high for this population, the idea that over a quarter of high school students participate in excessive drinking adds to the call for additional research and improved intervention methods.

Intervention

Miller, Naimi, Brewer, and Jones (2007) reported that, in adolescents, binge drinking may lead to homicide, suicide and unintentional injury, the top three causes of death for this age range. This increased awareness of the detrimental outcomes which may be affected by binge drinking in young adults has been accompanied by an increase in the interest surrounding intervention methods that may help to reduce alcohol consumption in high school and college-aged students. Multiple researchers have attempted to create intervention methods which will bring long-term decreases in overall alcohol consumption in order to truly change the detrimental behavior associated with alcohol use. It is optimistic that some studies have suggested that simply increasing the teen's exposure to information can result in lower alcohol consumption (Marlatt, et al, 1998; Baer, Kivlahan, Blume, McKnight and Marlatt, 2001). Specifically, Baer and colleagues (2001) have argued that extensive intervention methods are not necessary to affect the long term drinking rates of college students. Using a brief individualized intervention, researchers were able to educate individuals on their individual high risk behaviors, potential effects of those actions and ways to reduce those negative behaviors. Baer was able to show a long term reduction in binge drinking even accounting for maturational effects (Baer, Kivlahan, Blume, McKnight, Marlatt, 2001).

Borsari and Carey (2000) supported the use of brief intervention techniques in self-reported binge drinkers. As with the previous studies mentioned, there was a significant decrease in the amount of alcohol consumed after the brief intervention. Participants' attitudes towards the intervention techniques were also evaluated and high levels of satisfaction with the intervention were reported. Participants also claimed that

the intervention addressed drinking behavior and negative effects that were consistent with their own behavior. Additionally, it was reported that they would recommend this program to others with similar drinking patterns, including friends (Borsari & Carey, 2000).

Assessment

These methods of intervention, however, are only successful if they are able to identify the appropriate population to target. The studies described above, along with a number of others, have historically relied on adolescents' self-report of binge drinking. While self-report remains an inexpensive and efficient manner of assessing alcohol use, researchers have argued that for adolescents, self-report measures may not be ideal given that adolescents are asked to endorse engaging in an illegal activity which may result in embarrassment or fears of punishment and social disapproval (Swadi, 1990). Other studies, however, have argued for the validity of self report measures to assess dangerous behaviors within this age group. Sieving and colleagues (2001) reported consistent internal reliability within this population for more deviant and illegal behaviors, including carrying a weapon and substance use (Sieving et al, 2001). In addition, the strength of self-report measures appears to increase when participants believe their self report is going to be matched with a biological indicator (Murray, O'Connell, Schmid & Perry, 1987). While not measuring alcohol use specifically, Dolcini, Adler, Lee and Bauman (2003) found that in adolescents ages 12-14, self-report of recent substance use was most accurate when also assessed through biological indicators (Dolcini, Adler, Lee & Bauman, 2003).

During the past two decades, these findings have led to an increase in interest for the development of more comprehensive assessment of alcohol use and risk factors for later alcohol abuse. One reason for the interest in comprehensive assessment stems from past research suggesting that, while most forms of assessing alcohol use (e.g. alcohol screening measure, self-reported drinking, lab measures) are reasonably effective for assessing alcohol use, they are often not correlated with one another (Lee & DeFrank, 1988). Possible explanations for this lack of agreement between measures vary with some arguing that questionnaires which rely on retrospective assessment of drinking patterns lead to disparities in self-report of "average" drinks (e.g. per day, week, two-week period, or annual consumption (Kesmodel & Olsen, 2001).

Given possible limitations of self report of behavior, researchers who study alcohol and other illicit abuse literature argue for a multi-method assessment to find more reliable rates of alcohol consumption (Stacy, Widaman, Hays, & DiMatteo, 1985). While literature suggests that assessment focusing on multiple questionnaires or varied questions targeted at ascertaining alcohol consumption rate may be superior to simple yes or no questions or limited questions asking about number of drinks consumed, there are still limitations with multi-method assessment regarding accuracy, especially in certain situations. For example, research suggests that recent consumption of alcohol is negatively related to accuracy of consumption rates using multi-method assessment. (Babor, et al., 1987). Specifically, when self report measures of alcohol consumption are compared to biological indices of alcohol use (e.g. urinalysis), biological assessment occasionally indicates underreporting via self-report of alcohol use and other drug use (Magura & Kang, 1996).

The lack of correlation between the aforementioned measures that rely on self-report suggests that there is a need to explore alternative methods of assessing alcohol use, or possibly more importantly, a predisposition or risk for alcohol abuse. One type of assessment that has received attention during the past decade is the use of biological indices, such as electrophysiology, which measure physiological responses to alcohol cues.

Event-Related Potentials

Event-related potentials (ERP) are an effective technique used to evaluate how individuals process stimuli on both sensory and cognitive levels. In particular, early components, including the P2 and P300 or P3 component are associated with early cognitive processing, more specifically orienting attention to certain stimuli. The P300 component is the most commonly studied component to assess differences in selective attention in individuals who abuse alcohol compared to controls. The P300 is typically elicited through a visual "oddball" task and most frequently recorded from the parietal area (Porjesz et al, 2005). Some have argued that the P3 component may be a particularly useful method to evaluate visual cues associated with various types of addiction (Lubman, et al. 2007). Namkoong, Lee, Lee, Lee, and An (2004) specifically assessed the P3 in the context of alcoholism. The P3 amplitudes to alcohol related and neutral images were compared between those who abuse alcohol and those who abstain from alcohol. Results indicated that alcoholics exhibited larger amplitudes to the alcohol related images compared to the abstainers. Further support of the use of this electrophysiological index, and more pertinent to the current study, was a study which compared P3 amplitudes between social drinkers and non-drinkers when viewing

alcoholic and nonalcoholic drinks. Data from this study reported those who consumed higher amounts of alcohol had elevated P3 amplitudes when viewing alcoholic drinks, meaning that this electrophysiological difference is not limited to individuals who drink excessively or to the point of being considered an alcohol abuser (Bartholow, Henry, & Lust, 2007).

Interestingly, we only see this elevated P3 amplitude with alcohol related images. For other visual stimuli decreased P3 amplitudes are typically observed (Carlson, Katsanis, Iacono, & Mertz, 1999). For example, The Collaborative Study on the Genetics of Alcoholism (COGA) compared P3 amplitudes of adolescents of alcoholic families to adolescents of control families when presented non-alcohol visual stimuli. These target amplitudes for the children of alcoholic families were significantly lower than those of control families, $p < 0.00001$, possibly, providing further support of a genetic basis for alcohol abuse (Porjesz, et al, 1998). A later occurring component which may also shed light on the neurophysiology of those who binge drink is the late positive potential (LPP). While the LPP has not been assessed in studies of alcohol abuse, it seems reasonable to assume that there may be a difference between groups given that the LPP is thought to assess emotional/motivational responses to stimuli. The LPP is effectively elicited through an affective oddball paradigm (Schupp, Junghöfer, Weike, & Hamm, 2004). While elicited through a similar technique as the traditional P300 it usually occurs later than its nonaffective counterpart (Cacioppo, et al., 1996), it is believed that the LPP is the ERP component that best assesses emotional attention and motivation because LPP amplitudes are accentuated for pleasant, unpleasant or emotionally arousing images; and may engage basic motivational neural circuits (Lang, Bradley & Cuthbert, 1997).

To assess both earlier occurring visual orienting/attention components in addition to a later evaluative component, the P2 component in addition to the LPP will be assessed. The P2 is used to assess initial selective visual attention paid to different types of stimuli. It is necessary to use this slightly earlier component because the window for the LPP can begin as early as 300 to 350 ms (Schupp et al, 2000; Hajcak, Dunning, & Foti, 2008), where the P3 window traditionally extends in to the evaluative window of time. To assess both components, researchers have focused on the P2 component when interested in initial selective visual attention (Schupp et al, 2000; Pastor et al, 2007).

Hypothesis

Based on past findings it is hypothesized that the presentation of alcohol images will elicit a larger amplitude P2 response in individuals categorized as "Drinkers" compared to "Non Drinkers" (Namkoong, et al, 2004). In addition, it is believed that there will be a relationship found between the level of alcohol abuse and amplitude of the ERP component. Specifically, as the rate of consumption increases it is expected that the amplitude will increase. This study may provide evidence supporting the argument that there are neurophysiological differences between drinkers and non-drinkers in terms of their responses to alcohol and alcohol cues. Understanding possible neurophysiological differences between drinkers and non-drinkers may be useful in future studies assessing the utility of electrophysiological recordings to identify individuals at greater risk for binge drinking or future alcohol abuse.

METHOD

Participants

Ninety-five Introductory Psychology students were involved in the current study. Of this population, 23 were categorized as "Drinkers" and 21 as "Non Drinkers". Participants scoring in the highest quartile, a score of nine or above on the AUDIT, were categorized as "Drinkers" and those in the lowest quartile, scores of one, were "Non Drinkers."

Students received course credit for participating in the study. Consistent with previous research individuals with a history of traumatic brain injuries, neurological illness or psychiatric disorders were excluded from this study (Bartholow, Henry, & Lust, 2007; Namkoong, Lee, Lee, Lee, & An, 2004)

Visual Stimuli

A series of equally valenced images and alcohol images were presented by a software program (EPrime: Psychology Software Tools Inc., Pittsburgh, PA) on a Dell monitor. Images were displayed for one second with a response screen, viewed for a maximum of three seconds, following each image, with a "Pause" option after every five images. Participants were seated 122cm from the monitor in a dark control room.

Electrophysiological Recordings

Eight hand-placed electrodes (NuAmps) were placed on the face and scalp of participants, right forehead (ground), left mastoid (reference), superior and lateral to the left eye, right mastoid, FZ, CZ, and PZ. Impedences were kept below 10kΩ. Participants with fewer than ten trials were eliminated from the data set. Data was collected using the PZ electrode and analyzed using Neuroscan software.

Alcohol Use Assessment

In order to evaluate and categorize participants as "Drinkers" or "Non Drinkers" each participant completed the Alcohol Use Disorders Identification Test (AUDIT), a measure created by the World Health Organization to identify individuals with alcohol use disorders. This self report questionnaire has been field tested in six countries, including the United States (Babor, Higgins-Biddle, Saunders, & Monteiro, 2001). While this measure is typically used by primary health care workers to identify harmful drinking habits, the ultimate purpose of this evaluation is applicable to the needs of this study, which is the identification of individuals with high, low, or no alcohol consumption. The AUDIT can be found in Appendix 1.

In addition to the standard AUDIT questionnaire a question referring to Wechsler's (1995) gender specific definition of college binge drinking was included. This method defines binge drinking as a four /five, female/male, drink ratio per drinking occasion. The number of drinks a female needed to consume to be considered a binge drinker was reduced from five to four. This adjustment was based on blood alcohol levels (BAL) obtained between genders, showing females need less alcohol to reach the same

BAL and a need to account for gender when evaluating drinking habits. (Wechsler, Dowdall, Davenport, & Rimm, 1995)

In order to evaluate possible hereditary factors described earlier, questions concerning family abuse were also included, asking participants to identify who and what substances are used. An example is "Does anyone in your immediate family (parent, sibling) use substances (e.g. marijuana, cocaine, any other illicit substance)? If so, what is the relationship (e.g. brother) and the substance?"

Procedure

Each participant was asked to fill out a consent form and demographics survey. Demographics survey can be found in Appendix 1. All participants also completed the AUDIT Self Assessment Questionnaire. Participants were randomly assigned to complete these either before or after the EEG recordings. The participants were then asked to sit in the chair and have the electrode application process explained. Once the electrodes were in place instructions were given to the participants on behavior to avoid, for example crossing legs. When it was felt that the participant understood the procedure, the light was turned off and the images were presented. Following the experiment, each participant was debriefed.

Analysis

As noted previously, participants scoring in the highest quartile, a score of nine or above on the AUDIT, were categorized as "Drinkers" and those in the lowest quartile, scores of one, were "Non Drinkers."

The P200 component was defined as the largest positive peak occurring at all electrode sites following the N100 complex within a latency window between 150 and 295 ms.

The LPP component was utilized to evaluate differences in emotional/motivational responses for the valenced and alcohol images, with a latency window of 395 to 900ms.

RESULTS

The initial interest of the current investigation was whether there would be a difference in P2 amplitude between Drinkers and Non Drinkers in response to alcohol images. A two tailed, independent samples t test was used to compare means to evaluate this question showing a significant difference between these two groups, $t(44) = 3.77$, $p = .0005$. The second part of this initial question referred to differences between these groups in LPP amplitude for the same image type. A two-tailed, independent samples t test was used to compare means finding no significant difference between groups, $t(44) = -.63$, $p = .53$.

Additionally, two-way, repeated measure ANOVAs were used to compare means between groups for the affective image types for both P2 and LPP amplitudes to see if the differences found for the alcohol images were isolated to this image type or were found across image types. Main effects were found between drinker and non drinkers for P2 amplitudes in response to all image types, $F(1, 42) = 12.71$, $p = .001$. Pairwise comparisons were used to evaluate differences between groups for individual image types. Significant differences were not found for the neutral images, $t(44) = -1.69$, $p = .099$. However, significant differences were found for both positive, $t(44) = -2.37$, $p = .02$, and negative images, $t(44) = -4.10$, $p = .0002$. Interestingly, there were no main effects found between groups for LPP amplitude, $F(1, 42) = .178$, $p = .68$. Pairwise comparisons were evaluated to make sure no significant differences in LPP amplitude were found for any image type, positive, $t(44) = .23$, $p = .82$, neutral, $t(44) = .09$,

$p = .93$, or negative images, $t(44) = -.96$, $p = .34$. Overall, the LPP waves found in this study are consistent with past studies reporting significantly increased amplitudes for negative images compared to neutral or positive images across a variety of populations (Schupp, et al., 2000).

Representations of results for alcohol related, positive and negative images can be found in Figures 1 -3, respectively.

Additionally, two-way repeated measure ANOVAs were used to compare mean latencies for both P2 and LPP between drinkers and non drinkers across image type, $F(1, 42) = .12$, $p = .73$, $F(1, 42) = .27$, $p = .61$. As with P2 and LPP amplitudes, pairwise comparisons were made to ensure no significant differences were found between P2 latencies for any image type, alcohol, $t(44) = -1.15$, $p = .26$, positive, $t(44) = 1.98$, $p = .06$, neutral, $t(44) = .32$, $p = .75$, and negative, $t(44) = -1.15$, $p = .26$, or for LPP latencies, alcohol, $t(44) = .44$, $p = .66$, positive, $t(44) = -.28$, $p = .78$, neutral, $t(44) = .21$, $p = .83$, or negative images, $t(44) = 1.25$, $p = .22$. This data means that there was no difference in latency when either group hit peak amplitude for the P2 or LPP.

Means and standard deviations for all data discussed can be found in Table 1.

DISCUSSION

The current study supports past electrophysiological research suggesting that those individuals who abuse alcohol have increased initial attention to alcohol related stimuli compared to their non-drinking peers. This data suggests that the drinking population currently evaluated (e.g. binge drinkers) appear similar to more chronic abusers in terms of initial attention in response to alcohol related stimuli.

A unique contribution of this study was the inclusion of affective images. This inclusion was used to assess whether differences in neural responses were purely associated with alcohol stimuli or whether there could be an overall difference in how alcohol abusers respond to emotional stimuli. Since significant differences were found between drinkers and non drinkers for both positive and negative images for the initial visual attention measure, P2, these results suggest that there may be an inherent difference in the initial processing of emotional stimuli for the binge drinking population. Interestingly, this information combined with the aforementioned differences found for alcohol images and not neutral images suggest that drinkers are initially processing alcohol images in a similar manner to both affectively positive and negative images. While there have not been previous studies which assess the later ERP component, LPP, in alcohol abusing populations, it seems reasonable to assume that there may also be differences between groups on the later component. Interestingly, there were no significant differences for LPP amplitude between drinkers and non drinkers for any image type. These findings suggest that while there are initial attention differences, there

is no motivational significance or emotional evaluation differences between groups for any stimuli presented. Lack of difference is especially surprising for the alcohol images because we would expect drinkers to process alcohol images differently than those categorized as non-drinkers due to the intrinsic motivational aspect associated with this component.

The similarity of early selective attention within drinkers for positive, negative and alcohol-related images suggests an overall difference processing images initially within this population, compared to non-drinking peers, that later diminishes across image type. This leads us to believe that there are not significant differences in later cognitive processing of these images.

While we do not see significant differences between college drinkers and non drinkers we cannot necessarily assume that we would not see these differences between chronic alcohol abusers and non drinkers. Overall, participants in this study were relatively young and may not be those who, later in life, become chronic abusers. Bennette and colleagues (1999) posit that while those adolescents who drink heavily are at a higher risk to have problem drinking in adulthood compared to non drinking peers, many of these individuals will also mature out of this heavy drinking phase in early adulthood (Bennett, McCrady, Johnson & Pandina, 1999).

Another important variable regarding the population assessed, including the college-aged non drinkers, is that they are different from other populations in terms of exposure to everyday alcohol stimuli (e.g. images, bars, cheap drinks, etc) compared to adult chronic drinkers. Recent research assessing the availability of alcohol to college students suggests that there are significant correlations between density of establishments that are

licensed to serve alcohol within a two mile radius of a college campus and heavy drinking, frequent drinking and drinking related problems in college students (Weitzman, Folkman, Folkman, & Wechsler, 2003). Results from various studies focusing on the availability of alcohol to college students lead us to believe that the college-aged binge-drinking population is different in its exposure to alcohol stimuli than both non drinkers and chronic adult alcohol users. Therefore, a limitation of the current study in terms of its generalizability to the general population is that the P2 differences and lack of LPP differences may in fact reflect similar profiles to those that would be observed in adult alcohol abusers or they may reflect differences that are unique to college students. For example, as noted previously, the population studied may have excessive exposure to alcohol, bars, and drink specials that are less common outside of the college campus. This exposure may affect amplitudes in one of two ways. The lack of evaluative differences in the LPP waveform may represent minimized evaluative processes in this population regarding alcohol images, therefore leading to a lack of significant differences between groups. Another alternative is that the non-drinkers assessed in the current study may also be exposed to excessive alcohol images, therefore affecting their evaluative processes, leading to a lack of significant differences between groups. Future studies focusing on adults in non-college locations would provide further insight into these processes and whether there may be unique effects of the college environment on evaluative processes regarding alcohol.

Regardless of whether the current findings translate to adult alcohol abusers, the current study suggests that there may be something different about those students who binge drink and those who do not engage in this risky behavior. Initial inferences can be

made suggesting a possible physiological predisposition for alcohol abuse and/or alcohol related problems based on differences on these neurophysiological responses. It is believed that the P2 component, because of the increased amplitude in response to not only alcohol images but also affective images, can be paired with current assessment measures to evaluate current use in this population and identify those individuals that are at risk for binge-drinking.

Overall, the current investigation shows similarities between college-aged binge drinkers and alcoholics when it comes to initial attention to alcohol-related and neutral images. This study offers a unique addition to the literature due to the differences found towards all affective images and initial attention between the drinking and non drinking groups. Finally, no differences in later cognitive evaluation of these images suggests that though these young drinkers have initial attention that is similar to those of alcoholics, they are not dissimilar to their non drinking peers in how they evaluate alcohol (and other affective images). These results suggest that future research is needed to explore whether there may be differences due to environmental exposure in this population. In addition, future studies are needed to establish whether the lack of differences in later evaluative components in this population is specific to young binge drinkers and reflects a brain response that will change later in life if the individual continues to chronically abuse alcohol or rather this ERP pattern (or lack of difference during evaluation) stays consistent through adulthood. If the pattern appears specific to this younger population, it suggests that these individuals may be particularly sensitive to the effects of intervention on preventing further abuse and long term neurophysiological changes in the brain.

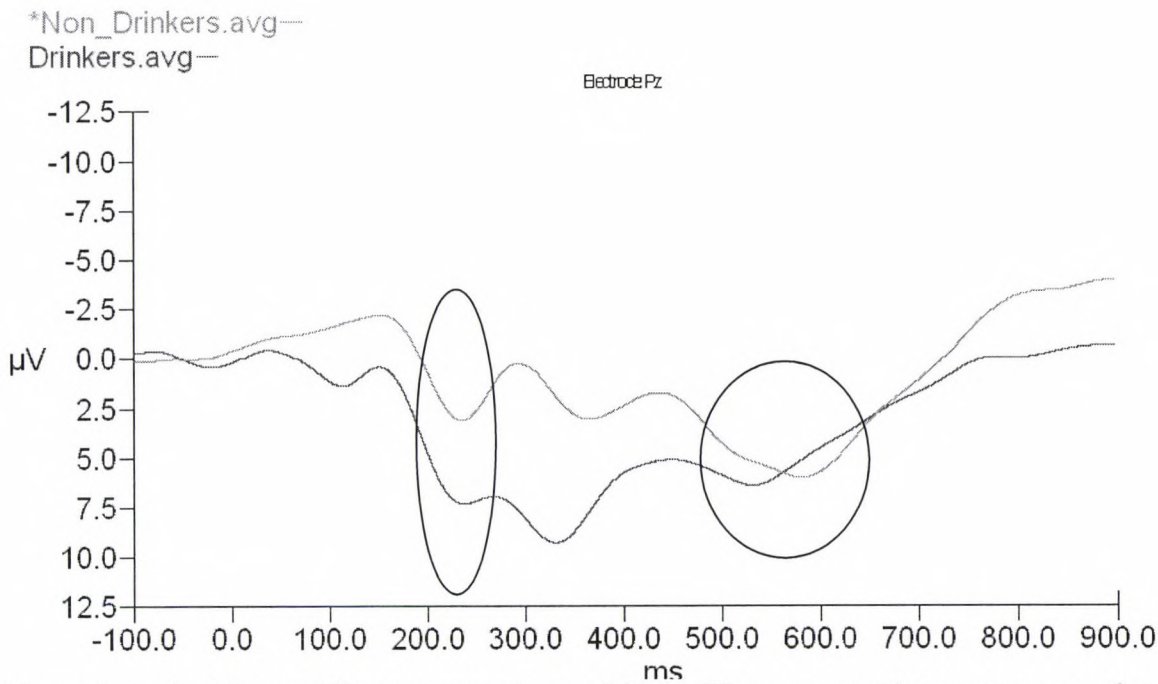

Figure 1. A significant difference was observed in the P2 component between groups for alcohol images $t(44) = 3.77$, p=.0005. There was no significant difference observed in the LPP, p=.53.

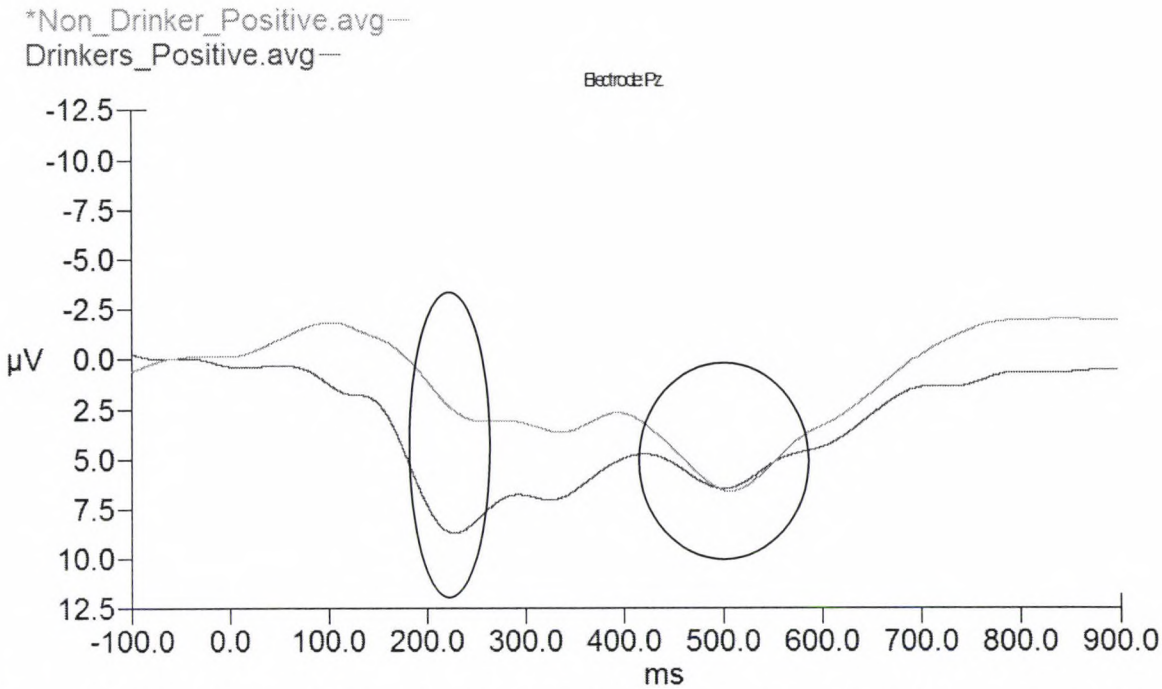

Figure 2. A significant difference was observed in the P2 component between groups for positive images $t(44) = -2.37$, $p=.02$. There was no significant difference observed in the LPP, $p=.82$.

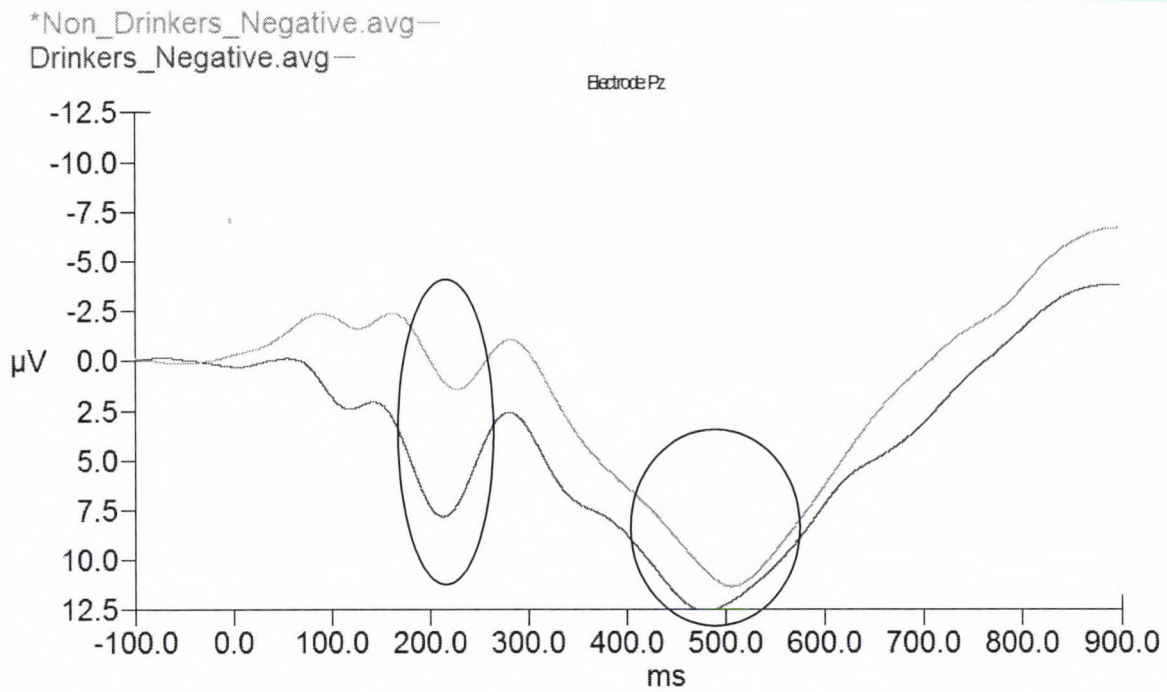

Figure 3. A significant difference was observed in the P2 component between groups for negative images $t(44) = -4.10$, $p=.0002$. There was no significant difference observed in the LPP, $p=.34$.

TABLE 1. P2 and LPP Differences between Binge Drinkers and Non Drinkers at PZ

Variable	Binge Drinkers Mean (SD)	Non-Drinkers Mean (SD)
Alcohol Images		
P2 latency	252.56(55.37)	2(47.60)
P2 Amplitude **	11.17(6.71)	4.70(4.32)
LPP latency	553.00(98.30)	564.10(64.78)
LPP Amplitude	8.98(5.44)	8.06(4.06)
Neutral Images		
P2 latency	222.13(17.34)	224.14(23.68)
P2 Amplitude	7.79(6.44)	4.94(4.47)
LPP latency	538.43(97.33)	543.67(59.23)
LPP Amplitude	5.62(4.83)	5.75(4.59)
Positive Images		
P2 latency	223.48(26.36)	240.48(30.65)
P2 Amplitude *	10.02(7.11)	4.85(7.38)
LPP latency	541.17(76.10)	535.14(68.27)
LPP Amplitude	7.80(4.77)	8.29(8.80)
Negative Images		
P2 latency	215.22(17.74)	223.10(15.19)
P2 Amplitude **	8.79(6.78)	1.84(3.97)
LPP latency	493.43(36.91)	511.14(55.86)
LPP Amplitude	14.06(5.87)	11.96(8.45)

*Significantly different between groups, independent t-test sample, $p<.05$
**Significantly different between groups, independent t-test sample, $p<.01$

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Appendix 1

AUDIT

1. In the past year, how many drinks containing alcohol do you have on a typical day when you are drinking?
   1 or 2 (0) 3 or 4 (1) 5 or 6 (2) 7 to 9 (3) 10 or more (4)

2. How often do you drink that amount?
   < 1 month (1) 2-4 times/month (2) 2-3 times/week (3) >4 times/week (4)

3. How often in the past year have you had 5 (male) / 4 (female) or more drinks on the occasion?
   Never (0) <monthly (1) Monthly (2) Weekly (3) Daily/almost daily (4)

   3a. How often in the past two weeks have you had 5 (male) / 4 (female) or more drinks on the occasion?
   ___Not at all ___ 1-2 times ___3-4 times ___ 5 or more times

4. How often in the past year have you found that you were not able to stop drinking once you had started?
   Never (0) <monthly (1) Monthly (2) Weekly (3) Daily/almost daily (4)

5. How often during the past year have you not done what was normally expected from you because of drinking?
   Never (0) <monthly (1) Monthly (2) Weekly (3) Daily/almost daily (4)

6. How often during the past year have you needed a drink first thing in the morning to get yourself going after a heavy drinking session.
   Never (0) <monthly (1) Monthly (2) Weekly (3) Daily/almost daily (4)

7. How often during the past year have you had a feeling of guilt or remorse after drinking?
   Never (0) <monthly (1) Monthly (2) Weekly (3) Daily/almost daily (4)

8. How often during the past year have you been unable to remember what happened the night before because you had been drinking?
   Never (0) <monthly (1) Monthly (2) Weekly (3) Daily/almost daily (4)

9. Has your drinking contributed to an injury to yourself or anyone else?
   Never (0) <monthly (1) Monthly (2) Weekly (3) Daily/almost daily (4)

10. Has a relative, friend, doctor, or other healthcare worker been concerned about your drinking or suggested that you should cut down?
    Never (0) <monthly (1) Monthly (2) Weekly (3) Daily/almost daily (4)

Participant Form/Demographics

Participant Number _____ Date: _____AM/PM? RA
Name(s):_____

1. Age: 2. Circle one: Male/Female 3. Circle one: Left handed/ Right handed

4. Circle One:

American Indian or Alaskan Native	Asian or Pacific Islander	Black, not Hispanic	White, not Hispanic	Hispanic	Other or Unknown

5. Do you smoke? If so, about how many cigarettes per day?

6. Have you had any brain injuries in the past? Were you ever knocked unconscious?
About how long were you out for? Ex. 15, 30, 45 seconds, 1, 2, 3, 4, 5 min or more than 5 min?

7. Have you ever been diagnosed with any psychiatric or neurological problems?
Circle or write in:

Depression Anxiety Disorder Personality Disorder Schizophrenia Migraine Epilepsy

8. Does anyone in your immediate family (parent, sibling) use substances (e.g. marijuana, cocaine, any other illicit substance)?

If so, what is the relationship (e.g. brother) and the substance?

9. Does anyone in your immediate family drink alcohol? If so, approximately how many drinks a week?

10. Has anyone in your immediate family been diagnosed with a substance abuse disorder (e.g. drug addiction, alcohol addiction)? If so, what is the relationship and the substance?

11. Has anyone in your family been diagnosed with a psychological condition (e.g. depression, anxiety, bipolar disorder)? If so, what is the relationship and the substance?

12. Are you currently taking any medications to treat one of these conditions (if applicable), or anything else that may affect your thinking or emotions (anti-depressants, sleep medication, cognitive enhancers, etc.)?
List all medication names:

13. a. If you are a **male**, please answer the following;

Have you consumed 5 or more drinks on at least one occasion during the 2 weeks before the survey?
Yes or No If so, how many drinks in one sitting?

b. If you are a **female** please answer the following:

Have you consumed 4 or more drinks on at least one occasion during the 2 weeks before the survey?
Yes or No If so, how many drinks in one sitting?

14. Do you have any visual problems? Corrected? Y/N VISION TEST: _____/_20_