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Research article

ERPs to Alcohol Images among Hispanic and Non-Hispanic Female College Freshmen

Natalie Ceballos *, Abigail Mayfield, and Reiko Graham

Department of Psychology, Texas State University, 601 University Drive, San Marcos, TX 78666, USA

* **Correspondence:** E-mail: nc18@txstate.edu; Tel: +1-512-245-2526; Fax: +1-512-245-3153

Abstract: Research suggests that young women, particularly Latinas, may be at risk for problem drinking during the home-to-college transition. In this study, we used ERP cue-reactivity to explore physiological correlates of alcohol use and expectancies across the freshman year in Hispanic (H) and Non-Hispanic White (N-H) women. In the fall (t1) and spring (t2) semesters of their freshman year of college, 40 women (16 H) reported alcohol use and expectancies. At each session, N200 and P300 ERPs were elicited by two oddball tasks (counterbalanced within session): 1) to detect alcohol targets while ignoring control items (household object distracters) and frequently presented nonsense shapes and 2) to detect object targets while ignoring alcohol distracters and nonsense shapes. P300 amplitude was larger for targets (versus non-targets) and for alcohol images (versus control images), but did not change over time or differ by ethnicity. P300 latency results included time x target and ethnicity x target interactions. Latency differences for target images were attenuated at t2, and N-Hs were more reactive to stimuli classed as targets regardless of whether these depicted alcohol or control images. N200s had higher amplitude and longer latency at t2, suggesting a change with acclimation to the college setting, but did not differ by target status, image type or ethnic group. P300 latency was positively correlated with the personalismo subscale of acculturation indicating that individuals with more social, people-oriented personalities were more distracted by alcohol images when they appeared as non-targets. N200 amplitude was correlated with positive alcohol expectancies, and this pattern changed over time (t1 versus t2), suggesting subtle, expectancy-related changes in alcohol processing as students acclimated to the college setting. Taken together, these results suggest that the cue-reactivity paradigm described here may be a useful tool for examining subtle physiological correlates of college drinking.

Keywords: P300; N200; visual attention; alcohol; college drinking; Hispanic

1. Introduction

1.1. Alcohol use and the home-to-college transition

The home-to-college transition phase is the time when students begin to separate from their families and home communities, but have not yet been fully exposed to or adapted to college norms and behaviors [1,2]. The literature on students' transition and adjustment to college has long recognized that the degree of difficulty students experience during this transition depends on the extent to which their pre-college norms and behaviors align with the college environment [1,2]. Studies suggest that incongruence between home values and college norms are more likely to occur among minority students and those from economically disadvantaged backgrounds [1,2], such as first-generation college students, those for whom neither parent has completed a four-year college degree [3]. In fact, researchers have recently acknowledged that an acculturation framework may be appropriate for understanding the home-to-college transition for both minority students, and first-generation college students regardless of their ethnic or racial group [1,4,5].

Alcohol consumption is one point on which home and college norms may clash. Though alcohol use tends to be popular in general among young adults aged 18 to 24 years, college students consume significantly more alcohol than their non-student peers [6,7]. Heavy episodic or binge drinking with the goal of becoming intoxicated is a preferred drinking pattern in the college culture [8] and may include pre-partying and drinking games [9]. This pattern of drinking is associated with a wide range of negative outcomes such as vehicular accidents, physical assault and academic failure [10]. Adjustment to the college drinking culture may be difficult for new students if their home environment or high school experiences typically did not include these activities. Difficulties may be particularly pronounced during the transition period, when incoming freshmen are experiencing newly found freedom from adult supervision at the same time as ready access to alcohol and liberal college drinking norms [7]. For many students, this situation sets the stage for alcohol misuse.

Research suggests that female college students, in particular, may be at increased risk of alcohol misuse while adjusting to the college drinking culture. Historically, the social acceptability of excessive drinking differed by gender with drinking to intoxication being considered a more appropriate activity for men than for women [11]. This double standard may have had protective effects for women, as evidenced by womens' historically lower rates of alcohol use disorders [11,12]. More recently, research suggests that social norms for alcohol use are changing and the gender gaps for alcohol use, abuse and dependence are closing in the United States population as a whole [13]. Thus, women comprise a group in which risk for alcohol misuse is on the rise perhaps due to increased acceptibility of hazardous drinking. However, among Hispanics/Latinos, the double standard for the acceptability of alcohol use persists. For instance, among college-bound high school seniors, a sex by ethnicity interaction for alcohol use has been reported, in which the gender gap (i.e., men drinking more than women) was larger for Hispanic/Latino students versus Non-Hispanic Whites and was largely explained through cultural values about the acceptability of drinking behavior [14]. Though these cultural values might be expected to protect young Latinas from alcohol misuse, the incongruence of home values and college norms could lead to problems during the home-to-college transition [1,2]. In particular, alcohol misuse among inexperienced Latina drinkers could ultimately have a negative impact on college adjustment and persistence [1,2,7].

However, to date, few studies have focused on college drinking among Latinas, whose numbers are growing rapidly in the U.S. [15]. Existing studies tend to use surveys and interviews regarding quantity/frequency of drinking and expectancies about the effects of alcohol. Such methods are limited by their susceptibility to social desirability bias [16], which is a particularly important issue for cultures in which drinking is a less acceptable behavior for women. Other approaches, beyond collection of self-reported drinking histories, may reveal more subtle or even unconscious adaptations to the college drinking culture, such as the development of attentional biases to alcohol-related stimuli, which have been associated with alcohol misuse.

1.2. Incentive sensitization, dual process model and adjustment to the college drinking culture

Alcoholic beverages are salient, attention-grabbing stimuli for most college students. However, some degree of experience with alcohol is needed to establish drinking as an attractive or wanted activity. According to Robinson and Berridge (Incentive-Sensitization Theory, [17]) addictive substances such as alcohol activate the mesolimbic dopaminergic system, causing pleasurable effects. Subsequently, stimuli related to addictive substances (for instance, the image of a frosty mug of beer) become more salient or attention-grabbing for the drinker. Repeated use of the addictive substance sensitizes this system through associative learning [17], such that salient stimuli may elicit craving and lead to alcohol consumption. Over time, alcohol misuse has been associated with a progressive decline of the regulatory executive system [18,19], expressed as an inability to ignore inappropriately salient alcohol-related stimuli and to inhibit alcohol consumption.

This concept forms the basis of the dual-process model for the development of addiction, which posits that addictive behaviors are the result of both implicit (unconscious, automatic) and explicit (conscious, controlled) cognitive processes [20,21]. In this model, problematic drinking is thought to arise because of increased automaticity or implicit sensitization to alcohol-related stimuli, coupled with a decrease in the executive, controlled processes that are necessary to ignore salient alcohol images and inhibit drinking behavior [22]. For some drinkers, this sensitization, coupled with a lack of control, tends to persist even in the face of negative consequences [17], such as hangover, academic decline or legal problems. The extent to which an individual exhibits cognitive sensitization or attentional biases to alcohol-related stimuli has been studied using behavioral measures, eye-tracking paradigms, and event-related potentials. Results have shown that attentional biases are related to quantity/frequency of alcohol use, the development and maintenance of addiction, and relapse after periods of abstinence [23–28].

The home-to-college transition and the first year of college may be an ideal setting in which to monitor the development of attentional biases to alcohol, as students' perceptions of, expectations about and attention to alcohol-related stimuli may change with experience and may be important determinants in the escalation of their drinking behaviors. In particular, female college freshman from different ethnic backgrounds, such as Hispanic versus Non-Hispanic, might have different alcohol-related perceptions and experiences based on their home environments. These differences might be reflected in their attentional responses to alcohol-related images, as well as in their drinking behaviors over the freshman year of college.

1.3. ERPs and alcohol cue-reactivity

As mentioned previously, event-related potentials (ERPs) are one method by which attentional functioning has been measured in relation to alcohol use, misuse and dependence. ERPs are temporally sensitive, allowing the measurement of brain electrical activity in real-time (on the order of milliseconds) as participants view images on a computer screen. The P300, an attention-dependent ERP occurring approximately 300 ms following infrequent, task-relevant stimuli, is particularly germane to the study of alcohol use. Traditionally, the P300 has been elicited using an oddball paradigm, which requires participants to focus on (and/or respond to) the presence of rarely presented, "relevant" target items within an ongoing presentation of frequently presented "irrelevant" non-target items. In the typical visual oddball paradigm, letters and shapes are used as stimuli [29], and the classic P300 waveform (also called the P3b) is thought to be an index of controlled processing [30]. In response to tasks of this nature, P300 amplitude tends to be reduced in alcohol dependent participants compared to non-dependent controls, in unaffected relatives of alcohol dependent participants compared to relatives of non-dependent controls, and in unaffected offspring of alcohol dependent fathers compared to offspring of non-dependent controls [31]. This reduced P300 amplitude has been proposed as an endophenotype of alcohol dependence [31–33]. Further, increased peak latency of the P300 waveform has been associated with cognitive inefficiency [34], or a reduced capacity in alcohol dependent participants to attend to relevant stimuli, while ignoring irrelevant information within a specified time frame [35].

More recently, researchers have used oddball tasks featuring alcohol pictures versus pictures of household objects to measure P300 cue-reactivity as an index of alcohol-related attentional bias [36–38]. In this context, P300 amplitude is sensitive to the arousal value of emotional stimuli, such that larger P300 amplitudes are associated with more highly arousing stimuli [39]. Thus, cue-reactivity is reflected in higher P300 amplitudes in response to alcohol pictures versus household objects. P300 cue-reactivity has been found not only in alcohol dependent populations, but also in social drinkers [37,38]. P300 ERPs elicited by alcohol cues have been found to predict alcohol use, potentially reflecting the motivational significance of alcohol cues [37]. Work by Bartholow and colleagues [37] also suggests that, for P300 cue-reactivity to alcohol images, risk status may be a more important predictor than alcohol consumption history. However, other studies have found significant ERP cue-reactivity effects only in older, heavy social drinkers [36] or in young binge drinkers [40].

The P300 waveform is often preceded by an earlier negativity, the N200 ERP, which is indicative of automatic processing. Occurring approximately 200 ms following stimulus presentation, the N200 is also sensitive to emotion and attentional processes [30,41]. N200 amplitude may be increased, and latency decreased, by emotionally relevant stimuli (such as alcohol images), leading to interference or enhancement of subsequent controlled processes reflected in the P300 [42].

In the current study, the authors used a unique, three-stimulus alcohol cue-reactivity design that allowed counterbalanced, within-subjects measurement of both automatic and controlled processing by varying task instructions. As described in Ceballos et al. [38], task version (a) required participants to detect alcohol targets while ignoring household object distracters and frequently presented nonsense shapes, and task version (b) required participants to detect object targets while ignoring alcohol distracters and nonsense shapes. This paradigm allows measurement of controlled processes (heightened reactivity to alcohol images while ignoring irrelevant household objects and shapes) and automatic processes (inability to ignore alcohol images even when they are classed as non-targets), reflected in amplitude and latency of the P300 and N200 waveforms.

1.4. Study aims

Based on the incentive sensitization and dual processing models described previously, as well as the potential conflict between home values and the college drinking culture that might be experienced by Hispanics/Latinas versus Non-Hispanic White women, we predicted that attentional processing of alcohol images might differ between these groups and that these differences might be reflected in the N200 and P300 waveforms. Thus, the current study examined Hispanic/Latina and Non-Hispanic White womens' alcohol consumption and ERP markers of attentional bias to alcohol stimuli (i.e., P300 and N200 amplitude and latency as measures of cue-reactivity to visual images) over the freshman year of college. The three-stimulus oddball task employed in the current study to measure P300 (and/or N200) cue-reactivity to alcohol images allowed us to explore both automatic and controlled processing of alcohol images. While the presence versus absence of ethnic differences and changes in N200 and P300 cue-reactivity over time remained empirical questions, we hypothesized that female participants' overall patterns of cue-reactivity to alcohol images at time 1 (t1; fall semester) and time 2 (t2; spring semester) would correlate with alcohol use and/or drinking expectancies, as predicted by Field and Cox [23]. Given the authors' focus on younger women of Hispanic/Latina or Non-Hispanic White ethnicity, this final hypothesis represents an important extension of the existing alcohol research literature, which has tended historically to focus on older, male populations (e.g., [36]).

2. Materials and Methods

Two separate, three hour-long testing sessions were conducted during the participants' freshman year of college. The first session (t1) occurred during the fall semester, and the follow-up visit (t2) occurred approximately 6 months later during the spring semester. The timing of the initial testing sessions is discussed further at the end of the Participants section.

All methods and materials were approved by the Institutional Review Board at Texas State University. Participants had adequate English language skills and provided written, informed consent prior to initiating the study. For students under the age of 21 years, parental consent was also documented, and parental consent forms were available in both English and Spanish versions, which were translated and back-translated by bilingual research assistants in accordance with National Institutes of Health (NIH) guidelines.

2.1. Participants

Seventy women [35 Hispanic/Latina and 35 Non-Hispanic White] in the first semester of their first year of college were recruited from the university setting using flyers, word-of-mouth, and e-mail lists prepared by the university registrar's office. Ethnicity and race were reported by the participants using National Institutes of Health guidelines. Hispanic or Latino persons were defined as those of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin. In accordance with NIH guidelines, Non-Hispanic White persons were those who did not identify as Hispanic or Latino and endorsed origins in any of the original peoples of Europe, the Middle East or North Africa.

Recruitment efforts focused on "first generation" college women, that is, women whose parents did not complete a 4-year college degree. This particular group was chosen as a focus because first generation students are expected to have a lower degree of acclimation to the college environment versus the traditional home environment. Participants lived in residence halls, independent settings off-campus or with their nuclear families. Telephone screening surveys were used to determine study eligibility. Individuals with a personal history of neuropathology, seizures, head injury, loss of consciousness for more than 20 minutes, or Axis I psychiatric diagnoses were excluded. All had normal or corrected-to-normal vision. Participants were reimbursed at the rate of $15/hour.

Although 70 participants completed the t1 testing session, 14 of these participants did not return for the t2 testing session (four formally withdrew; 10 did not respond to follow-up requests). Of the remaining 56 participants who completed both t1 and t2 testing sessions, 16 were excluded from ERP analyses due to poor data quality (details given in Electrophysiology section). Thus, the final sample for statistical analyses included 40 women (16 Hispanic/Latina and 24 Non-Hispanic White).

For these 40 women, 16% of participants completed t1 testing within the first three weeks of the start of the fall semester; 50% were tested during weeks four through six; 16% were tested during weeks seven through nine, and 18% were tested during weeks 10 through 13. Hispanic/Latina and Non-Hispanic White groups did not differ on distribution of testing week category ($\chi^2(3) = 5.99$, $p = 0.11$). The second testing session occurred 6 months later, in the spring semester.

2.2. Background variables

In addition to basic demographic information, at each testing session, participants completed questionnaires regarding their alcohol use over the previous 6 month period (quantity frequency index, QFI; [43]), and family history of alcoholism (for students raised by their biological parents) [44]. Participants also had the opportunity to identify themselves as "regular drinkers" if they had established a recurrent pattern of alcohol use, such as weekly, monthly or holiday drinking. Finally, binge drinking measures by Cranford, McCabe and Boyd [45] were embedded in the larger background questionnaire and included visual images depicting the volume of a "standard" drink for wine, beer and liquor. High school binge drinking was also included in the questionnaire. The background questionnaire presented at each laboratory visit also included a drinking expectancies measure, the Comprehensive Effects of Alcohol questionnaire (CEQ; [46]). This questionnaire was composed of 38 items and addressed both positive alcohol expectancies (sociability, tension reduction, liquid courage, and sexuality), and negative alcohol expectancies (cognitive and behavioral impairment, risk and aggression, and self-perception). Items began with the statement "If I were under the influence from drinking alcohol…" For example, an item in the positive expectancy scale ended with "I would act sociable." An item in the negative expectancy scale ended with "I would feel dizzy."

In the current study, acculturation was defined as acclimation from the traditional home environment to college life. Although acculturation is typically examined in terms of immigration from one country to another, similar processes may be observed when individuals raised in ethnically or socioeconomically insular environments move to more diverse communities (e.g., in order to pursue a college education). As mentioned previously, an acculturation framework has been deemed appropriate for understanding the home-to-college transition for both minority students, and first-generation college students regardless of their ethnic or racial group [1,4,5]. Familism, fatalism, personalismo and machismo subscales of the Multiphasic Assessment of Cultural Constructs—Short Form (MACC-SF; [47]) were administered at each laboratory visit in order to document any changes in traditional attitudes, beliefs and family values during the home-to-college transition. Briefly, familism refers to strong feelings of loyalty and obligation to the family, as well as reliance and attachment among members [47,48]. Fatalism refers to the extent to which people feel that their destinies are beyond their control [47]. Personalismo refers to an orientation toward people rather than toward impersonal relationships [47,49]. Machismo refers to negative (e.g., chauvinism, dominance, womanizing) and positive (e.g., strength, courage, independence) aspects of male behavior [47,50]. Female responses to the machismo subscale are of interest to this study, as a high score on machismo indicates greater endorsement of the strict gender roles that are part of many cultures. For instance, the machismo scale included items such as “Parents should maintain stricter control over their daughters than their sons”, an idea that is directly relevant to the double standard noted previously for alcohol consumption in women. The machismo scale also included more negative statements such as “Men are more intelligent than women” and more positive statements such as “It is important for a man to be strong.” The MACC-SF was developed and normed using college-aged populations from the Texas-Mexico border region and addresses traditional beliefs that are appropriate for both Hispanics/Latinas and Non-Hispanic White women in this study [47].

2.3. Three stimulus oddball paradigm

Presentation parameters were based on the timing and probability of tasks by Rodriguez Holguin and colleagues [51] with modifications for picture presentation [36]. Pictures were obtained from the public domain via Internet searches. Examples of alcohol-related items include a mug of beer, a glass of wine or a mixed drink; examples of household objects include a tea pot, a cup of pencils and a cheese grater. The stimuli were approximately 8 cm wide × 12 cm in height and are available from the first author. Images were matched for contrast and luminance. Forty-eight different target (probability = 0.10), 48 novel non-target (probability = 0.10) and 384 different frequent neutral distracter stimuli (color nonsense shapes [52], probability = 0.80) were presented at the center of a computer monitor on a white background for 500 ms [53]. Pictorial stimuli were preceded by a central fixation cross that was presented for 500ms. The inter-stimulus interval varied randomly (750, 1000 and 1250 ms).

Two variations of the task were presented (counterbalanced within testing session) to each participant: alcohol target items with non-alcohol distracters (e.g., household objects), and non-alcohol target items (e.g., household objects) with alcohol distracters. In both, frequently presented neutral non-target images (e.g., nonsense shapes) also appeared. Participants were instructed to attend only to the target items in each condition, while ignoring the frequently presented, neutral distracter items, as well as the novel non-target stimuli. Both the target and novel non-target items were expected to elicit a P300 and an N200. Task presentation occurred in two sets of three, five minute blocks interspersed with approximately 1 to 2 minute rest periods, and required approximately 40 minutes to complete the counterbalanced presentation.

2.4. Electrophysiology

ERP data were collected in a sound- and electrically-attenuated recording chamber. Tasks were displayed on a high-resolution color monitor and data were collected continuously throughout the testing session from an array of 64 sintered Ag/AgCl electrodes placed according to the International 10–20 electrode placement standard and held in place with an electrode cap (Quik-Caps, Neuroscan Compumedics USA). The SynAmp2 system was used in conjunction with Acquire version 4.3 (Neuroscan Compumedics USA). EEG was recorded with a sampling rate of 1000 Hz for 1100 ms starting 100 ms prior to stimulus onset. Channels were amplified with a filter bandwidth of 0.01–50 Hz. Linked mastoids served as a reference, and impedances were maintained at or below 5 kOhms.

Horizontal eye movements were monitored with bipolar electrodes on the outer canthus of each eye; vertical movements, from electrodes placed above and below the left eye. Ocular artifact was addressed in two ways. First, for all participants, individual trials with ocular electrode amplitude values above +100 or below −100 μV were excluded. Due to technical problems, for eight participants (4 Hispanic/Latina, 4 Non-Hispanic) in t1 and 13 participants (9 Hispanic/Latina, 4 Non-Hispanic) in t2, the FPz electrode was substituted for the vertical eye movement channels for purposes of exclusion based on the +/− 100 μV criterion. Next, for 13 participants (7 Hispanic/Latina, 6 Non-Hispanic) who required addition ocular artifact reduction, the Semlitsch method [54,55] was applied, using a single linear derivation file for t1 and t2. The ocular artifact reduction method of Semlitsch and colleagues [55] subtracts a fraction of the electrooculogram from the EEG using regression analysis in combination with artifact averaging and has been shown to be both reliable and valid [54,55]. After artifact rejection, ERPs were digitally bandpass-filtered from 0.1 to 35 Hz. At each testing session, there were 48 trials per each item category (i.e., alcohol images as targets, alcohol images as non-targets, control images as targets, control images as non-targets). To ensure adequate signal-to-noise ratios, data from participants contained at least 15 artifact-free trials per item category.

Of the 56 participants who provided ERP data at both t1 and t2 sessions, data from 16 participants were excluded from statistical analysis of ERPs due to technical problems or excessive artifact (less than 15 artifact-free trials per item category). Reasons for exclusion included presence of skin potentials apparent in the electroencephalographic recordings (related to perspiration, a hazard in our geographical region) and drowsiness reflected in excessive alpha activity, which though it interferes with ERP recordings, is not an unusual condition among college freshman. The average percentage of valid trials per item category for the participants included in final statistical analyses was 76%.

2.5. Data analysis

For basic demographic information collected at t1, analyses of variance (ANOVAs) were used to compare Hispanic/Latina and Non-Hispanic White groups on continuous variables (age at study enrollment, age at first drink, age at first drunken episode, QFI, days since last drink prior to testing session). Pearson's Chi-Square Test was used for categorical variables such as family history of alcoholism and regular drinker status. Repeated measures ANOVAs were used for longitudinal comparisons (t1 versus t2) of groups on alcohol use, drinking expectancies and acculturation. Forty-two participants completed both t1 and t2 sessions. *N*s of less than 40 on any individual variable indicate missing data.

ERP analyses focused on P300 and N200 amplitudes and latencies for infrequent target and non-target stimuli. Topographical analyses of ERPs in the current study indicated that P300 amplitudes peaked in the parietal regions. Thus, P300 amplitude and latency were derived from the largest positive peak occurring at the Pz electrode site between 250 and 700 ms following stimulus presentation.

Topographical analyses revealed that N200 amplitudes peaked in the fronto-central regions. Thus, N200 amplitude and latency were derived from the largest negative peak occurring at the FCz electrode site between 150 and 300 ms following stimulus presentation. N200 and P300 amplitudes and latencies were analyzed via separate repeated-measures ANOVAs using within-subject factors of time, stimulus type and target status and the between-subject factor of ethnicity. Interactions were interpreted using planned comparisons; specific comparisons are detailed in the Results section.

For all correlational analyses of ERP amplitude and latency with self-report measures, a more stringent alpha level of ≤ 0.01 was used to control for the elevated Type 1 error associated with the large number of correlations necessary to compare all conditions of the ERP task with all relevant self-report measures.

3. Results

3.1. Demographics and acculturation

Age differences between groups were not statistically significant ($t(38) = 1.93$, $p = 0.06$). Participants had a mean age of 18.0 years (± 0.3). Of the participants who provided data on their parents' educational status, 66% were first generation college students, defined as students whose parents have not completed a four-year university degree [56]. Distribution of first generation college student status did not differ between groups ($\chi^2(1) = 1.15$, $p = 0.28$).

See Table 1. Hispanics/Latinas were more likely than Non-Hispanic Whites to endorse familism ($F(1,38) = 5.35$, $p = 0.03$, $\eta^2 = 0.12$) and fatalism ($F(1,38) = 5.67$, $p = 0.02$, $\eta^2 = 0.13$) subscales of the MACC-SF; however, no group differences were noted for personalismo ($F(1,38) = 0.03$, $p = 0.86$, $\eta^2 = 0.001$) or machismo ($F(1,38) = 0.33$, $p = 0.57$, $\eta^2 = 0.009$). In both groups, endorsement of familism decreased over time ($F(1,38) = 7.86$, $p = 0.008$, $\eta^2 = 0.17$) as students became for acclimated to the college environment. No other significant effects or interactions were noted for acculturation (*ps* > 0.07, $\eta^2 < 0.08$).

Table 1. Acculturation subscales, Means (Standard Deviations).

	Hispanic		Non-Hispanic	
	Baseline	**Follow-up**	**Baseline**	**Follow-up**
Familism*†	7.56 (1.71)	6.38 (1.36)	5.63 (2.62)	5.42 (2.10)
Fatalism*	4.87 (1.20)	4.87 (1.26)	3.67 (1.49)	4.08 (1.69)
Personalismo	6.50 (1.46)	6.62 (1.71)	6.08 (1.41)	6.88 (1.83)
Machismo	3.12 (2.78)	3.88 (3.44)	3.88 (3.00)	4.25 (3.35)

*Significant effect of Ethnicity, $p < 0.05$; † Significant effect of Time, $p < 0.05$

3.2. Alcohol use characteristics

For participants who reported consuming alcohol at any point during the freshman year (80% of study sample), quantity/frequency of alcohol use did not differ between groups (levels were low at less than 0.5 drink/day), ($F(1,34) = 0.15$, $p = 0.70$, $\eta^2 = 0.004$), and remained stable over 6 months ($F(1,34) = 0.02$, $p = 0.90$, $\eta^2 = 0.001$). There were no interactions of time and ethnicity for quantity/frequency of alcohol use ($F(1,34) = 0.001$, $p = 0.98$, $\eta^2 < 0.001$). Eighty percent of the participant sample reported consuming alcohol at some point during their freshman year, and Hispanic/Latina and Non-Hispanic White groups did not differ on percentage of participants who consumed alcohol at some point during the freshman year ($\chi^2(1) = 0.42$, $p = 0.52$). Age at first drink did not differ by ethnicity ($t(32) = 1.21$, $p = 0.24$), and the average age of first drink for the study sample was 13 years (± 3.6). Age at first drunken episode also did not differ by ethnicity ($t(26) = 0.58$, $p = 0.57$), and the average age of first drunken episode for the study sample was 16.2 years (± 1.5). See Table 2.

Ethnic groups were also similar on the percentage of self-identified “regular drinkers” (χ^2(1) = 0.16, p = 0.69) with 53% of the study sample reporting a regular pattern of drinking. Similar percentages of Hispanic/Latina and Non-Hispanic White women reported episodes of binge drinking (defined as consuming four or more alcoholic beverages in one drinking episode) during their senior year of high school (χ^2(1) = 1.31, p = 0.25) with 35% of the study sample reporting binge drinking during the senior year. Likewise, groups did not differ on the percentage who endorsed binge drinking as their typical drinking pattern (χ^2(1) = 0.004, p = 0.95) with 15% of the study sample reporting a typical pattern of binge drinking. Ethnic groups did not differ in the distribution of participants who reported a positive family history for alcohol dependence (χ^2(1) = 0.03, p = 0.86), and 53% of the study sample was family history positive.

Table 2. Alcohol use characteristics, Means (Standard Deviations).

	Hispanic		Non-Hispanic	
	Baseline	**Follow-up**	**Baseline**	**Follow-up**
QFI	0.43 (0.79)	0.45 (0.91)	0.34 (0.40)	0.32 (0.37)
Age at first drink	14.1 (3.9)	_________	12.6 (3.4)	_________
Age at first drunken episode	16.4 (1.4)	_________	16.1 (1.6)	_________

No significant effects of Ethnicity or Time were noted. All *ps* > 0.05. QFI = quantity frequency index of alcohol use for students who reported any alcohol use during the freshman year; square root transformed QFI values were used for statistical analyses.

3.3. Alcohol expectancies

See Table 3. In terms of alcohol expectancies, Non-Hispanic White women had higher scores on the positive subscale of tension reduction (F(1,36) = 5.50, p = 0.03, η^2 = 0.13) and the negative subscale of risk and aggression (F(1,37) = 6.15, p = 0.02, η^2 = 0.14). In both groups, endorsement of alcohol use for tension reduction increased over time (F(1,36) = 8.62; p = 0.006, η^2 = 0.19), and negative effects of alcohol on self-perception decreased over time (F(1,37) = 8.05; p = 0.007, η^2 = 0.18) as students became more acclimated to the college setting. No other significant effects or interactions were noted for alcohol expectancies (*ps* > 0.10, η^2 < 0.06).

Table 3. Alcohol Expectancies, Means (Standard Deviation).

	Hispanic		Non-Hispanic	
	Baseline	**Follow-up**	**Baseline**	**Follow-up**
Positive Subscales				
Sociability	3.09 (0.74)	2.97 (0.82)	3.16 (0.57)	3.32 (0.44)
Tension Reduction*†	2.24 (0.70)	2.43 (0.80)	2.60 (0.49)	2.92 (0.48)
Liquid Courage	2.33 (0.96)	2.24 (0.76)	2.37 (0.70)	2.58 (0.50)
Sexuality	1.87 (0.95)	1.87 (0.80)	2.07 (0.71)	2.23 (0.70)
Negative Subscales				
Cognitive & Behavioral Impairment	2.55 (0.66)	2.56 (0.66)	2.85 (0.60)	2.89 (0.58)
Risk-Taking & Aggression*	2.13 (0.71)	1.93 (0.61)	2.37 (0.50)	2.47 (0.53)
Self-Perception†	2.13 (0.72)	1.87 (0.76)	2.23 (0.50)	1.99 (0.72)

*Significant effect of Ethnicity, $p < 0.05$; † Significant effect of Time, $p < 0.05$.

3.4. Event-related potentials

Figure 1 illustrates ERPs of Hispanic/Latina and Non-Hispanic White groups in response to alcohol images (labeled "Alcohol") and control images (i.e., household items; labeled "Control"). Waveforms are shown for each image type when they were presented as targets (red waveforms, thin line for t1; thick line for t2) and when they were presented as non-targets (green waveforms, thin line for t1; thick line for t2).

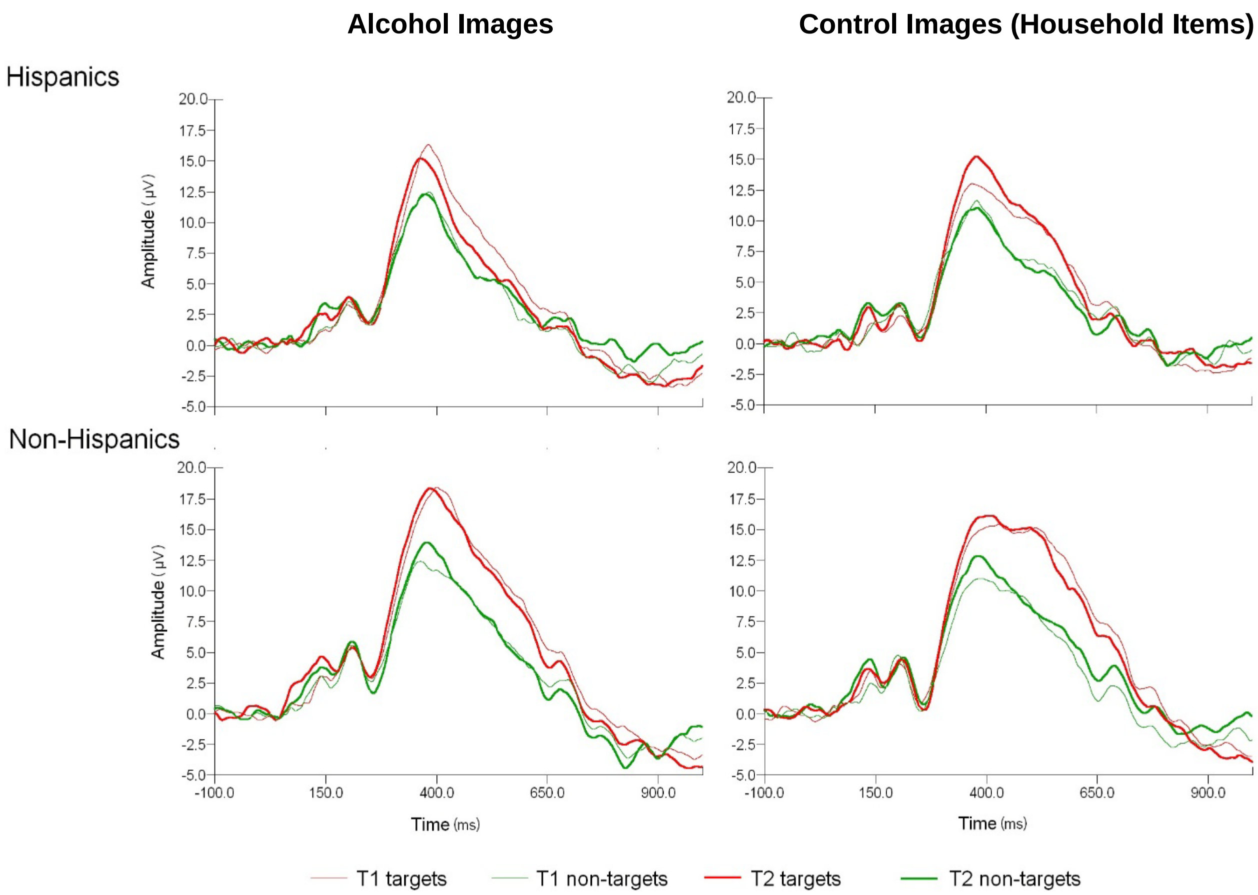

Figure 1. P300 waveforms of Hispanic and Non-Hispanic participants at testing session 1 (T1) and testing session 2 (T2) in response to target (thin red line = t1; thick red line = t2) and non-target (thin green line = t1; thick green line = t2) images.

3.4.1 P300 amplitudes and latencies

For P300 amplitude, the expected significant main effect of target status was observed (F(1,38) = 85.26, $p < 0.001$, $\eta^2 = 0.69$; targets = 18.15 μV, Std Err 0.74 μV; non-targets = 14.94 μV, Std Err = 0.66 μV), verifying the ability of the oddball task to elicit a P300 that was robust to target status. There was also a significant main effect of picture type (F(1,38) = 9.67, $p = 0.004$, $\eta^2 = 0.20$; alcohol images = 17.09 μV, Std Err = 0.76 μV; control images = 16.01 μV, Std Err = 0.64 μV), indicating that alcohol images were more salient than control images, as evidenced by larger P300 amplitudes to alcohol images. Changes in the P300 amplitude over time were non-significant (F(1,38) = 0.94, $p = 0.34$,

$\eta^2 = 0.02$), and there were no significant differences between ethnic groups ($F(1,38) = 1.68$, $p = 0.20$, $\eta^2 = 0.04$). Interactions between these variables were not statistically significant ($ps > 0.08$, $\eta^2 < 0.07$).

For P300 latency, there was a significant effect of target status ($F(1,38) = 5.76$, $p = 0.02$, $\eta^2 = 0.13$), in which P300 latencies to targets (415 ms, Std Err = 8 ms) were greater than those elicited by non-targets (400 ms, Std Error = 8 ms). Although the main effect of time was not significant ($F(1,38) = 0.55$, $p = 0.46$, $\eta^2 = 0.01$), time interacted significantly with target status ($F(1,38) = 9.11$, $p = 0.005$, $\eta^2 = 0.19$). At t1, latencies were significantly longer in response to targets versus non-targets, $t(39) = 5.02$; $p < 0.001$. At t2, there were no significant latency differences for targets versus non-targets ($p = 0.58$), see Figure 2. The main effect of ethnicity was not significant ($F(1,38) = 1.66$, $p = 0.21$, $\eta^2 = 0.04$), however, ethnicity interacted significantly with target status ($F(1,38) = 4.75$, $p = 0.04$, $\eta^2 = 0.11$). This interaction was driven by the Non-Hispanic group, in which P300 latencies were significantly longer for targets compared to non-targets, $t(23) = 4.20$; $p < 0.001$; there were no significant differences in the Hispanic group ($p = 0.91$), see Figure 3.

A main effect of picture type was also noted ($F(1,38) = 14.37$, $p = 0.001$, $\eta^2 = 0.27$), in which P3 latencies to control images (420 ms, Std Err = 9 ms) were significantly longer than those to alcohol images (395 ms, Std Err = 7 ms). This finding may have been related to the more morphologically sustained late P300 amplitude to control vs. alcohol targets; that is, for control targets, the P300 took longer to descend from peak amplitude (See Figure 1, Control column).

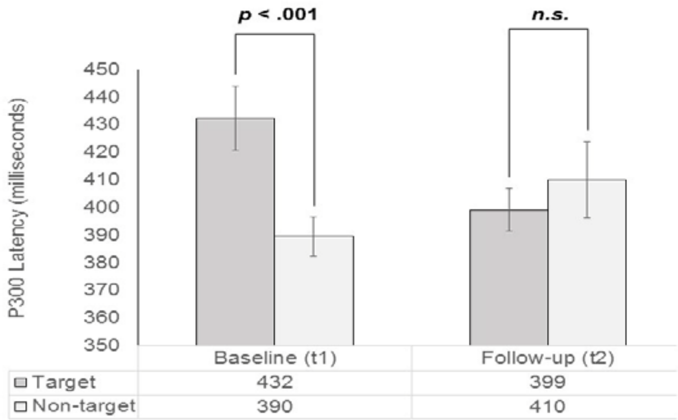

Figure 2. P300 latency: Interaction of target status x time, means and standard errors.

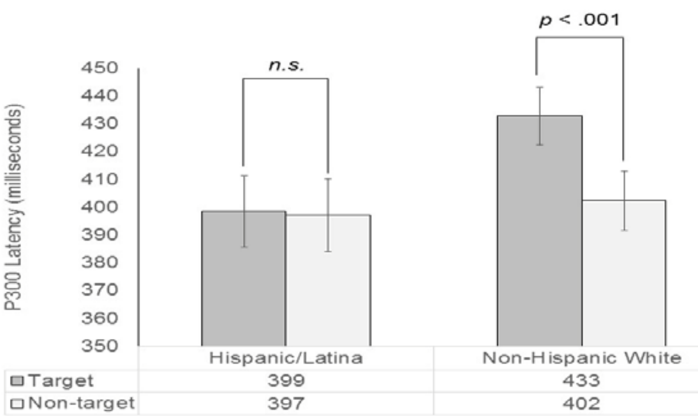

Figure 3. P300 latency: Interaction of target status x ethnicity, means and standard errors.

3.4.2 N200 amplitudes and latencies

For N200 amplitude, there was a significant main effect of time ($F(1,38) = 4.69$, $p = 0.04$, $\eta^2 = 0.11$), in which N200 amplitudes were larger (more negative) at t2 (t1 = −7.38 µV, Std Err 0.94 µV; t2 = −8.43 µV, Std Err 0.92 µV). No other main effects or interactions reached statistical significance ($ps > 0.09$; $\eta^2 < 0.07$).

For N200 latency, there was a significant main effect of time ($F(1,38) = 11.21$, $p = 0.002$, $\eta^2 = 0.23$), in which N200 latencies were longer at t2 (t1 = 260 ms, Std Err = 4 ms; t2 = 269 ms, Std Err = 3 ms). No other main effects or interactions reached statistical significance ($ps > 0.19$; $\eta^2 < 0.04$).

3.5. Correlational Analyses

3.5.1. P300 Correlations

Using a more stringent alpha level of ≤ 0.01, there were no significant correlations between P300 amplitude and alcohol consumption characteristics, alcohol expectancies or acculturation measures. There was a positive correlation between P300 latency and the personalismo subscale of the MACC-SF acculturation questionnaire ($r(38) = 0.43$, $p = 0.005$). Participants with greater endorsement of personalismo at the t1 testing session had longer P300 latencies when alcohol appeared as a non-target during the t1 testing session. See Figure 4.

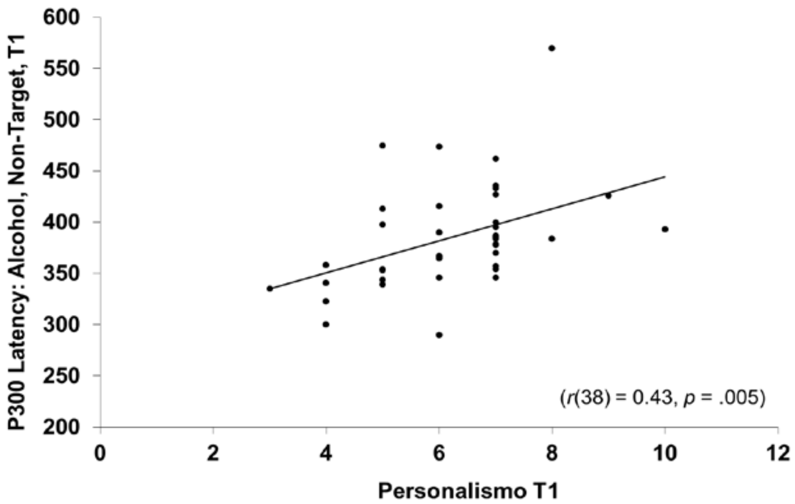

Figure 4. Significant correlation between P300 latency and acculturation subscale of personalismo.

3.5.2 N200 Correlations

N200 amplitude and latency were correlated with various subscales of the alcohol expectancies questionnaire. Using a more stringent alpha level of ≤ 0.01, there were significant correlations between tension reduction and N200 amplitudes at t1 when alcohol appeared as a target ($r(37) = −0.44$, $p = 0.006$) and when alcohol appeared as a non-target distracter ($r(37) = −0.42$, $p = 0.009$). Participants with a greater t1 endorsement of the notion that alcohol consumption reduces tension had larger (more negative) N200 amplitudes to alcohol images at t1 regardless of whether alcohol appeared as a target or a non-target distracter. At t1, endorsement of drinking for tension reduction was also negatively correlated with N200 amplitude to control images when they appeared as non-targets ($r(37) = −0.54$, $p < 0.001$); however, the relationship of t1 tension reduction to t2 N200 amplitude was noted exclusively for alcohol images when they appeared as targets ($r(37) = −0.41$, $p = 0.01$).

Other t1 alcohol expectancies were also negatively related to N200 amplitude. Time 1 endorsement of alcohol for use as liquid courage was negatively related to N200 amplitude to control item distracters as t1 ($r(37) = −0.42$, $p = 0.008$) and to alcohol items as targets at t2 ($r(37) = −0.40$, $p = 0.01$). Participants with a greater endorsement of alcohol as liquid courage had larger (more negative) N200 amplitudes under these conditions. Time 1 endorsement of alcohol for enhancement of sexuality was negatively related to control items as distracters at t1 ($r(37) = −0.41$, $p = 0.009$) and to alcohol items as targets at t1 ($r(37) = −0.50$, $p = 0.001$). Time 1 endorsement of alcohol for enhancement of sexuality was also negatively related to N200 amplitude at time 2, specifically when control items appeared as targets ($r(37) = −0.46$, $p = 0.003$), and when alcohol images appeared as targets ($r(37) = −0.39$, $p = 0.01$) or non-target distracters ($r(37) = −0.46$, $p = 0.003$). Time 2 endorsement of alcohol for enhancement of sexuality was also negatively correlated with N200 amplitude to alcohol when images appeared as targets at t2 ($r(38) = −0.41$, $p = 0.009$).

4. **Discussion**

College drinking is a public health concern, as it is associated with a wide range of both short- and long-term negative outcomes [10]. For many students, the autonomy of the college setting, paired with ready access to alcohol, leads to alcohol misuse, particularly during the transition period when students are adjusting (or acculturating; [1,4,5]) to the college drinking culture [7]. Researchers have long noted that college adjustment tends to be more difficult when there is incongruence between the values of the student’s home or community and the college environment [1,2]. This type of incongruence may be particularly noteworthy for minorities and first-generation college studies [1,2]. Alcohol use is one issue that may present a conflict during the home-to-college transition. Changing social norms have resulted in a closing of the gender gap for alcohol misuse, and college women may be at particularly high risk of developing problem drinking during the home-to-college transition perhaps due to these changing norms [14]. However, drinking to intoxication continues to be perceived as less acceptable for women (versus men) in the Hispanic/Latino culture [13]. These studies suggest that Latinas may be more likely to experience a cultural transition as they move from home to the college setting where drinking norms tend to be more liberal [13,57]. The literature remains relatively sparse with regard to studies of alcohol use in college women from different ethnic backgrounds, and existing studies have largely focused on pencil-and-paper or online surveys of self-reported alcohol use. In the current study, we have extended this work to address not only potential cultural differences in alcohol use and drinking expectancies over the freshman year, but also physiological indices of attentional biases to alcohol cues (i.e., N200 and P300 ERPs) as students acclimated to the college setting.

In this study, ethnic groups were similar with respect to background characteristics, including their endorsement of “traditional” values (indexed by the MACC-SF acculturation questionnaire), first generation college student status (defined as students whose parents have not completed a four-year college degree) and baseline experience with alcohol consumption (i.e., age at first drink, age at first drunken episode, percentage self-identified regular drinkers and binge drinkers in high school and college). In both groups, the initial quantity and frequency of alcohol use was low (less than 0.5 drinks/day over the previous 6 months) and did not change significantly over the freshman year of college.

Although studies of the general college student population have found that students increase their drinking during the freshman year [58], very few studies have addressed drinking patterns among first generation college students, a group that comprised 79% of Hispanics/Latinas and 57% of Non-Hispanic White women in the current study. This may at least partially explain the lack of increase in alcohol consumption over the freshman year that was observed in the current study. For instance, previous studies suggest that, regardless of ethnic/racial identity, first generation college students have a qualitatively different college experience compared to their continuing-generation peers [59]. They are less likely to be familiar with the college setting and more likely to encounter cultural conflict during the home-to-college transition [60,61]. Though the interplay of stress, coping and alcohol use is complex, conflict associated with this transition might be theoretically predicted to increase risk of alcohol use for college students (e.g., [62]). However, it is noteworthy that first generation college students are less likely to engage in social activities that have been linked with college drinking [63,64]; rather, they are more likely to spend time working for salary or wages [65]. Due to the small number of continuing generation students in this study, it was not feasible to examine alcohol consumption with first generation status as a grouping factor, as such analyses would have been significantly underpowered.

In terms of electrophysiological indices of cue-reactivity, our two-variant, three-stimulus oddball task elicited predictable results in terms of P300 amplitude increases to targets (versus non-targets) and alcohol images (versus control images). These results show that, across participants, the alcohol cue-reactivity task, with our novel use of within-subject target status variation in each testing session, functioned similarly to “classic” oddball paradigms. P300 amplitude did not change over time as students acclimated to the college environment and did not differ by ethnicity. This finding is likely related to the fact that alcohol consumption levels did not change over time for our participants and did not differ significantly by ethnic group. In fact, for our participant sample, P300 amplitude was not significantly correlated with alcohol expectancies or alcohol use in high school or college when a more stringent alpha level of 0.01 was used. This finding is not completely unexpected in our sample of light drinkers, as previous studies in adult male participants have reported P300 cue-reactivity for heavy drinkers, but not for light drinkers [36]. Our results seem to support those findings [36], at least for young, light drinking women.

P300 latency results included a target status interaction with time (longer latencies to targets at t1 versus t2) and ethnicity (longer latencies to targets for Non-Hispanic White participants versus Hispanics/Latinas). Thus, P300 ERPs peaked earlier in response to images classed as targets at the second testing session in the spring of the freshman year, which could reflect a faster evaluation of the target stimuli. Also, compared to their Non-Hispanic White peers, Hispanic/Latina participants also exhibited P300 ERPs that peaked earlier in response to targets overall, regardless to whether targets were alcohol images or control images, which could reflect an overall faster evaluation of the target stimuli. These results suggest subtle processing differences between Non-Hispanic White and Hispanic/Latina participants when they are confronted with a task containing alcohol and control images.

P300 latency also correlated with the personalismo sub-scale of the acculturation questionnaire, indicating that individuals with more social, people-oriented personalities, had longer P300 latencies (suggesting slower processing speed) when alcohol appeared as a non-target during the time 1 testing session. This finding might reflect the distracting or automatic interference of alcohol images when they are not classed as a target stimulus. This could be interpreted to suggest that more social or outgoing people might find alcohol to be more distracting when it is present, but is not the focus of an ongoing activity; they may automatically slow down processing to spend more time considering the distracting alcohol images. This may be an interesting avenue for future research, particularly involving eye-tracking technology, as other studies have noted that presence of alcohol image distracters tends to interfere with learning processes related to inhibitory signals, perhaps leading to persistence of a drinking episode [66].

In terms of overall N200 findings, amplitude became larger (more negative) with longer latencies over time as students acclimated to the college setting; however, this finding was not related to ethnicity, target status, or image type (alcohol or control). More intriguing findings appeared when relationships between N200 and self-report data were examined. There were a number of significant correlations between N200 amplitude and positive alcohol expectancies, and the pattern of these findings changed over time (t1 versus t2), suggesting subtle, expectancy-related changes in the way that alcohol versus control images were processed by participants after they had acclimated to the college setting.

For instance, participants with a greater time 1 endorsement of the positive expectancy of using alcohol to reduce tension had larger (more negative) N200 amplitudes to alcohol images presented at time 1, regardless of whether or not the alcohol appeared as a distracter, and control images also elicited larger N200s when they appeared as non-target distracters. In other words, there was a lack of specificity in the relationships of tension reduction expectancies and N200 amplitudes. However, at the time 2 session, the relationship between t1 tension reduction expectancies and N200 amplitude was only significant for alcohol images when they appeared as target stimuli, suggesting a subtle change toward a more specific relationship between expectancies and reactivity to alcohol cues. Similar patterns were noted for other positive subscales of the alcohol expectancies questionnaire, including the use of alcohol for liquid courage and for the enhancement of sexuality.

Despite the aforementioned correlations of cue-elicited ERPs with self-reported measures of personalismo (for the P300) and positive alcohol expectancies (for the N200), there were no significant correlations between quantity/frequency of alcohol use and ERP measures in this study. As noted previously, other studies have reported strong relationships between drinking patterns and ERP cue-reactivity for heavier drinkers, but not lighter drinkers [36]. In addition, Bartholow and colleagues [37] have suggested that risk status might be a more important predictor than alcohol consumption history for ERP cue-reactivity to alcohol images. Our findings support this notion, as students with greater positive expectancies about alcohol use and a more social, people-oriented personality, might be at greater risk of alcohol misuse while acclimating to the college environment. This is an important point, as both extroversion (high sociability) and positive expectancies about alcohol use have long been implicated as risk factors for problem drinking [67–69], and other work has shown that positive expectancies may exacerbate the risk relationship between personality factors and alcohol use [67]. Other risk factors, such as family history of alcoholism, which has been historically associated with decreased P300 amplitude in response to classic oddball paradigms involving letters and shapes [29] were less likely to have been an issue in the current study, as distribution of family history status did not differ between ethnic groups. Further, the relationship between family history of alcoholism and ERP cue-reactivity to alcohol images is less consistent in the literature (versus relationships to the classic oddball P300), and studies suggest that while both heavy drinking and positive family history of alcoholism may heighten reactivity to alcohol cues, these factors may have differential impacts on neural circuitry of cue-reactivity [70].

4.1. Limitations and future directions

Our study is the first to report quantity/frequency of alcohol use coupled with P300 cue-reactivity to alcohol images across the freshman year in both Hispanic/Latina and Non-Hispanic White women, the majority of whom were also first generation college students. The inclusion of a high proportion of first generation college students is both a strength and a weakness of the current study. It is a strength in that this population is understudied in the field of alcohol research. However, due to the small number of continuing generation students in our sample, it was not feasible to add first generation status as a second between-subjects factor. Additional research including equal numbers of first generation and continuing generation students is needed to more fully address this issue. Further, recruitment from college groups known to have higher rates of alcohol use such as collegiate athletes or social sororities [71,72] would have increased the generalizability of our sample.

The pace of enrollment for our study was constrained by the inclusion of physiological measures that required participants to be tested individually. As a result, though the majority of participants were tested within the first 6 weeks of classes in the fall semester (see Methods section), there was variation in the time of study enrollment. This could be considered a strength of the study, as it allowed us to control for time of year effect. It could also be viewed as a limitation because many students experience their greatest adjustment to the college drinking culture during the first several weeks of fall classes. Samples sizes for participants tested early in the semester were quite small; thus, is was not feasible to conduct a separate set of statistical analyses with ethnicity as a grouping factor for this smaller population. Likewise, though our study was conducted over a two-year period, most of the data collection occurred in year 2; thus, it was not feasible to conduct a multi-year comparison in the current study. These issues could be addressed in future studies using multi-site (multiple ERP labs collecting individual data) and/or planned multi-year data collection approaches.

Participant attrition was also a limitation. Seventy participants (equal numbers of Hispanic/Latina and Non-Hispanic White women) originally enrolled in the study, however, final data analyses included only 40 participants (16 Hispanic/Latina and 24 Non-Hispanic White women). Despite our best efforts to retain participants, 20% of our original sample was lost to voluntary withdrawal from the study and/or withdrawal from the university all together between t1 and t2. The remaining students who were excluded from final analyses had participated in both testing session but were excluded for reasons related to the ERP technique, which prohibits inclusion of data from students who exhibited excessive drowsiness (reflected in alpha activity), skin potentials resulting from perspiration (a common problem in our geographical region), or other technical problems. In order to provide the most accurate data possible, we focused on participants with high quality data and at least 15 artifact-free trials per item category. Our analysis strategy resulted in a smaller, but more scientifically sound sample.

5. Conclusion

The results of the current study enhance our understanding of alcohol-related behaviors, expectancies, and physiological cue-reactivity over the course of the first year of college. Differences in alcohol use and P300 cue-reactivity between Hispanics/Latinas and Non-Hispanic White women were subtle and remained relatively stable over time, despite changes in alcohol expectancies and endorsement of values related to family versus social/personal connections. N200 cue-reactivity was most frequently related to positive alcohol expectancies. Additional research is needed to determine whether or not these patterns differ among males and for college groups that may be more likely to engage in alcohol use (e.g., athletes and/or sorority/fraternity members). Ultimately, a better understanding of the relationships between alcohol use, expectancies and attention to alcohol images may facilitate the development of gender- and culturally-sensitive attentional training programs [73] for the treatment and prevention of alcohol misuse on college campuses.

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Conflict of Interest

The authors have no conflicts of interest.

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