THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

DEPARTMENT OF BIOLOGY

THE ROLE OF RESPONSE INHIBITION AND IMPULSIVITY IN ALCOHOL CONSUMPTION IN YOUNG ADULTS

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ABSTRACT

Recent studies have investigated the interactions of various genetic and environmental factors that may influence the rate of alcohol consumption in young adults, particularly those entering college. Among other factors, impulsivity is emerging as not only a result of long-term alcohol abuse, but as a behavioral predictor of alcohol use in college. A study was conducted with 32 participants in the months prior to beginning college, and at two more time points continuing into the second collegiate year. A Stop-Signal Reaction Time task was used to measure response inhibition, and the Barratt Impulsiveness Scale (BIS) was used as a measure of impulsivity. Participants reported alcohol drinking frequency and consequences at each of the three time points, and were categorized into different trajectories according to changes in drinking frequency from high school to college. No significant effect of drinking was discovered on response inhibition measured by Stop-Signal Reaction Time using an ANOVA analysis \( F(2, 7) = 2.93, p = 0.12 \). A significant effect of drinking trajectory was observed on impulsivity measured by the BIS \( F(2, 29) = 4.52, p = .02 \). Overall, results suggest that participants who were already drinking prior to beginning college were significantly more impulsive than those who began drinking in college or did not drink at all. Response inhibition results showed no significant differences between trajectories. Further studies may focus on identifying risk factors such as impulsivity in participants younger than college-age to better understand individuals predisposed to alcohol use.
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Introduction

Alcohol use among college students has been a topic of controversy for many years, particularly in describing the pattern of heavy alcohol abuse seen among college-age adults. The NIH reports that about four out of five college students drink alcohol, and that about half of those are considered binge drinkers. Binge drinking is defined as consuming 4-5 or more drinks within a two-hour period (Center for Disease Control and Prevention [CDC], 2012). Drinking alcohol not only affects many students academically, but also puts them at higher risk for health problems and injury, among other problems. While drinking heavily is likely ingrained in college culture, it is possible that certain factors may be partially responsible for making some students more likely to engage in dangerous drinking than others (National Institutes of Health [NIH], 2013).

There has been considerable research describing risk factors that have been shown to affect the likelihood of problematic drinking in college students. These include family history of alcohol abuse, decreased perceived sensitivity to the effects of alcohol, and history of delinquent behavior. Interestingly, research also suggests that although friends and family strongly influence drinking prior to college, peers tend to have much stronger effects on drinking behavior once students begin college (Marlatt, G.A., Baer, J.S., Kivlahan, D.R., Dimett, L.A., Larimer, M.E., and Quigley, L.A., 1998). This is of concern to university administrators or parents actively attempting to prevent dangerous drinking behavior in students.

Impulsivity and Alcohol

While the above examples are certainly significant factors, the study presented here aims to find a link between behavioral tendencies and dangerous drinking. One behavioral factor is described here as impulsivity. Impulsivity is the lack of self-control or deficiency in response
inhibition leading to unplanned behavior. Response inhibition may be further defined as the cognitive ability that allows dynamic change based on advanced information or feedback received once a previous cognitive process has already begun (Chiang-Shay et al., 2009). In other words, when a cognitive process has begun, response inhibition allows the initial process to be stopped and replaced with a new process. Another aspect of impulsivity is the concept of impulsive choice. Impulsive choice implies a lack of foresight in decision-making, and the preference for instant gratification rather than delayed gratification. Thus, impulsivity encompasses not only a lack of control over cognitive processes, but also a lack of foresight into the detrimental long-term effects of certain decisions or behaviors (Perry and Carroll, 2008).

While impulsivity can be developed before any introduction to alcohol, the reverse has been shown to occur in chronic abusers of alcohol. According to Verbuggen and Logan (2008), poor inhibitory control is characteristic of substance abuse disorders. Alcohol dependent subjects tend to perform poorly on tasks requiring motor response inhibition compared to control subjects (Verbuggen and Logan 2008; Irimia et al. 2013). Interestingly, a study by Chiang-Shay et al. (2009) showed slower reaction times and greater attention activity in alcohol dependent participants. This indicates that alcohol dependent participants took a relatively conservative approach to the task compared to control participants. Despite these apparently conflicting results, research suggests that alteration in cognitive control, specifically inhibition control, may be related to chronic alcohol use.

Arguably more relevant to the purpose of this research is the influence of impulsivity on initiation of alcohol use in adolescents. According to Nigg et al. (2006), response inhibition in adolescents predicts the onset of alcohol use-related problems independent of familial risks. The study concluded that impulsivity is an important factor that has an additive influence towards risk of alcohol use. This impulsivity predisposition may lead to earlier recreational experience and may even mediate transition from recreational use to dependence (Verdejo-Garcia et al. 2008).
Further support for this relationship has been discovered in studies involving non-human subjects. A study by Constantine et al. (1995) investigated alcohol intake among rodents demonstrating low, medium, and high impulsivity behaviors. Self-administered alcohol intake was positively correlated with impulsivity, indicating that the rodents with impulsive characteristics were predisposed towards increased alcohol intake and more rapid acquisition of self-administration.

**Measuring impulsivity: Stop-Signal Reaction Time Task**

With evidence indicating that impulsivity plays a clear role in tendency towards alcohol consumption, several tasks have been developed with the purpose of defining impulsivity in a measurable way. The Stop-Signal Reaction Time task is an adaptation of the Go/No Go task where participants either respond as quickly as possible by button press to a visual “Go” stimulus, or withhold a response to a visual “No Go” stimulus (Perry and Carroll, 2008). Similarly, the Stop-Signal Reaction Time task presents a “Go” stimulus and requires participants to respond as quickly as possible. However, certain trials present a “Go” stimulus, quickly followed by a “Stop” stimulus, and require the individual to withhold a response despite having begun the process of responding to the primary task (responding to the “Go” stimulus). Each trial is preceded and followed by a 500 ms and 2000ms fixation point. Figure 1 provides a visual of a stop trial when a stop stimulus has been presented after a delay following the go stimulus.

![Stop trial Stimuli: Go Signal (white arrow) followed by Stop Signal (red circle)](image)
The potential response types from participants are displayed in Table 1. During Go trials, a participant may either correctly respond by button press (hits), or may fail to respond or respond in the wrong direction (misses). During a Stop trial, a participant may either correctly withhold a response (correct rejections), or may fail to inhibit the response (false alarms).

Table 1. Response Options during Go and Stop Trials.

<table>
<thead>
<tr>
<th></th>
<th>Correct Response</th>
<th>Incorrect Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Go Trial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hits</td>
<td></td>
<td>Misses</td>
</tr>
<tr>
<td>Stop Trial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correct Rejections</td>
<td></td>
<td>False Alarms</td>
</tr>
</tbody>
</table>

Along with the development of the Stop-Signal task, various theories and models have arisen to explain the underlying cognitive processes required to complete it, and particularly, to explain how the task reflects on impulsivity. The most recent and well-supported model was developed by Logan and Cowan (1984). Unlike previous models, this model assumes no interference between the processes responding to the primary stimulus and those responding to the stop signal. In fact, the task behavior is modeled essentially as a race between these two sets of processes. According to the race theory, a response is inhibited when the processes responding to the stop signal finish before the processes responding to the go signal. Likewise, the response is not inhibited if the processes responding to the go signal finish before those responding to the stop signal. By this model, individuals with better response inhibition would have faster stop processes.

By defining the mechanism behind inhibition in this way, it is important to recognize that inhibition is being measured as a probability. Figure 2 provides a diagram of the Stop-Signal task as defined by the race model.
This visual representation essentially overlaps a stop trial with the distribution of responses from go trials. By doing so, the distribution of response times to the go trials (labeled here as “Distribution of Primary-Task RT) can be compared against a typical stop trial response speed. The probability of inhibition is reflected as the space under the curve to the right of the internal response to the stop signal. Across multiple trials, the Stop Signal Delay (SSD), or the time between presentation of the stop and go stimuli, can be increased to increase the difficulty of the task. This alteration can therefore elicit a pre-determined percentage of inhibition. This alteration allows the stop signal reaction time (SSRT) to be inferred after maintaining a constant probability of inhibition for each individual. The SSRT is in fact the measurement of interest by this model, as it reflects the speed of the stop processes, therefore informing on response inhibition and ultimately, impulsivity.

This research focuses on the effect of impulsivity on drinking behavior in college students. Few studies have looked uniquely at impulsivity as a risk factor for alcohol use in young adults entering the first year of college. If a relationship is found, a method of identifying individuals at risk may be developed to create a plan for preventative action. In the present study, a group of thirty-two participants was followed from the summer before starting college to two time points extending into the second year. Two measures were used to approximate impulsivity: 1) the Stop-Signal Reaction Time task and 2) the Barratt Impulsiveness Scale. It was
hypothesized that response inhibition and impulsivity, as measured by the stop-signal reaction time (SSRT) and the Barratt Impulsiveness Scale (BIS), would be significantly greater in participants who increased or maintained alcohol consumption after the first year of college compared to those who maintained little exposure to alcohol.
Methods

Participants

This study involved 32 participants who were recruited during the summer before college entrance. Due to an unexpected error in signal collection during the Stop-Signal task, the original 31 participants were divided into separate groups for analysis based on the sets of data available for each participant. The division of the participants is presented in Table 2. In addition, one participant was excluded from the full group due to missing Stop-Signal task data; however, the participant was included in Barratt Impulsiveness Scale analyses.

Table 2. Group Totals

<table>
<thead>
<tr>
<th>Group Name</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group A</strong></td>
<td>10</td>
</tr>
<tr>
<td><strong>Group B</strong></td>
<td>21*</td>
</tr>
<tr>
<td><strong>Group C (Full Group)</strong></td>
<td>31</td>
</tr>
</tbody>
</table>

*Participant 12 excluded

The primary group used for the estimation of the stop-signal reaction time (SSRT) is Group A. Group A consists of participants with full data sets that were not affected by the error in data collection. Group B consists of participants with incomplete but supplementary data sets that were not used in the estimation of the SSRT, but were combined with Group A to form the Full Group, or Group C.
**Measures**

*Alcohol Questionnaires and Trajectory Determination*

Alcohol use was determined by a combination of alcohol questionnaires completed by each participant. Two measures were used to assign “risk scores” to each participant: frequency and consequences of drunkenness. Frequency of drunkenness was reported by the participant by providing the following information (Di meff, L.A., Baer, J.S., Kivlahan, D.R., and Marlatt, G.A., 1999):

“During the past **30 days (about 1 month)**, how many times have you gotten drunk or very high from alcohol? (Please give your best estimate)”

<table>
<thead>
<tr>
<th>Code</th>
<th>Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Never</td>
</tr>
<tr>
<td>1</td>
<td>1 to 2 times</td>
</tr>
<tr>
<td>2</td>
<td>3 to 4 times</td>
</tr>
<tr>
<td>3</td>
<td>5 to 6 times</td>
</tr>
<tr>
<td>4</td>
<td>7 to 8 times</td>
</tr>
<tr>
<td>5</td>
<td>9 or more times</td>
</tr>
</tbody>
</table>

Consequences of alcohol use and drunkenness were assessed using the Young Adult Alcohol Problem Screening Test (YAAPST) (Hurlbut, S.C., and Sher, K.L., 1992). The YAAPST lists a series of 33 experiences to which the participant responds by indicating how many times each experience has occurred in the past year, and a score is obtained by simply adding the number of items experienced. An example of a question from the assessment is listed below:

“Given the list of experiences below, **please indicate the number of times you have had each experience DURING THE PAST YEAR** by clicking on the corresponding button.”

<table>
<thead>
<tr>
<th>Code</th>
<th>Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No, never</td>
</tr>
<tr>
<td>1</td>
<td>Yes, but not in the past year</td>
</tr>
<tr>
<td>2</td>
<td>1x in the past year</td>
</tr>
<tr>
<td>3</td>
<td>2x in the past year</td>
</tr>
<tr>
<td>4</td>
<td>3x or more in the past year</td>
</tr>
</tbody>
</table>
(1) Have you driven a car when you knew you had too much to drink to drive safely?
(2) Have you had a headache (hangover) the morning after you had been drinking?
(3) Have you shown up late for work or school because of drinking, a hangover, or an illness caused by drinking?

After completion of the questionnaires, the participant answers were combined to create a “risk score”. A risk score was determined at each of three designated time points when the questionnaires were distributed to the participants. At a certain time point, if the participant scored a “5” or less on the YAAPST and a “1” or less on the frequency test, he or she was given a risk score of “0”. If at a certain time point, the participant scored greater than “5” on the YAAPST and more than “1” on the frequency test, he or she was given a risk score of “1”. If the participant was above the cutoff for either measure, he or she was given a risk score of “1”.

The risk scores were collected at the three time points yielding a total of three scores for each participant. If the risk score started at 0 and did not change during college, the participant was placed in the category “Low-Low”. If the risk score changed from 0 before college to 1 after beginning college, the participant was considered “Low-High”. Finally, if the risk score was a 1 before college and did not change, the participant was labeled “High-High”. The total number of participants in each category, referred to here as “trajectory”, is listed below:

<table>
<thead>
<tr>
<th>Group</th>
<th>Trajectory</th>
<th>Participants</th>
<th>Group</th>
<th>Trajectory</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Low-Low</td>
<td>2</td>
<td>C</td>
<td>Low-Low</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Low-High</td>
<td>3</td>
<td>(Total)</td>
<td>Low-High</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>High-High</td>
<td>5</td>
<td>High-High</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Low-Low</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low-High</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High-High</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Barratt Impulsiveness Scale

The Barratt Impulsiveness Scale is a common method of acquiring a measurement of impulsivity by individual questionnaire. The most recently updated version is the BIS-11 which consists of 30 items. These items are scored on a 4-point scale and the points are combined to create a composite score that increases with increasing impulsiveness. The items containing an asterisk are reverse scored. The BIS-11 further divides the items into three sub-sections of impulsivity: non-planning impulsiveness, cognitive/attentional impulsiveness, and motor impulsiveness (Patton, Stanford & Barratt, 1995). Cognitive/attentional impulsivity is a lack of cognitive persistence or the inability to tolerate cognitive complexity. Non-planning impulsivity is the lack of sense of the future, and motor impulsivity is the tendency to act spur of the moment (Jakuszkowiak et al., 2012). The BIS-11A was used in the present study and excludes six items from the original BIS-11, leaving 24 items. Thus, the scores from the BIS-11A were converted by the suggested method in order to be compared to normative scores. An example question on the BIS-11A is included (InSRI):

<table>
<thead>
<tr>
<th>Score</th>
<th>Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rarely/Never</td>
</tr>
<tr>
<td>2</td>
<td>Occasionally</td>
</tr>
<tr>
<td>3</td>
<td>Often</td>
</tr>
<tr>
<td>4</td>
<td>Almost always/always</td>
</tr>
</tbody>
</table>

(1) I plan tasks carefully. *

(2) I buy things on impulse.

(3) I am restless at talks or lectures.

Stop-Signal Reaction Time Task

The Stop-Signal Reaction Time task was used to measure motor and decision-making impulsivity. The most important measure from this task was the stop-signal reaction time, or the
SSRT. Because the SSRT reflects the speed of the processes required to stop a response, this value can be interpreted as a measure of impulsivity (greater impulsivity equates to a slower SSRT). The SSRT is not directly observable and instead was inferred by obtaining direct measurements of other reaction times.

By referring to Figure 2, the SSRT can be inferred by the following equation:

\[
SSRT = \text{Mean Go Reaction Time} - \text{Stop Signal Delay}
\]

This equation allows for the estimation of the length of the stop process, measured from the point of the stop signal presentation. Other measures obtained from the Stop-Signal task include the speed of the Go trial response (Go Reaction Time), the speed of accidental responses during Stop trials measured from the appearance of the stop signal (False Alarm Reaction Time), and the total number of correct rejections, hits, misses, and false alarms.

Procedure

Participants completed three total sessions for data collection. The first session involved completion of questionnaires and the Stop-Signal task. All participants were prepared to complete the Stop-Signal task in an MRI scanner. The participants were briefed on the Stop-Signal task, and were instructed to respond with the same-side hand as the direction of the arrow; for example, they were instructed to respond with the right hand when presented with a right-pointing arrow. The task was divided into five “runs” or blocks, with 365 trials total. The time frame for each Go and Stop trial is illustrated in Figure 3:
During a Go trial, a cross fixation point was displayed for 500ms, followed by the appearance of a right or left-pointing arrow. The arrow was displayed for 1500ms during which the participant was expected to respond. This period was followed by a 2000ms fixation point display. During a Stop trial, a cross fixation point was also displayed for 500ms, followed by the appearance of a right or left-pointing arrow. The arrow was displayed followed by the appearance of a red circle for a total of 1500ms. The time before the appearance of the red circle was modulated to elicit a 66% correct rate of inhibition; however, the total time of the appearance of the arrow and red circle was fixed at 1500ms. The trial was completed with a 2000ms fixation point display.

After the task was completed in the scanner, participants were instructed to complete several questionnaires on a computer, including the Barratt Impulsiveness Scale and alcohol consequence and frequency questions.

For the last two sessions, the participants completed the same alcohol consequence and frequency questionnaires as a method of measuring the change in alcohol consumption over time. The first session was completed as a baseline measure before college entrance (T1). The last two sessions were completed during the winter of freshman year (T3), and in the fall of sophomore year (T5).
Results

Barratt Impulsiveness Scale

The BIS means were compared across all 31 participants. The average score for all participants was 63.40, with a standard deviation of 11.41. The trajectory means for Low-Low (LL), Low-High (LH), and High-High (HH) participants were as follows: 58, 59, and 71.15, respectively.

A one-way ANOVA was performed on the BIS data comparing the significance of the means of the three trajectories. There was a significant effect of drinking trajectory on the BIS scores at the $p<0.05$ level for the three conditions [$F(2, 29)=5.82, p = 0.008$]. Post-hoc comparisons using the Tukey HSD test indicated that the mean BIS scores for LL participants (M=58.0, SD=6.77) and LH participants (M=59.0, SD=8.75) were not significantly different, from each other, but both were significantly lower than those of HH participants (M=71.146, SD=12.16).

The BIS scores were further divided by question type, depending on whether the question probed non-planning, cognitive/attentional, or motor impulsivity. A one-way ANOVA was performed on the BIS non-planning impulsivity data comparing the significance of the means of the three trajectories. There was a significant effect of drinking trajectory on the non-planning scores at the $p<0.05$ level for the three conditions [$F(2, 29)=5.37, p=0.01$]. Post-hoc comparisons using the Tukey HSD test indicated that the mean non-planning scores for LH participants (M=19.87, SD=3.99) were significantly lower than those of HH participants (M=26.13, SD=6.33). However, LL participant means (M=20.46, SD=4.83) were not significantly different from either LH or HH scores.
A one-way ANOVA was performed on the BIS motor impulsivity data comparing the significance of the means of the three trajectories. There was a significant effect of drinking trajectory on the motor scores at the $p<0.05$ level for the three conditions [$F(2, 29)=4.52, \ p=0.02$].

Post-hoc comparisons using the Tukey HSD test indicated that the mean motor scores for HH participants ($M=25.87, \ SD=5.85$) were significantly higher than those of LH participants ($M=21.59, \ SD=3.83$) and LL participants ($M=19.80, \ SD=2.20$). However, LL participant scores were not significantly different from LH scores. Finally, a one-way ANOVA was performed on the BIS cognitive/attentional scores and did not yield a significant difference between trajectory means [$F(2, 29) = 0.199, \ p=0.82$]. Table 5 summarizes the descriptive statistics and significant interactions from the BIS scores.

Table 4. Barratt Impulsiveness Scale Results.

<table>
<thead>
<tr>
<th>Trajectory</th>
<th>BIS Total</th>
<th>Non-planning</th>
<th>Cognitive/Attentional</th>
<th>Motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-Low</td>
<td>58.0$^A$</td>
<td>20.46$^{AB}$</td>
<td>18.56$^A$</td>
<td>19.8$^A$</td>
</tr>
<tr>
<td>Low-High</td>
<td>59.0$^A$</td>
<td>19.87$^A$</td>
<td>18.35$^A$</td>
<td>21.59$^A$</td>
</tr>
<tr>
<td>High-High</td>
<td>71.15$^B$</td>
<td>26.13$^B$</td>
<td>19.2$^A$</td>
<td>25.87$^B$</td>
</tr>
</tbody>
</table>

*Matching letters indicate no statistical significance.

Stop-Signal Reaction Time Task

The total group of participants, Group C, was divided into a primary group (Group A) and a supplementary group (Group B) due to a large portion of incomplete data sets in Group B participants. Table 5 contains a summary of measures collected from the Stop-Signal Reaction Time Task that could be compared across these three groups.
Table 5. Descriptive Comparison of Group A, Group B, and Group C.

<table>
<thead>
<tr>
<th>Group ↓</th>
<th>% Hits</th>
<th>% Misses</th>
<th>% Correct Rejections</th>
<th>% False Alarms</th>
<th>% CR in Stop Trials</th>
<th>% FA in Stop Trials</th>
<th>False Alarm RT (ms)</th>
<th>Hits RT (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>--</td>
<td>--</td>
<td>14.78</td>
<td>7.02</td>
<td>67.81</td>
<td>32.19</td>
<td>129.31</td>
<td>--</td>
</tr>
<tr>
<td>Group A</td>
<td>73.54</td>
<td>4.67</td>
<td>15.24</td>
<td>6.56</td>
<td>78.75</td>
<td>21.25</td>
<td>120.69</td>
<td>795.04</td>
</tr>
<tr>
<td>Group B</td>
<td>--</td>
<td>--</td>
<td>14.58</td>
<td>7.23</td>
<td>66.85</td>
<td>33.15</td>
<td>133.42</td>
<td>--</td>
</tr>
</tbody>
</table>

Table 5 shows several measures obtained from the Stop-Signal task that could be compared across groups as a consistency check. As expected, the participants in Group A and Group B inhibited their responses to the primary task (%Correct Rejections) approximately 78.75% and 66.85%, respectively. The Group C total inhibition was 67.81%, indicating that regulation of correct inhibition at 66% was effective. False alarm reaction times were also consistent, although the reaction times for Group A (M=120.69ms) were slightly faster than those of Group B (M=133.42ms).

*Stop-Signal Task: Group A*

The average Go Reaction Time for Group A was 795.04 ms. The SSRT was calculated for each individual from the SSRT equation using the Stop-Signal Delay and the Go Reaction Time. Table 6 contains a summary of these results by individual participant.
<table>
<thead>
<tr>
<th>Participant</th>
<th>Trajectory</th>
<th>Go RT (ms)</th>
<th>False Alarm RT (ms)</th>
<th>Stop Signal Delay (ms)</th>
<th>SSRT (ms)</th>
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<td>795.04</td>
<td>120.69</td>
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</table>

A one-way ANOVA was performed on the calculated Stop-Signal Reaction Times for each trajectory group. There was no significant effect of drinking trajectory on Stop-Signal task performance as measured by the SSRT at the $p<.05$ level for the three conditions [$F(2,7) = 2.93$, $p = 0.12$]. A one-way ANOVA was also performed on the False Alarm reaction times for each trajectory. Again, no significant effect of trajectory was found on False Alarm reaction times at the $p<.05$ level [$F(2,7) = 3.95$, $p = 0.07$]. Figure 4 illustrates the mean SSRT and mean False Alarm reaction time for each trajectory.
To compare Go reaction times across trajectory, a one-way ANOVA was performed. This yielded no significant effect of drinking trajectory on Go reaction times at the $p<0.05$ level [$F(2,7)=0.45, p=0.65$]. Figure 5 illustrates the mean Go reaction time for each trajectory.
While the means are not significantly different, a trend of decreasing Go reaction time does exist. The Go reaction time means were 842.12 ms, 825.27 ms, and 758.06 ms for the Low-Low-, Low-High, and High-High trajectories, respectively.

Stop-Signal Task: Group A and Group B Comparisons

Group B was analyzed as a comparison group for False Alarm reaction times and probability of inhibition. Therefore, a one-way ANOVA was performed on the False Alarm Reaction Times for trajectory LL (M=147.85, SD=19.41), LH (M=131.13, SD=27.04), and HH (M=130.83, SD=15.02) in Group B. There was no significant effect of drinking trajectory on false alarm reaction times at the \(p<0.05\) level for the three conditions \([F(2,18) = 0.697, p=0.51]\).

A one-way ANOVA was performed on the False Alarm reaction time means for Groups A(M=120.69) and B(M=133.42). No significant difference was discovered between Group A and Group B reaction time means at the \(p<0.05\) level \([F(1, 29)= 1.93, p=0.18]\). These results are depicted in Figure 6.
False Alarm reaction time results were analyzed by run to determine whether any effects related to the fatigue or familiarity with the task exist. A one-way ANOVA was performed on the False Alarm reaction time to determine effects by run. There was a significant effect of Run on the false alarm reaction times at the $p<0.05$ level for the three conditions [$F(4, 150)=6.23$, $p=0.000115$].

Post-hoc comparisons using the Tukey HSD test indicated that the mean false alarm reaction times during Run 1 ($M=160.73$, $SD=47.03$) was significantly different than that of Run 2 ($M=126.78$, $SD=38.97$), Run 3 ($M=113.39$, $SD=40.03$), Run 4 ($M=127.95$, $SD=36.88$), and Run 5 ($M=117.71$, $SD=42.08$). However, the false alarm reaction times for Runs 2 through 5 did not significantly differ between each other.

Follow-up analyses were performed to determine if certain drinking trajectories affected the findings of run effects. False Alarm reaction times were divided by trajectory, and a one-way ANOVA was performed for each trajectory to determine the effect of run. There was a significant effect of run on the False Alarm reaction times of HH participants at the $p<.05$ level for the three conditions.
conditions \[ F(4, 55)=7.34, p=0.000 \]. Post-hoc comparisons using the Tukey HSD test indicated that the mean false alarm reaction times during Run 1 (M=180.85, SD=32.44) were significantly different than that of Run 2 (M=113.08, SD=36.41), Run 3 (M=103.87, SD=32.89), Run 4 (M=131.62, SD=36.53), and Run 5 (M=129.09, SD=49.46). However, the false alarm reaction times for Runs 2 through 5 did not significantly differ between each other.

A one-way ANOVA was performed on the False Alarm reaction time data for LH participants by run. There was a significant effect of the False Alarm reaction times of LH participants at the \( p<0.05 \) level \[ F(4,65)= 2.92, p=.03 \]. Post-hoc comparisons using the Tukey HSD test indicated that the mean False Alarm reaction times during Run 1 (M=158.25, SD=40.64) were significantly greater than those of Run 2 (M=135.49, SD=43.15), Run 3 (M=116.86, SD=43.15), Run 4 (M=125.89, SD=40.54), and Run 5(M=111.77, SD=40.83).

Finally, a one-way ANOVA was performed on the False Alarm reaction time data for LL participants by run. There was no significant effect of LH trajectory by run at the \( p<.05 \) level \[ F(4,20)= .21, p=0.93 \]. Results for each drinking trajectory by run are displayed in Figure 7.

![Figure 7. False Alarm Reaction Time by Run: Trajectories LL, LH, and HH](image-url)
Discussion

This study evaluated whether impulsivity is a risk factor for alcohol use in college students. Impulsivity, as measured by the Barratt Impulsiveness Scale and the Stop-Signal Reaction Time task, produced inconclusive yet consequential results. The mean total scores on the BIS were consistent with those reported in other studies with undergraduate students. A study by Patton et al. (1995) reported a mean BIS score for undergraduate students (M=63.82) and for substance abuse patients (M=69.78). The mean score for the sample in this study was 63.4; however, the High-High trajectory participants had a mean score of 71.15, which was much closer to the mean score for substance abuse patients. In fact, the Barratt Impulsiveness Scale scores indicated that participants in the High-High drinking trajectory scored significantly higher than those in the Low-Low and Low-High trajectories. This indicates that the participants that are most impulsive are those who were already drinking alcohol with significant consequences and frequency before college. The study further divided the BIS into question categories, including “non-planning” impulsivity, “cognitive/attentional”, and “motor” impulsivity. While the cognitive/attentional questions were not significantly different in any of the three trajectories, motor and non-planning impulsivity were, indicating that motor and non-planning behaviors may be of interest to target in identification or prevention of substance abuse. The suggestion from these results is that impulsivity is a behavioral trait existing in participants prior to entrance to college, and may be driving certain individuals to drink alcohol at an earlier age than expected. The goal then would be to identify the age at which these individuals are being exposed to alcohol, and to determine whether this impulsivity is a cause or effect of alcohol use.

Although the Stop-Signal Reaction Time task produced conflicting results, several important trends may be observed. First, the task appears to have controlled for probability of
inhibition at 66%, with a group mean of 67.81%. This assures that the relative difficulty of the task for each individual was maintained at a constant level. For Group A, the SSRT’s were not significantly different between drinking trajectories. However, a general trend of increasing SSRT was observed by drinking trajectory from Low-Low, Low-High, and High-High, respectively. It is likely that the small number of participants in Group A (N=10) was responsible for the lack of conclusive information on the SSRT results, and a larger sample may have yielded different results. The SSRT has been a consistent indicator of impulsivity as it measures the speed of the stop process and the ability to inhibit a primary response. Because of this, it would be important to explore the variation of SSRT’s in a larger sample in the future.

The differences in False Alarm reaction times also did not reach statistical significance, although these data showed a general trend of increasing False Alarm reaction time as a function of drinking trajectory. False Alarm reaction time is sometimes considered an indication of cognitive control, and a longer reaction time may suggest poor cognitive control in general. This is consistent with findings from Chiang-Shay et al. (2009) which suggested that alcohol-dependent participants produced slower reaction times and showed greater attention during decision-making. This may indicate that these participants are sacrificing speed for accuracy. Because the task was modulated to have equal accuracy among participants, this suggests that the High-High participants have poor cognitive control compared to Low-High participants, which in turn have poor cognitive control compared to Low-Low participants. This trend, although not significant, may support the hypothesis that an altered cognitive control exists among those with different drinking trajectories. In particular, those who were drinking before college had poor control compared to those who began drinking in college, supporting further investigation into introduction to alcohol at earlier ages.

False Alarm reaction times were also analyzed by run, and reaction times were significantly faster for the first run compared to the following four for the Low-High and High-
High trajectories. This again may imply greater attention at the expense of speed during the task, but with significant attention during the first run. This difference in False Alarm reaction times does not imply an increase in impulsivity as the hypothesis predicts; however, this increase in attention appears to lead to slower processing and decision-making in these participants.

This study was limited in several areas. Firstly, the data was limited to ten participants in Group A due to a technical software error in response encoding. Because of this, comparisons of SSRT’s were not as comprehensive as anticipated. In addition, the Barratt Impulsiveness Scale used in this study was an inconsistently used version of the test, and the scores were altered by the process of converting to the updated BIS-11. However, the difference between forms is not significant, and the results of the study are still applicable. Finally, the relatively small number of participants in the Low-Low category (N=5) may have affected the strength of analyses.

The results of this study indicate that an altered cognitive control does exist in participants who drank before college as well as those who began drinking in college in comparison to participants who did not drink significantly at all. From the Stop-Signal Reaction Time task results, it is unclear whether this alteration is an effect of drinking or a predisposition that increases the likelihood of drinking alcohol. However, the BIS results clearly indicate greater impulsivity in participants who were already drinking before entrance to college. Suggestions for future studies may include assessing various behavioral dimensions besides impulsivity as predictors of alcohol use. This study suggested an altered cognitive control in certain participants. Therefore, a task that measures factors of cognitive control may target the cognitive aspects affecting alcohol use. In addition, future studies may focus on identifying these differences at a younger age. If highly impulsive individuals are already drinking alcohol at dangerous levels before college, it would be important to identify the time at first exposure and assess behavioral traits at that point. Without doing so, it is unclear whether increased impulsivity was caused by alcohol use, or whether it existed in the individual beforehand. Finally, a more specific evaluation
of alcohol intake and indicators of alcoholism may provide more information on the role of impulsivity. Research has shown that at least 80% of college students drink alcohol, and drinking alcohol has become part of college culture. Therefore, simply increasing alcohol intake in college may not be an effective indicator of which individuals will develop dangerous long-term drinking habits. With these modifications, it may be possible to hone in on the specific factors leading to long-term alcohol abuse in order to identify those at risk and take preventative action.
Appendix A

Factors Associated with Neurocognitive Processing in College Students: Procedure Manual

STOP-SIGNAL TASK

During each set of stop-signal tasks you will see a card with an arrow, pointing to the left or right. Your task is to respond with the same-side hand as the direction the arrow is pointing: for example, if the arrow is pointing left, you should respond with your left hand. You respond by pulling the index finger trigger of the ring (below). Sometimes, a red circle will surround the arrow after it appears; when this happens, don’t respond by pulling the trigger. Please try to respond as quickly and accurately as possible. Throughout the entire scanning period, please remember to remain awake and alert and try to remain as still as possible.

For this task, you will respond using only the index-finger button on the ring (left) in the scanner. You will have a ring in both your right hand and your left hand. Pull the trigger when the arrow on the screen is pointing in the direction of that hand – but only when no red circle appears around the arrow.

Figure 8. Stop-Signal Task Instructions
Informed Consent Form for Biomedical Research
The Pennsylvania State University

Title of Project: Factors Associated with Neurocognitive Processing in College Students

Principal Investigator: Sheri A. Bearnbaum, Ph.D
519 Moore Building, University Park, PA 16802
Sab31@psu.edu; 814-865-6140

Other Investigator(s): Rick Gilmore, Anna Engels, Susan Lemieux, Elizabeth Susman, Steve Wilson, David Vandenbergh, Jenae Neiderhiser, Peter Molenaar, Christopher Petersen, Hobart Cleveland, Robert Turrisi

1. Purpose of the study:

Thank you for your participation in the research project, “Parent-based Intervention to Prevent Student Drinking (Project ACT)”, IRB#35141. You are invited to participate in an additional research project. Should you choose not to participate in this additional research project, you may still continue to participate in the original study.

The purpose of this research project is to use magnetic resonance imaging (MRI) to study brain anatomy and function in young adults. In particular, we are interested in how brain structure and brain function relate to certain behaviors, including the use of alcohol. Because the results of the study could be affected if the full purpose is known prior to your participation, the purpose of the study cannot be explained to you at this time. You will have an opportunity to receive a complete explanation of purpose following completion of the study.

This project will also collect buccal cell samples for exploratory analyses of genes (DNA) that might play a role in substance use or in modifying the effectiveness of interventions.

NONE of the procedures done during this study are designed to detect or evaluate any medical condition you may have. They are intended solely for research purposes.

2. Procedures to be followed:

If you agree to participate in the study, two types of MRI scans may be taken. Anatomy scans are used to determine the structure of the brain. Scans of brain function are used to determine areas of activity when you perform different tasks. To date, 150 million MRI studies have been performed around the world. We will be following standard MRI procedures and safety guidelines. MRI has been shown to be extremely safe as long as proper safety precautions are taken. MRI uses strong magnetic fields and radio waves to make pictures of the body. There is no exposure to x-rays or radioactivity during an MRI scan. Levels of energy used are within FDA safety limits. This study will use a 3.0 Tesla MRI scanner.

You will be asked to leave metal objects and personal belongings in lockers provided in the prep room of the MRI center. You will also be asked to remove any articles of clothing with metal inserts or clasps before entering the MRI room. Please ask the experimenter if you are unsure about any items.

Next, we will ask you to complete a set of simple vision screening tests in which we ask you to tell us what you see or do not see. We may use these results to fit you with special glasses that are safe to use in the scanner. The glasses will partially correct your vision so that you can see things we will show you once you are in the scanner. If you wear contacts or have normal vision, you will not need to wear the glasses.

Page 1 of 6. Participant Initials __________________

Figure 9. Informed Consent 1
You will be asked to lie on a bed that slides into the long tube of the scanner. You will be given earphones and/or earplugs for hearing protection since the MRI scanner makes loud noises during normal operation. You may be asked to attach sensors to your chest or clip a device to your finger that will allow us to record your heart rate. We may also put a strap on your abdomen that will record your breathing rate. You will be asked to remain very still at these times. For scans of the head, we may put cushions around your head and we may lightly tape your head to keep it from moving.

You will then be asked to watch the images we present. You may be asked to answer questions about the images, such as whether the images are changing, or whether one image is different from one you saw previously. You may also be asked to respond to one type of image but not another. To answer these questions, you will press buttons on a hand-held controller like one used in playing video games.

You will be able to talk to the MRI technologist by an intercom, and he/she will be able to see you and hear you at all times. You will also be given a squeeze-ball signaling device. If at any time you would like to discontinue the study, you can tell the investigators over the intercom or press the squeeze-ball signaling device and you will be removed immediately from the scanner. You can discontinue the study at any time without penalty. You will spend up to 1.5 hours in the MRI scanner.

After you finish the MRI part of the experiment, you will be asked to complete a computerized working memory task in which you will solve some math problems and remember words. Then, you will perform a choice task during which you will try to inflate balloons on a computer screen in order to earn points. You will either perform this task alone or along with another student who is participating in this study. You will be asked to complete questionnaires that will be administered over the internet using software called SurveyMonkey on a computer in the testing room. The questionnaires include questions about what types of situations you prefer, information about your physical development during puberty, your personality, your mood, and your alcohol use. Last, we will collect buccal cell samples using the following procedure. First, you will be asked to rinse your mouth out with water. After waiting for at least one minute, you will be asked to rub cotton swabs against your cheeks and then to place them in a vial. The vial is then placed into a leak-proof plastic bag. All samples will be marked only with a bar code (linked to a unique code) and date of data collection. The tasks, questionnaires, and buccal cell sample will take approximately 45 minutes to complete.

Finally, you will be debriefed and given an opportunity to ask questions about the study. Altogether, the experiment will take approximately between 2½-3 hours to complete.

After you complete the study, we will examine patterns of brain activity that occurred while you were looking at the images. We will also examine patterns of brain structure, as well as conduct exploratory analyses of genes.

We will combine your data with that from survey responses collected as part of your participation in the research project "Parent Based Interventions to Prevent Student Drinking (Project ACT),” IRB # 355141. By combining the data sets, we will analyze whether different patterns of use and attitudes toward alcohol relate to brain structure or function.

3. Discomforts and risks:

Risk of injury is very low during an MRI scan. However, MRI is not safe for everyone. It may not be safe for you to have an MRI scan if you have any metal containing iron in or on your body. This is because metal containing iron can pose a safety risk when in the presence of strong magnetic fields. Radio waves may also heat the body and metallic objects within or on the body, possibly resulting in burns. Before you are allowed in the scanner room, you will be asked a set of questions to determine if it is safe for you to have an MRI scan at this time. For example, it may not be safe to have an MRI scan if you have a cardiac pacemaker, aneurysm

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Figure 10. Informed Consent 2
clips, an intrauterine device (IUD), etc. For your safety, it is very important that you answer all questions truthfully.

It is possible that you may feel uncomfortable or confined once inside the scanner. This feeling usually passes within a few minutes as the experimenters talk with you and the study begins. You might experience slight dizziness, mild nausea, or tiny flashing lights in your field of vision. These sensations are mostly due to movement while inside the magnet and can be minimized by holding still. All of these sensations should stop shortly after you leave the magnet.

There are no known risks apart from those described above. However, there is always the possibility that there are unknown risks associated with this procedure. Because MRI has not been proven to be safe during pregnancy, it is important that a baby developing in the uterus not be exposed to any unnecessary risks. Therefore, in order to participate in this study, you must not be pregnant at the time of your scan.

Some people may feel uncomfortable about providing a sample of their DNA. We will not share this information with anyone, and it will be used only for research purposes. In addition, we will provide no feedback to the participant or to anyone outside of the research team about the genetic tests.

There is some risk due to combining your data with that from survey responses collected as part of your participation in the research project "Parent Based Interventions to Prevent Student Drinking (Project ACT)," IRB # 33141. Some of the survey questions ask about potentially illegal behavior, such as drinking under the legal drinking age. This information could potentially be a risk to you if it became known and could be linked to your identity.

4. Benefits:

The benefits to society include a better knowledge about how the brain develops in early adulthood and whether alcohol use influences it.

5. Duration/time of the procedures and study:

A number of MRI scans will be performed with the entire procedure lasting up to 90 minutes. You may be asked to lie still for up to 90 minutes at a time.

After you finish the MRI part of the experiment, you will be asked to complete a memory task, choice task, complete two questionnaires, and to provide a buccal cell sample (DNA). These tasks will take approximately 45 to an hour minutes to complete.

Altogether, the experiment will take approximately 2 1/2 - 3 hours to complete which includes time for consent forms, scanner preparation, and debriefing.

6. Statement of confidentiality:

Your participation in this research is confidential. All possible steps have been taken to assure your privacy. For the MRI and all other data, you will be assigned a code number that will be used throughout the scan. Only this code (and never your name) will be used when analyzing or reporting the data. Any identifying information will be kept in a locked location and password protected electronic files. The information you provide in the questionnaires completed on the Internet will be kept confidential to the degree permitted by the technology used. All possible steps have been taken to assure your privacy, but no guarantees can be made regarding the interception of data sent via the Internet by any third parties.

Your DNA samples will be used during the course of this study and then stored at The Pennsylvania State University. As new genes are discovered, your DNA samples may be used for future exploratory analyses to

Figure 11. Informed Consent 3
explore how genes play a role in substance use or in modifying the effectiveness of interventions. Additional information about storing and usage of the DNA samples is provided in a separate document at the end of this consent form. The Department of Health and Human Services (DHHS) has issued a Certificate of Confidentiality for “Parent-based Intervention to Prevent Student Drinking (Project ACT)”, IRB#35141. The Certificate of Confidentiality does not represent an endorsement of this research project by the Secretary of Health and Human Services. This Certificate protects the researchers from being forced to release any research data in which you are identified, even under a court order or subpoena. This protects you from being identified in any civil, criminal, administrative, legislative, or other proceedings whether federal, state, or local. Once data from this study is combined with the data from IRB # 35141, the Certificate of Confidentiality will then cover the data for this study as well. We may report child abuse or suicide to the appropriate authorities. In accordance with the ethical code of psychologists, we will report threats of imminent harm to you or to someone else (i.e., suicide or homicide) to the appropriate authorities.

Penn State’s Office for Research Protections, the Institutional Review Board, and the Office for Human Research Protections may review records related to this research study.

In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared. The results of the research, including but not limited to your images, may be published and presented at lectures and professional meetings, but you will not be identified in any such publication or presentation.

7. Right to ask questions:

Please contact Sheri Berenbaum at (814) 865-6140 or Rick Gilmore at (814) 865-3664 with questions, complaints or concerns about this research. You can also call this number if you feel this study has harmed you. If you have any questions, concerns, problems about your rights as a research participant or would like to offer input, please contact Penn State University’s Office for Research Protections (ORP) at (814) 865-1775. The ORP cannot answer questions about research procedures. Questions about research procedures can be answered by the research team.

8. Payment for participation:

You will spend a total of approximately 1.5 hours while in the MRI scanner and you will receive $20 per hour for the time that you spend in the MRI scanner. You will spend a total of approximately 60 minutes completing tasks outside of the MRI scanner and you will receive $10 per hour for these tasks. In addition, you will have a chance to earn up to $60.00 extra dollars based upon your performance during the study. This means that the total compensation you may expect is $100. If you withdraw from the study before completion you will be compensated for the time you participated to the ½ hour (i.e., ½ hour = $10 for tasks performed while in the MRI scanner; ⅔ hour = $5 for tasks performed while not in the scanner). Total payments within one calendar year that exceed $600 will require the University to annually report these payments to the IRS. This may require you to claim the compensation that you receive for participation in this study as taxable income.

9. Voluntary participation:

Your decision to be in this research is voluntary. You can stop at any time. In order to participate you must answer all Participant Safety and Screening questions accurately; however, you do not have to answer any other questions that you do not want to answer. Refusal to take part in or withdrawing from this study will involve no penalty or loss of benefits you would otherwise receive.

10. Injury Clause:

Page 4 of 6. Participant Initials __________________
In the unlikely event you become injured as a result of your participation in this study, medical care is available. It is the policy of this institution to provide neither financial compensation nor free medical treatment for research-related injury. By signing this document, you are not waiving any rights that you have against The Pennsylvania State University for injury resulting from negligence of the University or its investigators.

11. Incidental findings:

The investigators for this project are not trained to perform medical diagnosis, and the MRI scans to be performed in the study are not optimized to find abnormalities. On occasion, a member of the research team may notice a finding on a MRI scan that seems abnormal. When a finding is noticed, the investigator or designee may consult a physician specialist, such as a radiologist or neurologist, as to whether the finding merits further investigation. If the specialist recommends further follow-up, the investigator or another designee will contact you within 48 hours of the recommendation and suggest that you contact your private medical provider for follow-up. To facilitate follow-up care, you may be given a copy of your MRI images upon written request. Being told about a finding may cause anxiety as well as suggest the need for additional tests and financial costs. Medical insurance may be affected whether or not the finding is ultimately proved to be of clinical significance. Costs for clinical follow-up are not included in the cost of research. The decision as to whether to proceed with further examination or treatment lies with you.

DNA analysis results will not be shared with you or with your physician. Results of the combination of the DNA data, MRI data, and survey responses also will not be shared with you or with your physician.

12. Abnormal test results:

Please provide contact information so that you can be reached in the event of an incidental finding and/or abnormal test results.

Address ____________________________________________________________

Phone ____________________________________________________________

By consenting to participate, you agree to:

- Answer the SLIC 3T MRI Participant Safety & Screening questions accurately,
- Tell the investigators about all metallic devices in/on your body, and
- Not bring any metal devices (e.g., pens, coins, keys, credit cards) into the scanning room without staff approval.

You must be 18 years of age or older to take part in this research study. If you agree to take part in this research study and the information outlined above, please sign your name and indicate the date below.

You will be given a copy of this signed and dated consent form for your records.

_________________________________________  __________________________________________  ________________________
Participant Signature                          Printed Name                         Date

_________________________________________  __________________________________________  ________________________
Person Obtaining Consent                       Printed Name                         Date

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Figure 13. Informed Consent 5
OPTIONAL—CONTACT ABOUT FUTURE STUDIES
May we keep your name and contact information (phone, email) in our research volunteer database in order to contact you about your possible interest in participating in other studies at the University, both with our research group and other groups with whom we collaborate?

______ YES, contact me about other studies for which I might participate

______ NO, do not contact me about other studies

Optional DNA storage for future use
As explained in this consent, we are obtaining a DNA sample from you that if you agree, the researcher Dr. Sheri Berenbaum and her research team would like to store. As new data are collected on the participants, new candidate gene analyses may be appropriate. Your DNA sample will be used only for academic research and will not be sold or used directly for the production of commercial products and we will not share this information with you or with anyone else who is not part of the research team without your permission. Your decision regarding storage of your DNA does not affect your participation in this or other studies being conducted by Dr. Berenbaum and/or other members of the research team.

Your DNA sample will be labeled only with a barcode number assigned for storage purposes at the PSU facility. Your name and/or subject identification number assigned for this study will not appear on the samples. The list that contains the link between the storage barcode and your identifying information will be secured, as described in the confidentiality section of this consent form. The DNA samples will be stored frozen in a special freezer designed for this purpose that is located on the grounds of the University Park campus of PSU. This freezer is locked and accessible only to the staff at this facility.

If you consent to allowing storage of your DNA sample for future research, the period for the use of the samples is unknown. You will be free to change your mind at any time and may contact Dr. Sheri Berenbaum by calling collect to (814) 865-6140 or by email at sab31@psu.edu and let her know that you wish to withdraw your permission for your DNA to be used for future research. The sample will be destroyed and not used for future research studies.

Please initial below to indicate your preferences regarding the optional storage of your child’s DNA sample for future research studies.

a. Your DNA may be stored and used for future research studies.

   Participant 18 years of age or older  ____ Yes  ____ No

b. Your DNA sample may be shared with other investigators/groups without any identifying information.

   Participant 18 years of age or older  ____ Yes  ____ No

Participant 18 years of age or older: By signing below, you indicate that you have read the information written above and have indicated your choices for the optional part of the research study.

__________________________  ______________________________  ____________
Signature                     Printed Name           Date

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Figure 14. Informed Consent 6
Appendix B

Barratt Impulsiveness Scale

**BIS 11, TO BIS-11: SCORING**

<p>| | | | | |</p>
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<td></td>
<td>RARELY/NEVER</td>
<td>OCCASIONALLY</td>
<td>OFTEN</td>
<td>ALMOST ALWAYS/ALWAYS</td>
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<td>1. I plan tasks carefully</td>
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<td>2. I do things without thinking</td>
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<td>3. I am happy-go-lucky</td>
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<td>4. I have “racing” thoughts</td>
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<td>5. I plan trips well ahead of time</td>
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<td>6. I am self-controlled</td>
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<td>7. I concentrate easily</td>
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<td>8. I save regularly</td>
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<td>9. I am a careful thinker</td>
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<td>10. I plan for job security</td>
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<td>11. I say things without thinking</td>
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<td>12. I like to think about complex problems</td>
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<td>13. I change jobs</td>
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<td>14. I act &quot;on impulse&quot;</td>
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<td>15. I get easily bored when solving thought problems</td>
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<td>16. I act on the spur of the moment</td>
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<td>17. I am a steady thinker</td>
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<tr>
<td>18. I change where I live</td>
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<tr>
<td>19. I buy things on impulse</td>
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<tr>
<td>20. I spend or charge more than I earn</td>
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<tr>
<td>21. I have outside thoughts when thinking</td>
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<tr>
<td>22. I am more interested in the present than the future</td>
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<tr>
<td>23. I am restless at lectures or talks</td>
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<td>24. I plan for the future</td>
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</table>

**Prorating score to BIS-11 Total Impulsiveness:** (score/24)*30
**BIS 11A TO BIS-11: NON-PLANNING IMPULSIVENESS**

**Name:**  
**Date:**

**Directions:** People differ in the ways they act and think in different situations. This is a test to measure some of the ways in which you act and think. Read each statement and darken the appropriate circle on the right side of the page. Do not spend too much time on any statement. Answer quickly and honestly.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Rarely/Never</th>
<th>Occasionally</th>
<th>Often</th>
<th>Almost Always</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I plan tasks carefully</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>5. I plan trips well ahead of time</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>6. I am self-controlled</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
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<tr>
<td>8. I save regularly</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
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<tr>
<td>10. I am a careful thinker</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
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<tr>
<td>11. I plan for job security</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>12. I say things without thinking</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>13. I like to think about complex problems</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
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<tr>
<td>16. I get easily bored when solving thought problems</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>28. I am more interested in the present than the future</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

**Prorating score to BIS-11 Non-planning Impulsiveness:** \((\text{score}/10) \times 11\)
**BIS 11 A TO BIS-11: COGNITIVE/ATTENTIONAL IMPULSIVENESS**

| Name: __________________________ | Date: ________________ |

**Directions:** People differ in the ways they act and think in different situations. This is a test to measure some of the ways in which you act and think. Read each statement and darken the appropriate circle on the right side of the page. Do not spend too much time on any statement. Answer quickly and honestly.

<table>
<thead>
<tr>
<th></th>
<th>RARELY/NEVER</th>
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</table>

4. I have “racing” thoughts ........................................ 1 2 2 4

7. I concentrate easily .................................................. 4 3 2 1

19. I am a steady thinker .................................................. 4 3 2 1

27. I have outside thoughts when thinking .............................. 1 2 2 4

29. I am restless at lectures or talks ................................... 1 2 2 4

**Prorating score to BIS-11 Cognitive Impulsiveness:** (score/5)*8
### BIS 11a TO BIS-11: MOTOR IMPULSIVENESS

**Name:** ___________________________  **Date:** ___________________________

**Directions:** People differ in the ways they act and think in different situations. This is a test to measure some of the ways in which you act and think. Read each statement and darken the appropriate circle on the right side of the page. Do not spend too much time on any statement. Answer quickly and honestly.

<table>
<thead>
<tr>
<th></th>
<th>RARELY/NEVER</th>
<th>OCCASIONALLY</th>
<th>OFTEN</th>
<th>ALMOST ALWAYS/ALWAYS</th>
</tr>
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</table>

2. I do things without thinking ........................................ 1 2 2 4
3. I am happy-go-lucky .................................................... 1 2 2 4

14. I change jobs ............................................................. 1 2 2 4
15. I act "on impulse" ...................................................... 1 2 2 4

18. I act on the spur of the moment .................................... 1 2 2 4
20. I change where I live ................................................... 1 2 2 4
21. I buy things on impulse ................................................ 1 2 2 4

25. I spend or charge more than I earn .................................. 1 2 2 4

30. I plan for the future ..................................................... 4 3 2 1

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**Prorating score to BIS-11 Motor Impulsiveness:** (score/9)*11
BIBLIOGRAPHY


ACADEMIC VITA

Lorena Laura Gonzalez
747 Stratford Drive
State College, PA 16801
Llg5055@psu.edu

EDUCATION
The Pennsylvania State University at University Park (Graduating May 2014)
Schreyer Honors Scholar in Eberly College of Science
- Major in Biology, Minor in Psychology
- Academic Excellence Scholarship (2009-2013)

INTERNSHIP EXPERIENCE
The Vista School at Hershey, PA
Speech-Language Pathology Intern (July-August 2013)
- Observed and interned with two Speech-Language Pathologists treating school-age children living with moderate to severe autism
- Created and edited materials for use with the children, including PECS icons and icons on AAC devices using “Proloquo2Go” and other assistive programs

RESEARCH EXPERIENCE
Brain Development Lab at The Pennsylvania State University,
Advisor: Rick Gilmore, Ph.D.
Undergraduate Research Assistant (August 2011-Present)
- Responsible for participant preparation and safety throughout two-hour research sessions, including attaining participant consent, placement and arrangement of EEG nets, and participant observation and care during data collection.
- Planned senior thesis project under supervision of lab director
- Thesis: The role of response inhibition and impulsivity in alcohol consumption in young adults

Ocular Health Research at The Pennsylvania State Milton S. Hershey Medical Center,
Advisor: Ingrid Scott, M.D.
Summer Research Assistant (May-August 2010)
- Developed code for data collected during three extensive epidemiological surveys on ocular health

ACTIVITIES
World Outside My Shoes at The Pennsylvania State University
Club member (2010) and Vice President (Spring 2011-Fall 2012)
- Organized events focusing on raising awareness and funds for various community and international causes