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Analysis of Substance Use and Impulsivity in Relation to Juveniles Committing an Offense

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Author Note

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This research was conducted as part of an undergraduate honors thesis project. Committee

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Abstract

Research suggests that among high-risk adolescents there is a strong relationship between substance use and having committed an offense. Further, adolescents with impulsive personality characteristics are more likely to use or abuse alcohol and other substances than their less impulsive peers. Therefore, impulsivity may be one potential mediator in the relationship between adolescent alcohol use and externalizing disorders such as conduct disorder, which increases the likelihood of committing an offense large enough to end up in a juvenile detention facility. Using a subset of data collected from a larger longitudinal study, this study utilized behavioral and neuroimaging data to examine the relationship between substance use, impulsivity, and committing an offense among a population of adolescent offenders. Participants ($n=225$), were between the ages of 14-18 years and were recruited from the Youth Reporting Center (YRC) in Albuquerque, New Mexico. Impulsivity was significantly correlated with having committed an offense ($r = .176, p < .01$), and was also correlated with, alcohol use ($r = .167, p < .01$), alcohol related problems ($r = .289, p < .01$), and alcohol dependence ($r = .213, p < .01$). Contrary to previous research findings, none of the alcohol measures were significantly correlated with committing an offense. The orbitofrontal cortex, amygdala, nucleus accumbens, and cerebellum volumes were also not correlated with impulsivity or having committed an offense. Although results were not in line with hypotheses, they do offer insight into the complex relationship between adolescent substance use and personality characteristics.

Keywords: Juvenile-justice youth, impulsivity, alcohol use, MRI data

Analysis of Substance Use and Impulsivity in Relation to Juveniles Committing an Offense

Adolescent alcohol use is a major public health concern. There are more than 12,500,000 underage individuals who drink per year, making alcohol the most commonly used and abused drug among youth in the United States (CDC, 2012). In 2012, the National Institute on Drug Abuse found that children start using alcohol as young as 11 and that use continues to increase, such that by 8th grade, 11% are using and by 12th grade, 40% have used alcohol. The prevalence of alcohol use among youth today could prove to be very harmful in the future; large alcohol consumption during adolescence can lead to a plethora of problems ranging from legal to physical and psychological.

The effects of alcohol use on the developing adolescent brain are under investigation, but what is known now suggests that it is extremely detrimental. The human brain is not fully developed until the early twenties so substance use at a young age could have a critical effect on normal development and learning (NIAAA, 2004). Most of the addiction and substance use related research is conducted using adult samples, whose findings indicate that alcohol affects many parts of the body including the brain regions involved in coordination, emotional control, thinking, decision-making, hand-eye movement, speech, and memory (NIH, 2012). Current research on adolescent alcohol use suggests that exposure of the developing brain to alcohol influences intellectual capabilities, learning, and memory (Coldera et al., 2007). This is further complicated by factors such as quantity and frequency of drinking, the age they begin drinking, their education level, gender, family history, and genetic background (NIAAA, 2004). Infrequent alcohol consumption has some negative effects on adolescent consumers, however, heavy alcohol consumption as an adolescent can lead to increased likelihood of alcohol consumption as

an adult; thus exacerbating the chances of developing a substance use disorder, which could lead to long-term health problems and brain damage in the future. It is clear that the individual effects of alcohol use abuse are hard to ignore, but what is less clear are the long-term negative effects of alcohol abuse during adolescence on society as a whole.

Alcohol consumption by minors contributes to over 1,500 traffic fatalities, 1,800 homicides, 28,000 teen pregnancies, and almost 2,000,000 property crimes (NIH, 2012). These incidents cost the United States over \$62 billion dollars a year in medical, work lost, and pain and suffering for underage drinking alone (UDETTC, 2011). A large sum of this money is paid to housing adolescents who are charged with fighting, assault, possession, and burglary; all offenses that were committed while intoxicated. To make matters worse, adolescent alcohol use is a predictor of future use, which if results in abuse could potentially increase the overall financial burden. Given the current cost of adolescent alcohol use and the potential future costs that could be incurred, it is imperative that the factors that underlie both alcohol use and juvenile delinquency be more closely examined. One avenue often explored in an attempt to answer this question is the comorbidity of adolescent substance use and psychological diagnoses.

The relationship between substance use and delinquency among adolescents is well documented (Barnow et al., 2004). Many studies have found that adolescents who drink frequently are more likely to have behavior problems and engage in delinquent activities (Barnow et al., 2004). The direction of this relationship is not always as well understood. Adolescents who drink are more likely to engage in delinquent behavior but it is not clear whether the association is causal or driven by an underlying factor (Sen et al., 2009). Sen and colleagues (2009) concluded that, “after controlling for the influence of unobservable factors, there is little evidence that substance use increases likelihood of delinquent behavior.” This

finding suggests that it could be a personality trait, intelligence level, genes, environment, or most likely, a combination of all these factors that is the unobservable bridge connecting substance use to delinquency. Personality traits like impulsivity have frequently been studied because of their strong association with delinquency in adolescent populations.

Numerous studies have demonstrated the association between impulsivity and alcohol use among adolescents as well as adolescent delinquency (Robbins & Bryan, 2004). Consistent with the current body of research, Robbins and Bryan (2004) established that, “higher impulsivity reliably predicts alcohol problems, alcohol use” in their research regarding impulsive risk behaviors and future orientation among adjudicated adolescents. Prior research has examined the relationship between impulsivity and alcohol use as well as delinquency and substance use, but no one has explored impulsivity as a mediator in the relationship between substance use and committing an offense. Barnow and colleagues (2004) investigated the relationship between drinking behavior and impulsivity and found that impulsivity may lead to forming more positive alcohol use expectancies. In general, when exposed to alcohol and the consequences of alcohol consumption, impulsive individuals tend to form more positive and fewer negative expectations (Barnow et al., 2004). If impulsive behavior leads to positive alcohol expectancies, impulsive individuals may be more likely to consume alcohol. Further, if increased alcohol consumption is a predictor of committing an offense, then impulsivity may indirectly affect whether or not an adolescent is more or less likely to commit an offense. Emerging research has suggested that there are areas of the brain that are associated with impulsivity among adolescents.

Research on the areas of the brain associated with impulsivity suggests associations with the limbic system, amygdala, nucleus accumbens, and cerebellum (Casey et al., 2008). The article “The Adolescent Brain” explains that these areas in the reward circuit of the brain are

associated with dopamine release and that a balance between excitatory and inhibitory dopamine transmission is crucial for communication with the prefrontal cortex (Casey et al., 2008).

Therefore, the study found that during adolescence there are significant peaks in dopamine expression that may contribute to impulsive and risky behaviors. King and colleagues (2003) agree that the amygdala, cerebellum, accumbens and cortex are all areas involved in the neural circuitry behind impulsivity, as their research showed bold activity in these regions during an fMRI scan in adolescents with ADHD (King et al., 2003). Other studies using brain-imaging techniques have also found that a decrease in grey matter in the orbitofrontal cortex is correlated with both non-planning impulsivity and substance use (Schiffer et al., 2010). It is clear from these studies that there is a connection between impulsivity and brain regions involved in reward (amygdala, accumbens) and control (frontal cortex, OFC) and that addiction is due in part to increased impulsiveness because of loss of frontal cortex inhibition of limbic drive and impulse (Crews & Boettiger, 2009). The most interesting results came from a study investigating the premotor connections that predict impulsivity in juvenile offenders (Shannon et al., 2011). This study used an fMRI to look at the dorsolateral premotor cortex (PMdr) and found that less impulsive offender's motor planning regions were correlated with the attention/control network and more impulsive offender's motor planning regions were correlated with default-mode network (DMN is associated with spontaneous, self-referential cognition, i.e., daydreaming) (Shannon et al., 2011). This research further highlights the importance of utilizing fMRI technology in the research of impulsivity, delinquency, and addictions within adolescent populations.

The current study aims to gain a better understanding of the relationship between adolescent delinquency and substance use by utilizing MRI data from a sample of juvenile

delinquents. The overarching goal was to examine the association between alcohol use, impulsivity, and juvenile delinquency by focusing on impulsivity as mediating this relationship. Specifically, MRI scan data will be utilized in order to examine how the volume of different brain regions may be associated with impulsivity (amygdala, nucleus accumbens, cerebellum, orbitofrontal cortex), substance use, and juvenile delinquency. The data set includes over 200 adolescents recruited from the Youth Reporting Center (YRC) in Albuquerque, New Mexico. All of the participants were either on probation or in the facility for committing different offenses such as theft, auto theft, possession, and assault. It is the hope that this research will advance the current data regarding juvenile delinquency by assessing how impulsivity and substance use can determine which adolescents are more likely to commit a crime. Since impulsive behavior plays a role in substance use it is important to realize that impulsivity affects substance use, which can then affect adolescent crime. We hypothesized that adolescents who have committed an offense are more likely to be frequent users of alcohol as well as more likely to participate in more impulsive behaviors; thus there will be an interaction between having committed an offense and substance use which is mediated by impulsivity.

Methods

Self-report data from 225 justice-involved adolescents was analyzed. Only a subset of the original study's data was utilized, specifically data from the single session magnetic resonance imaging (MRI). Participants were between the ages of 14 and 18 years old (75.6% male, 24.4% female), and were very ethnically diverse (62.2% Hispanic, 15.6% Caucasian, 10.2% Multiracial, 6.2% African American, 4.0% American Indian, 1.3% Asian/Pacific Islander, and 0.4% unknown). More details on the participants are included in Table 1. Participants were recruited from the Youth Reporting Center (YRC); a day program for high-risk adolescents offered by

Bernalillo County Juvenile Justice services in Albuquerque, New Mexico. All participants who completed the baseline measures and MRI part of the study were compensated \$50 dollars. Prior to participating, both adolescent assent and parental/guardian consent were obtained prior to involvement in the study. The University of New Mexico's (UNM) Human Research Review Committee (HRRC) approved the study, and a certificate of confidentiality was obtained from the Department of Health and Human Services to protect the minor participants in the study. Although only a subset of the data was utilized for the current analysis the National Institutes of Health and the National Institute (NIH) of Alcoholism and Alcohol Abuse (NIAAA) funded the larger study.

Self-Report Assessments

Self-report questionnaires were administered on individual laptop computers using Audio Computer-Assisted Self-Interviewing (ACASI) technology on laptop computers, which assists participants by reading questions aloud over headphones as they are presented (Bryan et al., 2005; Schmiege et al., 2009). All participants were told that they should not feel obligated to answer any questions that made them feel uncomfortable, or that they did not wish to answer. Using the MediaLab software, participants could read the questions and enter their answers while hearing the questions through headphones. Baseline questionnaires assessed demographic variables, attitudes and self-efficacy, and also alcohol use during the last 30 days and 3-month period of time. The specific questionnaires used in this analysis include; Impulsivity and Sensation Seeking Scale (IMPSS), alcohol frequency and alcohol quantity questions, Alcohol Use Disorders Indication Test (AUDIT), and Rutgers Alcohol Problems Index (RAPI) (All full-length questionnaires are located in the appendix).

Impulsivity and sensation seeking. The Impulsivity and Sensation Seeking Scale (IMPSS) (Zuckerman et al., 2002) is made up of 19 true/false questions such as, “I often do things on impulse”, “I’ll try anything once”, and “I often get so carried away by new and exciting things and ideas that I don’t think of what might go wrong.” These are direct sample questions from the impulsivity subscale, which consists of 8 questions from the IMPSS. (True=1, False=0). To score this measure all items are summed for a total impulsivity score ($\alpha = .75$). Of those who completed this questionnaire (222), the mean score was 3.69 ($SD = 1.96$, Range = 0-8).

Alcohol use. Participant’s alcohol use was assessed with a variation of the alcohol use measure created by White and Labouvie (1989). The questions about quantity and frequency of alcohol use include, “In the last 3 months, how often did you consume a least one alcoholic drink?” (Never=1, Occasionally=2, Once a month=3, 2-3 times a month=4, 4-5 times a month=5, Once a week=6, 2-3 times a week=7, 4-5 times a week=8, Everyday=9) and “In the last 3 months, how many drinks did you usually have at one time?” (None=1, 1 drink=2, 2-3 drinks=3, 4-6 drinks=4, 7-9 drinks=5, 10-12 drinks=6, 13-15 drinks=7, 16-18 drinks=8, 19-20 drinks=9, More than 20 drinks=10). The average age of having their first alcoholic drink was 12 years old (see Table 1 for further information).

Alcohol dependence. The Alcohol Use Disorders Identification Test (AUDIT) by Chung et al., (2002) was used to assess alcohol dependence (13 or more for females or 15 or more for males). The questionnaire is made up of 10 questions assessing hazardous drinking outcomes using a 5-point scale. Participants’ responded to questions which assessed their drinking behaviors over the past 6 months (never=0 to daily or almost daily=4), their drinking frequency (1-2 drinks=0 to 10 or more=4), and whether or not different things had happened to them (no=0, yes, but not in the last 6 months=2, yes, during the last 6 months=4). A sample question reads,

“How often do you have 6 or more drinks on occasion?” To score this measure all items are summed for a total alcohol use dependence score ($\alpha = .81$) where high numbers are indicative of high risk for alcohol dependence. The average AUDIT score among participants in this sample was 8.02 ($SD = 7.43$, Range = 0-32), suggesting that the participants are engaging in hazardous drinking and are close to being considered alcohol dependent.

Alcohol use problems. The Rutgers Alcohol Problem Index (RAPI) by White and Labouvie (1989) consisting of 23 questions was used to assess alcohol related problems (scores greater than 20 generally indicate alcohol problems on a clinical scale) using a 5-point scale (0= “Never”, 4= “more than 10 times”). A sample question reads, “While you were drinking alcohol or because of your alcohol use during the last 6 months you neglected your responsibilities” (never=0, 1-2 times=1, 3-5 times=2, 6-10 times=3, more than 10 times=4). To score this measure all items are summed for a total alcohol problem score ($\alpha = .94$). Of those who completed this questionnaire (192), the mean score was 13.97 ($SD = 15.58$, Range = 0-92).

MRI Imaging Techniques

In addition to analyzing the questionnaires above, MRI brain scan volumes were incorporated into the participant data. Using a 3T Siemens Trio system equipped with Sonata gradient subsystem (40 mT/m amplitude, 200 μ s rise time, 100% duty cycle). A 12-channel receiver head phased array coil combined with body coil transmission to achieve greater sensitivity in cortical areas was employed. *Structural MRI.* High resolution T1-weighted scans were collected with a multi-echo MPRAGE (MEMPR) sequence with the following parameters: TR/TE/TI=2300/2.74/900ms, flip angle=8°, FOV = 256x256mm, Slab thickness=176 mm, Matrix=256x256x176, Voxel size=1x1x1 mm, Number of echos=4, Pixel bandwidth =650 Hz. *Diffusion Tensor Imaging (DTI).* White matter was assessed with a DTI protocol sensitive to 35

diffusion directions. A single-shot EPI sequence was acquired with the following parameters: TR/TE=9100/86ms, FOV=256x256 mm, matrix size: 64x64, 72 slices, voxel size: 2.0x2.0x2.0mm³; total scan time=6:30 min.

Using the FreeSurfer suite (which aligns images based on cortical fold patterns), to calibrate a 3D image of the brain into distinct regions of volumetric calculations the volumes of associated brain regions were calculated for each participant scanned (n=225). The brain volumes were calculated based on grey matter of the amygdala, nucleus accumbens, cerebellum, and orbitofrontal cortex (OFC). These particular regions were chosen because previous research on impulsivity (as mentioned in the introduction) has been found to be associated with these particular regions of the brain. The OFC volume was calculated by adding the volumes for the medial and lateral orbitofrontal cortex, and the left and right pars orbital. The scan data volumes were calculated for the left and right hemisphere separately and put into SPSS to be correlated with committing an offense and the IMPSS questionnaire.

The overarching goals of this study were to gain further knowledge into the contributing factors behind juvenile delinquency (i.e., personality traits and behaviors) in the hopes that the information found could lead to a better understanding of the interactions between offenses and individual characteristics. This research is important to help explain why some individuals are more likely to engage in delinquent behaviors than others as well as to help society find a more effective way to control and prevent delinquent behaviors for future youth. Specifically, analyzing a personality trait, such as impulsivity, which in prior research is shown to be influential in both substance use and delinquent behavior, is important in order to detect who the most likely candidates would be for using alcohol and committing an offense. Therefore adolescents who have committed an offense are more frequent users of alcohol, and also

participate in more impulsive behaviors; thus there may be an interaction between offense and substance use that may be mediated by impulsivity.

Results

The main goal of this study was to examine the relationship between alcohol use, impulsivity, and adolescent offenses in order to determine if there was a significant interaction involving impulsivity in the relationship between alcohol use and committing an offense. It was hypothesized that the relationship between these variables would be mediated by impulsivity (see Figure 1). The results of this study were found through regression tests, independent samples t-tests, and correlation tables using the SPSS data program. The dependent variable was committing an offense and included selling drugs, joy riding, auto theft, burglary, vandalism, carrying weapon to school, possession of a controlled substance, threatening a teacher, sex offense, and curfew violation. The independent variables were alcohol use (consumption, frequency, dependence, and problematic use) and impulsivity (i.e., acting on impulse without thinking about consequences).

Demographics

Of those participants that indicated they were still in school (45.8%), the average grade level completed was 10th. Most of the participants have used alcohol and marijuana (85.3% have used alcohol, 79.6% have used marijuana). Of those who committed an offense (40%), the types of offenses they committed included: assault/fighting (34.4%), joy riding/auto theft/burglary (16.7%), selling drugs/possession (14.4%), multi offender (more than 3 different offenses) (11.1%), unknown (8.9%), curfew/probation violation (5.6%), carrying weapons/threatening a teacher/missing school (4.4%), vandalism (2.2%), sex offender (2.2%). More than two-thirds of

the participants indicated they had used alcohol and marijuana (85.3% have used alcohol, 79.6% have used marijuana). For more details on the participants' characteristics, please see Table 1.

Relationships among Impulsivity and Substance Use

To determine the relationships between impulsivity and substance use, correlations were computed. We assessed the relationship between impulsivity, alcohol use, and committing an offense. The correlations, means, and standard deviations are all summarized in Table 2. There were 192 participants (85.3%) who indicated drinking alcohol and of those the average age of first use was 12 ($SD = 2.42$). All alcohol use measures (i.e. consumption, frequency, dependence, and problems), as expected, were significantly correlated with one another (p 's < .01). The impulsivity subscale of the IMPSS was significantly correlated with both the past 3-month alcohol consumption ($r=0.167, p < .01$) and the AUDIT ($r= .206, p < .01$), but the strongest relationship was between impulsivity and the RAPI ($r= 0.289, p < .01$). These findings suggest that there is a modest relationship, within this selected sample, between impulsive behavior and alcohol use, specifically, problematic alcohol use. This finding was in line with hypotheses; it was expected that those who are impulsive would be more likely to use alcohol as well as have more problems from their alcohol use.

Relationships among Impulsivity, Substance Use, and Committing an Offense

To further assess the relationships between substance use, impulsivity, and committing an offense, correlations were computed. The impulsivity subscale was significantly correlated with having committed an offense ($r = 0.176, p < .01$). Contrary to the hypotheses, having committed an offense was not significantly correlated with any of the alcohol measures (all r s > .05). To further test these relationships, a mediating model was utilized (shown in Figure 1). A standard multiple regression analysis was conducted to evaluate how well alcohol frequency, marijuana

use, AUDIT scores, RAPI scores, and the impulsivity subscale predicted having committed an offense. Consistent with hypotheses, the predictor variables were significantly related to having committed an offense $F(5, 206) = 4.79, p < .001$. The multiple correlation coefficient was .32, indicating that approximately 10% of the variance in having committed an offense can be accounted for by the linear combination of the predictor variables (the significance values from the regression analyses are provided in Table 3). To further understand the effects of these variables on committing an offense, independent samples t-tests were ran. On average, more impulsive participants were more likely to have committed an offense ($M = 4.11, SD = 2.01$) than to not have committed an offense ($M = 3.41, SD = 1.88$). This difference was statistically significant, $t(220) = -2.65, p < .01$, indicating that committing an offense among impulsive participants was more likely than what would have been expected due to chance. This was the only independent variable that significantly predicted the likelihood of having committed an offense.

Relationships Between Brain Volume and Impulsivity

All MRI data from the original neurocognitive dataset was utilized for this comparison. Given the present body of literature, there were very specific brain regions that were ideal for trying to gain a better understanding of the relationship between the model constructs. The Areas that were chosen were the amygdala, cerebellum, nucleus accumbens, and orbitofrontal cortex (OFC). After calculating the volumes of each of these areas in FreeSurfer, the volumes were implemented in the dataset. Not in line with hypotheses, none of the variables were significantly associated with any of the neurocognitive regions utilized in this analysis. Specifically, impulsivity was not related to left/right amygdala ($r = -.045, p = .506$), left/right accumbens (r

= .003, $p = .969$), left/right cerebellum ($r = -.084$, $p = .210$) and left/right OFC ($r = .033$, $p = .630$).

Although the correlations table, regression analyses, and independent samples t-test all indicated that a significant relationship was present between impulsivity and having committed an offense the initial hypothesis of a mediating relationship must be rejected. Impulsivity was significantly related to the alcohol use variables as well as having committed an offense, but the alcohol use variables were not significantly related to having committed an offense. Although the primary hypothesis was not supported, the other significant findings suggest that there is a relationship within the variables studied (not necessarily a mediating relationship) (see Figure 2). These findings add to the body of research on impulsivity as a contributing trait to adolescent offenses and substance use could be beneficial.

Discussion

The goal of this study was to analyze the influence of impulsivity on the relationship between alcohol use and having committed an offense within a population of adolescents. The results indicated that contrary to the hypothesis, there was not a mediating relationship between impulsivity, alcohol use and having committed an offense. In fact, the results suggested that there was not a correlation between the alcohol use variables (i.e., consumption, frequency, dependence, and problems) and having committed an offense. There was a significant relationship between impulsivity and the alcohol variables and a significant but weak relationship between impulsivity and having committed an offense (see Figure 2). The brain volume data for hypothesized regions were not significantly correlated with either impulsivity or having committed an offense. These results are surprising because previous research suggests significant relationships between the specified brain regions and impulsivity as well as between

alcohol use and having committed an offense. Although the hypotheses are not supported, the results indicate that there are separate, significant relationships between impulsivity and having committed an offense, and between impulsivity and alcohol use.

In accordance with current research impulsivity was in fact significantly correlated with alcohol use (Robbins & Bryan, 2004) and adolescents committing offenses (Shannon et al., 2011). Barnow and colleagues (2004) found that adolescents who drink more frequently are more likely to engage in delinquent activities, contrary to this finding, the current study suggests that there is no significant relationship between alcohol use and having committed an offense. This conflicting finding could be due to the nature of the sample used in the study and also the complexity of the alcohol variables used.

The current study is limited by the sample of participants (no extremities/subset of larger study), data reliability, and the difficult to define phenotype. The data from the participants in this sample were taken from a larger longitudinal study whose aim was to assess substance use and risky sexual behavior in juvenile offenders, thus this study was not specifically designed to address the current hypotheses. This sample is a limitation in that behaviors committed by high-risk adolescents may not generalize to more general populations of adolescents. Since no extremities were used in the sample (meaning the participants were not chosen based on high impulsivity or high alcohol consumption) and impulsivity did show correlations with all alcohol measures and committing an offense, these results could prove to be significant if done with a different sample of adolescents.

The self-reported data could have impacted the results as well. For example, if someone answered the question "Did you commit an offense?" "No" when they actually had committed an offense, this would affect the entire data set because the dependent variable is whether or not the

adolescent had committed an offense. Therefore, the lack of reliability of the self-reported questionnaires is a big constraint in the current study's assessments because all data analyses were done on self-reported questions. Impulsivity is also a very difficult phenotype to define. The current research used a broad definition of trait impulsivity as simply acting on impulse. In other research it has been defined as, "the inability to stop initiated actions, intolerance to delay, lashing out, lack of reflectiveness and planning, rapid decision making and action, carelessness, reward seeking, lack of consideration of consequences of actions." Because of its multifaceted nature, it proves to be difficult to replicate current findings regarding impulsivity. The brain regions selected in this study were based off previous research in which impulsivity was defined differently and was assessed using measures other than the IMPSS which was the only measure of impulsivity used in the current study. These differences could contribute to why no significant relationship was found.

Future research would benefit from studies which aim to see how the results turn out using a different sample of adolescents to get a better picture of difference in committing offense vs not committing an offense. It would also be important to look at the interaction of other personality traits (e.g., aggression, extraversion), environmental factors, and genes in order to find the more interactive (yet complex) picture of all the relationships involved in committing an offense. Although impulsivity is a difficult trait to clearly define, the current study still showed significant relationships between it, having committed an offense, and alcohol use, making it an ideal personality trait for future research. It would also be beneficial to incorporate different types of fMRI imaging tasks such as the BART (balloon analogue risk task) with other ways to measure impulsivity and alcohol use without relying only on self-report questionnaires.

Although the hypothesis of this study was not supported, these findings open the door for

future research on the relationship between impulsivity, alcohol use, and committing an offense. Because of the positive correlational findings within the current sample, if the study were conducted with a sample, which could represent a broader population of adolescents, the findings could potentially be useful for further research. Looking at the neuronal circuitry of impulsivity could prove to be a key factor in the relationship between alcohol use and offenses. Although the results for the current study were not in line with hypotheses, they do offer insight into the complex relationship between adolescent substance use and personality characteristics involved in adolescent likelihood of committing an offense. A study designed to look specifically at impulsivity, which incorporates fMRI technology and other environmental and genetic factors, would be the most beneficial in order to understand the complex relationship of adolescent alcohol use and offense. Although impulsivity is only one personality factor analyzed in the relation to delinquency, it is still important; more knowledge in this area is critical to provide a detailed understanding of the variables underlying adolescent substance use and likelihood of committing an offense.

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Table 1

Participant Characteristics (N = 225)

Demographics	
Ethnicity (% Hispanic)	62.2
Age	16.11 (1.11)
Gender (% female)	24.4
Attending school (%)	45.8
Grade level	10.27 (1.37)
Committed an offense (%)	40.0
Individual Differences	
IMPSS	3.69 (1.96)
Alcohol Use	
Age at first drink	12.46 (2.42)
Freq. of drinking (last 3 months)	3.79 (2.41)
Drinks per drinking occasion (last 3 months)	3.69 (2.31)
RAPI	13.97 (15.58)
AUDIT	8.02 (7.43)
Marijuana Use	
Age at first use	12.03 (2.54)
Freq. of MJ use (last 3 months)	5.58 (3.46)

Note. Standard deviations provided in parentheses.

Table 2

Correlations, raw means, and standard deviations of juveniles who have committed offenses

Variable	1	2	3	4	5	6	7
1. Ever committed an offense	----						
2. I often do things on impulse	0.183**	----					
3. Impulsivity subscale IMPSS	0.176**	0.615**	----				
4. Past 3 month alcohol consumption	0.118	0.159*	0.167*	----			
5. Past 3 month drink frequency	0.058	0.170*	0.114	0.594**	----		
6. Total audit score	0.063	0.206**	0.213**	0.594**	0.575**	----	
7. Total RAPI score	0.130	0.238**	0.289**	0.355**	0.440**	0.651**	----
<i>M</i>	0.400	0.552	3.694	3.493	3.409	7.688	13.103
<i>SD</i>	0.491	0.498	1.963	2.434	2.336	7.369	15.465

Note. Range for impulse (1,0), impulsivity subscale (1,0), alcohol consumption (1-9), drink frequency (1-10), audit (0-4), rapi (0-4)

* $p < .05$, ** $p < .01$

Table 3

Summary of Multiple Regression Analysis for Committing an Offense (n = 206)

Variable	B	SE(B)	β	<i>t</i>	Sig. (<i>p</i>)
Impulsivity	0.037	0.017	0.149	2.145	0.033
Alcohol Frequency	0.033	0.017	0.165	1.983	0.049
Marijuana Use	-0.335	0.091	-0.25	-3.67	0.000
RAPI Score	0.004	0.003	0.139	1.547	0.123
AUDIT Score	-0.007	0.007	-0.113	-1.114	0.266

Note. $R^2 = .104$

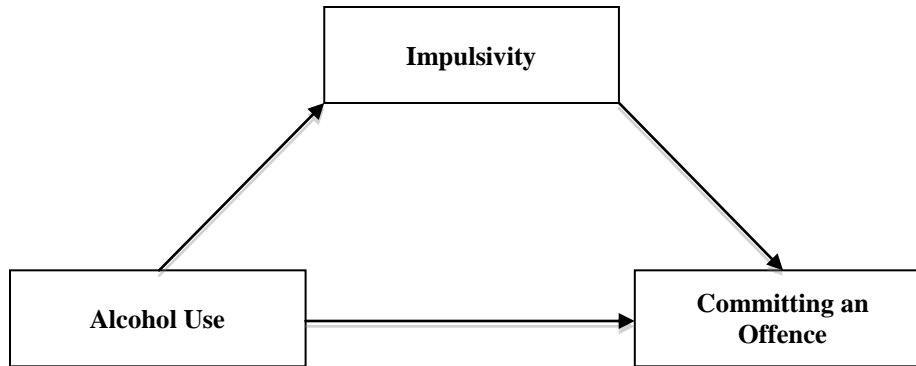


Figure 1. Hypothesized relationship: Independent variable (alcohol use), dependent variable (Committing an offense), Mediator (Impulsivity).

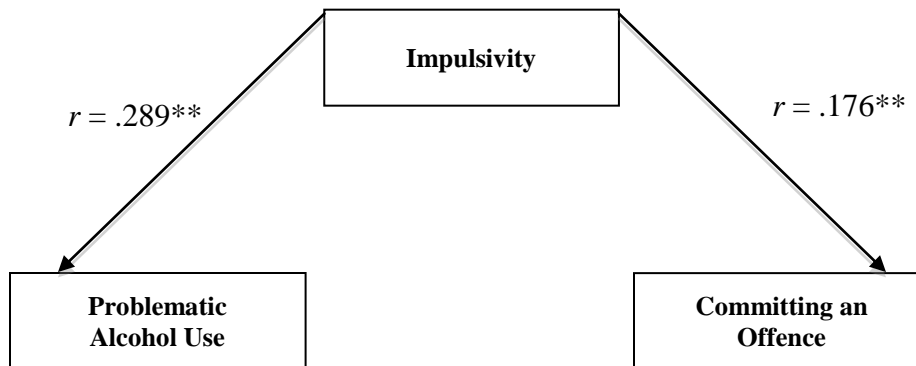


Figure 2. Actual relationship found: Independent variable (problematic alcohol use) and (Committing an offense), Dependent variable (Impulsivity).

Appendix

IMPSS:

Read each of the following statements. If you agree with a statement or decide that it is true for you, answer TRUE. If you disagree with a statement or feel that it is not true for you, answer FALSE.

ANSWER EVERY STATEMENT BY CIRCLING EITHER TRUE OR FALSE EVEN IF YOU AREN'T ENTIRELY SURE OF YOUR ANSWER. *Imintro2*

All questions are answered with choosing True=1 False=0

1. I tend to begin a new job without much advance planning on how I will do it. *IMPSS1*
2. I usually think about what I am going to do before I do it. *IMPSS2*
3. I often do things on impulse. *IMPSS3*
4. I don't spend much time on the details of planning ahead. *IMPSS4*
5. I like to have new and exciting experiences and sensations, even if they are a little frightening. *IMPSS5*
6. Before I begin a complicated job, I make careful plans. *IMPSS6*
7. I would like to take a spontaneous trip with no pre-planned or definite routes or timetable. *IMPSS7*
8. I enjoy getting into new situations where you can't predict how things will turn out. *IMPSS8*
9. I like doing things just for the thrill of it. *IMPSS9*
10. I tend to change interests frequently. *IMPSS10*
11. I sometimes like to do things that are a little frightening. *IMPSS11*
12. I'll try anything once. *IMPSS12*
13. I would like the kind of life where I am on the move and traveling a lot, with lots of change and excitement. *IMPSS13*
14. I sometimes do "crazy" things just for fun. *IMPSS14*
15. I like to explore a strange city or section of town by myself, even if it means getting lost. *IMPSS15*
16. I prefer friends who are exciting and unpredictable. *IMPSS16*
17. I often get so carried away by new and exciting things and ideas that I don't think of what might go wrong. *IMPSS17*
18. I am an impulsive person. *IMPSS18*
19. I like wild and uninhibited parties. *IMPSS19*

Alcohol Use:

The next set of questions, ask about your behavior with regard to alcohol and drug use. For the questions about alcohol, one "drink" is defined as one beer, one glass of wine, or one serving of hard liquor (a shot) either by itself or in a mixed drink. *drugintro*

1. Have you ever used alcohol? *ALCYESNO* Circle one Yes=1 No=0 (if no skip to ques. 5)

a. If yes, how old were you when you first tried alcohol? **ALCTRY**
 _____ (R 5-18)

b. How many years have you been drinking alcohol? **YEARALC**
 _____ (R 0-15)

2. *In the last 3 months*, how often did you consume *at least one* alcoholic drink? **ALC1**
Circle one:

Never =1	Occasionall y=2	Once a month=3	2-3 times a month= 4	4-5 times a month= 5	Once a week=6	2-3 times a week=7	4-5 times a week=8	Every day=9
-------------	--------------------	-------------------	----------------------------------	----------------------------------	------------------	-----------------------------	-----------------------------	----------------

3. *In the last 3 months*, how many drinks did you usually have at one time? **ALC2**
Circle one:

None =1	1 drink= 2	2-3 drinks=3	4-6 drinks=4	7-9 drinks=5	10-12 drinks=6	13-15 drinks=7	16-18 drinks=8	19-20 drinks=9	More than 20 drinks=10
------------	------------------	-----------------	-----------------	-----------------	-------------------	-------------------	-------------------	-------------------	------------------------------

Marijuana Use:

24. Have you ever used marijuana? **Marysno** Circle one Yes=1 No=0 (If no skip to ques 26)

a. If yes, how old were you when you first used marijuana? **maritry**
 _____ (R 5-18)

b. How many years have you used marijuana? **yearmari**
 _____ (R 0-15)

25. *In the last 3months*, how frequently have you used marijuana? **Marfreq** Circle one:

Never =1	Occasionall y	Once a month	2-3 times a month	4-5 times a month	Once a week	2-3 times a week	4-5 times a week	Every day=9
-------------	------------------	-----------------	----------------------------	----------------------------	----------------	---------------------------	---------------------------	----------------

AUDIT:

1. Have you had an alcoholic drink (examples: beer, wine, liquor, mixed drink including alcohol) in the past year? **ALCYEAR**

Yes=1

No=0 Skip to Rapiint1

5. How often do you have a drink containing alcohol? **AUDIT1**
 Never=0 Less than monthly=1 Monthly=2 Weekly=3 Daily or almost daily=4
6. How many drinks containing alcohol do you have on a typical day when you are drinking? **AUDIT2**
 1 or 2=0 3 or 4=1 5 or 6=2 7 to 9=3 10 or more=4
7. How often do you have 6 or more drinks on one occasion? **AUDIT3**
 Never Less than monthly Monthly Weekly Daily or almost daily
8. How often during the last 6 months have you found that you were not able to stop drinking once you had started? **AUDIT4**
 Never Less than monthly Monthly Weekly Daily or almost daily
9. How often during the last 6 months have you failed to do what was normally expected of you because of drinking? **AUDIT5**
 Never Less than monthly Monthly Weekly Daily or almost daily
10. How often during the past 6 months have you needed a first drink in the morning to get yourself going after a heavy drinking session? **AUDIT6**
 Never Less than monthly Monthly Weekly Daily or almost daily
11. How often during the last 6 months have you had a feeling of guilt or remorse after drinking? **AUDIT7**
 Never Less than monthly Monthly Weekly Daily or almost daily
12. How often during the last 6 months have you been unable to remember what happened the night before because you had been drinking? **AUDIT8**
 Never Less than monthly Monthly Weekly Daily or almost daily
13. Have you or someone else been injured as a result of you drinking? **AUDIT9**
 No=0 Yes, but not in the last 6 months=2 Yes, during the last 6 months=4
14. Has a relative or friend, doctor or health worker been concerned about your drinking or suggest you cut down? **AUDIT10**

No=0 Yes, but not in the last 6 months=2 Yes, during the last 6 months=4

RAPI:

Different things happen to people when they are drinking ALCOHOL, or because of their ALCOHOL use. Some of these things are listed below. Please answer regardless of whether you have never had a drink. **Rapiint1**

READ EACH STATEMENT CAREFULLY, AND CIRCLE ONLY *ONE* ANSWER TO EACH STATEMENT. **Rapiint2**

How many times did the following things happen to you *while you were drinking alcohol* or *because of your alcohol use* during the *last 6 months*? **Rapiint3**

1. Not able to do your homework or study for a test **RAPI1**
Never=0 1-2 times=1 3-5 times=2 6-10 times=3 More than 10 times=4
2. Got into fights, acted bad, or did mean things **RAPI2**
Never 1-2 times 3-5 times 6-10 times More than 10 times
3. Missed out on other things because you spent too much money on alcohol **RAPI3**
Never 1-2 times 3-5 times 6-10 times More than 10 times
4. Went to work or school high or drunk **RAPI4**
Never 1-2 times 3-5 times 6-10 times More than 10 times
5. Caused shame or embarrassment to someone **RAPI5**
Never 1-2 times 3-5 times 6-10 times More than 10 times
6. Neglected your responsibilities **RAPI6**
Never 1-2 times 3-5 times 6-10 times More than 10 times
7. Relatives avoided you **RAPI7**
Never 1-2 times 3-5 times 6-10 times More than 10 times
8. Felt that you needed more alcohol than you used to use in order to get the same effect **RAPI8**
Never 1-2 times 3-5 times 6-10 times More than 10 times
9. Tried to control your drinking by trying to drink only certain times of day or certain places **RAPI9**
Never 1-2 times 3-5 times 6-10 times More than 10 times

10. Had withdrawal symptoms, that is, felt sick because you stopped or cut down on drinking **RAPI10**
- | | | | | |
|-------|-----------|-----------|------------|--------------------|
| Never | 1-2 times | 3-5 times | 6-10 times | More than 10 times |
|-------|-----------|-----------|------------|--------------------|
11. Noticed a change in your personality **RAPI11**
- | | | | | |
|-------|-----------|-----------|------------|--------------------|
| Never | 1-2 times | 3-5 times | 6-10 times | More than 10 times |
|-------|-----------|-----------|------------|--------------------|
12. Felt that you had a problem with school **RAPI12**
- | | | | | |
|-------|-----------|-----------|------------|--------------------|
| Never | 1-2 times | 3-5 times | 6-10 times | More than 10 times |
|-------|-----------|-----------|------------|--------------------|
13. Missed a day (or part of a day) of school or work **RAPI13**
- | | | | | |
|-------|-----------|-----------|------------|--------------------|
| Never | 1-2 times | 3-5 times | 6-10 times | More than 10 times |
|-------|-----------|-----------|------------|--------------------|
14. Tried to cut down on drinking **RAPI14**
- | | | | | |
|-------|-----------|-----------|------------|--------------------|
| Never | 1-2 times | 3-5 times | 6-10 times | More than 10 times |
|-------|-----------|-----------|------------|--------------------|
15. Suddenly found yourself in a place that you could not remember getting to **RAPI15**
- | | | | | |
|-------|-----------|-----------|------------|--------------------|
| Never | 1-2 times | 3-5 times | 6-10 times | More than 10 times |
|-------|-----------|-----------|------------|--------------------|
16. Passed out or fainted suddenly **RAPI16**
- | | | | | |
|-------|-----------|-----------|------------|--------------------|
| Never | 1-2 times | 3-5 times | 6-10 times | More than 10 times |
|-------|-----------|-----------|------------|--------------------|
17. Had a fight, argument, or bad feelings with a friend **RAPI17**
- | | | | | |
|-------|-----------|-----------|------------|--------------------|
| Never | 1-2 times | 3-5 times | 6-10 times | More than 10 times |
|-------|-----------|-----------|------------|--------------------|
18. Had a fight, argument or bad feelings with a family member **RAPI18**
- | | | | | |
|-------|-----------|-----------|------------|--------------------|
| Never | 1-2 times | 3-5 times | 6-10 times | More than 10 times |
|-------|-----------|-----------|------------|--------------------|
19. Kept drinking when you promised yourself not to **RAPI19**
- | | | | | |
|-------|-----------|-----------|------------|--------------------|
| Never | 1-2 times | 3-5 times | 6-10 times | More than 10 times |
|-------|-----------|-----------|------------|--------------------|
20. Felt you were going crazy **RAPI20**
- | | | | | |
|-------|-----------|-----------|------------|--------------------|
| Never | 1-2 times | 3-5 times | 6-10 times | More than 10 times |
|-------|-----------|-----------|------------|--------------------|
21. Had a bad time **RAPI21**
- | | | | | |
|-------|-----------|-----------|------------|--------------------|
| Never | 1-2 times | 3-5 times | 6-10 times | More than 10 times |
|-------|-----------|-----------|------------|--------------------|
22. Felt physically or physiologically dependent on alcohol **RAPI22**
- | | | | | |
|-------|-----------|-----------|------------|--------------------|
| Never | 1-2 times | 3-5 times | 6-10 times | More than 10 times |
|-------|-----------|-----------|------------|--------------------|
23. Was told by a friend or neighbor to stop or cut down your drinking **RAPI23**
- | | | | | |
|-------|-----------|-----------|------------|--------------------|
| Never | 1-2 times | 3-5 times | 6-10 times | More than 10 times |
|-------|-----------|-----------|------------|--------------------|