Proceedings of The National Conference
On Undergraduate Research (NCUR) 2019
Kennesaw State University
Kennesaw, Georgia
April 11-13, 2019

Understanding More About College Students Who Use Multiple Drugs – Who They Are, Their Temperaments and Their Genotypes

Shivani Vasudev
Psychology
Georgia Gwinnett College
Lawrenceville, Georgia 30044 USA

Faculty Advisor: Dr. Jennell Talley and Dr. Matthew T. Schmolesky

Abstract

Robert Cloninger's theory of personality includes four dimensions of temperament: novelty seeking, harm avoidance, reward dependence, and persistence. Reward dependence (RD) is the tendency to respond to social rewards in maintaining behavior while novelty seeking (NS) is the tendency to take adventure-driven activities and make impulsive decisions. Drug use affects individuals in multiple aspects of their life such as performance at school or jobs, in social settings, and their health. The main purpose of this study was to analyze correlations between RD and NS and use of multiple drugs. We collected survey data and DNA via cheek swabs from student participants (n=226). Thirty-six percent of the participants never tried drugs while 64% tried at least one drug. To date we have not found correlations between RD and multiple drug use but did find that participants that used more types of drugs had a slight tendency to have higher NS scores (r=0.13, p=0.05). As expected, analysis of frequency of drug use and perceived risk resulted in a significant negative correlation (r=-0.18, p=0.007). Additionally, we discovered that participants who engaged in multiple types of drugs perceived drug use as a low risk (r=-0.13, p=0.056). Female participants exhibited higher NS scores than the male participants (p=0.03). A one-way ANOVA suggested Biracial/Multiracial and White/Caucasian participants were significantly different from all other groups in their frequency of drug use, exhibiting a higher average frequency. Biracial/Multiracial perceived drug use significantly different from all other groups, exhibiting a lower perceived risk. Ongoing research involves investigating the relationships between these two temperaments, multiple drug use, and the STin2 polymorphism of the serotonin transporter gene (*SLC6A4*) as well as performing additional analysis on participants who have a more extreme use of multiple drugs.

Keywords: Novelty seeking, Reward dependence, Drugs, Serotonin, 5-HTTLPR, SLC6A4

1. Introduction

Robert Cloninger's personality model establishes four dimensions of temperament: novelty seeking, harm avoidance, reward dependence, and persistence[1]. The four temperaments were assessed through a 240-item Temperament and Character Inventory (TCI) questionnaire[1]. Novelty seeking (NS) is defined as impulsive decision making, quick loss in temper, excitation by reward cues, engagement of adventure-driven activities, and avoidance of frustration[1,2]. Reward Dependence (RD) is defined as the tendency to respond to social rewards in maintaining behavior[1,2].

Individuals who are highly reward dependent are attracted to immediacy of rewards and have a higher risk for drug dependence[3]. Individuals who are high novelty seekers may engage in drug use as a means to self-medicate in response to depression, anxiety, and panic disorders; they also tend to be more drug dependent[4]. This study analyzed individual's reward dependence scores as well as novelty seeking scores and their drug usage based on the frequency of use of six drugs: opiates, illegal stimulants, cigarettes/e-cigs, club drugs, alcohol, and hallucinogenic drugs[4]. These six different types of drugs were chosen as they tend to be addictive, psychedelic, or illegal[5]. Additionally, opiates and illegal stimulants tend to relieve pain; cigarettes/e-cigs and club drugs stimulate euphoric and relaxation feelings;

alcohol is an anxiolytic and sedative, and; hallucinogenics intensify feelings, and change perception[5]. Alcohol, smoking, and opiate use has been shown to be correlated with high novelty seeking as well as high reward dependence[3,4,6,7]. Further research is necessary to determine whether the other drugs are related to reward dependence and/or novelty seeking.

Behaviors are often influenced by culture and environment[8,9]. Young adults growing up with a bicultural identity may struggle to assimilate as they attempt to balance between family values and peer groups when it involves decision-making[8,9]. Interestingly, this intergenerational conflict with culture varies among each ethnicity when it comes to substance use. Some cultures may prohibit use while others accept specific drug use as this may revolve around certain values, attitudes, and norms[8]. Additionally, the availability of information surrounding the risks of drug use may be limited among each ethnicity group with factors such as access to education affecting their perception and ultimately, their choices[9].

The serotonin neurotransmitter plays a crucial role in functioning of mood, sleep, appetite, and sexual activity in humans. The serotonin transporter protein (5-HTT) is essential to reuptake serotonin so it can be reused and to clear the synaptic cleft of the neurotransmitter[10]. Understanding the biochemistry of neurochemical reactions in the brain have contributed to understanding why varied amounts of neurotransmitters affect behavior. Neurotransmitters such as monoamines (e.g. dopamine, norepinephrine, and serotonin) are integral in determining how behavior is shaped, particularly mechanisms such as inhibition and arousal, which are important in the development of temperaments[11].

An insertion/deletion in the promoter region of the 5-HTT gene (*SLC6A4)* affects the expression of the protein. These polymorphisms are referred to as short (S) and long (L)[10]. The S allele has decreased expression of the serotonin transporter protein while the long version displays increased expression[10]. Heterozygotes (S/L) have an intermediate level of expression of the serotonin transporter protein[10]. Individuals who are homozygous for the S allele could presumably have more serotonin in the synaptic cleft because there would be less transporter present to remove the neurotransmitter, though developmental compensatory mechanisms are likely to influence the actual end result in adults. It is thought that differences in the amounts of neurotransmitter in the cleft has the potential to impact an individual's behavior. Interestingly, individuals who have lower expression of the serotonin transporter gene (S/S), are more likely to perceive consumption of drugs as a low risk activity and are more likely to participate in multi-drug use[11]. This suggests that decreased reuptake of the serotonin neurotransmitter, or increased serotonin present in the synaptic cleft, may increase the likelihood of using drugs. By studying this gene in individuals who use multiple drugs, we have determined relationships between reward dependence and novelty seeking for individuals who use multiple drugs; we have investigated their perceived risk of drug use, explored how ethnicity may be related to drug use, and started evaluating what relationship the short and long alleles of the *SLC6A4* gene may have on temperament and drug use.

2. Methodology

2.1 Participants

All of the participants that volunteered for this study were students at Georgia Gwinnett College (GGC). Two-hundred and thirty-one students volunteered, of which 72% (n=166) identified as female, 28% (n=64) identified as male, and one participant identified as "other". Participants were recruited from biology and psychology courses and incentivized with extra credit or credit.

2.2 Procedures With Participants

Participants were required to sign an informed consent and notified that all responses to the questionnaires would be anonymous. Participants' DNA were collected using a buccal swab. Each participant was assigned a random number that was matched to their DNA and survey information. Participants completed the physical risk assessment inventory (PRAI), physical risk frequency inventory (PRFI), and the temperament and characteristics inventory (TCI). Surveys were conducted on a computer platform using SONA. All procedures were approved by GGC IRB committee.

2.3 Surveys

2.3.1. physical risk assessment inventory (PRAI)

The physical risk assessment inventory (PRAI) questionnaire was used to understand how a participant assessed the risk of a specific activity. There were a total 28 risky activities ranging from adventurous sports, drug usage, and other general risky activities. The participants used a Likert scale to score how they perceived the risk of the particular activity: 0 = no risk, 1 = little risk, 2-4 = moderate risk, and 5-6 = extreme risk. For this study, we analyzed the scores for opiates, illegal stimulants, cigarettes/e-cigs, club drugs, alcohol, and hallucinogenic drugs.

2.3.2. physical risk frequency inventory (PRFI)

The physical risk frequency inventory (PRFI) questionnaire was used to measure how frequently a participant engaged in the same 28 activities used for PRAI. The scale was based on how many days in a year the participant engaged in a particular activity. For example, participants marked frequency that they engaged in "heavy drinking of alcohol" 0 = never tried it, 1 = tried 1-3 times, 2 = 1-10 days per year, 3 = 11-20 days per year, 4 = 21-30 days per year, 5 = 30-40 days per year, 6 = 41-50 days per year, and 7 = tried more than 51 days per year. For this study, we analyzed the frequency scores for opiates, illegal stimulants, cigarettes/e-cigs, club drugs, alcohol, and hallucinogenic drugs.

2.3.3. temperament and characteristics inventory (TCI)

The last questionnaire, Temperament and Characteristics Inventory (TCI), was developed by Robert Cloninger. It consisted of 240 true and false statements that assessed four dimensions of temperament: Novelty Seeking (NS), Harm Avoidance (HA), Reward Dependence (RD), and Persistence and three dimensions of character: Self-Directedness, Cooperativeness, and Self-Transcendence. Each statement was associated with a particular temperament and character trait. A value was assigned to each statement and all the values were added for each category in order to have a score for each temperament. For this study, we analyzed reward dependence and novelty seeking scores.

2.3.4 sociodemographics

Additional participant information was obtained through sociodemographic questions. Participants were asked about their age, gender, occupation, marital status, and ethnicity. Other questions included any ongoing or future drug addictions. For this study, we analyzed age, gender, and ethnicity information.

2.4 Genotyping

The DNA collected from the participants through buccal swab methods was analyzed through genotyping. Each participant swabbed their inner cheek. The swab was dried for about 15 minutes and then stored at -20°C until processed. To remove DNA from the swab, it was immersed in 500 µL of DNA extraction solution (QuickExtract™) and swirled for approximately 30 seconds. This solution was vortexed for ten seconds, incubated for 1 minute at 65°C, vortexed again for fifteen seconds, and incubated for 2 minutes at 98°C. The DNA tube was stored at -20°C until PCR analysis was performed.

The DNA was amplified using polymerase chain reaction (PCR). The PCR contained 1X PCR Master Mix (Thermofisher), 1 µL of 25 mM primers (JP and GR) and approximately 50-100 ng of DNA template. The sequence of the JP primer (forward primer) used was 5'-TGGATTTCCTTCTCTCAGTGATTGG-3'. The sequence of the GR primer (reverse primer) used was 5'-TCATGTTCCTAGTCTTACGCCAGTG-3'. The PCR protocol was 1 cycle of 5 minutes at 94°C; 40 cycles of: 1 min at 94°C, 1 min at 60°C, and 1 min at 72°C. The final phase was a 20-minute elongation at 72°C. SYBR™ green (Invitrogen™) was added to the samples, which were then run on a 2% agarose gel for approximately three hours and then visualized using a UV box.

2.5 Statistical Analysis

Data were analyzed using Microsoft Office Excel and online ANOVA with post-hoc Tukey software[12]. The information analyzed was used to find mean ± standard deviation (SD), and mean differences were compared using ANOVA, t-tests, and post-hoc analyses. R-values were used to understand if a relationship existed between the variables analyzed. The strength and significance of the correlation was assessed on the alpha level of 0.05.

2.6 Hypotheses

For this study, there were several hypotheses based off previous research:
(1) Female and male participants differ in how often they use drugs.
(2) Participants ages 18-24 use drugs less often than those 25 and above.
(3) Individuals who use drugs more often are more reward dependent.
(4) Individuals who use multiple types of drugs are more reward dependent.
(5) Individuals who use drugs more often are more novelty seeking.
(6) Individuals who use multiple types of drugs are more novelty seeking.
(7) Frequent drug users perceive drug use as a lower risk activity than those who use drugs less frequently.
(8) Individuals who use multiple types of drugs perceive drug use as a low risk activity.
(9) There is a difference in how different ethnic groups use drugs.
(10) There is a difference in how different ethnic groups perceive drug usage.
(11) Individuals with the S/S genotype have higher NS scores and engage in multiple drug use[11].

3. Data

3.1 Descriptive Statistics

Table 1. Descriptive statistics for age, reward dependence and novelty seeking overall and by gender.

	Overall Statistics			Females			Males		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
Age	22.60	6.90	226	23.15	7.93	163	21.11	2.83	62
RD	19.71	4.46	231	19.93	4.30	166	19.19	4.85	64
NS	19.23	4.95	231	19.62	4.82	166	18.19	5.20	64

This study was comprised of 231 students: 166 females, 64 males, and 1 other. The average RD score for GGC participants was 19.71 (Table 1) (national average of RD = 18.8)[1]. The average NS score for GGC participants was 19.23 (Table 1) (national average of NS = 19.2)[4]. Thus, the range for both RD and NS are within the national average. Participants were between 18-65 years old (average = 22.60 ± 6.90 years). The population was diverse and matched the demographics of the college: 15% Asian, 10% Biracial/Multiracial, 26% Black or African American, 18% Hispanic or Latino, and 31% White or Caucasian. Biracial/Multi-racial individuals were classified based on whether they put more than one ethnicity down on the sociodemographic questions.

To determine how prevalent drug use is among GGC students, we analyzed frequency of drug use and number of types of drugs used. Thirty-six percent reported never having tried any drugs (n=82), 20% have tried drugs once (n=47), and 44% have tried drugs more than once (n=102) (Figure 1a). 34% of the participants have tried one type of drug (n=79), 21% have tried two types of drugs (n=48), 3% have tried three types (n=8), 3% have tried four types (n=6), 2% have tried five types (n=5), and 1% have tried all six types of drugs (n=3) (Figure 1b). Only 9% of the participants have tried three or more types of the six drugs analyzed.

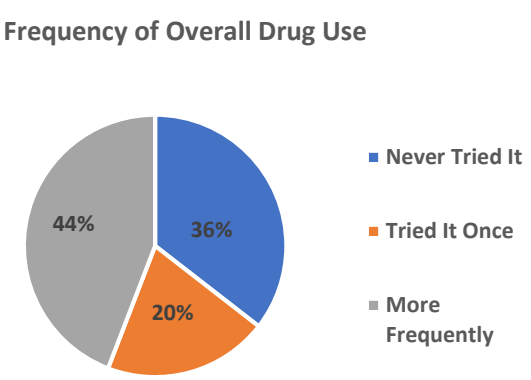

Figure 1a. Participants were classified based on how frequently they engage in drug use in a year.

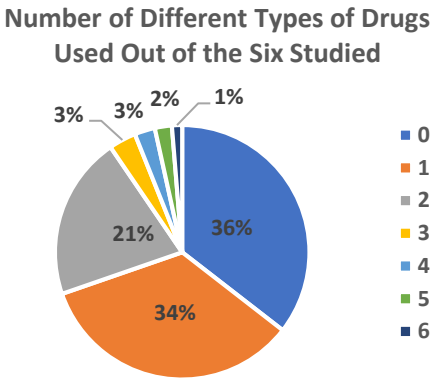

Figure 1b. Participants were classified based on the number of different types of drug they used within a year.

3.2 Gender and Age Comparisons

Table 2. Comparison of means between gender and personality type, gender and frequency of drug use, and age and frequency of drug use. An asterisk denotes statistical significance.

Comparison	p-value	Females	Males
Reward dependence by gender	p>0.05	19.93 ± 4.3019.19_± 4.85	1
Novelty seeking by gender	p=0.029*	19.62 ± 4.82	18.19 ± 5.20
Frequency of drug use by gender	p>0.05	2.05 ± 2.73	2.50 ± 3.51
		Ages: 18-24	**Ages: 25 and above**
Frequency of drug use by age	p>0.05	2.13 ± 2.95	2.69 ± 3.11

3.2.1 gender comparisons

There was no difference between female and male participants in reward dependence scores (n=230, p>0.05). However, there was a difference in female and male participants in novelty seeking scores (n=230, p<0.05) (Table 2). Additionally, there were no differences between females and males in how often they used drugs (n=230, p>0.05) (Table 2).

3.2.2 age comparisons

To determine if there were any differences in the frequency of drug use between more traditional students and non-traditional students, drug use for students between 18 and 24 were compared to those over 24 years. There was no statistical difference in frequency of drug use for students in these two categories (n=226, p>0.05). Note some students were removed from this analysis because they did not report an age.

3.3 Correlations between drug use, temperaments, and perceived risk

Table 3. Correlations tested between drug use, temperaments and perceived risk. An asterisk denotes statistical significance

Correlation tested	**Overall Statistics**	
	r-value	p-value
Frequency of drug use and RD	0.01	p>0.05
Number of types of drugs and RD	0.06	p>0.05
Frequency of drug use and NS	0.09	p>0.05
Number of types of drugs and NS	0.13	p=0.05*
Frequency of drug use and perceived risk	-0.18	p=0.007*
Number of types of drugs and perceived risk	-0.13	p=0.05*

3.3.1 correlations between reward dependence and drug use

Some drugs show a relationship with reward dependence, such as smoking, alcohol, and opiates [3,6,7]; to determine if individuals who engage either in frequent drug use or use many types of drugs are also reward dependent, an association test was done. There were no correlations detected between frequency of drug use and reward dependence (n=231, r=0.01, p>0.05) or average number of types of drugs used and reward dependence (n=231, r=0.06, p>0.05) (Table 3).

3.3.2 correlations between drug use and novelty seeking

Use of drugs such as alcohol, nicotine and opiates have been linked to novelty seeking behaviors[4,6]. To test if this link is also present in individuals who use drugs frequently or use multiple types of drugs, participant's frequency of use and novelty seeking scores were analyzed. Though there was no significant relationship between frequency of drug use and novelty seeking (n=231, r=0.09, p>0.05), there was a significant, positive, relationship between the number of types of drugs used and novelty seeking (n=231, r=0.13, p=0.05*) (Table 3), suggesting that those who use more types of drugs tend to have a higher NS score.

3.3.3 correlations between drug use and perceived risk

Typically, the more frequently someone engages in a particular activity, even if it is generally considered risky, they perceive it as less risky[9]. Indeed, in this study, participants who reported participating in more frequent drug use, perceived the activity as less risky (n=231, r=-0.18, p=0.007*) (Table 3). Additionally, those who use more types of drugs also viewed drug use as less risky than those who have tried fewer types of drugs (n=231, r=-0.13, p=0.05*) (Table 3).

3.4 Ethnicity Comparisons

3.4.1 differences in frequency of drug use between ethnicities

The GGC population is a majority minority population; we wanted to investigate whether groups differed in their drug use based on their cultural background. Asians have a restraining relationship with drug usage, therefore we hypothesized they would use drugs less than other ethnicities[25]. When analyzed by ethnicity, there was a significant difference between ethnic groups in how frequently they engaged in drug use. Biracial/Multiracial and White or Caucasian individuals differed in average frequency of drug use compared to Asians, Black or African Americans, and Hispanic or Latino individuals (Figure 2). Biracial/Multiracial and White or Caucasian individuals did not differ from each other in frequency of drug use. In order to determine differences in frequency of drug use between ethnicities, an ANOVA was completed followed by a post-hoc Tukey.

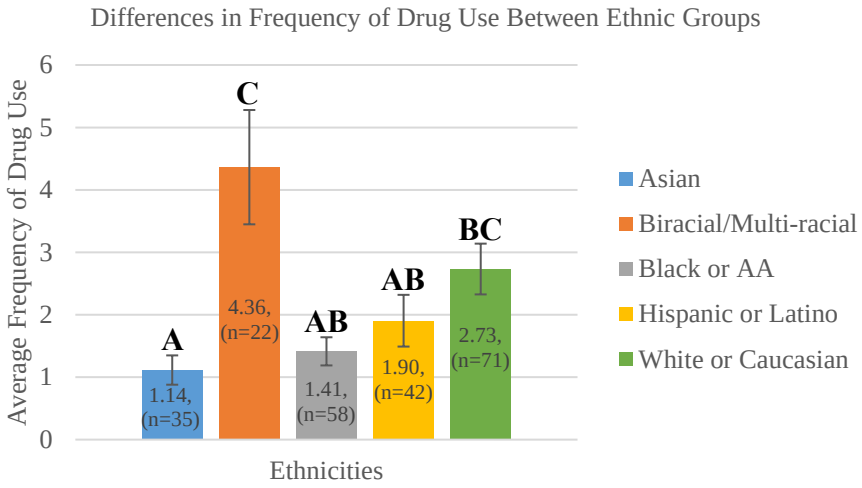

Figure 2. Comparison of frequency of drug use between ethnicities. The average and sample size for each ethnicity indicated within each bar (n=228, $p<0.05$*). The letters above each bar denote relationships; Biracial/Multi-racial individuals reported an average frequency of drug use that was significantly different than all other ethnicities except White or Caucasian individuals.

3.4.2 differences in perceived risk between ethnicities

Those who engage in frequent drug use tend to perceive drug use as low risk. Based on the previous difference, Biracial/Multiracial and White or Caucasian individuals were predicted to perceive engaging in drug use with low risk. There was a significant difference in ethnic groups when comparing their perceived risk of drugs use ($p=0.035$*) (Figure 3). A post hoc Tukey test revealed that Biracial/Multiracial individuals differed significantly from all other ethnicities.

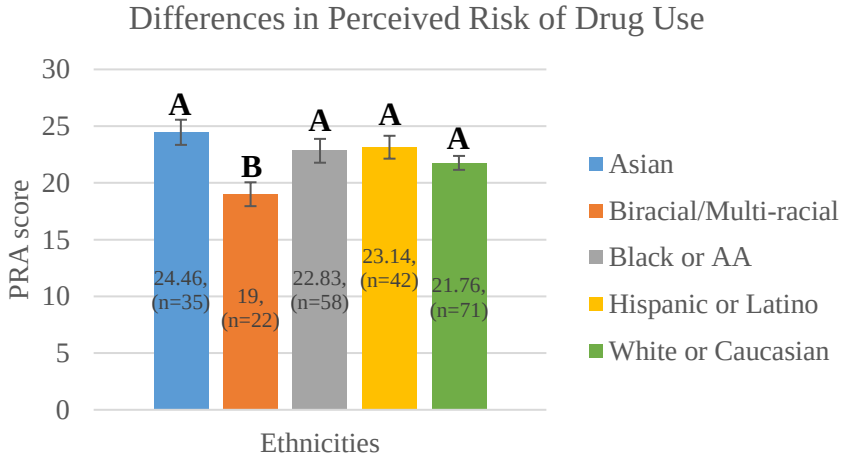

Figure 3. Comparison of average perceived drug risk between ethnicities. The average and sample size for each ethnicity indicated within each bar (n=228, $p=0.035$*). Biracial/Multi-racial individuals significantly differed in perceived risk from all other ethnicities.

3.5 Analysis of Genotypes

Polymorphisms in the serotonin transporter gene *SLC6A4* have been linked to both reward dependence and novelty seeking[10]. To determine if our population also showed relationships between genotype and RD or NS an ANOVA was performed on the average RD or NS score for each genotype (S/S, L/S, and L/L). To date, 70 of the 231 participants

have been genotyped. There was no significant difference for RD scores when comparing genotypes ($p>0.05$), but there was for NS scores ($p=0.019$*) (Table 4). A post-hoc Tukey revealed the L/L genotype differed significantly from the S/S in novelty seeking (Table 4).

Table 4. Statistics of genotypes completed and correlation to RD and NS, frequency of drug use, average number of drugs used, and perceived risk of drug use.

Genotype (*n*=51)	**N**	**Average RD score**	**Average NS Score**	**Ave. Frequency of Drug Use**	**Average Number of Drugs Used**	**Average Perceived Risk of Drug Use**
L/L	19	20.11	20.42	2.63	1.21	22.21
L/S	32	20.63	17.5	1.59	0.78	25.13
S/S	19	20.74	15.47	2.58	1.32	19.63
p-value		$p>0.05$	$p=0.019$*	$p>0.05$	$p>0.05$	$p=0.004$*

To determine if frequency of drug use or number of types of drugs used was different between the three genotypes an ANOVA was completed. In both cases, there was no statistical difference detected ($p>0.05$) (Table 4). When testing for differences for perceived risk between the three genotypes, there was a significant difference, with L/S being different from the other genotypes ($p=0.004$*) (Table 4).

4. Conclusion

This study was conducted in order to understand the relationship between reward dependence and novelty seeking in college students who use drugs and to determine if their genotype may also play a role in their temperament and drug use. DNA was collected from each participant in order to analyze their genotype. Furthermore, survey data was analyzed to understand relationships between variables and determine significant differences between groups.

The average reward dependence scores of GGC participants were within range of the national average for reward dependence. It was hypothesized that females would score higher than males in reward dependence, but our analysis did not support this[13]. GGC female students had similar RD scores to their male counterparts.

Novelty seeking scores for GGC participants were comparable to the national average and at GGC female students have higher NS scores compared to male students, as expected and hypothesized[4].

Older people tend to use more drugs, most likely due to encountering more stress in their lifetime compared to younger individuals[14,15]. Additionally, illicit and prescription drugs have a high likelihood of misuse among older populations, with alcohol being the most commonly abused drug[14]. Given these data, we hypothesized that older people have used drugs more often than younger people. Our hypothesis was not supported; older individuals use these drugs at the same frequency as younger individuals in our sample. It is important to note that a majority of our participants were under 25 years of age. Therefore, we may not have detected a difference due to a smaller sample size for the older student population.

Most of drugs in this study have the potential for abuse and dependence[16-19]. Additionally, individuals who frequently use these drugs tend to be highly reward dependent[20-23]. From these data, we hypothesized, individuals who use multiple drugs would be highly reward dependent. Interestingly, we found no correlation between frequency of drug use and RD nor did we find any relationship between the number of types of drugs used and RD in our population. A third of our sample stated they never engaged in drug use, leaving a smaller population of students who do use drugs. Our population size may not be large enough to detect statistical significance for RD. Most studies that investigate RD do so using one or two drugs, not six, as in this study. It is possible that use of certain drugs is due less to RD and more to another temperament or specific environmental situations. By collapsing the use of six drugs together, it may have inadvertently diluted the ability to discern a relationship between general drug use and RD.

Individuals who use multiple types of drugs may do so because they are curious about how the drugs may affect their senses or state of mind, suggesting that individuals who are novelty seeking may be more interested in trying or using many types of drugs[4]. Furthermore, most of the drugs analyzed are associated with addiction and high NS individuals tend to vary in their drug use compared to low NS individuals[4, 23,]We hypothesized that individuals who have tried or use multiple types of drugs or use them more frequently will also have higher NS scores. Though there was no significant relationship between frequency of drug use and NS, individuals who have tried or use multiple types of drugs do have higher NS scores. Supporting that high NS individuals use multiple types of drugs.

It is clear that environmental cues such as education and availability of the substance can impact drug use[9]. Individuals who use drugs routinely often do not see it as very risky[9]. This may be due to the fact that those who have used drugs for only a short period of time may not have yet personally experienced or fully recognized the negative impact such drugs can have. Also, it is possible that drug use can alter brain functioning causing individuals to assess risk improperly[24]. To this end, it was hypothesized that those who engage in drug use more frequently would assess drug use as less risky and those who engage with more types of drugs (of the six drugs surveyed) would assess drug use as less risky. Our hypotheses were supported and agree with previous studies[24].

Behaviors are generally modified through cultural and social norms, and expectations can be influenced by one's ethnicity[25]. Some ethnicities may refrain from drug use because they believe it may negatively affect them academically, professionally, or socially[25]. These factors may be seen as "protective" to prevent an individual from engaging in activities that have negative outcomes. Individuals who identify as Asians tend to be more school and goal-oriented and do not engage in activities that may hinder their growth because of culture-influenced expectations[25-27]. Drug use is growing among college-aged Asian-Americans, though it is not as high as average drug use compared to other ethnicities[25]. For this reason, we hypothesized that Asians would engage in drug use less than other ethnicities. Interestingly, we found that participants who identify as Biracial/Multi-racial and White or Caucasian exhibited higher average frequencies of drug use compared to all other ethnic groups (there was no difference between the two ethnicities). Although Asians did not differ in average frequency of drug use from all ethnic groups, as predicted, they did differ from Biracial/Multi-racial and White or Caucasian individuals.

Because the more frequently a person uses a drug the less risky they view it (Table 3), we hypothesized that because the more frequently a person uses a drug the less risky they view it (Table 3), it might be expected that Biracial/Multi-racial and White or Caucasian individuals would view drug use as less risky than other ethnicities. Our analyses partially supported our hypothesis; Biracial/Multi-racial individuals did perceive drug use as a less risky activity, but White/Caucasian individuals did not.

Mutations in the serotonin transporter protein SLC6A4 affect the amount of serotonin in the cleft and is thought to influence behavior[10]. Individuals with the S/S genotype already have decreased expression of the serotonin transporter, causing more serotonin to remain in the synaptic cleft[10]. Based on these data, we hypothesized that individuals with the S/S genotype would be more likely to be reward dependent and novelty seeking. To date, a difference in the NS scores between the three different genotypes has been detected, with L/L individuals having a higher NS score compared to S/S individuals, which does not support our hypothesis. There was no difference in RD scores between the three genotypes. Interestingly, individuals who are S/S, perceive drug use as less risky than the individuals with the L/S genotype. There was no statistically significant difference between the genotypes and frequency of drug use or number of types of drugs tried. Because only 70 out of 231 individuals have been genotyped thus far, these data remain preliminary and results may change as more genotypes are determined.

One limitation of this study is that we chose to study several types of drugs that yield different effects in people (stimulants and depressants). It is possible that collapsing multiple drugs together may make it harder to detect any significant differences. For example, many depressants such as alcohol are frequently used in party environments which very much fit the novelty seeking pattern. Therefore, because different types of drugs were collapsed and studied together, significant differences between variables may have been masked. This may be why other studies tend to focus on a single drug or drugs that have a similar mechanism of action rather than multiple drugs. Though we would argue it is still important to understand why some individuals use many types of drugs, especially given that a majority of overdoses involve opiates in combination with at least one other drug[28].

Another limitation is the small sample size of this study. In order to increase confidence in our results, it would be beneficial to increase our sample size to be more representative of the GGC population. Additionally, a third of the participants indicated they did not engage in any drug activity and more than half have only used one drug, making the population of students engaging in multiple drug use quite small, limiting our power to see differences. To determine if those students who do not use drugs altered any findings, an additional analysis was conducted removing participants who do not use drugs. None of the results presented above qualitatively changed when these participants were excluded. For future studies, using populations who do not engage in drug use and a population (e.g. drug rehabilitation center, prison facilities, etc.) where drug activity is heavy, may result in stronger correlations or differences among groups being detected.

Surveys were lengthy and covered very sensitive areas (such as illicit drug use) both of which may have affected participant responses. To help with the length, the surveys could be given in smaller sections (for example, only ask the reward dependence questions on the TCI) in order to strengthen the validity of the participants' responses. As for obtaining truthful answers to sensitive questions, one can only reassure the participant that their anonymity is completely respected in hopes that most people answer truthfully.

In future studies, since GGC female and male participants differed in NS scores, it would be interesting to know how they differ in their drug usage as related to novelty seeking. For example, do females with higher NS scores use different drugs than their male counterparts? Or are there certain drugs that one gender uses more than another? Additionally, it would be interesting to know if there are different relationships for RD and NS between ethnic groups. Knowing why the Biracial/Multiracial group and White or Caucasian group reported using drugs more would be interesting. Lastly, another take on this study could be looking into illegal versus legal drug use and if novelty seeking individuals are more likely to use one type of drug than the other.

This research and its findings may be significant in understanding if there is an underlying genetic component in multiple drug use. This may urge further research in controlling and reducing multiple drug use in relation to those predisposed genetically (i.e. reducing drug overdoses & drug interactions).

5. Acknowledgements

This research project would like to thank Georgia Gwinnett College, and the Vice President of Academic and Student Affairs (VPASA) SEED grant.

6. References

1. Cloninger, C. Robert. “A Psychobiological Model of Temperament and Character.” Archives of General Psychiatry 50, no. 12 (1993): 975-990.
2. Washington University School of Medicine “What the TCI measure?”, 2015, http://psychobiology.wustl.edu/what-does-the-tci-measure
3. Schreckenberger, M., A. Klega, G. Grunder, H.-G. Buchholz, A. Scheurich, R. Schirrmacher, E. Schirrmacher, C. Muller, G. Henriksen, and P. Bartenstein. “Opioid Receptor PET Reveals the Psychobiologic Correlates of Reward Processing.” Journal of Nuclear Medicine 49, no. 8 (2008): 1257–61.
4. Wingo, Taylor, Tanseli Nesil, Jung-Seok Choi, and Ming D. Li. “Novelty Seeking and Drug Addiction in Humans and Animals: From Behavior to Molecules.” Journal of Neuroimmune Pharmacology 11, no. 3 (2015): 456–70.
5. Drug Evaluation and Classification Program (n.d.), http://www.decp.org/drug-recognition-experts-dre/7-drug-categories/
6. Pomerleau, Cynthia S., Ovide F. Pomerleau, Karen A. Flessland, and Susan M. Basson. “Relationship of Tridimensional Personality Questionnaire Scores and Smoking Variables in Female and Male Smokers.” Journal of Substance Abuse 4, no. 2 (1992): 143–54.
7. Varma, V. K.; Basu, D.; Malhotra, A.; Sharma, A.; Mattoo, S. K. "Correlates of early- and late-onset alcohol dependence". Addictive Behaviors 19, no. 6 (1994): 609–619.
8. Westermeyer, J. “Cultural patterns of drug and alcohol use: an analysis of host and agent in the cultural environment.” Bulletin on Narcotics 39, no. 2 (1987):11-27.
9. Lipari, R. and Jean-Francois, B. “Trends in perception of risk and availability of substance use among full-time college students.” The CBHSQ Report, (2016).
10. Heils, A., teufel, A., Petri, S., Stober, G., Riederer, P., Bengel, D., & Lesch, K.P. “Allelic variation of human serotonin transporter gene expression”. Journal of Neurochemistry 66, no. 6 (1996): 2621-2624.
11. Zuckerman, M., & Kuhlman, D. M., “Personality and risk-taking: common bisocial factors.” Journal of Personality 68, no. 6 (2000): 999–1029.
12. One-way ANOVA with Post-hoc Tukey HSD Test Calculator for comparing multiple treatments., http://astatsa.com/OneWay_Anova_with_TukeyHSD/
13. Otter, C., Huber, J., Bonner, A. “Cloninger's Tridimensional Personality Questionnaire: Reliability in an english sample.” Personality and Individual Differences 18, no. 4 (1995): 471-480.
14. Delvecchio, G., Garzitto, M., Fagnani, C., Fornasari, L., Stazi, M.A., Picardi, A., Ciappolino, V., Fabbro, F., Altamura, A.C., Brambilla, P. “Normative Data and Effects of Age and Gender on Temperament and Character Dimensions across a Lifespan in an Italian Population: A Cross-Sectional Validation Study.” Journal of Affective Disorders 204, (2016): 83-91.
15. Hoffman, J.P and Bahr, S.J. “Estimating the Prevalence and Frequency of Adolescent Drug Use: Do the Models Fit the Measures?” Journal of Drug Issues 40, no. 4 (2016): 871-899.

16. Lüscher, C. and Ungless, M.A. “The Mechanistic Classification of Addictive Drugs”. Public Library of Science 3, no. 11 (2006): e437.
17. United Nations Office on Drugs and Crime. “Understanding the extent and nature of drug use”. UNODC, (2010): 123-135.
18. United Nations Office on Drugs and Crime (n.d.), Drug Use Statistics, https://data.unodc.org
19. National Institute on Drug Abuse (n.d.), Trends and Statistics, https://www.drugabuse.gov/related-topics/trends-statistics.
20. Landgren, S., Berglund, K., Jerlhag, E., Fahlke, C., Balldin, J., Berggren, U., Zetterberg, H., Blennow, K., Engel, J.A. “Reward-related genes and personality traits in alcohol-dependent individuals: a pilot case control study.” Neuropsychobiology 64, no. 1 (2011):38-46.
21. Pournaghash-Tehrania, S., Hassantash, M., Imani, S. “Assessment of reward dependence and its subscales in drug addicts and non addicts”. Procedia – Social and Behavioral Sciences 15, (2011):198-202.
22. Ball, S.A., Kranzler, H.R., Tennen, H., Poling, J.C., Rounsaville, B.J. “Personality disorder and dimension differences between type A and type B substance abusers.” Journal of personal disorder 12, (1998):1-12.
23. Gourion, D., Pelissolo, A., Lepine, J.P. “Test-retest reliability of the temperament and character inventory in patients with opiate dependence.” Psychiatry Research 118, (2003): 81-88.
24. Michalowski, A. and Erblich, J. “Reward Dependence Moderates Smoking-Cue- and Stress-Induced Cigarette Cravings.” Addictive Behaviors 39, no. 12, (2014): 1879-1883.
25. Marsiglia, F.F., Kulis, S., Hecht, M.L., and Sills, S. “Ethnicity and Ethnic Identity as Predictors of Drug Norms and Drug Use Among Preadolescents in the US Southwest.” Substance Use Misuse 39, no. 7 (2004): 1061-1094.
26. Moloney, M., Hunt, G, Evans, K. “Asian American Identity and Drug Consumption: From Acculturation to Normalization.” Journal of Ethnicity in Substance Abuse 7, no. 4 (2008): 376-403.
27. McCabe, S.E., Morales, M. Cranford, J.A., Delva, J, McPherson, M.D, Boyd, C.J. “Race/Ethnicity and Gender Differences in Drug Use and Abuse Among College Students.” Journal of Ethnicity in Substance Abuse 6, no. 2 (2007): 75-95.
28. Barocas, J.A., Wang, J., Marshall, B.D.L., LaRochelle, M.R., Bettano, A., Bernson, D., Beckwith, C.G., Linas, B.P., Walley, A.Y. “Sociodemographic factors and social determinants associated with toxicology confirmed polysubstance opioid-related deaths.” Drug and Alcohol Dependence 200, (2019): 59-63.