STUDYING MEASUREMENT INVARIANCE AND DIFFERENTIAL VALIDITY OF THE SHORT UPPS-P IMPULSIVE BEHAVIOR SCALE ACROSS RACIAL GROUPS

by

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A Thesis

Submitted to the Faculty of Purdue University

In Partial Fulfillment of the Requirements for the degree of

Master of Science

Department of Psychology at IUPUI

Indianapolis, Indiana

December 2021

THE PURDUE UNIVERSITY GRADUATE SCHOOL
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ACKNOWLEDGMENTS

Thank you to my supervisor, Dr. Melissa Cyders, for your open and genuine mentorship. Your support, guidance and patience have been present at every part of this journey, and your extensive knowledge and revisions have shaped me into a better writer and student. I'm lucky to have a mentor who will celebrate the victories with me but also be there when I leak tears on Zoom calls. Thank you to my committee members, Dr. Tamika Zapolski and Dr. Wei Wu. Dr. Zapolski, your insight and generous sharing of data have made my thesis possible. Dr. Wu, your knowledge of statistics has been invaluable in guiding my journey into Mplus.

Thank you to my lab and cohort for their enthusiastic support and helpful feedback through grad school and this milestone. Thanks to my parents for their endless support, even if describing my work is a vigorous exercise in Google Translate. Thanks to James and Zoey for getting me through the past year, listening to me hoot and holler through any problem, and being an essential part of the work-life balance.

Finally, thanks to the people in my life who show me every day that distance does not deter friendships in the slightest: Ashley, Brian, Kevin, Michael, Terrence, and Gigi.

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ABSTRACT

Previous research has identified impulsive personality traits as significant risk factors for a wide range of risk-taking behavior, substance use, and clinical problems. Most work has been conducted in primarily White samples, leaving it unclear whether these patterns generalize to racial and ethnic minorities, who have higher rates of negative consequences of substance use behavior. The most widely used assessment of impulsive traits is the UPPS-P Impulsive Behavior scale, which has strong psychometric properties across demographic subgroups, such as gender and age; however, data supporting its use in racial and ethnic minorities is less well-developed. The aims of this study are to 1) examine the measurement invariance of the UPPS-P Impulsive Behavior Scale-Short Form (Cyders et al., 2014) across racial minority groups and 2) determine if impulsive personality traits differentially relate to substance use outcomes across racial groups. Participants were 1301 young adults (ages 18-35, fluent in English), recruited through an online survey for both college students at a large public university and Mechanical Turk, a crowdsourcing online platform. Measurement invariance was assessed using multigroup confirmatory factor analysis. Differential validity was assessed using a structural equation modeling framework. I established model fit for each racial group (White group: RMSEA= .067, CFI= .94; Black group: RMSEA= .071, 90% CFI= .952; Asian American group: RMSEA= .073, CFI= .94; Hispanic group: RMSEA=.081, CFI=.934). Based on change in CFI/RMSEA indices, I concluded strong measurement invariance of the Short UPPS-P as a valid scale of impulsive behavior across racial groups. In the White group, findings indicated significant relationships between multiple SUPPS-P traits and alcohol and substance use. In the Asian American group, positive relationships were found between sensation and alcohol use (p=.015) and negative urgency and drug use (p=.020). I found that there were no differences in the relationships between the Short UPPS-P traits and substance use outcomes across White and the racial and ethnic groups studied (p's>.06).

INTRODUCTION

Compared to Whites, racial minority groups report less problematic alcohol and substance use, but experience more negative health, legal, and social consequences (Chartier & Caetano, 2010; Cokkinides et al., 2008). One important risk factor linked to maladaptive use is impulsive personality traits, but most of the research in this field has been conducted in predominantly White populations (Littlefield et al., 2014; Zapolski et al., 2009). This leaves significant gaps in our understanding of relevant risk factors in underrepresented racial and ethnic minority groups. First, it is unclear if existing measures of impulsive personality traits assess the trait equally across racial minority populations. Second, it is unclear if the role of impulsive personality traits in risk models generalizes to minority populations. The aims of this study are to 1) examine if one of the most widely used impulsive personality scales, the UPPS-P Impulsive Behavior Scale-Short Form (Cyders et al., 2014), validly measures across racial minority groups and 2) determine if impulsive personality traits differentially relate to substance use across racial majority and minority groups.

Racial and ethnic disparities in substance use outcomes

The negative social, health, and legal consequences of substance use disproportionately impact racial and ethnic minorities (Buka, 2002; Fagan et al., 2007; Mulia et al., 2009; Trinidad et al., 2011; Zapolski et al., 2014). Although Whites report a higher lifetime prevalence of Alcohol Use Disorder, Black and Hispanic adult drinkers are more likely to report adverse social and health consequences of alcohol use, such as alcohol-attributed intimate partner violence and liver disease (Chartier & Caetano, 2010). Similarly, nicotine use rates (both lifetime and daily use) are lower in racial minorities, yet they consistently experience higher rates of tobacco-related cancer and disease compared to Whites (Fagan et al., 2007; Gourin & Podolsky, 2006; Haiman et al., 2006; Trinidad et al., 2011). Finally, racial and ethnic minorities are disproportionately impacted by the legal consequences of substance use. A review from Iguchi and colleagues (2005) highlights how Black males are overrepresented in drug offense incarcerations in both the juvenile and adult justice system, likely due to biased legal decision-

making and policies, which leads to decreased access to jobs, health benefits, housing, financial support, and voting rights.

In order to unpack the underlying drivers of racial disparities in substance use, we must examine this pattern through a theoretical framework of intersecting historical, environmental and individual factors (Spillane & Smith, 2007; Zapolski et al., 2014; Zemore et al., 2018). On a historical level, alcohol and tobacco industries have strategically exploited communities of color, resulting in the 'African Americanization' of menthol cigarettes and disproportionately high alcohol and tobacco availability and targeted advertising in minority neighborhoods (Alaniz, 1998; Cruz et al., 2010; Gardiner, 2004). Environmental factors, such as social influences, acculturation, minority stress, racial discrimination, religiosity, and cultural norms may also differentially explain variance in substance use risk (Caetano et al., 1998; Zapolski et al., 2014). Zapolski and colleagues (2017) found that higher ethnic identity acts as a protective factor for lower substance use for minority youth, but not for White youth. In Asian Americans and Hispanic drinkers, alcohol-related problems may be due to traditional gender-relevant norms, which may be protective in women (i.e. modesty, *marianismo*) and a risk factor in men (i.e. masculinity, *machismo*) (Iwamoto et al., 2016; Perrotte et al., 2018).

Lastly, individual differences, such as gene expression, subjective response, drinking motives, and personality traits may also act as a protective or risk factors. For instance, the ADH2*2 gene, which is most commonly found in those of Asian ancestry, causes adverse reactions to alcohol metabolism and is associated with lower rates of alcohol dependence (Wall et al., 2001). However, the ADH1B*3 gene, which is most commonly found in people of African ancestry, may result in a greater simulative response to alcohol at lower quantities of use, acting as a protective factor against drinking quantity but a risk factor for negative drinking consequences (See Zapolski et al., 2014 for comprehensive review).

Personality traits, such as impulsivity, have also been highlighted as important protective or risk factors to maladaptive behaviors. However, much of the research on substance use risk models incorporating impulsivity have been conducted in White samples and racial minorities have not been widely represented (Littlefield et al., 2014; Zapolski et al., 2009). A broad number of external factors, highlighted above, uniquely impact racial minorities risk of substance use and may be more salient risk factors for racial minorities than Whites (Chartier & Caetano, 2010; Zapolski et al., 2014, 2017). A key question is whether or not impulsivity, which is a strong risk

factor among Whites (Coskunpinar et al., 2013), relates to substance use to the same degree among racial and ethnic minorities. This question is important to answer as new and emerging treatments have started to focus on modifying impulsivity to reduce risk for substance use (Um et al., 2018). If impulsivity is not related to substance among racial minorities, application of such treatments would be mis-guided. In order to test the relative contribution of impulsivity for substance use in racial and ethnic minorities, as well as to compare the effects of impulsivity across racial and ethnic groups, two key first steps need to be conducted: First, we need to first establish if impulsive traits are measured accurately in this population. Second, we need to examine if impulsive traits significantly relate to substance use in a similar manner among racial and ethnic minorities as compared to whites. This thesis comprises these first two steps. After these two first steps are completed, additional research will be able to answer other important extensions of this work, such as comparing the relative contribution of impulsivity and external factors to substance use across white and racial and ethnic minority groups, and determining which factors are the key modifiable risk factors to focus on in prevention and treatment approaches for each group.

Need for racial minority inclusion in substance use risk models

Underrepresentation of minority populations in research can lead to systemic problems in conceptualization and treatment (Britton et al., 1999; Miranda et al., 2003; Nelson, 2002). Specifically, substance use risk models may exclude culturally relevant factors and/or lack generalizability to racial and ethnic minority groups, contributing to decreased accessibility to and efficacy of interventions for minority populations (Rogers & Lange, 2013). There is some research supporting the fact that comprehensive substance use risk models do not always generalize from racial majority to minority populations. Risk factors for adolescent substance use vary widely in sensitivity and pattern across racial groups, suggesting differential predictive value rather than a comprehensive and generalizable model (Vega et al., 1993). Banks and Zapolski (2017) found that positive alcohol expectancies (i.e., 'I will be more social if I have a few drinks; Jones et al., 2001), a traditional risk factor for alcohol initiation and use, was a significant predictor among White youth, but not Black youth. A review by Fagan and colleagues (2007) found that the traditional dose-response model (i.e., number of cigarettes per day supports

negative health consequences) and differences in risk indicators did not sufficiently explain tobacco-related cancer outcomes across racial minority groups. These differential findings suggest the need to develop models to explain these inconsistencies.

Non-generalizable risk models may contribute to widening racial disparities in substance use treatment. Compared to Whites, Asians and Hispanics have higher rates of unmet need for substance abuse treatment (Mulvaney-Day et al., 2012). Hispanic and Black patients are less likely to complete outpatient substance use treatment and less likely to receive and use tobacco cessation interventions (Cokkinides et al., 2008; Mennis & Stahler, 2016; Park et al., 2011). Further, research shows that compared to White smokers, Black smokers have greater difficulty successfully quitting smoking and are less likely to use quit aids, including nicotine replacement therapy (Gandhi et al., 2009; Stahre et al., 2010). This clear gap in clinical care may be a result of applying interventions that fail to identify and address the specific needs of racial minority groups.

Recent attempts have been made to create prevention and intervention strategies for substance use based in impulsivity research (Hershberger et al., 2017; Um et al., 2018; Zapolski & Smith, 2017). However, if impulsivity fails to be an important risk factor in racial minority groups, interventions based on decreasing impulsivity may only be effective for White individuals and not those from other racial groups. Thus, it could lead to intervening on a non-meaningful factor, decreasing treatment effectiveness, and further widening health disparities for racial minority groups. This may suggest that prevention and treatment options for minority populations need to be better matched to the factors that contribute to risk specifically in these groups, as supported by empirical evidence in these populations, rather than assuming that risk models based in majority groups will always generalize. Thus, direct testing of how impulsivity may or may not be implicated in substance use risk models for racial minorities is an important endeavor with multiple long-range clinical implications.

Impulsivity and the UPPS-P Model

Impulsivity is a multifactorial phenomenon which includes characteristics such as premature responding, lack of persistence, sensation-seeking, and acting without thinking (Evenden, 1999). It is comprised of behavioral (state-like) and personality (trait-like) constructs,

which have been found to be largely unrelated to each other and most likely constitute separate constructs and tendencies (Cyders & Coskunpinar, 2011). The current study focuses on studying impulsive personality, rather than its behavioral counterpart, for several reasons. First, impulsive traits have been implicated across a range of risk-taking behaviors and psychopathology, such as borderline personality disorder, eating disorders, substance use, alcohol use initiation, and Alcohol Use Disorder development and continuation (Um et al., 2018; Zapolski et al., 2010; Lejuez et al., 2010; Littlefield et al., 2010). Second, although state-like measures of impulsivity also show relationships with risk-taking behaviors (Krishnan-Sarin et al., 2007; MacKillop & Kahler, 2009), they tend to give a snapshot of impulsive behavior that reflects the individual's peak level of impulsivity, rather than their typical functioning (Ellingson et al., 2018). Thus, they represent shorter-term predictors rather than longer-term predictors of such behaviors, the latter of which are more useful for comprehensive risk models (King et al., 2014; Wilbertz et al., 2014). Third, impulsive personality traits may decrease effectiveness of substance use disorder treatment; thus, targeting impulsive traits may be a clinically useful intervention across a wide range of psychopathology (Hershberger et al., 2017; Kim & Hodgins, 2018; Lai et al., 2011; Zapolski et al., 2010; Zapolski & Smith, 2017). Based on this evidence, accurately identifying and assessing impulsive personality traits as a potential risk factor has important implications for developing comprehensive risk models and improving clinical interventions (Um et al., 2018).

Recent developments in the field of impulsive personality have identified the multiple, separate traits at play (Whiteside & Lynam, 2001). The UPPS-P model measures impulsive personality through five separate but related traits, including Negative **U**rgency (i.e., the tendency to act rashly in response to negative emotion), Lack of **P**remeditation (i.e. the tendency to act without thinking of the consequences), Lack of **P**erseverance (i.e. the difficulty to remain focused on and complete a task), **S**ensation Seeking (i.e. the tendency to seek new and exciting activities), and **P**ositive urgency (i.e., the tendency to act rashly in response to positive emotion) (Lynam et al., 2007). A short version of the UPPS-P Impulsive Behavior Scale (SUPPS-P) has been found to be a valid and reliable alternative to the full UPPS-P scale (Cyders et al., 2014).

Importantly, separating impulsive personality into specific UPPS-P traits has documented that the traits are differentially related to clinical disorders and substance use behaviors. Two meta-analyses (Berg et al., 2015; Coskunpinar et al., 2013) have documented that alcohol use disorders are most strongly predicted by positive and negative urgency rather than the other

UPPS-P traits. On the other hand, drinking and substance use frequency is more likely to be related to sensation seeking or other tendencies (Coskunpinar et al., 2013). Thus, separating impulsive personality traits is important not just for definitional reasons, but also because it improves the ability to predict specific aspects of clinical disorders and maladaptive risk behaviors (Smith et al., 2007). However, some questions about the UPPS-P scale have yet to be answered. An important one, which is the focus of this investigation, is whether the UPPS-P measures impulsive personality traits similarly across racial majority and minority groups and whether the UPPS-P traits are related to substance use outcomes similarly across these groups.

Measurement Invariance of the UPPS-P across Racial Groups

Measurement invariance exists when a construct is equally assessed by a measure across two or more distinct groups (Byrne et al., 1989). To rule out differential validity, a scale should be tested in a wide range of subgroups, such as age, gender, and race. Measurement invariance is most commonly tested using multigroup confirmatory factor analysis (CFA), which compares the observed model in new groups to the traditional model found in the original developmental sample (Reise et al., 1993). Measurement invariance allows for the testing of multiple aspects of invariance, including differences in how items cluster onto factors, how factors are inter-related, and how the factor levels may differ across groups (Byrne et al., 1989). If invariance is not established between groups, the scores may be impacted by bias, artificial inflation or deflation, cultural factors, or another external variables (Shultz et al., 2013). Invariance is a problem, since it may indicate that the scale cannot be used validly across groups and that any mean differences measured between groups wouldn't indicate true differences, but rather differences in the validity of the measurement across the groups.

The levels of invariance tested are usually configural, metric, and scalar invariance (Dimitrov, 2010; Fischer & Karl, 2019; van de Schoot et al., 2012). Configural invariance first establishes the same pattern of factor loadings across groups (i.e., whether the same items measure the underlying construct across groups). Then, metric invariance, or weak invariance, establishes if item discrimination or factor loadings are identical across groups. In other words, are items equally related to the underlying latent variable in all samples, such that changes in scores are associated with the same change in the underlying latent variable. When this condition

is met, correlations and patterns of means can be compared across groups. Finally, scalar invariance, or strong invariance, is established when intercepts are constrained to be equal, which tests whether there is uniform item bias present. This final step allows us to directly compare means and interpret differences as indicators of the underlying construct.

The UPPS-P scale and its associated short form were originally developed and validated in mostly young, healthy, White samples (Cyders et al., 2014; Whiteside & Lynam, 2001). Some previous work has extended and supported the scale's usefulness outside of its original validation group, such as across undergraduate and young adult populations, clinical samples, and adolescent samples (Aklin et al., 2005; Balodis et al., 2009; Dom et al., 2007). Cyders (2013) tested and supported the measurement invariance of the UPPS-P across gender, albeit still in a largely young, healthy, White sample. Argyriou and colleagues (2019) replicated measurement invariance across gender using a more diverse sample across race and age, but did find some individual items with differential item functioning across age. To date, few studies have established measurement invariance of the UPPS-P across race, specifically for Latino/Hispanic college students, Black adult males, and youths from a large community-based sample (Bertin et al., 2021; Stevens et al., 2018; Watts et al., 2020).

Although this is reason to believe that the UPPS-P would accurately assess across racial groups, it is still important to empirically establish measurement invariance across racial groups to establish conceptual, normative, and factor equivalence (Marsella et al., 2000). First, although qualitative examination of the SUPPS-P items suggests no overtly culturally bound wording or items, we cannot assume the Western definition and connotations of 'impulsivity' apply equally across cultures (Marsella et al., 2000). Second, there is a clear need to extend previous findings into diverse populations; most of the research on impulsive personality's role in substance use has utilized young, healthy, White samples, which are not representative of a diverse community population (Argyriou et al., 2018; Liu et al., 2020). Lastly, given that individual traits of the UPPS-P are uniquely related to substance use outcomes, it is essential to compare if factorial structures across racial groups are similar to those of the normative White sample, or if some individual items load onto traits differentially. Given these salient cross-cultural assessment considerations, there is a need to establish measurement invariance to ensure that scores reflect facets of impulsivity rather than culture-specific traits.

Group Differences and Differential Validity of the UPPS-P Model across Racial Groups

Prior research has suggested that group-level differences in impulsive personality do exist, and that, in most cases, impulsive traits do not differentially relate to outcomes across groups. Cyders (2013) found that males tend to report higher levels of sensation seeking and positive urgency, but that the relationships between UPPS-P traits and risk outcomes were generally invariant across sex. Argyriou and colleagues (2019) found that sensation seeking was higher in males and lower as age increased, but that, in general, the relationships between UPPS-P traits and risk-taking behaviors were invariant across age and sex.

Findings have been mixed thus far on if impulsive personality traits exhibit group-level differences or have a differential relationship to substance use across race. A meta-analysis on impulsive traits' relationship to alcohol use found that race (defined as %White) was not a significant moderator, but more than half the studies included in analysis were conducted in predominantly White samples (Coskunpinar et al., 2013). A longitudinal study found that Black youths had higher initial levels of impulsivity but that sensation seeking predicted greater levels of alcohol use only for White youths (Pedersen et al., 2012). However, impulsivity and sensation seeking were conceptualized as facets of disinhibition, and the UPPS-P was not used to measure impulsive traits. Finally, a recent study in college students found that non-White and non-Hispanic/Latinx students were more likely to be minimal substance users. Lack of premeditation significantly differed across substance use class comparisons, such that polysubstance users were more likely to endorse higher lack of premeditation compared to non-alcohol abstaining or minimal users (Shi et al., 2020).

These emerging differences across racial groups could indicate true differences in these traits across these groups; however, they could also occur due to differences in how validly the measures assess these traits across groups. Some evidence suggests that these might be true differences; however, that cannot be concluded until it is first shown that the measures assess the traits equally across group. Therefore, the first step is to establish whether the UPPS-P accurately assesses impulsive personality traits across racial minority groups. Ruling out measurement invariance will allow for the accurate comparison across groups and more meaningful measurement of differential patterns of relationships across race.

Current Study

Thus, the aims of this study are to 1) examine if the UPPS-P Impulsive Behavior Scale-Short Form (Cyders et al., 2014) measures impulsive personality traits validly and reliably across racial majority and minority groups and 2) determine if impulsive personality traits differentially relate to substance use measures across racial majority and minority groups. Using a large U.S. community and college-based sample group, I compared racially diverse young adults to White young adults, which was the initially validated demographic group (Cyders et al., 2014). My first hypothesis is that the SUPPS-P will be an acceptable measure of impulsive personality traits and will demonstrate measurement invariance across racial groups because of prior evidence of invariance across age and sex, and in Hispanic/Latino students (Argyriou et al., 2019; Cyders, 2013; Stevens et al., 2018). To test for measurement invariance, I used a statistical approach called multigroup confirmatory factor analysis (Reise et al., n.d.). This study is the first to test measurement invariance of the SUPPS-P scale in Asian American and African American adults.

My second hypothesis posits that UPPS-P traits may not always similarly relate to substance use behavior across racial groups. Based on existing supporting literature, a subset of proposed hypotheses was tested across racial groups and compared to the original findings. *Hypothesis 2A: Alcohol Use* Consistent with past findings, I posit that all traits will equally predict alcohol use problems across racial groups (Coskunpinar et al., 2013). However, I hypothesize that sensation seeking will relate more weakly to alcohol use in Black drinkers (Pedersen et al., 2012). *Hypothesis 2B: Marijuana Use* I posit that all traits will equally predict marijuana use problems across racial groups, except for lack of perseverance (VanderVeen et al., 2016). *Hypothesis 2C: Drug Use* I posit that negative and positive urgency will be similarly associated with problematic drug use across racial groups (Thomsen et al., 2018; Zapolski et al., 2009). However, I hypothesize that lack of perseverance and lack of premeditation may have less predictive power in predicting drug use across racial groups (Shi et al., 2020). To test for differential validity, I used structural equational modeling to compare if the racial group regression coefficients are significantly different from each other in magnitude.

METHODS

Participant Recruitment

Participants were recruited using two methods. First, participants were drawn from a parent study examining stress and health outcomes among adults 18-35. An online survey was administered to Introduction to Psychology students at Indiana University Purdue University in Indianapolis (IUPUI) during Fall 2018 through Spring 2020. Participants were eligible to participate in the study if they were between the ages 18-35 and were able to read in English. A total of 1,160 individuals completed this survey.

Second, participants were recruited using two rounds of Amazon Mechanical Turk (MTurk), an online marketplace that is comparable to other routes of online recruitment (Buhrmester, Kwang, & Gosling, 2016). The survey was limited to those residing in the United States, between the ages of 18-35, and who self-identified as belonging to one or more racial/ethnic categories (European American/White, African American/Black, Asian American/Pacific Islander, Native American, Hispanic/Latino, Biracial/Multi-racial, Other).

In the first round of MTurk recruitment, the survey was restricted to MTurk users with a high approval rate of a 95 percent cutoff on previous Human Intelligence Tasks to ensure participants' attentiveness while completing the survey (HITs; Buchheit et al., 2018). Qualtrics ReCAPTCHA scores were used to estimate whether the activity on a computer screen was completed by a human or a computer, resulting in the removal of participants whose scores were lower than 0.5 (Von Ahn, Maurer, McMillen, Abraham, & Blum, 2008). In the second round of MTurk recruitment, additional measures were added to ensure data quality. First, all MTurk worker IDs from the first round were blocked from completing the survey to protect against repeat participants. Second, to take further measures to protect against bots (e.g., computer-generated responses), any participant with a ReCAPTCHA score lower than 0.5 was automatically disqualified from taking the survey in the beginning. Finally, a comprehension question was included: "What do you call a student in their third year of high school", with the only accepted answer being "junior". The use of the additional qualitative comprehension question with the previous measures has been shown to help ensure a more reliable data set

(Hauser, Paolacci, & Chandler, 2018). A total of 392 individuals completed this survey through MTurk.

Procedure

After obtaining IRB approval, participants completed an online questionnaire that aimed to examine various health, behavioral, academic, and trauma-related variables among adults aged 18-35. The study took approximately 45 minutes to complete. Participants recruited through the IUPUI Introduction to Psychology class received course credit for completing the study, while participants recruited through MTurk were compensated with $2.50 through their MTurk account.

Initial data collection and cleaning was conducted under the direction of Dr. Tamika Zapolski by the Prevention Research in Substance Use and Minority Health Lab at IUPUI. The total initial recruitment size was 1,552 participants. Five participants were removed due to incorrectly answering the comprehension question (e.g., “third grade”, “senior”, and “sophomore”). Eight participants were removed for failing the ReCAPTCHA. 184 participants were excluded from analyses because of missing data or failing random responding checks. The current study is a secondary analysis of this cleaned, de-identified database.

Only items pertaining to demographic information, UPPS-P traits, and substance use were included in analysis. Participants were included in the current study if they indicated membership with at least one racial/ethnic group of interest (White, African American /Black, Asian American, and Hispanic), but were able to select as many racial/ethnic categories as they identified with. 91 individuals identified as more than one race. In cases where the individual identified as White and a racial minority group, they were placed into the racial minority group (i.e., if endorsed Black and White, placed in Black racial group). In cases where the individual identified as multiple racial minority groups (i.e., Hispanic and Black), they were placed in both groups. As race was dummy coded against a White comparison group, participants were never placed in both groups that were being statistically compared (i.e., no one person was in both the White and compared racial/ethnic minority group). This allowed me to retain as many individuals in the study as possible while also ensuring independence of statistical comparisons. 63 participants were removed for not identifying as one of the target racial groups. Listwise

deletion was used for 4 participants for those missing 50% or more SUPPS-P items. Thus, the final sample size was 1301 participants.

Measures

Demographics

Participants were asked to provide their age, gender, and race/ethnicity.

Impulsive Behavior

The Short UPPS-P scale (SUPPS-P) was used to assess for negative urgency, positive urgency, sensation seeking, lack of premeditation, and lack of perseverance traits. The SUPPS-P is a self-report, 20-item measure on a 4-point Likert scale from 1 (strongly agree) to 4 (strongly disagree) (See Appendix A for full measure). Previous research has demonstrated that it produces valid and reliable measurements of impulsive behavior traits compared to the full UPPS-P (Cyders et al., 2014). Items are reverse coded as necessary and averaged so that higher scores indicate greater levels of the trait (Cronbach's alpha in the current sample=.82).

Substance Use Measures

The Alcohol Use Disorder Identification Test (AUDIT) is a validated 10-item measure of alcohol consumption and related problems, e.g., "How often during the last year have you had a feeling of guilt or remorse after drinking?"(Saunders et al., 1993). Higher scores indicate higher risk for meeting Alcohol Use Disorder criteria (Cronbach's alpha in the current sample=.79).

The Cannabis Use Disorder Identification Test (CUDIT) is a validated 8-item measure of current and developing cannabis-related problems, i.e. 'How often during the past year did you find that you were not able to stop using marijuana once you had started?' (Adamson et al., 2010). Higher scores indicate higher risk for meeting Cannabis Use Disorder criteria (Cronbach's alpha in the current sample=.84).

The Drug Use Disorder Identification Test (DUDIT) is a validated 11-item measure of current and developing drug-related problems, i.e. 'Over the past year, have you felt that your

longing for drugs was so strong that you could not resist it?' (Berman et al., 2005). Higher scores indicate higher risk for meeting drug use disorder criteria (Cronbach's alpha in the current sample=.88).

Data Analysis Plan

All analyses were performed using SPSS 26 and MPlus statistical packages. Study measures were assessed for normal distribution scatter plots, skewness, and kurtosis. Exploratory analyses were conducted by examining descriptive statistics, such as means, medians, standard deviations, and frequencies. Bivariate correlations and independent samples t-tests were conducted to examine the associations between substance use, demographic variables, and the UPPS-P subscales.

Aim 1: Measurement Invariance Testing Across Racial Groups

Confirmatory Factor Analysis (CFA) was used to test the measurement invariance of the SUPPS-P across racial minority groups (as guided by Shultz et al., 2013; van de Schoot et al., 2012). The models were estimated using the mean- and variance-adjusted diagonally weighted least squares (WLSMV) estimator, which is a recommended estimator for ordinal indicators (Wang & Wang, 2019). First, I established and tested the measurement model, with latent constructs defined as the 5-dimensional constructs of impulsive personality- negative urgency, lack of premeditation, lack of perseverance, sensation seeking, and positive urgency. Covariance was assumed between all 5 latent constructs, represented as bidirectional arrows. Each latent construct was characterized by 4 observed variables, the corresponding SUPPS-P individual items. Factor loading of each observed variable to each construct is represented by unidirectional arrows, with the first item loading set to 1. As latent factors may not fully explain observed variation, each observed variable is associated with an unmeasured residual error. See Figure 1 for a diagram of the proposed structural model. The model fit was evaluated through two indices- the comparative fit index (CFI) and root mean squared error or approximation (RMSEA). Fit was considered using the following guidelines: For global fit indices (RMSEA), exact fit = 0.00, close fit = 0.01–0.05, acceptable or cut-off fit = 0.05– 0.08; for relative fit indices (CFI), adequate fit >.90, close fit>.95 (van de Schoot et al., 2012, Hu & Bentler, 1999).

Second, a series of multigroup CFAs was conducted to test for invariance between racial minority groups (Black, Asian American, and Latinx), with each group dummy-coded against a White comparison group. These groups were tested using a stepwise sequence of increasingly stringent parameters: 1) configural (no parameter restraints), 2) metric (factor loadings constrained), and 3) scalar invariance (factor loading and intercepts constrained to be equal across groups). If the model failed at any level, the subsequent levels would not be tested unless individual items could be identified that exhibited differential functioning. In this case, these items would be excluded, and additional testing would proceed.

Invariance of each increasingly constrained model was evaluated using three change-in-fit statistics: chi-square difference test, ΔCFI and ΔRMSEA. The chi-square difference test compares the chi-square of the more constrained model to the less constrained model, where a significant difference indicates significantly worse fit in the more constrained model. Although traditionally used to evaluate measurement invariance, the chi-square difference test is sensitive to sample size, which often leads to over-rejection of invariant models (Brannick, 1995; Cheung & Rensvold, 2002). To account for this, I performed a sensitivity analysis for each group using a random sub-selection of White participants to account for group size difference. I also examined ΔCFI and ΔRMSEA because they are less affected by sample size compared to chi-squared tests. Although there is no universal agreement on cut-off criteria, current standards are to accept models that show ΔCFI and ΔRMSEA differences $\leq$.01 (Fischer & Karl, 2019).

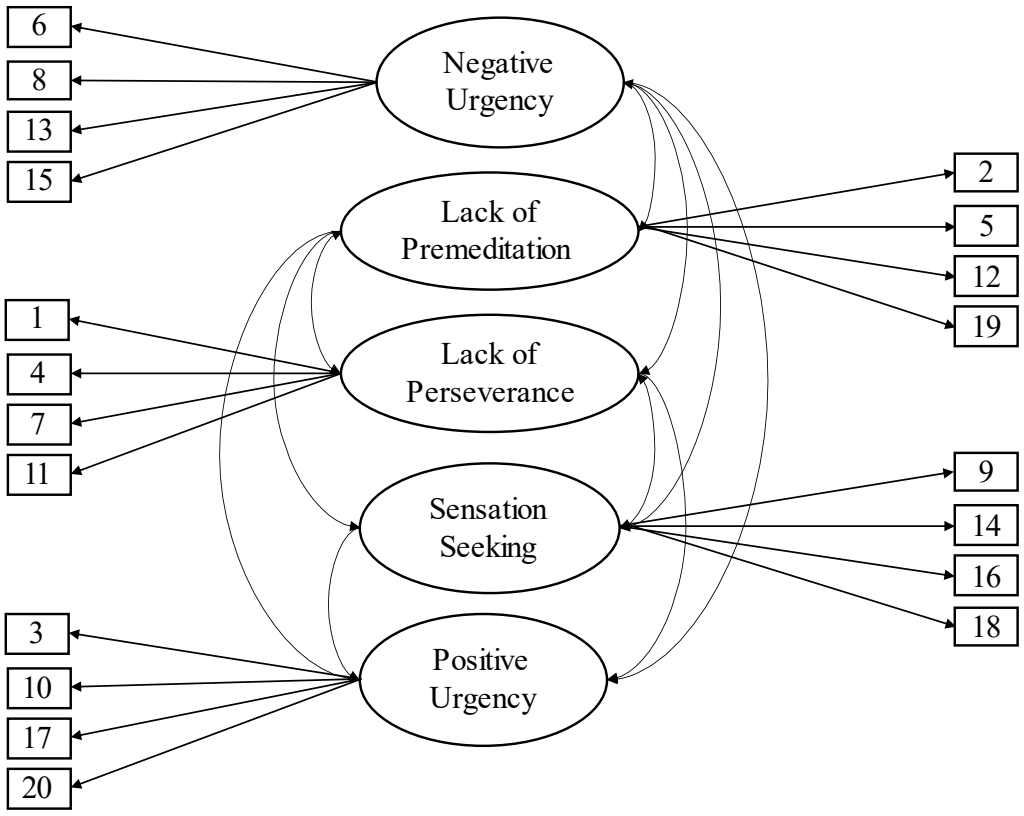

Figure 1. Proposed five-factor structural model of the SUPPS-P

Aim 2: Predicted Relationships between SUPPS-P and Substance Use Behavior across Racial Groups

Given invariance was established, the average sub-score for each trait of the SUPPS-P would be calculated, excluding any individual items with differential functioning (if found). First, I used independent samples t-tests to examine racial group differences in the UPPS-P traits. Second, I used structural equation modeling to conduct a series of linear regression analyses to examine the relationship between each domain of UPPS-P with alcohol use, cannabis use, and drug use, controlling for gender (Cyders, 2013). Latent constructs were defined using the Aim 1 model. Unidirectional arrows from UPPS-P traits and covariates to the substance use outcome represented linear regression coefficients. Each substance use variable was created using a sum score of scale items, and individually tested in independent models. Finally, I compared model fit between the racial minority and White comparison groups to examine if the regression coefficients between UPPS-P traits and substance use measures significantly differ. Latent

constructs were defined using the Aim 1 model. I then defined a model for each of the racial groups being compared, constraining the loadings to the level of invariance met (i.e., Model White group vs. Model Hispanic group, constrained to weak or strong invariance). Within each racial group model, linear regression coefficients were defined from each UPPS-P trait and covariate to the measured substance use variable. For instance, the AUDIT score on positive urgency factor regression coefficient was defined as 'A1' in the White group and 'A2' in the Hispanic group. I set a model constraint to compare regression coefficients across racial groups and determine if they significantly differed in magnitude (i.e., A1-A2 to determine if the relationship between AUDIT and positive urgency were significantly different across White and Hispanic groups).

Table 1. Predicted significant relationships. Gender will be included as a covariate for all analyses.

Outcome	**UPPS-P Trait**	**Supporting Literature**
Alcohol Use (AUDIT)	Negative Urgency Positive Urgency Lack of Planning Lack of Perseverance	Coskunpinar et al., 2013; Thomsen et al., 2018; Pedersen et al., 2012
Cannabis Use (CUDIT)	Negative Urgency Positive Urgency Sensation Seeking Lack of Planning Lack of Perseverance	Thomsen et al., 2018; VanderVeen et al., 2016; Stevens et al. 2018
Drug Use (DUDIT)	Negative Urgency Positive Urgency	Thomsen et al., 2018; Zapolski et al. 2009

Power Considerations

Aim 1

Determining an ideal sample size for using confirmatory factor analysis (CFA) depends on numerous factors, such as number of measure items, number of groups and group observations, and size of the model; however, a typical minimum cutoff is N≥200 for theoretical models and N≥300 for population models (Myers, 2011). Previous studies that examined measurement invariance in the UPPS-P had similar or smaller sample sizes and subgroups compared to the current study. Specifically, a study examining measurement invariance across sex had a sample size of n=1372 (Cyders, 2013), a study examining sex and age had 799 (18-30 years old n=232, 31-60 years old n=351, 61-85 years old n=198) participants (Argyriou et al., 2019), and a study in Latinx college students consisted of 718 (n=186 Hispanic Latino) participants (Stevens et al., 2018).

Aim 2

Similarly, there is little consensus on determining an ideal sample size for using multiple-group structural equation modeling (SEM). Sample size requirements can vary drastically based on number of indicators and factors, magnitude of path coefficients, and other structural elements of the model (Wolf et al., 2013). However, for multi-group modeling, at least 100 participants in each group has been suggested as a general rule of thumb (Kline, 2005; Kyriazos, 2018). Prior research examining the relationship between UPPS-P traits and substance use outcomes, had comparable samples sizes compared to the available dataset. For instance, a study examining UPPS-P traits a drug use had 109 participants (Thomsen et al., 2018).

RESULTS

Preliminary Results

Of the study sample (n=1301), most participants identified as female (n=875; 67.3%) and the average age was 21.0 (SD=4.46). Racial/ethnic membership of the sample included White (n=813; 62.5%), African American/Black (n=208; 16%), Asian American (n =2-8; 16%), and Hispanic (n=173; 13.3%). Age was found to significantly differ across groups (i.e., White vs. minority racial group) and was subsequently included as a covariate with gender. Descriptive statistics and group comparisons of the study variables for the sample are included in Table 2. Correlations among study variables are included in Table 3.

Table 2. Demographic Characteristics. Participants appeared in more than one category if identified as multiracial. A participant was never placed in both groups that were being statistically compared. Group comparisons (i.e., White vs. Black, White vs. Asian American, and White vs. Hispanic) used independent samples *t*-tests (* $p<.005$) and chi-squared analyses (^ $p<.05$), respectively.

	Full Sample (n= 1301)	White (n=813)	Black (n=208)	Asian American (n=208)	Hispanic (n=173)
UPPS-P *(Mean, SD)*					
Negative Urgency	9.60 (2.73)	9.73(2.65)	9.18(2.9)	9.43(2.69)	9.87(2.76)
Positive Urgency	8.22 (2.54)	8.24(2.39)	7.94(2.75)	8.21(2.66)	8.81(2.83)
Lack of Perseverance	7.23 (1.97)	7.22(1.97)	7.10(2.03)	7.28(1.86)	7.5(2.08)
Lack of Premeditation	7.21 (2.02)	7.32(2.00)	6.93(2.07)	7.04(1.85)	7.16(2.1)
Sensation Seeking	10.36 (2.50)	10.57(2.41)	9.84(2.58)	9.88(2.52)	10.62(2.48)
Substance Use *(Mean, SD)*					
AUDIT Score	3.07 (4.16)	3.31(4.11)	3.18(4.68)	2.22(3.84)*	2.74(4.17)
CUDIT Score	2.31 (4.65)	2.53(4.98)	2.71(4.70)	1.59(3.79)*	2.03(3.77)
DUDIT Score	1.83 (4.44)	2.05(4.71)	1.97(4.46)	1.15(3.33)*	1.86(4.71)
Age *(Mean, SD)*	21.0 (4.46)	19.61(2.80)	23.09(5.62)*	23.72(5.63)*	21.08(4.75)*
Gender *N(%)*			χ^2=1.78	χ^2=11.1^	χ^2=3.42
Male	418 (32.1)	245(30.1)	68(32.7)	82(39.4)	43(24.9)
Female	875 (67.3)	563(69.2)	138(66.3)	124(59.6)	130(75.1)
Other	8(.60)	5(.60)	2(1.0)	2(1.0)	0

Table 3. Correlation matrix of study variables p < .05; * p < .01; **

	Age	Negative Urgency	Lack of Perseverance	Lack of Premeditation	Sensation Seeking	Positive Urgency	AUDIT	CUDIT	DUDIT
Age	1								
Negative Urgency	-.05	1							
Lack of Perseverance	.02	.032	1						
Lack of Premeditation	-.06*	.25**	.47**	1					
Sensation Seeking	-.15**	.22**	-.08**	.05	1				
Positive Urgency	-.09**	.64**	.05	.31**	.39**	1			
AUDIT	.12**	.21**	.12**	.14**	.12**	.18**	1		
CUDIT	.013	.14**	.11**	.09**	.07**	.13**	.40**	1	
DUDIT	-.01	.18**	.10**	.09**	.11**	.16**	.41**	.77**	1

Aim 1

Aim 1.1: Full and Single Group CFA

First, the overall sample was tested to confirm the 5-factor structure is a model fit for the data. The model fit was acceptable (RMSEA= .067, 90% CI= [.064, .071]. CFI= .94) (see Figure 2). Thus, I concluded that the 5-factor structure model was appropriate for this sample.
Next, the 5-factor model was tested separately in each racial group to discern any potential differences in structure within each group. In the Asian American group, SUPPS-P Items 1 and 5 had zero observations in one of the four levels (i.e., "agree strongly" was not endorsed by any Asian American participants). To resolve this issue, I collapsed levels 3 and 4 into once category (i.e., combined "agree strongly" with "agree some"). Based on RMSEA and CFI results, the 5-factor model was an acceptable fit for each racial group (White group: RMSEA= .067, 90% CI= [.064, .071], CFI= .94, see Figure 3; Black group: RMSEA= .071, 90% CI= [.060, .082], CFI= .952, see Figure 4; Asian American group: RMSEA= .073, 90% CI= [.062, .084], CFI= .94, see Figure 5; Hispanic group: RMSEA=.081, 90% CI= [.069, .093], CFI=.934, see Figure 6).

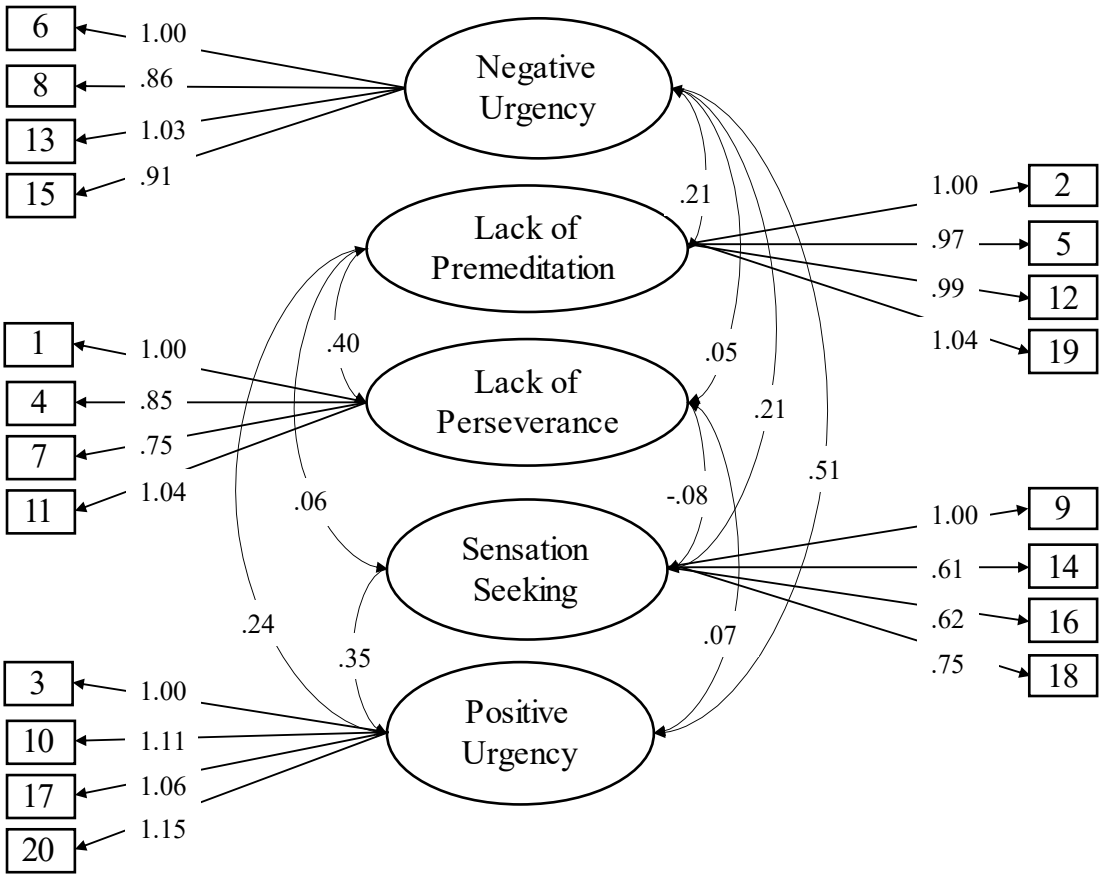

Figure 2. Full Sample CFA. RMSEA= .067, 90% CI= [.064, .071]. CFI= .94

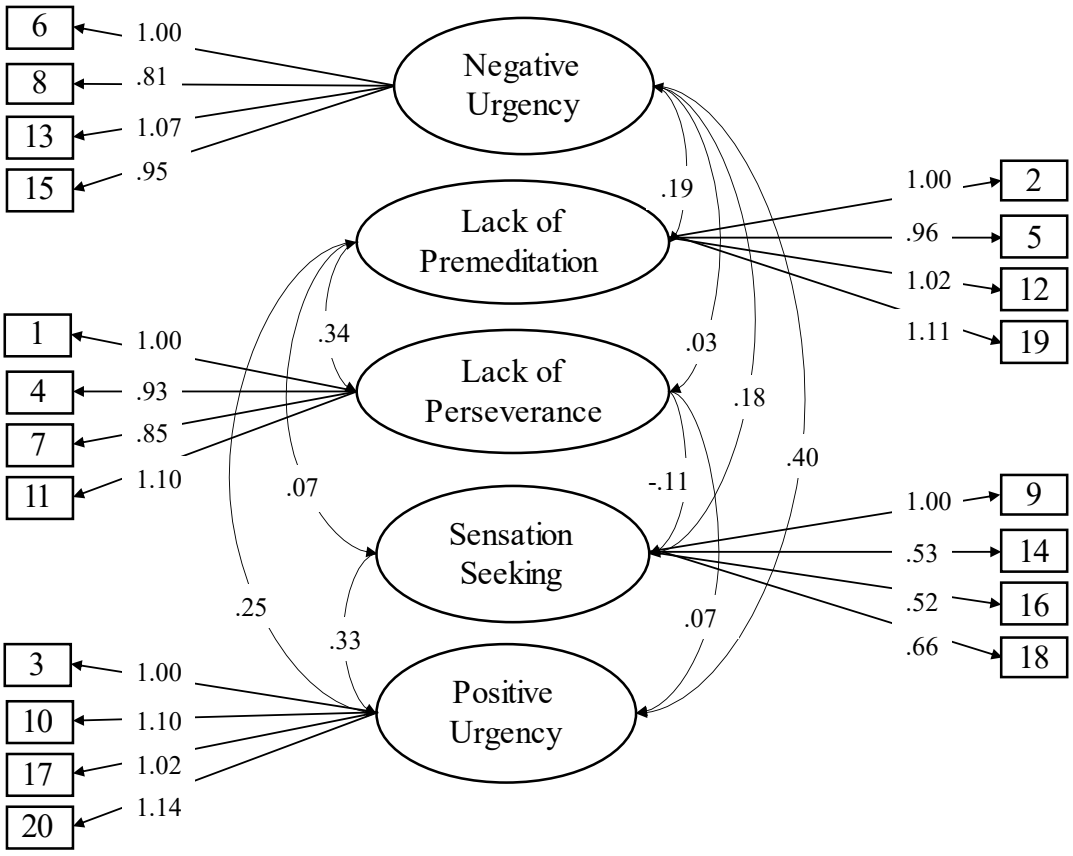

Figure 3. Five Factor Structure White Racial Group. RMSEA= .067, 90% CI= [.064, .071], CFI= .94

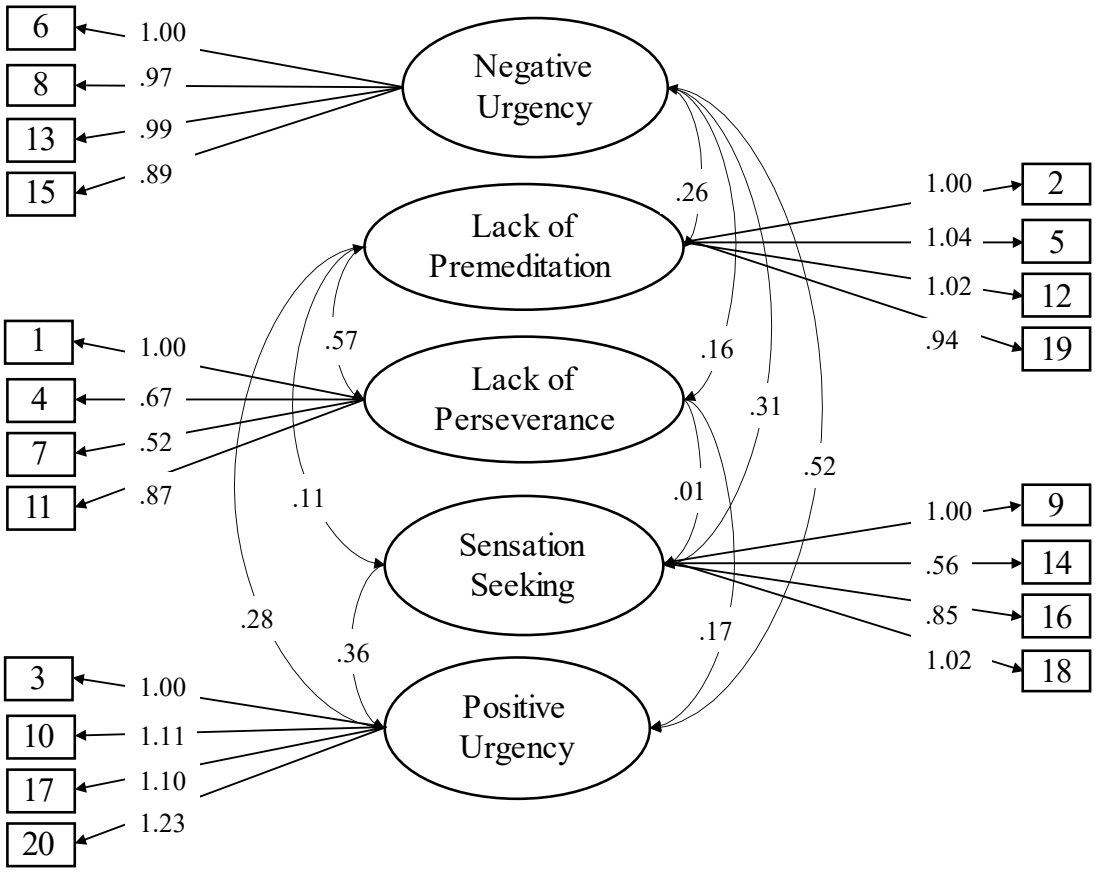

Figure 4. Five Factor Structure Black Racial Group. RMSEA= .071, 90% CI= [.060, .082], CFI= .952

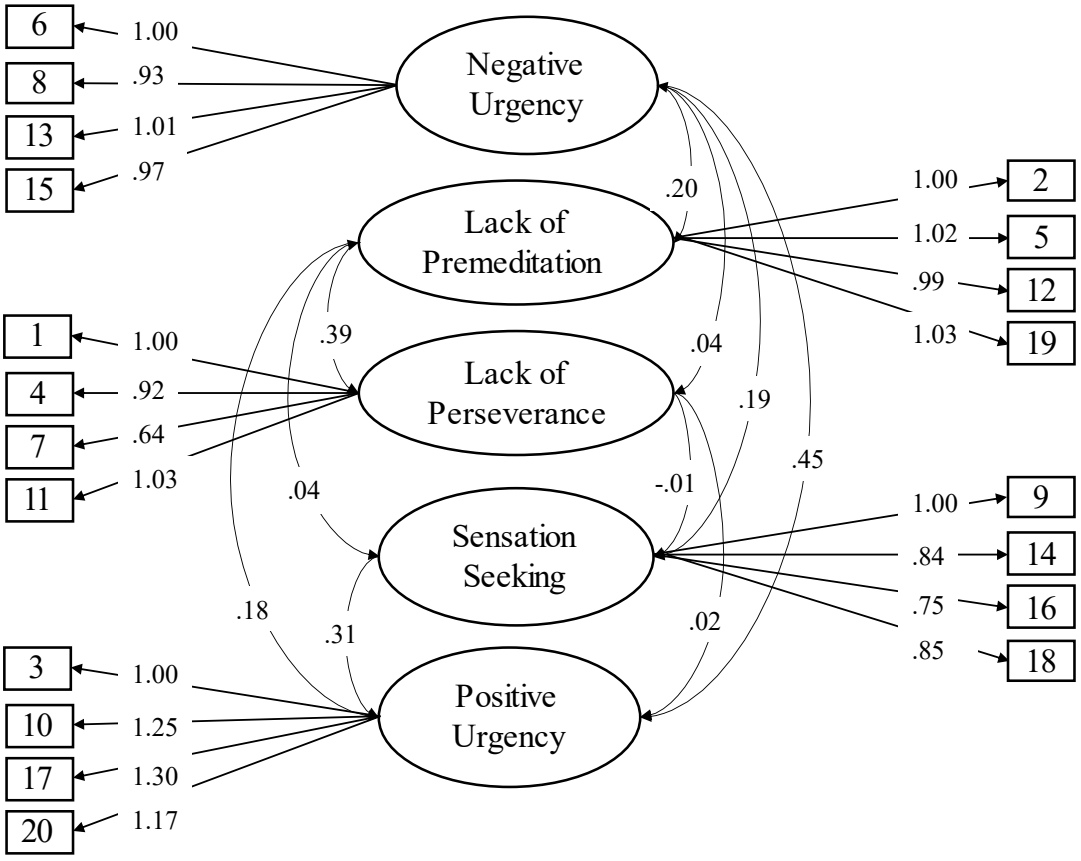

Figure 5. Five Factor Structure Asian American Racial Group. RMSEA= .073, 90% CI= [.062, .084], CFI= .94

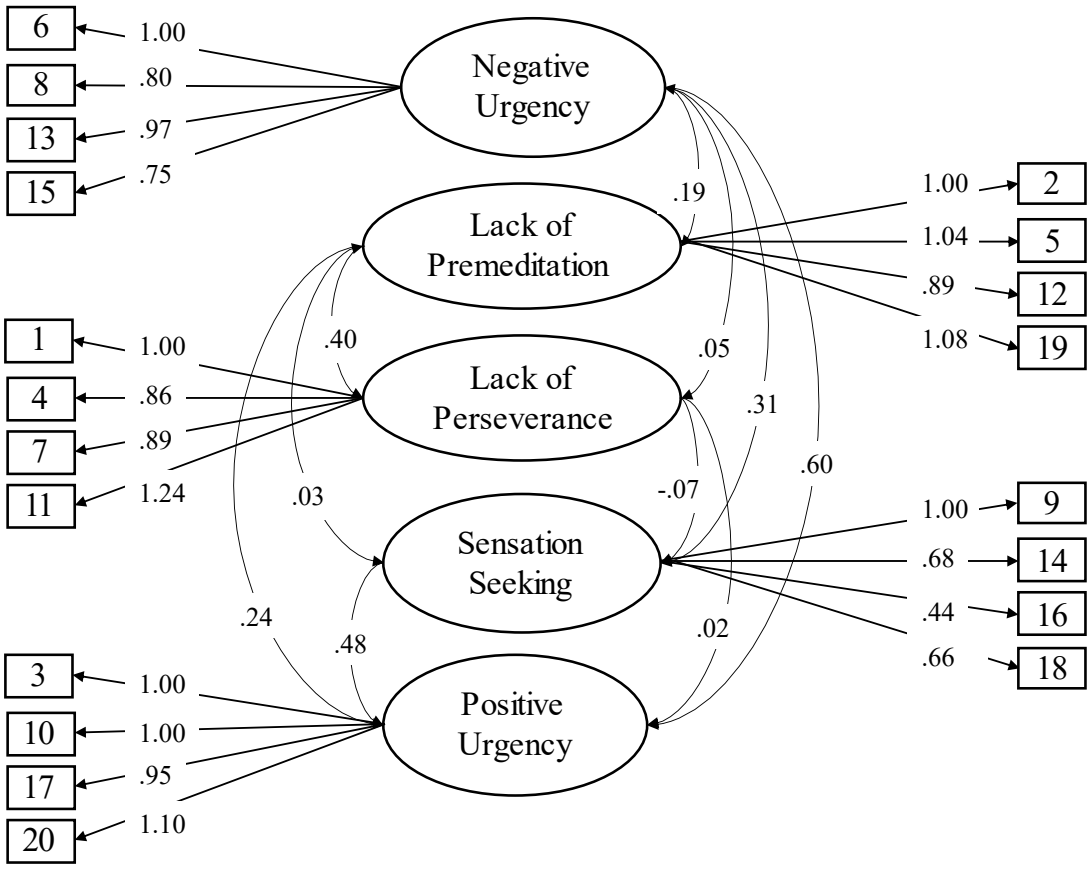

Figure 6. Five Factor Structure Hispanic/Latino Racial Group. RMSEA=.081, 90% CI= [.069, .093], CFI=.934

Aim 1.2 Multigroup CFA MI.

After establishing 5-factor model fit in each racial group, I conducted a two-group analysis to test for measurement invariance to examine if the model significantly differed between each racial/ethnic minority group as compared to the established group (White).

Black Vs White CFA

Chi-square difference results suggest that model fit is significantly worse moving from configural (no parameter restraints) to metric (factor loadings constrained) ($p<.001$) and from metric to scalar (factor loadings and intercepts constrained) models ($p=.016$). However, change in CFI ($\Delta CFI=-.002$ from configural to metric and $\Delta CFI=.002$ from metric to scalar) and RMSEA ($\Delta RMSEA=0$ from configural to metric and $\Delta RMSEA=-.005$ from metric to scalar) data suggest that the configural, metric, and scalar models comparably fit the data. Chi-square difference results suggest that invariance was rejected, while ΔCFI and ΔRMSEA indicate strong invariance was met. Based on the latter fit indices, I concluded that strong invariance was met between the Black and White groups and utilize this strong invariance measurement model for subsequent analyses across these groups.

Table 4. Measurement Invariance for Black Racial Group (dummy coded against White group).

	χ^2	*df*		CFI	RMSEA	RMSEA 90%CI
Configural	1090	320		.938	.069	[.065, .074]
Metric	1136	335		.936	.069	[.064, .073]
Scalar	1142	370		.938	.064	[.060, .069]
Models compared	χ^2	*df*	p-value	ΔCFI	ΔRMSEA	
Metric Against Configural	63	15	.000	-.002	0	
Scalar Against Metric	55	35	.016	.002	-.005	
Scalar Against Configural	111	50	.000	0	-.005	

Asian American vs. White CFA

Chi square results suggest that the model fit is comparable between configural and metric models (p=.177) but was significantly worse moving from metric to scalar models (p=.001). However, change in CFI (ΔCFI=.001 from configural to metric and ΔCFI=.001 from metric to scalar) and RMSEA (ΔRMSEA=-.002 from configural to metric and ΔRMSEA=-.004 from metric to scalar) data suggest that the configural, metric, and scalar models comparably fit the data. Chi-square difference results suggest that weak invariance was met, while ΔCFI and ΔRMSEA indicate strong invariance was met. Based on the latter fit indices, I concluded that strong invariance was met between the Asian American and White groups and utilize this strong invariance measurement model for subsequent analyses across these groups.

Table 5. Measurement Invariance for Asian American Racial Group (dummy coded against White group)

	χ^2	*df*		CFI	RMSEA	RMSEA 90%CI
Configural	1088	320		.935	.069	[.064, .073]
Metric	1094	335		.936	.067	[.062, .071]
Scalar	1115	368		.937	.063	[.059, .067]
Models compared	χ^2	*df*	**p-value**	**ΔCFI**	**ΔRMSEA**	
Metric Against Configural	20	15	.177	.001	-.002	
Scalar Against Metric	64	33	.001	.001	-.004	
Scalar Against Configural	82	48	.001	.002	-.006	

Hispanic Vs White CFA

Chi square results suggest that the model fit was significantly worse moving configural to metric models (p= .019), but comparable between metric and scalar models (p=.240). However, change in CFI (ΔCFI=0 from configural to metric and ΔCFI=.002 from metric to scalar) and RMSEA (ΔRMSEA=-.002 from configural to metric and ΔRMSEA=-.004 from metric to scalar) data suggest that the configural, metric, and scalar models comparably fit the data. Chi-square difference results suggest that invariance is rejected, while ΔCFI and ΔRMSEA indicate strong

invariance was met. Based on the latter fit indices, I concluded that strong invariance was met between the Hispanic and White groups and utilize this strong invariance measurement model for subsequent analyses across these groups.

Table 6. Measurement Invariance for Hispanic Racial Group (dummy coded against White group).

	χ^2	*df*		CFI	RMSEA	RMSEA 90%CI
Configural	1048	320		.933	.070	[.065, .075]
Metric	1058	335		.933	.068	[.064, .073]
Scalar	1067	370		.935	.064	[.059, .068]
Models compared	χ^2	*df*	p-value	ΔCFI	ΔRMSEA	
Metric Against Configural	15	15	.019	0	-.002	
Scalar Against Metric	41	35	.240	.002	-.004	
Scalar Against Configural	68	50	.045	.002	-.006	

Aim 1.3 Sensitivity Analysis

Because chi-squared tests are sensitive to sample size, I conducted a sensitivity analysis to confirm results were not driven by the large White group, which was approximately 4 times larger than any other racial group. First, I used SPSS to produce a randomized subset of White participants. The White subset was n=208 to be comparable to the Black, Asian American, and Hispanic group sizes. Analysis from Aim 1.2 was replicated comparing the chi-square results of the randomized White subset vs. each racial minority group (i.e., White vs. Black, White vs. Asian American, White vs. Hispanic).

In the Black vs White subset, Asian American vs White subset, and the Hispanic vs. White subset comparison, model fit did not significantly differ from the original analysis. Measurement invariance conclusions were retained. However, p-values of the chi-square analysis did shift towards non-significance, which suggests that sample size does influence my findings. See Appendix Table 1 for chi-squared fit results.

Aim 2

For Aim 2, the relationship between UPPS-P trait and substance use measures was first examined within each racial group. Then, each racial minority group and White group were compared using a strong invariance measurement model to test for significant differences across groups in the linear regression path coefficients between UPPS-P traits and substance use outcomes. Age, which was found to be significantly different across groups, and gender were included in all models as covariates. Because of the small group size, those who identified as non-binary gender categories were removed from analysis.

Aim 2.1 Alcohol Use

Racial Group Comparisons

Across the Black and White groups, there were no significantly different linear regression path coefficients between UPPS-P traits and AUDIT scores (*p's*>.06). Across the Asian American and White groups, there were no significantly different linear regression path coefficients between UPPS-P traits and AUDIT scores (*p's*>.08). However, the effect of age was significantly different across Asian American and White groups (p=.028). Across the Hispanic and White groups, there were no significantly different linear regression path coefficients between UPPS-P traits and AUDIT scores (*p's*>.20; Figure 9). See Table 7 for difference test results.

Table 7. UPPS-P traits and AUDIT difference tests across Black versus White comparison, Asian American versus White comparison, and Hispanic versus White comparison, covarying for age and gender.

Parameter	**Black**		**Asian American**		**Hispanic**	
	B	P value	B	P value	B	P value
Gender	.463	.526	-.035	.960	-1.155	.207
Age	.050	.522	.153	**.028**	-.058	.459
Positive Urgency	6.915	.181	1.534	.306	-1.337	.706
Negative Urgency	-4.403	.281	-.669	.599	1.233	.678
Lack of Perseverance	2.494	.112	1.623	.081	-.521	.694
Lack of Premeditation	-3.906	.061	-1.107	.167	.647	.691
Sensation Seeking	-.993	.254	-.733	.199	.754	.533

Individual Models

In the White group, negative urgency (*B*=.897, *p*=.015), lack of perseverance (*B*=1.062, *p*=.004), and sensation seeking (*B*=.596, *p*=.003) were significantly related to alcohol use. In the Asian American group, there was a positive relationship between sensation seeking and alcohol use (*B*=1.347, *p*=.013; Figure 8). No other UPPS-P traits were significantly related to alcohol use in any of the groups studied.

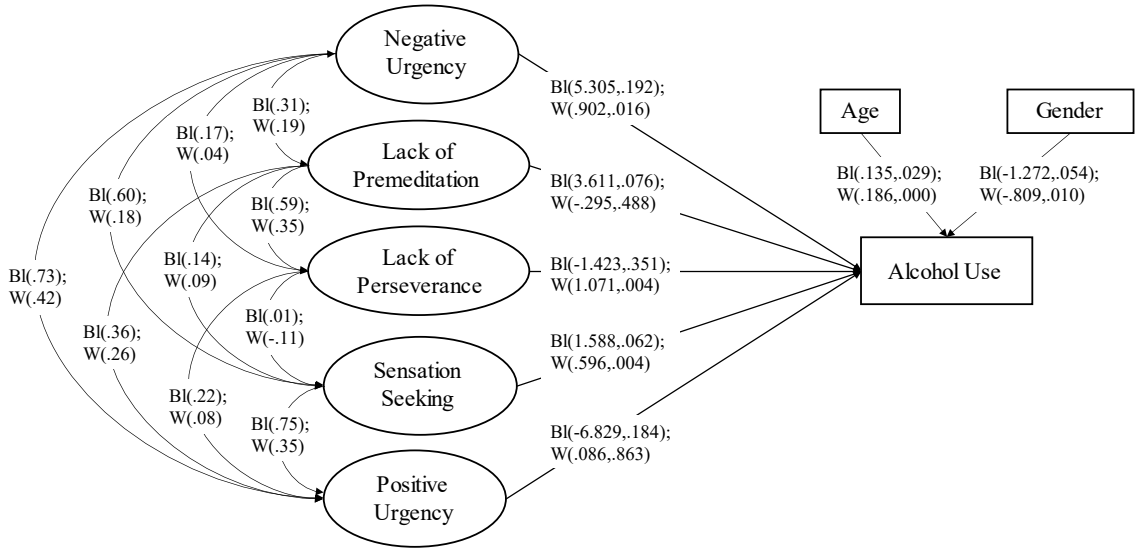

Figure 7. Black vs. White group on Alcohol Use. Note: Covariates and linear regression coefficients for Black and White groups ordered as (Bl; W). Bidirectional arrows indicate correlations (*r* values shown). Unidirectional arrows indicate linear regression coefficients (*B*, *p*). Individual SUPPS-P items not shown (see Figure 4).

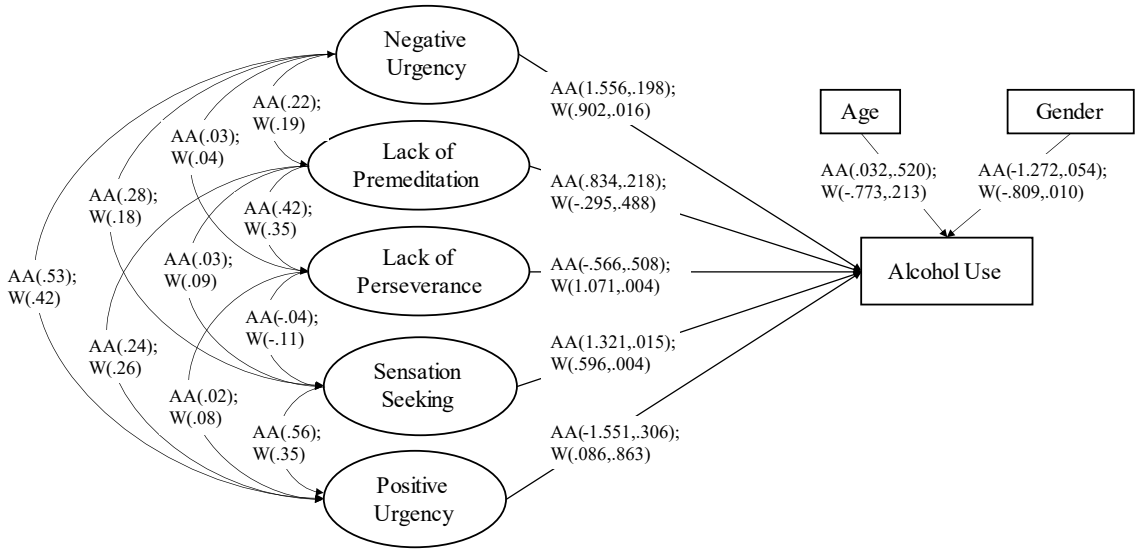

Figure 8. Asian American vs. White group on Alcohol Use. Note: Covariates and linear regression coefficients for Asian American and White groups ordered as (AA; W). Bidirectional arrows indicate correlations (*r* values shown). Unidirectional arrows indicate linear regression coefficients (*B*, *p*). Individual SUPPS-P items not shown (see Figure 5).

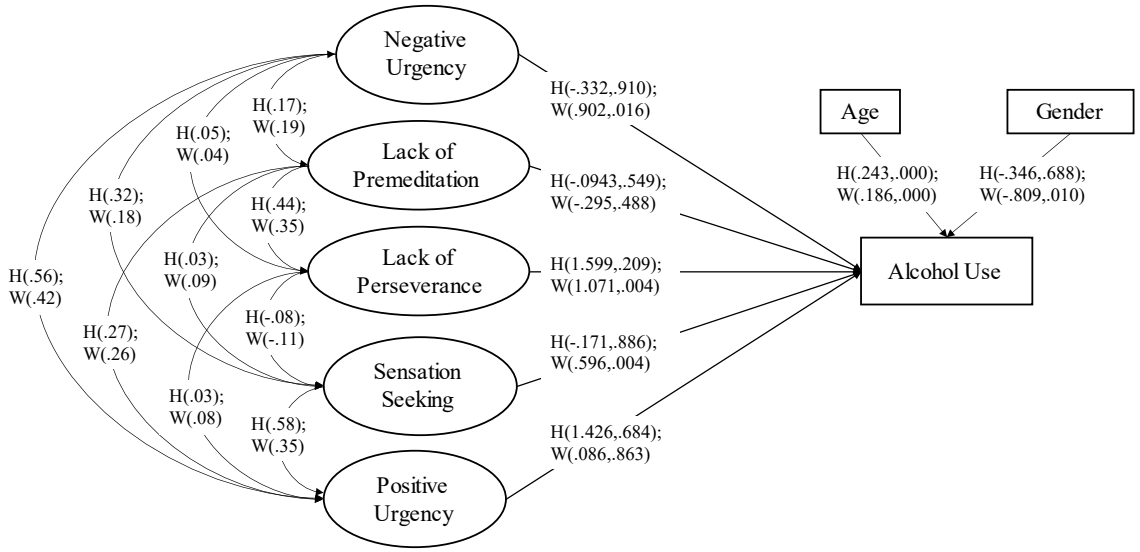

Figure 9. Hispanic vs. White group on Alcohol Use. Note: Covariates and linear regression coefficients for Hispanic and White groups ordered as (H; W). Bidirectional arrows indicate correlations (*r* values shown). Unidirectional arrows indicate linear regression coefficients (*B, p*). Individual SUPPS-P items not shown (see Figure 6).

Aim 2.2 Cannabis Use

Racial Group Comparisons

Across the Black versus White comparison, Asian American versus White comparison, and Hispanic versus White comparison, there were no significantly different linear regression path coefficients between UPPS-P traits and CUDIT scores, respectively (*p's*>.10; see Table 8).

Table 8. UPPS-P traits and CUDIT difference tests across Black versus White comparison, Asian American versus White comparison, and Hispanic versus White comparison, covarying for age and gender.

Parameter	**Black**		**Asian American**		**Hispanic**	
	B	P value	B	P value	B	P value
Gender	-.695	.419	-.188	.800	-.815	.355
Age	.096	.274	.103	.238	-.078	.355
Positive Urgency	4.605	.293	.903	.542	-.801	.735
Negative Urgency	-2.923	.386	-.537	.625	1.082	.588
Lack of Perseverance	1.549	.301	1.524	.124	.042	.943
Lack of Premeditation	-2.262	.214	-.839	.371	.145	.914
Sensation Seeking	-.385	.644	.502	.422	1.003	.230

Individual Models

In the White group, lack of perseverance was significantly related to cannabis use (*B*=1.419, *p*=.001). No other UPPS-P traits were significantly related to cannabis use in any of the groups studied.

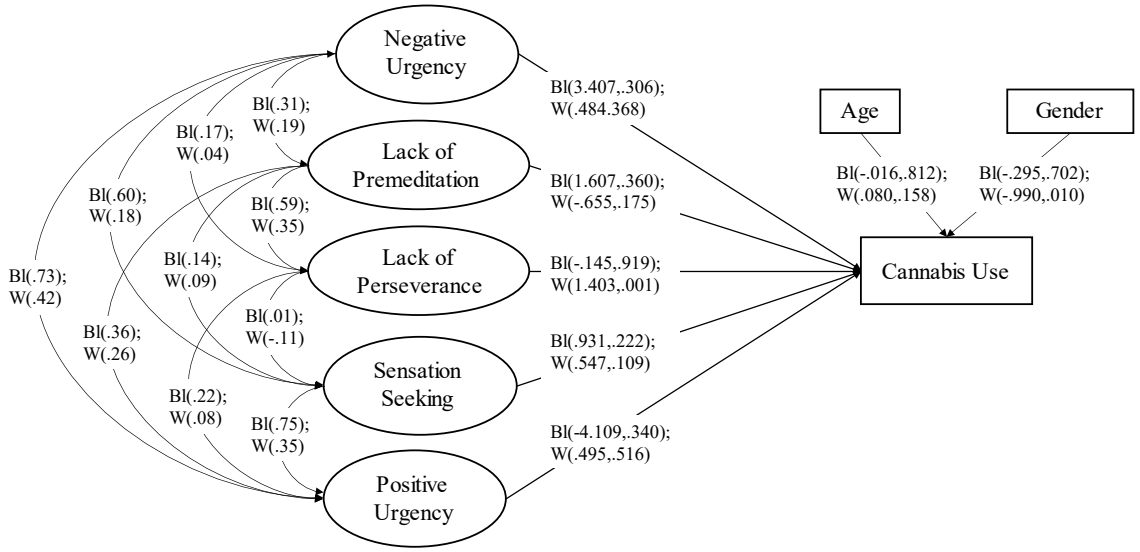

Figure 10. Black vs. White group on Cannabis Use. Note: Covariates and linear regression coefficients for Black and White groups ordered as (Bl; W). Bidirectional arrows indicate correlations (*r* values shown). Unidirectional arrows indicate linear regression coefficients (*B, p*). Individual SUPPS-P items not shown (see Figure 4).

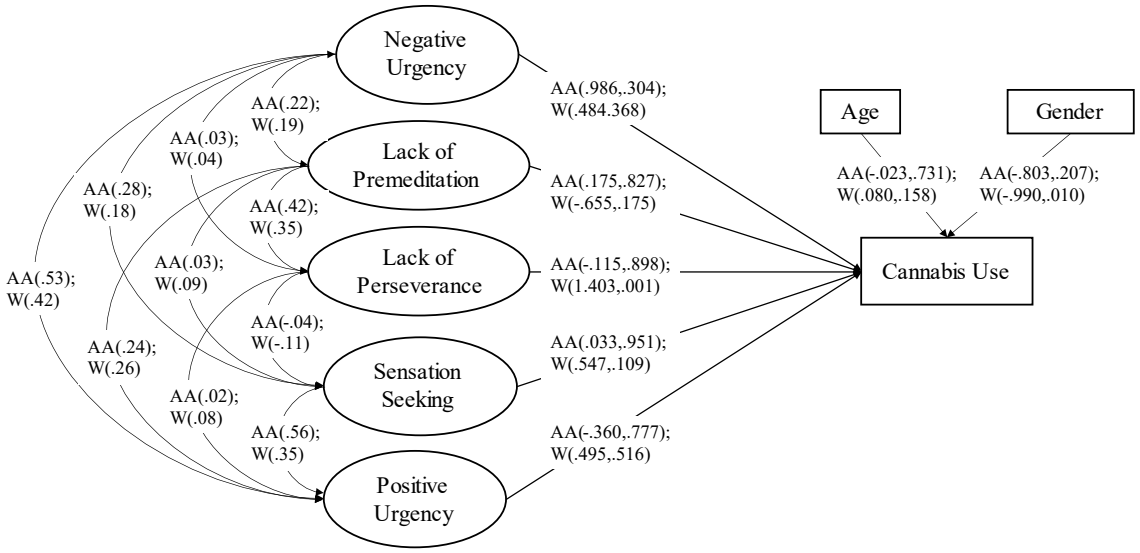

Figure 11. Asian American vs. White group on Cannabis Use. Note: Covariates and linear regression coefficients for Asian American and White groups ordered as (AA; W). Bidirectional arrows indicate correlations (*r* values shown). Unidirectional arrows indicate linear regression coefficients (*B, p*). Individual SUPPS-P items not shown (see Figure

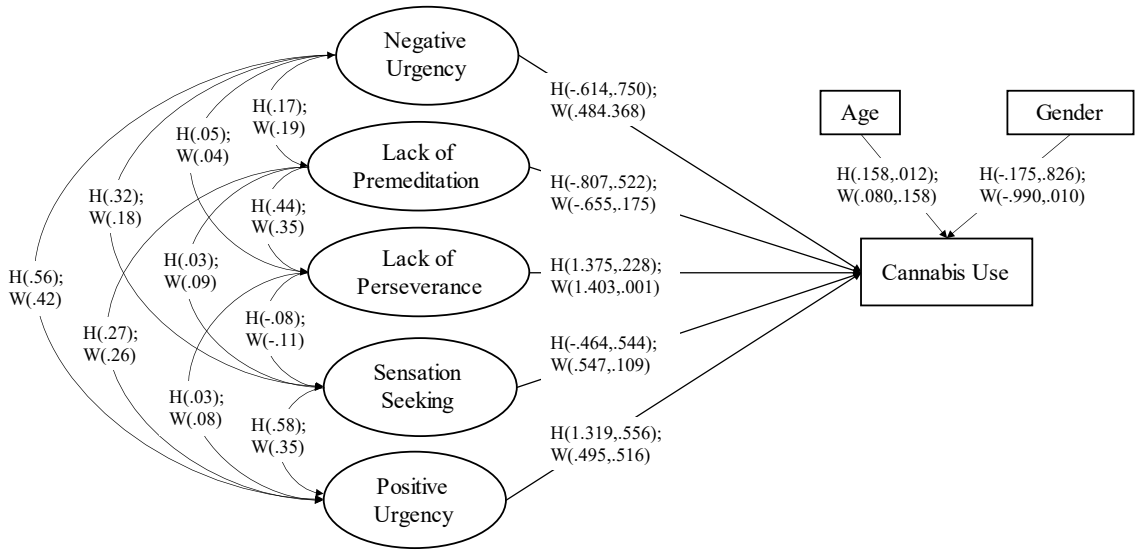

Figure 12. Hispanic vs. White group on Cannabis Use. Note: Covariates and linear regression coefficients for Hispanic and White groups ordered as (H; W). Bidirectional arrows indicate correlations (*r* values shown). Unidirectional arrows indicate linear regression coefficients (*B, p*). Individual SUPPS-P items not shown (see Figure 6).

Aim 2.3 Drug Use

Racial Group Comparisons

Across the Black versus White comparison, Asian American versus White comparison, and Hispanic versus White comparison, there were no significantly different linear regression path coefficients between UPPS-P traits and DUDIT scores, respectively (*p's*>.20; see Table 9).

Table 9. UPPS-P traits and DUDIT difference tests for Black versus White comparison, Asian American versus White comparison, and Hispanic versus White comparison, covarying for age and gender.

Parameter	**Black**		**Asian American**		**Hispanic**	
	B	P value	B	P value	B	P value
Gender	-1.213	.117	-.449	.532	-1.570	.266
Age	.107	.343	.020	.816	-.051	.654
Positive Urgency	6.199	.241	1.287	.241	-1.087	.802
Negative Urgency	-5.223	.212	-1.104	.229	.295	.939
Lack of Perseverance	1.367	.448	.826	.257	-1.781	.281
Lack of Premeditation	-2.208	.306	-.323	.688	1.538	.406
Sensation Seeking	.073	.934	.381	.388	.602	.655

Individual Models

In the White group, lack of perseverance (*B*=1.44, *p*=.002) and sensation seeking (*B*=.860, *p*=.004) were significantly related to drug use. In the Asian American group, there was a significant positive relationship between negative urgency and drug use (*B*=1.745, *p*=.022). No other UPPS-P traits were significantly related to drug use in any of the groups studied.

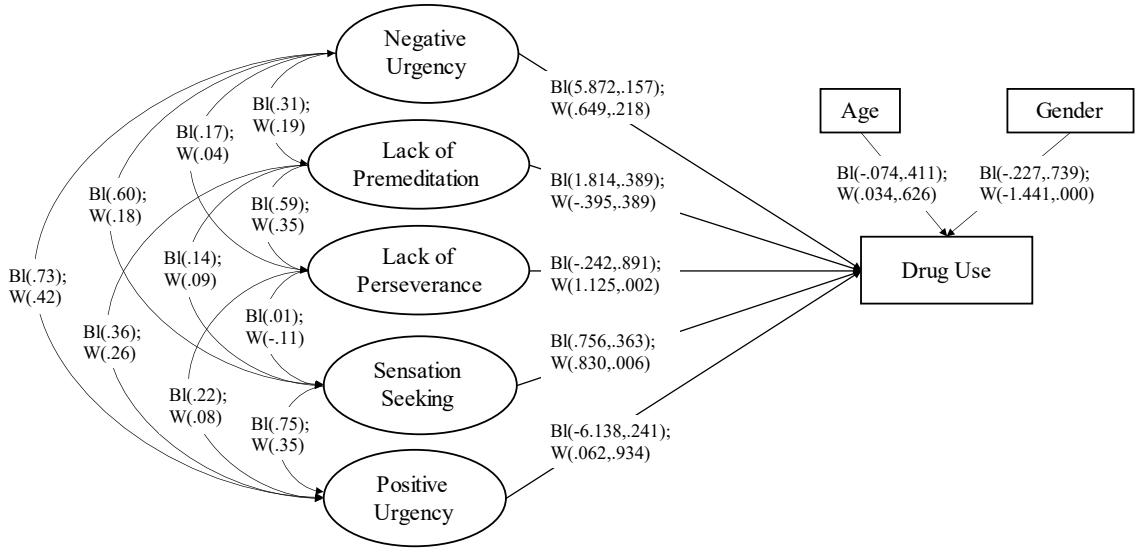

Figure 13. Black vs. White group on Drug Use. Note: Covariates and linear regression coefficients for Black and White groups ordered as (Bl; W). Bidirectional arrows indicate correlations (*r* values shown). Unidirectional arrows indicate linear regression coefficients (*B*, *p*). Individual SUPPS-P items not shown (see Figure 4).

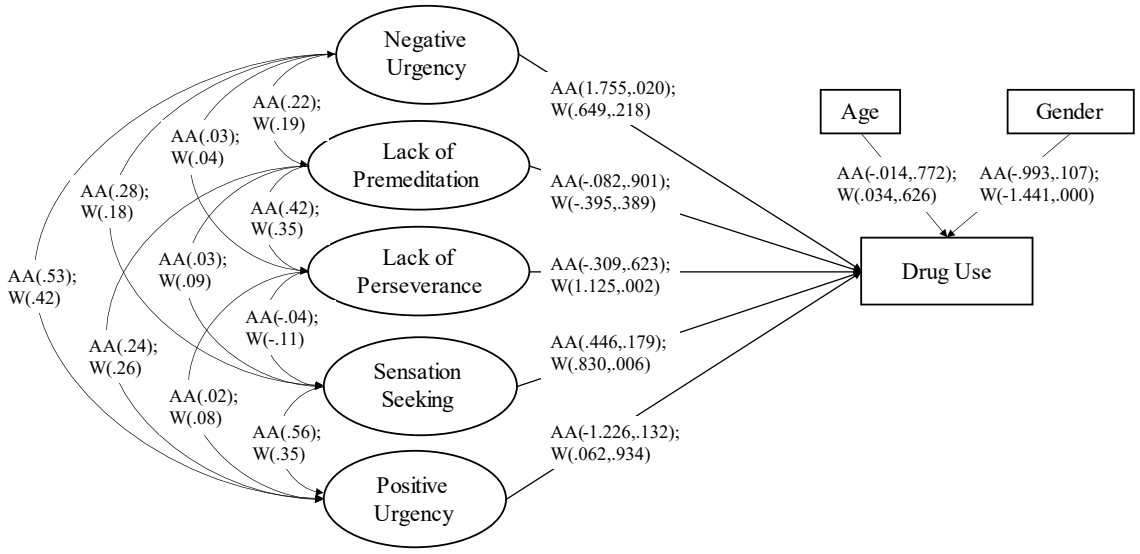

Figure 14. Asian American vs. White group on drug Use. Note: Covariates and linear regression coefficients for Asian American and White groups ordered as (AA; W). Bidirectional arrows indicate correlations (*r* values shown). Unidirectional arrows indicate linear regression coefficients (*B*, *p*). Individual SUPPS-P items not shown (see Figure 5).

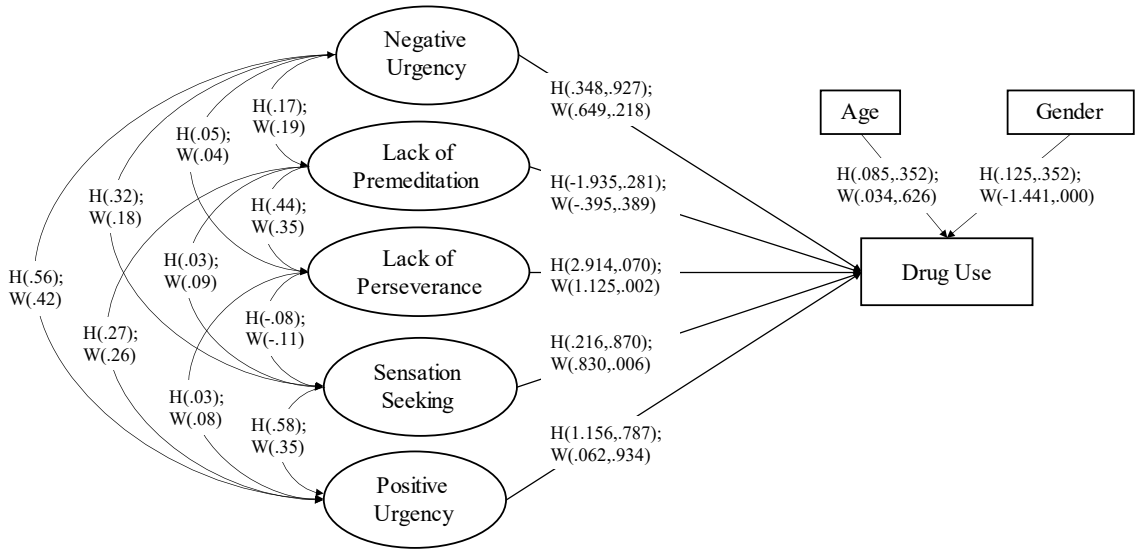

Figure 15. Hispanic vs. White group on Drug Use. Note: Covariates and linear regression coefficients for Hispanic and White groups ordered as (H; W). Bidirectional arrows indicate correlations (*r* values shown). Unidirectional arrows indicate linear regression coefficients (*B, p*). Individual SUPPS-P items not shown (see Figure 6).

DISCUSSION

Main Findings

The current study adds to our understanding of whether the SUPPS-P can validly and reliably measure impulsive personality traits in racial and ethnic minority groups, and if there are differences in how these traits relate to substance use equally across racial groups. I found that the 5-factor SUPPS-P model provides an appropriate fit for Asian American, Black, and Hispanic groups. I concluded that the SUPPS-P can validly measure impulsive behavior in Hispanic/Latino, Asian American, and Black individuals between the ages of 18 and 35 and can be used for comparison of mean differences and differential validity patterns across groups. To my knowledge, this study is the first to test measurement invariance of the SUPPS-P scale in Asian American and African American adults. Additionally, this study supported prior findings that, among White individuals, some impulsive personality traits related to substance use. However, impulsive personality traits generally did not relate to substance use within the racial and ethnic minority groups, although the relationships did not significantly differ across racial and ethnic minority and White groups. This questions the utility of the SUPPS-P traits in substance use risk models among racial and ethnic minority groups.

Aim 1

In Aim 1 of this study, I concluded that the SUPPS-P can validly measure impulsive behavior in Hispanic/Latino, Asian American, and Black individuals, and can be used to compare mean differences and differential validity patterns across groups. This conclusion was based on examining configural, metric, and scalar invariance through evaluation of model fit indices as guided by Putnick & Bornstein (2016), van de Schoot et al. (2012), and Vandenberg & Lance (2000). The chi-square test is most commonly used for model fit, but it is overly sensitive to minor differences between group factor patterns and sample size (Vandenberg & Lance, 2000). To account for this, I conducted a sensitivity analysis to examine if chi-square results were influenced by group size differences using two equal sample sizes. Additionally, I followed recommendations to consider several additional fit indices, the CFI and RMSEA (Hu & Bentler, 1999). Findings from the chi-square test and the CFI and RSMEA indices drew conflicting

conclusions on model invariance. Thus, it is important to consider possible implications in evaluating model fit with my selected indices, which may lead to different conclusions for the field.

If the chi-square test was my sole marker of invariance, I would reject invariance for Black and Hispanic groups but meet weak invariance for the Asian American group. This would suggest that current research on the SUPPS-P constructs of impulsive behavior does not generalize to racial ethnic minority groups. In order to validly assess impulsivity related risk in racial/ethnic minority models, a new model of impulsive personality would need to be developed that would perform better in these groups. Such a conclusion would also mean that the existing SUPPS-P scale should not be used in racial and ethnic minority groups, and that the plethora of research on the SUPPS-P might not generalize to these groups. Further, this would also suggest a need to develop a novel scale and model to be utilized in racial and ethnic minority groups, which would necessitate additional time to be tested for validity and reliability before more in depth work could be conducted. On the other hand, if this conclusion were not accurate, and invariance should have been retained, research in this field would be unnecessarily slowed as new measures are developed and tested.

However, because the chi-square test is sensitive to large sample sizes, and the White group was four times as large as any other ethnic and racial minority groups, I conducted a sensitivity analysis with a randomly selected smaller group of White participants. Although measurement invariance conclusions were consistent with the original results, p-values shifted towards non-significance. This result suggests that the chi-square results utilizing the full White sample might have been sensitive to the larger relative size of the comparison group. However, using this randomized group could also be problematic, in that I randomly chose the White subgroup and may have introduce other sources of error or bias in not utilizing the full data available to us. Taking into account this conflicting evidence, I concluded that the chi-square results should not be the sole marker of model fit, and that alternative fit indices may be more meaningful and help to provide a more complete picture about the measurement invariance of the SUPPS-P scale.

If I rely on CFI and RMSEA as my indicators of model fit, I would conclude strong invariance for the Black, Asian American, and Hispanic groups. This would suggest that the SUPPS-P scale can validly assess impulsive personality traits for these groups, and that mean

scores can be validly compared across groups. It would also allow us to reliably build upon the existing, and thorough, body of research with the SUPPS-P, most of which has been conducted in White participants, to inform directions for future work with more diverse populations. Such a conclusion then allows future work to test whether previously found relationships and models of impulsive-personality driven behaviors generalize to more diverse populations. The CFI and RMSEA results are consistent with the sensitivity analyses; however, goodness-of-fit indices may be sensitive to model size and were originally designed to assess model fit in terms of covariance structure, not mean structure variance (Fan & Sivo, 2009), potentially limiting their usefulness for questions of measurement invariance. The risk of utilizing these alternative fit indices is that, if invariance should have been rejected, I could potentially retain a model that inaccurately assesses impulsive behavior these groups.

Depending on which fit index I consider, the conclusions on measurement invariance can drastically change. In order to choose which fit indices to utilize, I considered three factors that moderate model fit: sample size, number of groups compared, and model size (Putnick & Bornstein, 2016). As sample size increases, chi-square tests increase in power to reject the null hypothesis (e.g., tending to reject if the sample is large and fail to reject if the sample is too small), whereas change in RMSEA and CFI are less sensitive to sample size than chi-square. Although there is some evidence that RMSEA may over-reject models in small samples ($n<100$), the smallest group size is $n=173$, suggesting that this is likely not a factor in the current study (F. Chen et al., 2008). Although RMSEA and CFI can be influenced by large number of group comparisons (e.g., 10-20), I only compared two groups at a time (White versus a racial minority group), again suggesting little influence of this limitation (Rutkowski & Svetina, 2014). Finally, all 3 fit indices are sensitive to model size; RMSEA and CFI tend to be overly sensitive for smaller models, while chi-square is overly sensitive for larger models (Putnick & Bornstein, 2016). The SUPPS-P scale is a relatively large model, with 57 degrees of freedom (Cyders et al., 2014). Given the large sample size, 2-group comparison, and large model size, I conclude that change in CFI and RMSEA indices are good indicators of measurement invariance.

Although there is some risk of accepting invariance when it should have been rejected, the findings of the current study suggest that strong invariance is met across Black, Asian American, and Hispanic groups, as compared to a White comparison group, and that making direct comparisons of SUPPS-P scores between White and ethnic/racial minority groups is valid

and possible. My findings align with prior research establishing measurement invariance in Hispanic/Latino individuals and African American men (Bertin et al., 2021; Stevens et al., 2018). This conclusion allows for additional testing of whether or not impulsive personality traits, as measured by the SUPPS-P, relate to substance use outcomes similarly across White and racial and ethnic minority groups.

Aim 2

The second aim of the current study found that although there were no significant differences in how the SUPPS-P traits related to substance use the groups studied, very few relationships were significant in the racial and ethnic minority groups. Overall, findings in the White group indicated significant relationships between multiple SUPPS-P traits and alcohol and substance use, as supported by previous research (Coskunpinar et al., 2013; Thomsen et al., 2018; VanderVeen et al., 2016). The lack of significant relationships outside the White group questions the utility of the SUPPS-P traits in substance use risk models among racial and ethnic minority groups.

Two relationships between impulsive personality traits and substance use were found in the Asian American sample. My findings corroborate previous work, not using the SUPPS-P, that found a significant positive relationship between sensation seeking and alcohol use (Han & Short, 2009; Hittner & Swickert, 2006). Additionally, I found that negative urgency was significantly related to drug use in Asian Americans, which aligns with prior research in White samples, but has not specifically been examined in Asian Americans (Smith & Cyders, 2016). This suggests that some existing evidence in White samples may extend to Asian Americans, and that traits of impulsive behavior may be a relevant mechanism of risk in this group. Of note, the Asian American group was the only group with SUPPS-P restricted item variance. This is consistent with evidence of cross-cultural differences in Likert scale response styles, where East Asian students are less likely to choose extreme values compared to North American students (C. Chen et al., 1995). This may be driven by cultural values of collectivism or dialectical thinking; tolerating contradictory beliefs may lead to a more moderate response pattern among East Asians (Hamamura et al., 2008).

No other SUPPS-P traits were found to have significant relationships to substance use outcomes across the racial groups of interest. This contradicts past research that highlights

impulsive traits as a significant risk factor across substance use outcomes (Coskunpinar et al., 2013; VanderVeen et al., 2016), but contributes to emerging research that suggests these relationships may not generalize to racial minorities. Prior research supports that the relationship between sensation-seeking and alcohol use may not extend to Black participants, and the effect may be stronger in Whites than in other racial/ethnic groups (Hittner & Swickert, 2006; Pedersen et al., 2012). A recent paper found that, among Black males, only deficits in conscientiousness (second order factor of lack of perseverance and lack of premeditation) predicted problem substance use, and that, overall, prior use was a more robust predictor of later use over impulsivity (Bertin et al., 2021). Another study, conducted in a sample of mostly Black youths, found that negative urgency was not a significant moderator between perceived discrimination and substance use (Zapolski et al., 2019). On the other hand, Stevens and colleagues (2018) found that, among Hispanic/Latino college students, all UPPS-P traits (except sensation seeking) significantly related to substance use outcomes. Given these mixed findings, impulsive personality traits may not be a proximal risk factor for substance use among minority racial groups, but more research is needed to fully characterize these relationships. It is possible that some of the well-established relationships, found predominantly in White participants, may not generalize to other racial and ethnic minority groups.

Some alternative interpretations should also be considered in understanding these largely null effects. In Aim 1, considering sample size was an important factor in interpreting the results. However, in Aim 2, power is less of a concern, as SEM model recommendations are group sizes of at least 100, regardless of unequal sample sizes (Hox & Maas, 2001). As the study group sizes are all above this threshold, lack of statistical power likely does not account for these results. Although I found the presence of different significant relationships between SUPPS-P traits and substance use relationships in individual racial groups, I found no interactions effects between groups, such that, difference test results indicated that linear regression coefficients were not significantly different between racial group comparisons. In other words, when compared to the null hypothesis, significant relationships emerged in the Asian American and White groups but did not emerge in the Black and Hispanic Groups; yet the strength of the relationships did not differ between the ethnic/racial minority group and the White group, when directly compared.

This somewhat confusing set of results could be a reflection of comparing p-values that are not significantly different from each other (i.e., .04 vs. .06), despite one being significantly

different from zero. For example, when Black vs. White groups are compared to each other, difference tests show that linear regression coefficients of sensation seeking with alcohol are not significantly different (p=.199). However, when compared to zero (i.e., the null hypothesis), the relationship is significant in the White group (p=.003) but not in the Black group (p=.060). As this relationship approaches significance, this null effect in the Black group could reflect the smaller Black group size, and thus, lower power in this group to detect a relationship. It's quite possible that this relationship in the Black group could reach statistical significance with a larger, and more powered, group size, similar to that of the White group.

Limitations

There are several limitations to the current study. First, the sample is restricted by demographic and study collection parameters. The study was comprised of young adults only, which is similar to prior studies examining the validity of the SUPPS-P and captures an important developmental period associated with increased substance use and problems (Cyders et al., 2014; Schulenberg & Maggs, 2002). However, this may limit the generalizability of these results across the developmental lifespan, which may overlook the unique role impulsive traits may play in substance use among middle-to-older adults (Liu et al., 2020). Attentional checks were only incorporated for MTurk surveys and not SONA because of concern of bots on MTurk (i.e., low-quality responses that may be computer generated); however, including attentional checks in both samples would likely increase validity of results. The data are self-report, which is limited by the individual's willingness and openness to report, and cross-sectional, which cannot determine causation.

Second, operational definitions of racial groups may contribute to greater variability within-groups than between-groups. I found that the Asian American group reported significantly lower substance use mean scores than the White group. However, this categorization consists of multiple subgroups (Korean, Chinese, Japanese, Vietnamese, etc.), which may mask differential problematic risk-taking behaviors between subgroups (Iwamoto et al., 2016). For instance, although Asian Americans have lower rates of substance use than other racial groups, Japanese Americans report rates similar or higher than Whites across substances (Price et al., 2002) Multi-racial individuals were also categorized based on 'at least' rules, which may mask multi-racial group specific patterns such as higher rates of substance use and problem

behaviors compared to monoracial racial/ethnic minorities (Choi et al., 2006). Although this approach increased power and allowed us to include participants who would otherwise be excluded, this may have led to more overlap between groups and contributed to non-significant difference tests. In this sample, those who endorsed both White and a racial ethnic minority group consisted of 8.2% (n=17) in the Black group, 4.3% (n=9) in the Asian American group, so it is unlikely to have dramatically affected results in these groups. However, 37% (n=64) endorsed White and Hispanic in the Hispanic group, which is likely reflective of multidimensional perspectives on Hispanic backgrounds as both racial and ethnic identities (Parker et al., 2015). Future studies should take a more comprehensive approach to operationalizing and disaggregating their racial group of interest.

Third, substance use outcomes were limited to measures of problematic alcohol, cannabis, and drug use. Although these measures are widely used, there may be more accurate measures of alcohol use in these groups. For instance, AUDIT performance is generally consistent across ethnic groups, but some studies have found that alternate measures of alcohol dependence are more sensitive than the AUDIT for Black, Hispanic, and male demographic groups (Cherpitel & Bazargan, 2003; Reinert & Allen, 2007). The AUDIT, CUDIT, and DUDIT are also 'face-value' screening measures, which rely on participants willingness to self-disclose on negative consequences of use, which might lead to under-reporting of use and failure to detect relationships within, or differences between, groups in Aim 2. It may be useful to instead isolate frequency, quantity, or include additional biomarkers of alcohol use. Additionally, nicotine use should be explicitly examined in the future given well-documented racial disparities in use and treatment outcomes (Cokkinides et al., 2008; Trinidad et al., 2011).

Future directions

Testing for measurement invariance is infrequently applied in cross-cultural research; however, it is a critical first step to avoid systematic bias and make valid cross-cultural comparisons (Boer et al., 2018). This study provides further evidence that the SUPPS-P measures impulsivity in minority racial groups. The SUPPS-P can continue to be used in research applications to make valid racial/ethnic group comparisons and identify impulsivity's relationship to other variables of interest. Additionally, future research should aim for larger, more representative samples and more nuanced categorical definitions to further strengthen

evidence for the UPPS-P model across demographic groups. The current finding of measurement invariance of the SUPPS-P across White and Black, Asian American, and Hispanic groups offers some positive signal that such invariance might be found in other UPPS-P variations as well. However, specific scale versions, such as the full UPPS-P scale or abbreviated youth version, should also be tested for measurement invariance before comparisons can be validly made (Cyders, 2013; Watts et al., 2020). Finally, the current study suggests further research into understanding how, if at all, impulsive personality traits might relate to and/or predict substance use among racial and ethnic minorities.

Determining how impulsive personality might contribute to substance use for racial and ethnic minority groups has important long-term implications for the design and testing of interventions to reduce substance use. Recent work has suggested that impulsive personality affects substance use treatment outcomes and is a relevant target of clinical intervention (Hershberger et al., 2017; Um et al., 2018), although this is mostly based on research conducted in predominantly White samples. Nevertheless, there is evidence that these interventions might also be effective among racial minorities. A pilot study among African American female college students found that training in emotion modulation decreased negative and positive urgency and reduced risk-taking (Weiss et al., 2015). Similarly, among racially diverse adolescents, a school-based dialectical behavioral skills group, which is postulated to address deficits in impulsivity, has been shown to reduce risk-taking behaviors (Zapolski & Smith, 2017). These findings somewhat conflict with findings of the current study that suggest that impulsive behavior is not a proximal risk factor for substance use for racial minorities. However, because the size of the relationship between UPPS-P traits and substance use outcomes did not differ between groups, it's likely that the relationships hold and limited power in the racial and ethnic minority groups in the current study at least in part drove null results in those groups. Thus, the current study suggests that these interventions may be equally effective for Asian American, Black and Hispanic racial/ethnic groups as they are for White groups. However, this should be tested directly in future work.

Since there is a growing body of evidence that the traditional model of risk-taking may not generalize well, other risk factors may be applicable to developing a more comprehensive model of risk in racial and ethnic minority groups. Future research may want to examine other personality models or behavioral measures of impulsive behavior to examine whether they better

detect relationships between impulsivity and substance use in small samples. Additionally, other individual factors, such as subjective differences in alcohol response, may supersede the effect of impulsive behavior (Pedersen & McCarthy, 2013; Rueger et al., 2015). Alternatively, impulsivity may be a moderator that interacts with other culturally relevant risk factors to parse out individual differences in substance use risk (Latzman et al., 2013). Finally, we may need to question if personality traits are the most relevant factor to focus on. Instead, we may need to expand our scope and include systemic, sociocultural, and external factors. Cultural norms, acculturative stress, discrimination and racism have all been highlighted as potential factors related to substance use among racial minorities (Gil et al., 2000; Hendershot et al., 2005; Zapolski et al., 2014). Evidence suggests that incorporating culturally relevant factors into substance use treatment may improve efficacy and acceptability among racial minorities (Burlew et al., 2013; Castro & Alarcón, 2002).

Overall, there is a dearth of research that focuses the role of impulsivity in substance use among racial minorities. Assumptions of generalizability and 'one size fits all' models based on White samples may lead to interventions that are not optimized for an increasingly diverse population. As such, more nuanced work is needed to establish if there is a prospective role of impulsive behavior in contributing, exacerbating, or maintaining substance use among diverse groups. The SUPPS-P can produce valid and reliable data to answer this question.

APPENDIX

Short UPPS-P (SUPP-S) Impulsive Behavior Scale

Below are a number of statements that describe the ways in which people act and think. For each statement, please indicate how much you agree or disagree with the statement.

		Agree Strongly	Agree Some	Disagree Some	Disagree Strongly
1. (4.)	I generally like to see things through to the end.	**1**	**2**	**3**	**4**
2. (6.)	My thinking is usually careful and purposeful.	**1**	**2**	**3**	**4**
3. (10.)	When I am in great mood, I tend to get into situations that could cause me problems. **(R)**	**1**	**2**	**3**	**4**
4. (14.)	Unfinished tasks really bother me	**1**	**2**	**3**	**4**
5. (16.)	I like to stop and think things over before I do them.	**1**	**2**	**3**	**4**
6. (17.)	When I feel bad, I will often do things I later regret in order to make myself feel better now. **(R)**	**1**	**2**	**3**	**4**
7. (19.)	Once I get going on something I hate to stop	**1**	**2**	**3**	**4**
8. (22.)	Sometimes when I feel bad, I can't seem to stop what I am doing even though it is making me feel worse. **(R)**	**1**	**2**	**3**	**4**
9. (23.)	I quite enjoy taking risks. **(R)**	**1**	**2**	**3**	**4**
10. (20.)	I tend to lose control when I am in a great mood. **(R)**	**1**	**2**	**3**	**4**
11. (27.)	I finish what I start.	**1**	**2**	**3**	**4**
12. (28.)	I tend to value and follow a rational, "sensible" approach to things.	**1**	**2**	**3**	**4**
13. (29.)	When I am upset I often act without thinking. **(R)**	**1**	**2**	**3**	**4**
14. (31.)	I welcome new and exciting experiences and sensations, even if they are a little frightening and unconventional. **(R)**	**1**	**2**	**3**	**4**
15. (34.)	When I feel rejected, I will often say things that I later regret. **(R)**	**1**	**2**	**3**	**4**
16. (36.)	I would like to learn to fly an airplane. **(R)**	**1**	**2**	**3**	**4**

17. (35.)	Others are shocked or worried about the things I do when I am feeling very excited. **(R)**	**1**	**2**	**3**	**4**
18. (46.)	I would enjoy the sensation of skiing very fast down a high mountain slope. **(R)**	**1**	**2**	**3**	**4**
19. (48.)	I usually think carefully before doing anything.	**1**	**2**	**3**	**4**
20. (52.)	I tend to act without thinking when I am really excited. **(R)**	**1**	**2**	**3**	**4**

Note. Item numbers indicate the item order on the Short UPPS-P, whereas numbers in parentheses indicate the original item numbers on the UPPS-P. Items with an (R) are reverse coded, so that higher values indicate more impulsive behavior.

Appendix Table 1. Sensitivity analysis chi-squared results comparing racial minority group with randomized White subset (n=208)

Models compared	χ^2	*df*	**p-value**
Black vs White subset			
Metric Against Configural	28	15	.022
Scalar Against Metric	46	34	.084
Scalar Against Configural	72	49	.018
Asian American vs. White subset			
Metric Against Configural	13	15	.620
Scalar Against Metric	49	32	.025
Scalar Against Configural	62	47	.067
Hispanic vs. White subset			
Metric Against Configural	32	15	.007
Scalar Against Metric	35	34	.407
Scalar Against Configural	66	49	.054

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