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The Faces of Substance Use: A Reverse Correlation Analysis of Perceptions of Alcohol and Cannabis Use

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Thesis presented to the Graduate Faculty of The College of William & Mary in Candidacy for the Degree of
Master of Science

Psychological Sciences Department

College of William & Mary
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APPROVAL PAGE

This thesis is submitted in partial fulfillment of
the requirements for the degree of

Master of Science

Madison H. Colby

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COMPLIANCE PAGE

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ABSTRACT

Alcohol and cannabis are some of the most ubiquitous substances on college campuses. While the reason for use varies between each individual, from social lubricant to sleeping aid, nearly half of higher-education students endorse alcohol and/or cannabis use in the last month. Despite this popularity, there is still a deeply ingrained level of stigma around substance use and substance use disorders and people who use substances or struggle with substance use disorders are subject to a litany of damaging perceptions, such as being deemed violent, unpredictable, weak, and untrustworthy.. Most research on the stereotypic thinking surrounding substance use focuses on explicit judgements about the moral character of users. However, to the best of our knowledge, there is little information about the implicit judgements and perceptions of people who use substances. Humans glean vast amounts of information just from looking at another person's face and the fluency of that processing often leads to fallible judgments. Do you know what a person with substance use disorder looks like? Are there characteristics in a person's appearance that may lend themselves to being identified as a user or nonuser of substances? The purpose of this study is to determine the implicit visual characteristics that are part of the implicit perceptual biases regarding substance use — the primary aims being (1) create proxies of the mental representations of alcohol and cannabis users in a reverse correlation paradigm and (2) determine if there are common properties within the images generated that can be used to discriminate between substance type and use status. The results revealed that implicit perceptual biases regarding substance were rooted in gender differences with masculinity being strongly associated with substance use. Interestingly, the implicit perceptual biases related to the type of drug used (alcohol or cannabis) was less rooted in gender biases but defined more by dimensions of race and personality. These findings confirm that there are implicit biases related to substance use and demonstrate that these biases may be unique to different substance types.

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Additionally, this writer would like to thank the members of the Cognitive Psychophysiology Lab for their time and support.

This thesis is dedicated to my parents, David and Amy Colby. There are not enough words to express my gratitude, but I'll start with thank you.

LIST OF FIGURES

Chapter 1: The Perception of Faces

The fluent processing of faces is an incredibly adaptive quality that humans possess. We glean vast amounts of information from just a glance at another person's face (Tsao & Livingstone, 2008). Identifying and responding to facial stimuli is a complex, holistic process (Tanaka & Farah, 1993; Young et al., 1987) that can survive visual noise interference (McKone et al., 2001). While we all learn from a young age that one should not judge a book by its cover, this maxim is consistently negated in social psychological studies. Facial perceptions can, for example, predict legal outcomes (Zebrowitz & McDonald, 1991), judgements of intelligence (Zebrowitz et al., 2002), and sociability (Snyder et al., 1977).

Despite the amount of information received from studying faces, it is a fallacy to believe in the validity of these judgments. For example, trustworthiness decisions can be made below the threshold of objective awareness (Todorov et al., 2009). Researchers presented previously rated trustworthy and untrustworthy faces for 20ms before a neutral target face and asked participants to decide the trustworthiness of the facial image. Participants categorized the neutral faces in accordance with their paired priming images even though a recognition study indicated there was no objective awareness of the primed images (Todorov et al., 2009). One of the most important data points people get from viewing faces alone is emotional state and these judgments of trustworthiness impede the ability to recognize emotion. When shown images of trustworthy, neutral, and untrustworthy rated faces, participants were slower and less accurate in judging happiness, anger, and sadness for the untrustworthy faces

(Colonnello & Russo, 2019). There is no indication that these decisions are true to reality, even when high in interrater consensus. In order to test the veracity of these ubiquitous judgements about trustworthiness, some research has compared participants' judgements for images of people with known criminal backgrounds (Rule et al., 2013). The results of this research suggest that judgements of trustworthiness are no better than chance. Despite the lack of meaningful relationship between reality and perception for many traits, the judgments informed by facial appearance can elicit very real behavioral responses and differential outcomes. These outcomes can range from the perceiver's tendency towards altruistic behaviors (Cunningham, 1986) to the likelihood of receiving the death sentence (Eberhardt et al., 2006). Personality characteristics, gender, and race are some attributes people attempt to discern from looking at a face alone and these perceived traits influence the way we categorize and behave towards others (Freeman & Johnson, 2016; Macrae & Bodenhausen, 2000).

Chapter 2: Visualizing Stigma

Implicit attitudes are unconsciously held attitudes predicated on previous experiences being leveraged against novel stimuli (Greenwald & Banaji, 1995). There is a growing body of evidence that implicit attitudes have properties that can be visualized; the literature demonstrates that people imbue novel facial images with personality traits and characteristics (Dotsch et al., 2008; Oliveira et al., 2019; Zebrowitz et al., 2002). Stigma, stereotyping, and implicit attitudes, while not synonymous terms, share traits that can cause harm to the observed groups they are formulated about. All three concepts are related in the sense that they overgeneralize characteristics about an

identity; stereotyping being defined as shared beliefs about a social group (Greenwald & Banaji, 1995), stigma as negative beliefs or stereotypes about individuals whose identities or behaviors deviate from standard norms (Dudley, 2000). Importantly, both stigma and stereotyping may sometimes be implicit (Greenwald & Banaji, 1995) in the sense that they can be informed by unconscious attitudes (as well as explicit). Thus, it follows that highly stigmatized and stereotyped social categories could also be elicited by visual representations.

Stigma is a pernicious issue with a myriad of impacts on those whose identities fall into socially unacceptable categories. Goffman describes stigma as “the situation of an individual who is disqualified from full social acceptance” (1963). The salience of the people’s response to stigmatized groups is even evident in the electrophysiological measures of brain activity (Krendl et al., 2017). EEG studies are used to examine neural correlates of perception and cognition. Particularly, event-related potentials (ERP) are averaged measures of neural activity time locked to some stimulus onset (e.g. presentation of a facial image). There has been extensive literature within the social neuroscience discipline examining neural correlates of facial perception (Belanova et al., 2018; Eimer, 2011; Meyer et al., 2021). For example, images of stigmatized targets (e.g problematic substance users and homeless people) have been shown to elicit higher amplitudes on the early positive event-related potential (which is associated with directing emotional attention) compared to negative but non-stigmatizing stimuli (Krendl et al., 2017). Moreover, when tasked with emotional reappraisal for the images, the non-stigmatizing negative targets show attenuation in the late positive potential (LPP) amplitude (associated with regulatory goals) while the stigmatizing targets do not

(Krendl et al., 2017). Peak amplitude of the LPP was also correlated with scores on the Implicit Association Task for images of homeless individuals. Not only is stigma discernable from generally negatively arousing social stimuli, but it is also resistant to cognitive reappraisal (Krendl et al., 2017).

There is also burgeoning evidence that, despite social categories being substantively unrelated to each other, a shared conceptual framework can make them cognitively interdependent, particularly in regards to cognitive shortcuts like stereotyping (Stolier & Freeman, 2016). Studies have shown that stereotyping can intersect across multiple categories like race and gender. For example, Black and Male attributes have both been connected to aggression whereas Female and Asian attributes have been associated with docility (Freeman & Johnson, 2016). Breaking from these associations (showing Asian male faces or female angry faces) leads to consequences in down-stream perceptual processing (Freeman & Johnson, 2016). Images or people who visually differ from the typicality of their categorization (e.g. prototypical racial or gender traits) may experience differential reactions that can be predictive of electoral success (Carpinella et al., 2015) or likelihood of receiving capital punishment (Eberhardt et al., 2006).

A suite of studies using both fMRI and mouse tracking data showed the cognitive load of appraising and categorizing facial images (Stolier & Freeman, 2016). In the mouse tracking study, participants were shown an image of a face and moved the mouse either to the upper right or left corner of the screen to match the face with a descriptor trait (e.g. male or female). Faces varied in gender (male or female), race (black, white, asian) and emotion (angry, happy). Deviation from the correct target

response trajectory indexed stereotypic association activation. The authors were able to create a dissimilarity matrix (a symmetric matrix of scores indicating how similar or dissimilar a set of categories are) of stereotype activation across gender, race, and emotion which portrayed the degree of intersection between these associations. They confirmed this data by asking another set of participants about explicit stereotypical traits of the 3 types of attributes which upheld the findings. Black was consistently associated with Male and Angry, Asian was associated with Female, Male was associated with Angry, and Female was associated with Happy (Stolier & Freeman, 2016).

The second part of Stolier & Freeman's (2016) study involved recording fMRI while a new sample of participants passively viewed and attempted to remember the same faces from the mouse-tracking study. The dissimilarity matrix created from subjective and perceptual responses in the mouse-tracking study predicted neural activation of the right fusiform gyrus (including the fusiform face area) and orbitofrontal cortex (involved in integrating cues in social categorization). Taken together, these studies give evidence that social categorization influences visual processing using cues that intersect across race, gender, and emotion for top-down cognitive reasoning (Stolier & Freeman, 2016).

Other studies have looked at stigma related to race and ethnicity using random pixel noise to create visual proxies of a mental representation of these groups. A study in the Netherlands examined perceptions of Moroccan immigrants, a highly stigmatized ethnic group (Dotsch et al., 2008). Participants were divided into groups for level of prejudice based on a single choice implicit association task: low, moderate, and high.

For each group, a composite image of a Moroccan face and Chinese face was created using a reverse correlation paradigm (we will discuss this technique in depth in the next chapter). The generated images were rated by a new sample of participants on stereotypical (criminal) and non-stereotypical (trustworthy) traits associated with Moroccans. The high prejudice group's composite image was significantly higher in criminal ratings and lower in trustworthy ratings than the moderate and low prejudice group composite images. A regression was performed on prejudice scores of individuals and the subsequent criminal rating of their classification image. They showed that individuals higher in prejudice created images that were independently rated as higher in criminality (Dotsch et al., 2008).

In effort to determine whether there are physical traits associated with concealable stigmas (e.g. mental illness), researchers have employed various methodologies using facial morphs, random noise, and recognition paradigms. One study sought to compare stigma negativity associated with depression and migraines by pairing the condition with a face ranging on degrees of lip curve and smile (50% morph of a neutral face with a sad face ranging in 10% increments to 50% morph with happy face, upturned lips). After viewing the face paired with depression, migraine, or healthy, participants were asked to identify the face they were shown previously from 11 possible morphs. Migraine and depression conditions both received perceptual down-grading responses, choosing faces that were higher in sadness than the actual stimuli they were presented with while the healthy condition did not. However, when the task was repeated with anger-morphs, only the depression condition elicited the perceptual down-grading response even though anger was not directly associated as a stereotype

of depression (Cassidy & Krendl, 2018). This study indicated that highly stigmatized conditions like depression impact visual processing and may also elicit negative visualizations.

Chapter 3: The Reverse Correlation Method

Another method to visually represent concealed identities is using the reverse correlation (RC) paradigm, a technique in which an image (typically of a face) is overlaid with random visual noise across pixels (similar to TV static) and then paired with the same image overlaid with the inverse of that noise. The original being paired with its inverse assures the greatest differentiation between the pictures, allowing for salient, discernable variation. As reviewed by Brinkman and colleagues (2017), reverse correlation is a somewhat novel technique used to examine trait integration in facial perception in a social context without relying on an a priori hypothesis as it facilitates the visualization of mental representations of facial perceptions.

The image pairs are typically shown simultaneously in a 2 image forced-choice task in which participants are asked to select one of the images that they deem to match some target trait or characteristic under study. The collection of images that were selected by a participant as possessing that target trait are averaged together on a pixel-by-pixel basis to form a classification image (CI) and those that were not selected are often compiled into an anti-CI. In some studies, the CIs can then be rated by an independent group of participants on any number of perceptual and or personality dimensions in order to quantify the perceived characteristics of the CI and anti-CI. The benefit of this technique regarding controversial social issues is that participants are

inadvertently building their mental representation over hundreds of trials with very little input from the researcher. Additionally, raters are naive to the method by which the images they are rating were generated. Theoretically, this allows for a more authentic visualization of internally held perceptions that may be socially unacceptable for a participant to admit, if they are even cognitively aware of these internal representations.

Reverse correlation is sometimes used in conjunction with more popular measures of implicit attitudes. For example, tests for implicit bias on the basis of social categories are very prevalent within the social sciences fields. Perhaps most popular, the Implicit Association Test (Greenwald et al., 1998) has been able to demonstrably show various degrees of preference between racial groups, religion, sex, and more. This has given valuable insight into the ways people may associate groups and implicit attitudes towards these categories. The Implicit Association Test typically works by pairing visual stimuli with negative and positive words. One is tasked with following grouping instructions that will switch across trials. At first, black faces and positive traits may be indicated with the left arrow and white faces and negative traits may be grouped with the right arrow. Then, directions will be flipped around to white and positive, and black and negative. Response times and accuracy measures are taken to indicate automatic preferences between groups. The idea is to capture implicit attitudes towards a specific construct rather than relying on self-reports that only give lens to explicit attitudes (Meissner et al., 2019).

However, there are some significant limitations for the insight the IAT can give us. The test can only look at comparative associations between binary groups (ie.: relative positivity/preference between black and white faces) and thus far has not been

validated to strongly predict behavior nor what meanings the cutoffs between “strong”, “moderate”, and “slight” actually represent. These associations may be in part primed by the test itself, from block order effects (Nosek et al., 2005) or may be affected by issues of task-switching (Ito et al., 2015). To get a better understanding of factors that contribute to implicit bias and social perception, we want to move away from a framework of simply “good” or “bad.” We posit here that a reverse correlation task allows us to reduce researcher expectations in driving the outcomes of the study and potentially serves as a conduit towards examining the nuances of social perception.

RC studies have been employed across a multitude of disciplines to visualize constructs, not all relating directly to prejudice and stigma. Things as abstract as perceptions of the face of the Christian God in America have been used to show the way people varying in age and political affiliation view higher powers. Older people and conservatives tended to generate CIs of God that were rated as more masculine, older, powerful, and white while liberals created images of God that were rated as more African-American and loving (Jackson et al., 2019). The idea posited by this study was that the visual representation of God satisfies an internal motivation towards things people prioritize, be it egocentrism, law and order, or acceptance— characteristics that should not necessarily be associated with an external appearance.

Reverse correlation designs have also been used to examine the perceptual relatedness of constructs. For example, trustworthiness and warmth have traditionally been considered as highly correlated traits in social cognition deemed universally positive (Oliveira et al., 2019). Researchers juxtaposed these constructs with dominance and competence, traits that have been correlated but are regarded with

more clear perceptual distinction. As the authors hypothesized, the CIs created to represent traits associated with trustworthiness and warmth shared considerable overlap where dominance and competence were dissociated (Oliveira et al., 2019). In this way, the RC can be used as a method of confirming the degree of association of construct perception.

RC has also been used to visualize how race and gender relate to a construct of interest. For example, in the United States, there is much partisan debate about social welfare programs. In an investigation of how racial stereotyping influences the opposition to welfare, researchers created CIs of a welfare recipient (WR) and non-welfare recipient (NWR). The WR image was rated as more African-American, lazy, inhuman, unattractive, unhappy, and unlikeable when compared with the NWR image. Additionally, in a separate study when participants were asked which image was deserving of welfare, they were more likely to give it to the NWR image (Brown-Iannuzzi et al., 2017). Another study used the RC method to look at gender stereotypes in teaching. Students created individual classification images (ICIs) of language arts and physics teachers. With no priming of gender, the language teacher ICIs were rated as feminine while the physics teacher ICIs were rated as masculine revealing the tendency to associate males with STEM and females with humanities (Degner et al., 2019).

The RC method may be an invaluable tool in social psychology. With the ability to estimate mental representations of social constructs, we have the potential to empirically visualize implicit attitudes in relation to highly stigmatized identities, both on an individual with ICIs and systemic level with group CIs (though we will discuss the limitations associated with inferences of group CIs later). Therefore, it follows that the

next step should be to apply this technique to one of the most stigmatized mental health concerns, substance use.

Chapter 4: The Stigma of Substance Use

Substance use can be a polarizing subject in the US. While seemingly ubiquitous in modern, American settings where alcohol is commonly used as a social lubricant and cannabis is quickly climbing the legislative ladder into societal acceptance, there still exists a deep-seeded negative connotation around the use of substances. Substance use disorder (SUD) is an incredibly prevalent mental health concern, affecting 40.3 million Americans over the age of 12 (SAMHSA, 2021). Despite how common the diagnosis, people with SUDs are subject to extreme stigma, often characterized as more violent, unpredictable, less likely to be trusted with decision making, and more responsible for their diagnosis than those with other psychiatric disorders, like depression or schizophrenia (Schomerus et al., 2011; Yang et al., 2017; Kilian et al., 2021). These stigmas can directly play into the likelihood of a person seeking help for their SUD. According to the Health Belief Model, fear of stigma and discrimination is a significant factor in the underutilization of comprehensive mental health care (Verissimo & Grella, 2017). These stigmatizations can differentially affect people on the basis of gender and sex, with males often being classified as aggressive and dangerous while women may be classified as more likely to be sex-workers or unfit mothers (Sattler et al., 2021). Additionally, though previous studies have shown a greater tendency to classify males as cannabis users (Hirst et al., 2018), there is a more negative perception to female cannabis users than males (Sorsdahl et al., 2012). Social

perceptions and biases do not occur in a vacuum. Within the US, there has been a tumultuous relationship between substance use and stigma dating even prior to the introduction of prohibition (Moore & Gerstein, 1981). More recently, however, one can point towards the War on Drugs and its ramifications as a modern interpretation of how substance use is viewed (Netherland & Hansen, 2016).

Historical Disparities

The war on drugs deeply affected the way Americans view substance use. Beginning in the 1970s, as a method to reduce the illicit drug trade in the United States, incarceration rates for nonviolent, substance-related offenses began a steady and unprecedented incline. In 1980, approximately 50,000 Americans were incarcerated for drug-related offenses. By 1997, this number skyrocketed to over 400,000 (DPA, 2018). This criminalization directly impacted the way in which Americans viewed narcotics, with public officials like LAPD Chief Daryl Gates even recommending “casual drug users … be taken out and shot” (Ostrow, 1990, para. 1). While research suggests the absence of a causal link between cannabis and “hard drug” use (Morral et al., 2002), proponents of criminalization branded it “the gateway drug” and in 1971 the Controlled Substances Act was passed declaring cannabis a Schedule I narcotic, with high propensity for addiction and no approved medical uses. Framing substance use as an issue of criminality rather than public health has had far-reaching impacts on how the public views people struggling with addiction. Despite SUD being an incredibly prevalent mental health concern, affecting millions of Americans (SAMHSA, 2021) there is a deeply-rooted stigma in the diagnosis. People with substance dependence are often characterized as violent, unpredictable, and untrustworthy (Yang et al., 2017). Additionally, people with

SUDs are more likely to be seen as at fault for their diagnosis than people with other psychiatric disorders (Schomerus et al., 2011). Perhaps most troubling, approximately 50% of respondents polled believed that SUDs do not require professional treatment and that people can simply make better choices (Crisp et al., 2000). Beliefs of addiction as self-infliction and personal choices such as these make it difficult to obtain equitable funding for critically important mental healthcare.

The effects of anti-drug legislation and subsequent criminalizing mindset disproportionately affects nonwhite communities. Currently 80% of those incarcerated for federal drug-related crimes are black or latine (ACLU, 2014). Black Americans are 4 times more likely to be arrested for marijuana charges and 6 times more likely to be incarcerated for drug-related offenses than their white counterparts (ACLU, 2014). Nonwhites are also overrepresented in the carceral system for drug offenses despite having similar rates of use (Mitchell & Caudy, 2013) and SUDs as whites (NIDA, 2022). There may also be burgeoning evidence of a gender bias in perceptions of substance use. While males and females have similar rates of SUD diagnosis (NIDA, 2022), men are more likely than women to be arrested for a drug-related offense (FBI, 2020). Additionally, research into whether or not people could identify cannabis users from pictures alone found that masculine images were more likely to be endorsed as cannabis users, regardless of whether or not they actually used cannabis (Hirst et al., 2018). Despite higher propensity to identify males as substance users, females may experience more negative associations with using (Sorsdahl et al., 2012). This suggests that while males are more likely to be perceived as substance users, being female may not be protective against the prejudice associated with substance use. Instead, being a

female substance user defies expectations in gender roles and submits female-identifying people to more negative attributions.

Despite evidence of substance use stereotypes resulting in racial and gendered prejudices, there are also indications that these can be moderated. While males were more likely to be seen as cannabis users than females, these gender biases reduced significantly when raters had experience with cannabis themselves (Hirst et al. 2018). This may indicate that a higher proximity to a substance can reduce implicit bias towards other users of that substance, regardless of sex or gender.

Importance of Perceptions

Currently, there is a wealth of research on the perceived moral character of people with substance use disorders. Studies consistently corroborate perceptions of violence, distrust, personal failings, and weakness. There is also evidence that these moral failings may elicit punitive feelings. In a recent study, researchers at John Jay University found that, when shown bodycam footage of an altercation with police, participants were more likely to feel the civilian deserved punishment if they were a user of illicit substances (Jones et al., 2021). Moreover, there is evidence that discrimination on the basis of race and gender impacts substance use, particularly insofar as coping, receiving and accepting treatment, and criminal justice outcomes (Matsuzaka & Knapp, 2019). What is not clear at this time, however, is if the mental representations of a substance user varies on the basis of racial and gender stereotypes.

Chapter 5: Faces of Alcohol and Cannabis

To the best of our knowledge, the reverse correlation technique has never been used to investigate the nature of implicit perceptual biases associated with substance use before. While a wealth of information exists with respect to disparities in policing, incarceration rates, and utilization of mental health resources, there remains a need to develop an improved understanding about how perceptions of substance use may be linked with racial and/or gender stereotypes. This study will add to the important body of research surrounding implicit bias within mental health and substance use. Perhaps even more importantly, this can also add evidence to our understanding of how implicit biases perpetuate dangerous stereotypes within the criminal justice system. While we know inequity exists from prison records and arrest statistics, little is known about the nature of the implicit biases that may contribute to the inequities. We hypothesize that implicit attitudes on the basis of gender and race may play a substantial role in the biased perceptions of substance users and that classification images produced using the reverse correlation procedure when participants are asked to select faces on the basis of their substance use status will therefore be judged by independent raters to be imbued with these gender and race stereotypes.

Methods

This experiment followed the 2-phase, 2 image forced choice methodology described by Brinkman et al. (2017). Two sets of participants were recruited for the image generation phase to create alcohol and cannabis CIs and a novel third sample was recruited to rate the CIs on the traits of interest. For online data collection, the software PsyToolkit was used (Stoet, 2010; Stoet, 2017).

Image Generation Phase:

For sample 1a, we recruited 47 students (41% female-identifying, *M*age=19.04, *SD*=1.49) from a small, public university in the United States via SonaSystems and all were awarded class credit for their participation. For sample 1b, we recruited 50 students and excluded 3 from data analysis for failing to provide demographic information for a total of 47 (68% female-identifying, *M*age=18.87, *SD*=1.15) using the same sampling strategy. Participants were invited into the lab in groups of 4 and each sat at a cubicle with a computer to complete the study. Prior to beginning the trial, participants were asked to fill out a brief survey which includes demographic information like race/ethnicity and gender identification as well as a substance use survey. Participants indicated age of first use, frequency, and quantity of use for both alcohol and cannabis as well as family history of problematic substance use to determine placement in low and high proximity to the substance groups.

Face stimuli was generated with the R package rcicr 0.3.0 (Dotsch, 2015). A base face image was superimposed with a layer of visual noise. The base face image was created to represent a gender-neutral, multiracial face by averaging 30 images of equal amounts of male and female faces as well as white, black, and Asian faces from the Face Research Lab London Set from the Students' Face Research Resources website (DeBruine & Jones, 2017) and averaging using PsychoMorph. The final image was gray-scaled and resized to 215 × 215 pixels (see Dotsch & Todorov, 2012 for more details on image generation). 300 pairs of original and inverse stimuli were generated for a 2IFC (i.e., two-image forced-choice) task. Stimuli were paired with their inverse image (negative pixel luminance) to ensure the greatest amount of salient differentiation

between the images and reduce guessing (see figure 1 for an example of the base face and stimulus pairs). Participants were shown a total of 300 image pairs, with sample 1a receiving instructions to select the face that most looks like an alcohol user and sample 1b receiving instructions to select the face that most looks like a cannabis user. All participants were asked to make these decisions as accurately and quickly as possible.

Every selected image was averaged to create a classification image and every non-selected image was averaged to create an “anti” classification image. Classification images (CIs) were generated using the rcicr package for R (Dotsch, 2015) and were based on the forced-choices made during the generation phase. CIs were generated separately for the alcohol user/anti-user and cannabis user/anti-user, binary sex of the generators, and proximity to substance (defined by past consumption in the last 30 days) of the generators for a total of 20 unique CIs.

Image Rating Phase:

For Sample 2, 83 participants were recruited via SonaSystems for class credit. One participant was excluded for failing to follow instructions and another for not providing demographic information resulting in a final total of 81 (64% female-identifying participants with a mean age of 18.89 *SD*=0.89). Sample 2 was kept naive to the previous phase of the study to negate any possible substance-related bias in their responses. Participants were invited into the lab in groups of 4 and each sat at a cubicle with a computer to complete the study. Each of the classification images were rated on 9 dimensions in three categories of race, gender, and personality. Each CI was rated one at a time on only one of the dimensions at a time. Ratings were indicated by clicking on a red bar that spanned the width of the computer monitor and was positioned

below the CI. The anchors “low” and “high” were placed at each end of the colored bar (for a depiction of the task see figure 2). The ratings were recorded as the x-position of the cursor at the time the participant clicked the mouse. These pixel-based ratings were centered so that the lowest rating was -600 and the highest rating was +600. The combination of 20 CIs, paired with each of the 9 to-be-rated dimensions meant that each participant rated 180 CI-dimension pairs. Each CI was shown in random order and raters were asked to determine on a continuous scale from low to high the gender, ethnicity, and personality traits of the images. Ratings included how black, white, latine, and asian for ethnicity; how feminine and masculine for gender; how violent, trustworthy, and warm for personality traits. Position of the mouse along the x-axis of the continuous scale was recorded from -600 to +600 to determine raw scores of the ratings.

Results

Classification Images:

A total of 20 CIs were created during the image generation phase. For the purposes of this study, CIs were considered “user” faces while anti-CIs were considered “nonuser” faces. The first group made images in relation to alcohol use. The entire sample was averaged to create a whole group CI and a whole group anti-CI. Based on their demographic information and responses to the substance use questionnaire, the images were further separated into subgroups including high proximity CI, high proximity anti-CI, low proximity CI, low proximity anti-CI, male CI, male anti-CI, female CI, and female anti-CI. The second group made images in relation to cannabis use and the same process for averaging CIs was used to create a total of 20 CIs, 10 per

substance condition. For the analysis covered in this portion of the study, only full group Alcohol (see figure 3) and Cannabis (see figure 4) CIs and anti-CIs were used. For all subgroup CIs and anti-CIs, see figure 5.

Profiles of Alcohol and Cannabis Users

The ratings for each of the nine dimensions were averaged across participants to get mean trait scores for alcohol user, nonuser, and cannabis user, nonuser images. Means are graphically contrasted by use status and substance type in figure 6.

Multivariate Analysis of Variance

To verify the significance of the observed differences, we performed a two-way MANOVA with substance type (cannabis or alcohol) and use status (user or nonuser) as the factors and the 9 traits (feminine, masculine, asian, black, latine, white, trustworthy, violent, warm) as dependent variables. The main effect of use status was significant, Pillai's Trace= 0.773, $F(9, 312)=118.091$, $p<0.001$, $\eta^2=0.77$, as was the main effect of substance type, Pillai's Trace= 0.069, $F(9,312)=2.602$, $p<0.05$, $\eta^2=0.07$. The interaction between use status and substance type did not reach statistical significance.

Univariate Analysis of Variance

We followed the MANOVA with a series of 2x2 factorial ANOVAs for each of the 9 dependent variables to determine discrete significance and directionality (see figure 7 for graphical illustration of ANOVAs).

Feminine

A main effect of Use Status was found $F(1,80)= 417.1$, $p<0.001$ where user images were rated significantly less feminine than nonuser images. There was no main effect of Substance Type $F(1,80)=0.11$, $p>0.05$. There was an interaction effect of Use

Status on Substance Type $F(1,80)= 5.32$, $p<0.05$ where cannabis nonuser images received higher scores on femininity than alcohol nonuser images but cannabis user images received lower scores on femininity than alcohol user images.

Masculine

A main effect of Use Status was found $F(1,80)= 240.3$, $p<0.001$ where user images were rated significantly more masculine than nonuser images. There was no main effect of Substance Type $F(1,80)= 0.25$, $p>0.05$, or interaction $F(1,80)= 0.13$, $p>0.05$.

Asian

A main effect of Use Status was found $F(1,80)= 47.03$, $p<0.001$ where user images were rated significantly less asian than nonuser images. There was a main effect of Substance Type $F(1,80)=12.34$, $p<0.001$ where alcohol images were rated significantly more asian than cannabis images. There was an interaction effect of Use Status on Substance Type $F(1,80)= 6.66$, $p<0.05$ where only alcohol nonuser images were positively associated with asian while alcohol user, cannabis user, cannabis nonuser were all negatively associated with asian.

Black

A main effect of Use Status was found $F(1,80)=5.73$, $p<0.05$ where nonuser images were rated significantly more black than user images. There was a main effect of Substance Type $F(1,80)=9.08$, $p<0.01$ where cannabis images were rated significantly more black than alcohol images. There was no interaction $F(1,80)= 0.21$, $p>0.05$.

Latine

A main effect of Use Status was found $F(1,80)=37.23$, $p<0.001$ where nonuser images were rated significantly more latine than user images. There was a main effect of Substance Type $F(1,80)=7.10$, $p<0.01$ where cannabis images were rated significantly less latine than alcohol images. There was no interaction $F(1,80)= 0.21$, $p>0.05$.

White

A main effect of Use Status was found $F(1,80)= 9.73$, $p<0.01$ where user images were rated significantly more white than nonuser images. There was no main effect of Substance Type $F(1,80)= 0.20$, $p>0.05$, or interaction $F(1,80)= 2.99$, $p>0.05$.

Trustworthy

A main effect of Use Status was found $F(1,80)= 117.82$, $p<0.001$ where nonuser images were rated significantly more trustworthy than user images. There was a main effect of Substance Type $F(1,80)= 4.37$, $p<0.05$ where cannabis images were rated significantly more trustworthy than alcohol images. There was no interaction $F(1,80)= 0.87$, $p>0.05$.

Violent

A main effect of Use Status was found $F(1,80)= 57.78$, $p<0.001$ where user images were rated as significantly more violent than nonuser images. There was no main effect of Substance Type $F(1,80)= 0.98$, $p>0.05$, or interaction $F(1,80)= 0.00$, $p>0.05$.

Warm

A main effect of Use Status was found $F(1,80)= 131.25$, $p<0.001$ where nonuser images were rated as significantly more warm than user images. There was a main

effect of Substance Type $F(1,80)= 5.48$, $p<0.05$ where cannabis images were rated as significantly more warm than alcohol images. There was no interaction $F(1,80)= 0.38$, $p>0.05$.

Descriptive Discriminant Analysis

A descriptive discriminant analysis (DDA) was also performed to better understand how the multivariate ratings combined in each of the significant main effects of the MANOVA. While the univariate analyses assume that ratings on each dimension are made completely independently of one other, the DDA provides a more ecological valid picture of the ratings in their natural, multivariate context. The analysis revealed that, for Use Status, gender was most heavily weighted in differentiating users and nonusers, with positive weights on masculinity and negative weights on femininity being associated with use for both substance group images. For Substance Group, race and personality were most heavily weighted in discriminating the alcohol from cannabis, with positive weights on black, trustworthy, warm and negative weights on asian and latine being associated with cannabis images. Neither factor heavily weighted violent or white in the differentiation. See figure 8 for a graphical representation of the descriptive discriminant functions.

Discussion

Consistent with our hypothesis, the findings revealed that substance use is associated with implicit perceptual biases related to race and gender. Particularly, users are most strongly discriminated from nonusers on the basis of masculinity and femininity with both cannabis and alcohol users being rated as significantly more masculine and nonusers being rated significantly more feminine by independent raters. This pattern of

results is consistent with the prior assertions in the literature that males are more likely to be perceived as substance users than females (Hirst et al., 2018; Hathaway et al., 2016). The DDA did not indicate a strong association between use status and any other traits. While femininity was negatively associated with substance use, it is not likely indicative that females are protected against stigma associated with substance use. For example, cannabis use by women is considered more aberrant, rebellious, and indicative of promiscuity than it is for men and nonusers are more permissive of male users (Hathaway et al., 2016). This may stem from expectations of gender roles. Males are more likely to be associated with substance use than females possibly because they are not saddled with the same expectations of decorum. Females are connected with the ideas of motherhood, responsibility, and caregiving. When one breaks from those assigned expectations, the stigma may increase (Toner et al., 2008). In a qualitative study on the perceptions of cannabis use, male students were quoted indicating that using cannabis is a male-oriented activity and it was unconventional to see women partake because they are meant to be caregivers (Hathway et al., 2016).

In regards to substance specific biases, cannabis CIs and anti-CIs were more likely to receive a higher “black” rating while alcohol CIs and anti-CIs were associated with higher “asian” and “latine” ratings. The alcohol related images were also rated as less trustworthy and warm than cannabis related images. Additionally, cannabis was not associated with negative trait perceptions that have been previously associated with substance use like untrustworthiness, lack of warmth, and violence. In fact, the DDA revealed that cannabis related images were positively associated with warmth and trustworthiness and alcohol related images were negatively associated with warmth and

trustworthiness. The lack of trustworthiness may relate to findings well documented in alcohol literature. People who use alcohol incur higher levels of distrust than people who use cannabis, being rated as more dangerous (Sorsdahl et al., 2012). The relative association of cannabis-related images and blackness may coincide with the well-documented racial disparities in criminal justice outcomes in marijuana-related offenses (ACLU, 2014). It is important to note, however, that all user images were rated as significantly more white than any other race. While the DDA discriminated cannabis images from alcohol images on relative race ratings, with cannabis having a stronger weight on the “black” category, these images were not universally categorized as nonwhite. The data indicates that race plays a discriminating role in differing the categorization of images, but the explicit directionality is more nuanced than simply associating cannabis users with Blackness.

This research importantly adds to the body of understanding around how substance users are perceived in the populace. Our research suggests that the mental representation of substance use is gendered, but how stigma around substance use differentially impacts the genders is not well understood at this time. The literature is mixed on whether males or females who use substances are more stigmatized (Meyers et al., 2021). Across reviews of gendered attitudes, stigma manifests differently towards males and females. For example, studies suggest people are more likely to coerce males into treatment for substance use (Meurk et al., 2014; Sorsdahl et al., 2012) but view women who use more negatively (Khuat et al., 2015; Sorsdahl et al., 2012). While stigma related to substances can impact anyone who uses, the underutilization of substance-specific comprehensive healthcare is more clearly documented in gender

and racial minorities (Algeria et al., 2002; Gary, 2005; Shober & Annis, 1999). Women are significantly less likely than men to seek out alcohol specific treatment modalities (Shober & Annis) and those who enter treatment report higher levels of shame and embarrassment than men (Thom, 1986). Stigma is pervasive, existing even amongst healthcare workers charged with overseeing the treatment of people with substance use disorder (van Boekel et al., 2013). Negative attitudes associated with these stigmas harm patients' quality of care and reduce their feelings of empowerment in medical settings (van Boekel et al., 2013).

Limitations

The major limitation of this study comes from the convenience sample used. All participants were psychology students at a predominantly white institution between the ages of 18 and 22. This generation likely did not receive the same kind of messaging around the use of cannabis as older generations experienced and have spent a significant portion of their lives in a country where some territories have legal recreational use. Additionally, as psychology students, they are likely more educated on addiction as a mental health concern than the average person and may have less stereotype-consistent views in regards to cannabis and alcohol use. This study should be repeated with a larger, more representative sample across multiple age groups to be able to generalize the visual perceptions of substance users.

There is also a limitation of the methodology employed for generating and rating CIs. While the 2 phase, group CI design was the traditional method for assessing the reverse correlation analysis, a recent paper by Crone et al. points to a higher incidence of type I error when group CIs are rated rather than individual CIs (2020). The issue

cited with group CIs is that, because they are a composite across many individuals that are rated by an independent sample, any error in the generation phase is lost in the secondary statistical analysis. Our study methodology falls into the trappings cautioned, the samples that generated alcohol and cannabis composites were smaller than the sample that rated the composites (47 compared to 81). The standard deviation of the group CIs was lost and replaced by the standard deviation of a nontrivially larger sample. It is difficult to determine if the statistically significant variation in judgments of the CIs is truly different from the natural variation we would expect due to chance (Crone et al., 2020).

The researchers recommend that to avoid the largest issues in type I error inflation, variation can be maintained by instead rating individual CIs (ICIs) rather than group CIs. In this case, the variation of individual mental representations would be maintained and, based on their simulations, is less likely to produce a false positive significant result. They also recommend increasing the sample size of Phase I though there are limitations with the feasibility of this approach (Crone et al., 2020). To make this investigation more robust, the methodology should be repeated using both objective metrics of the differences in CIs as well as recruiting a larger, more representative sample. We should also explore the feasibility of either evaluating ICIs or randomly generating subgroup CIs to preserve a level of variance in the phase II evaluation.

Despite the significant limitations on the generalizability of this study, it remains a first attempt at visualizing one the most highly stigmatized mental health concerns. While there are methodological issues as the study exists at present, a visual inspection of the composite images generated reveals nontrivial, salient differences that should be

further explored with better validated techniques. Our future directions include improving the methodology in accordance with Crone et al.'s recommendations as well as collecting a more representative sample. We also plan to include convergent validity checks using implicit and explicit measures of bias towards the generated faces in relation to substance use.

Appendix

Figure 1. Example of random noise original and inverse stimuli from base face created for rating phase.

Base Image

Original

Inverse

Figure 2. Depiction of image rating task.

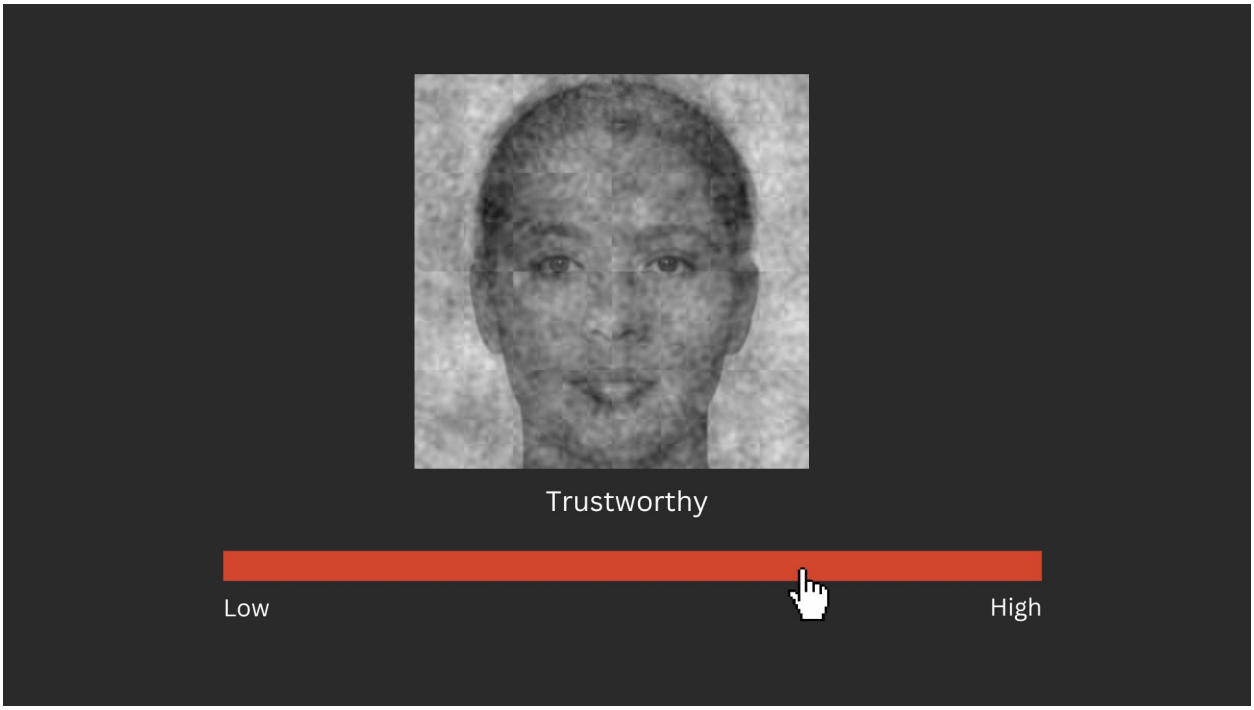


Figure 3. Classification images (CI) generated from sample 1a: Alcohol Condition.

Alcohol CI (user) Alcohol anti-CI (nonuser)

Figure 4. Classification images (CI) generated from sample 1b: Cannabis Condition.

Cannabis CI (user) Cannabis anti-CI (nonuser)

Figure 5. Alcohol and Cannabis CI and anti-CI pairs. Groups include proximity level and binary gender. CIs are one the left side of the pair and anti-CIs are on the right side of the pair.

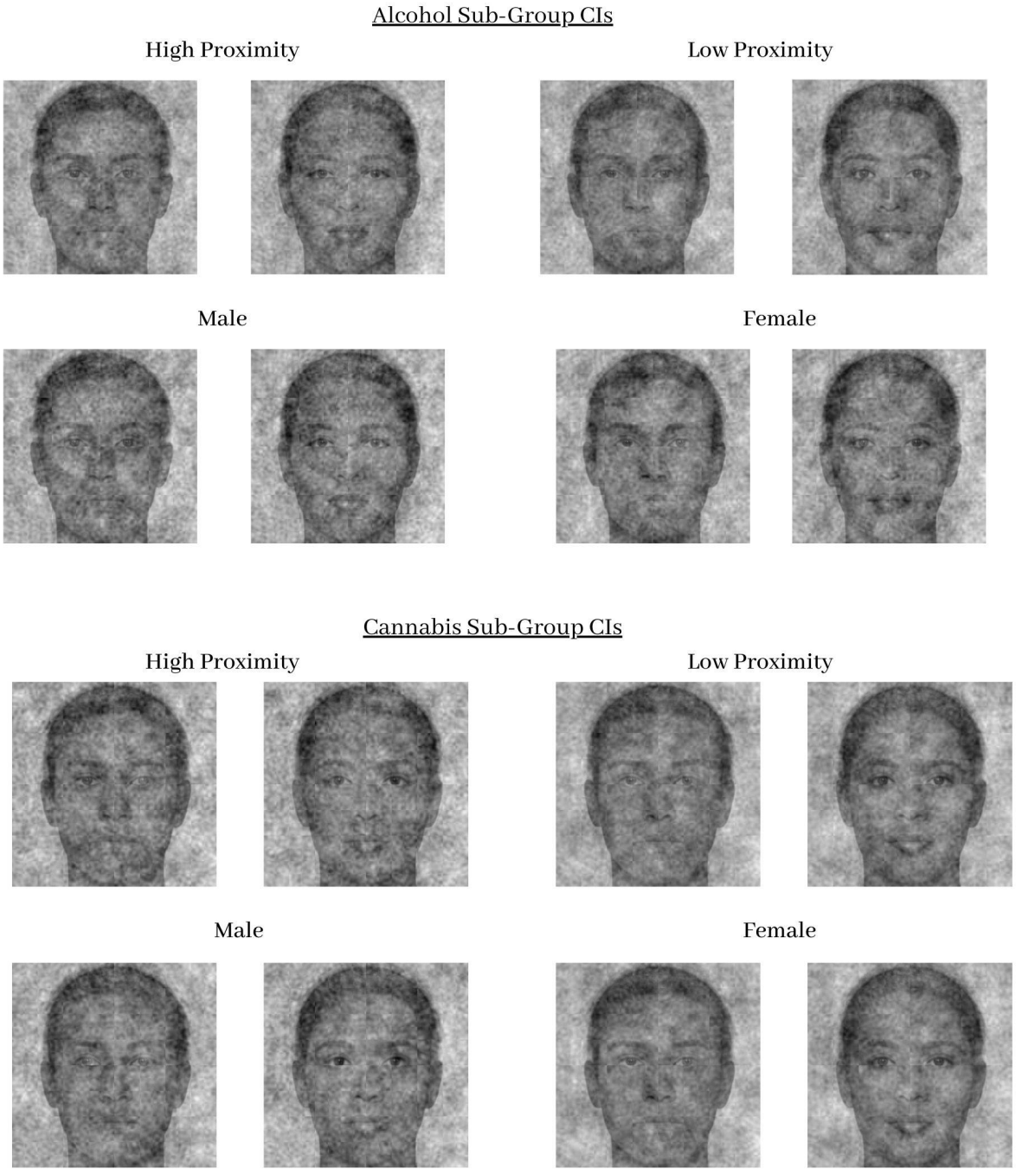
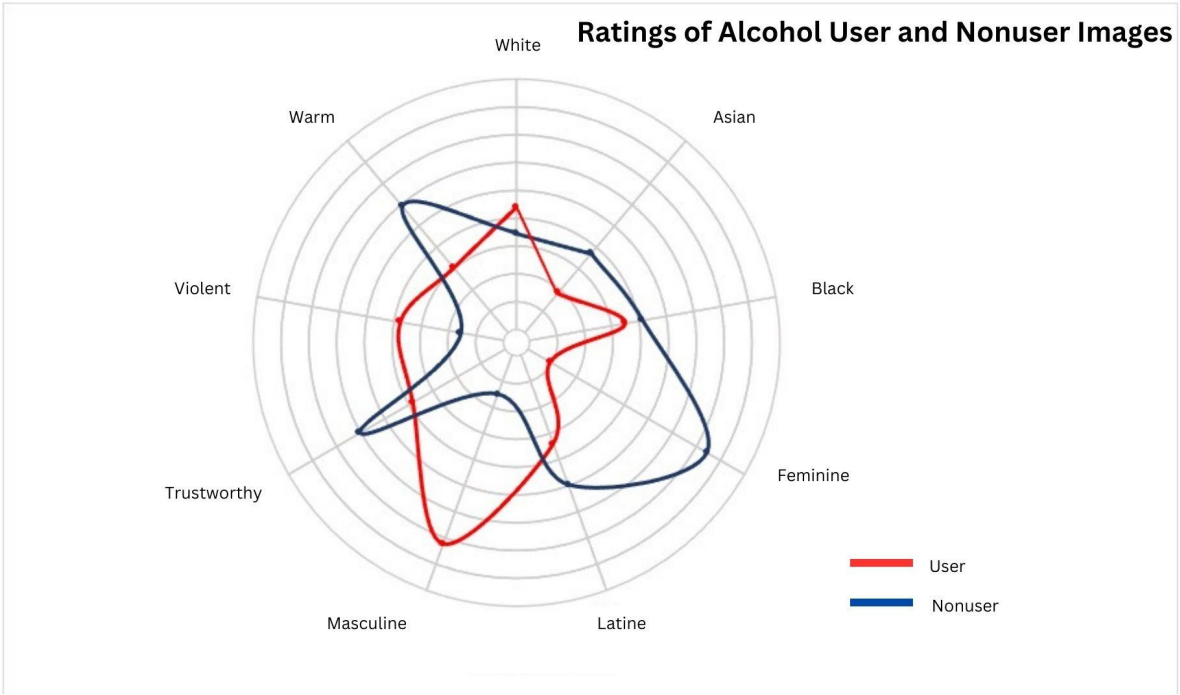


Figure 6.

a. Polar plot of Alcohol User v.s. Nonuser



b. Polar plot of Cannabis User v.s. Nonuser

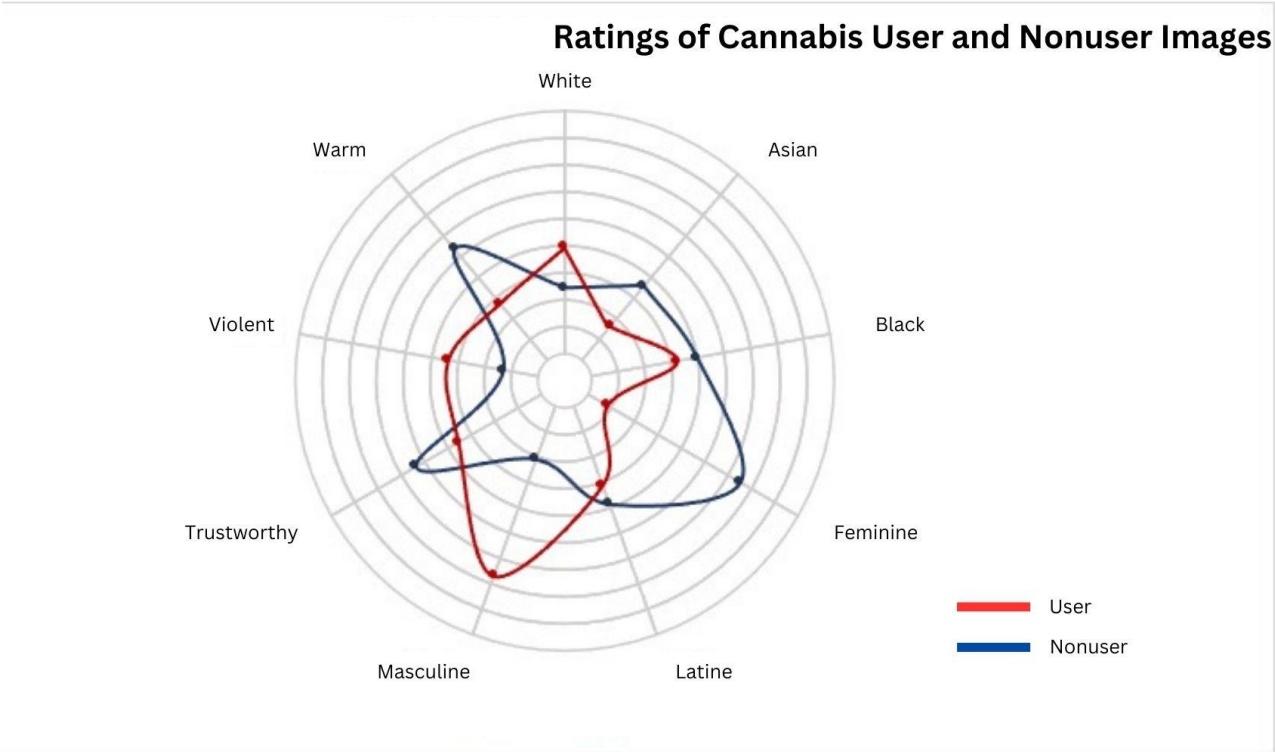
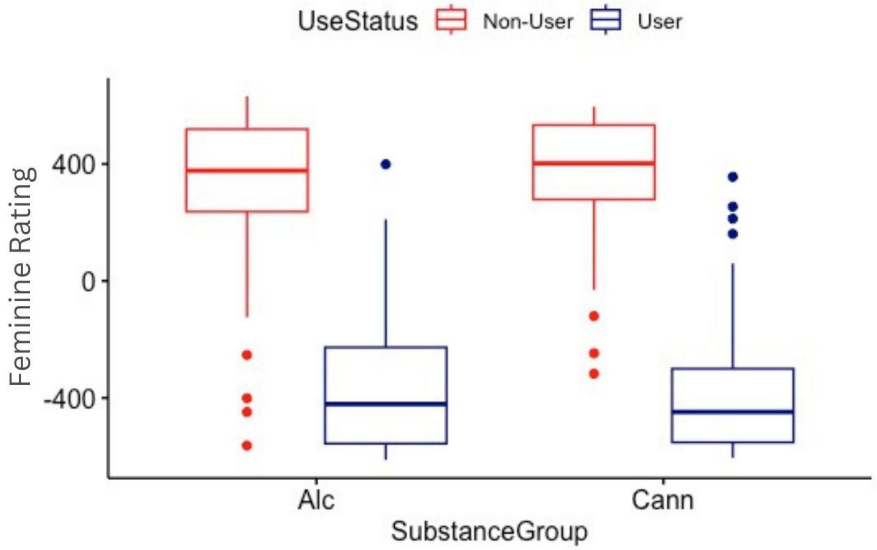
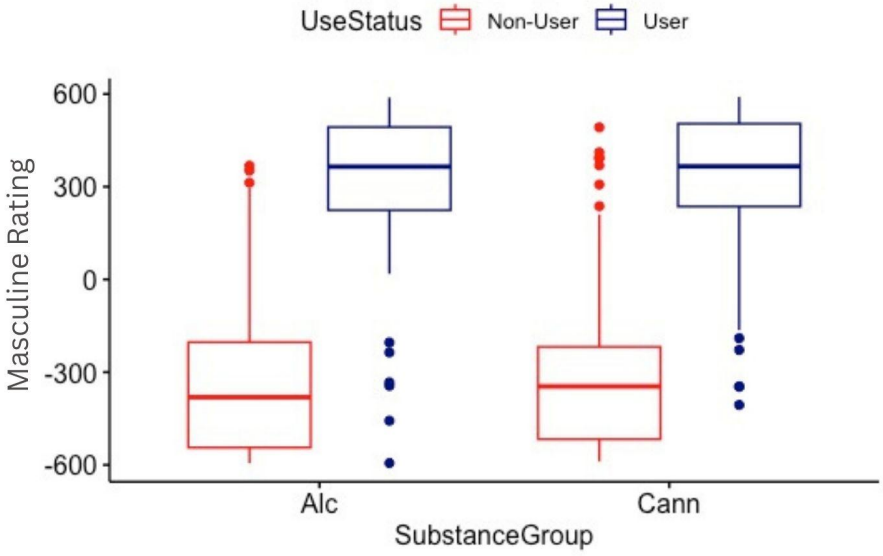


Figure 7. Univariate 2x2 ANOVAs of each dependent variable trait.

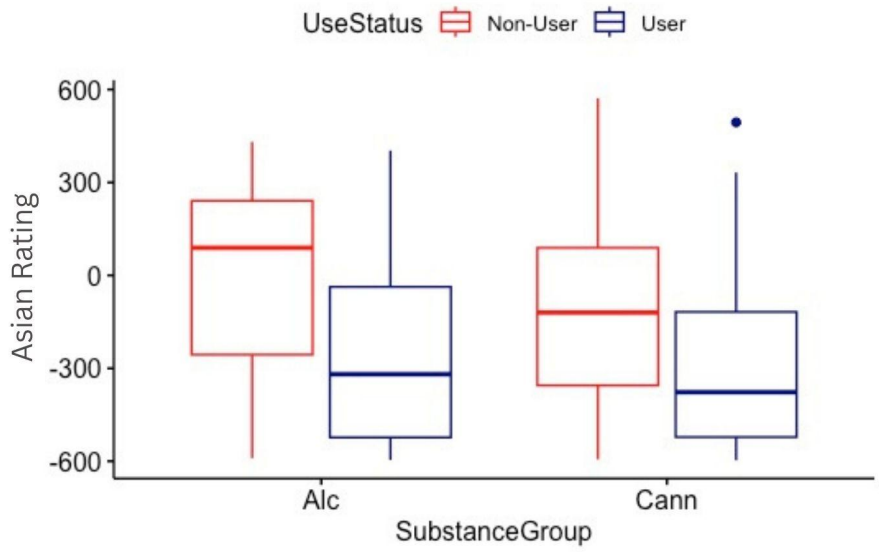
a. Feminine rating data



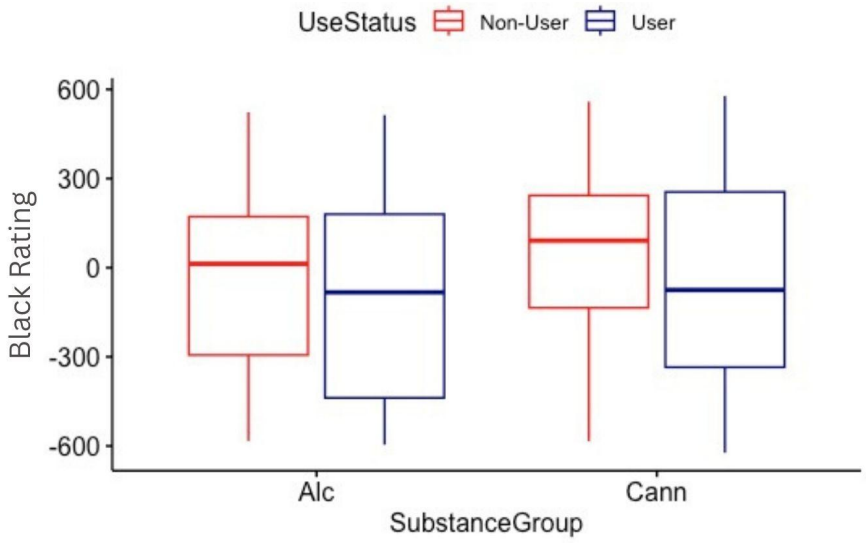
b. Masculine rating data



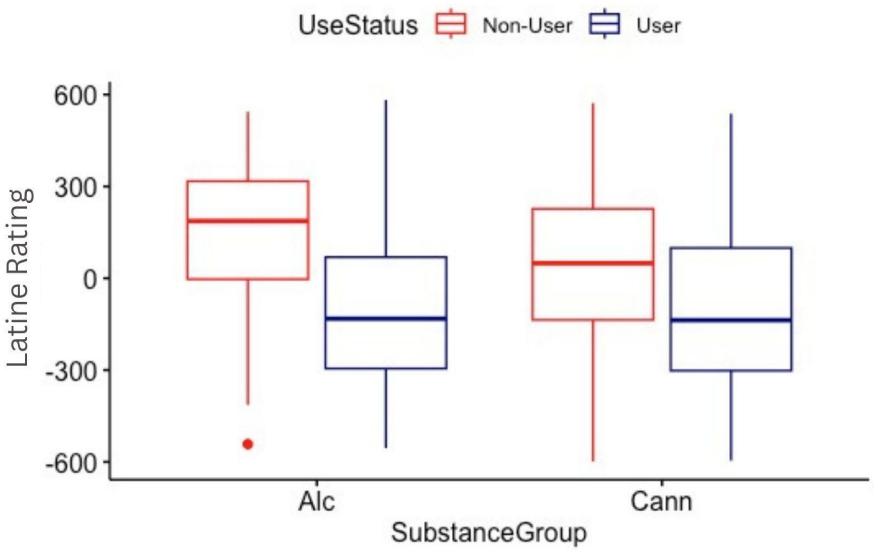
c. Asian rating data



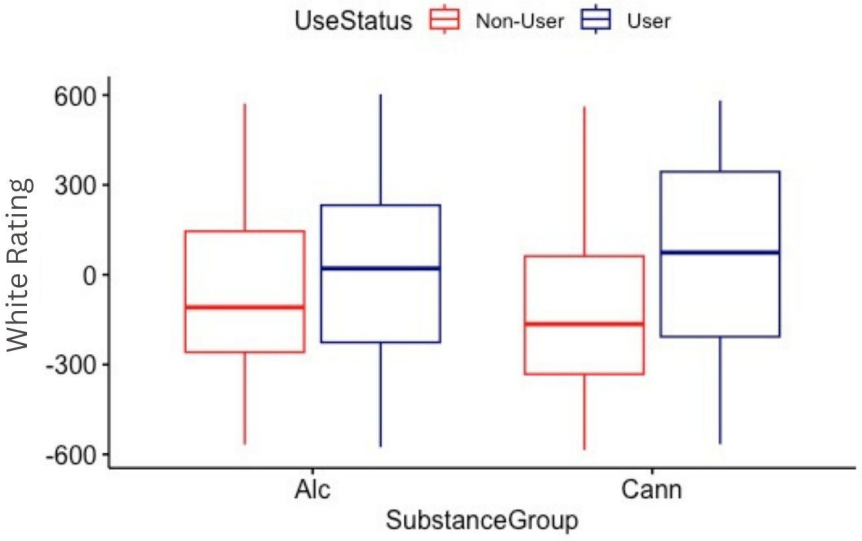
d. Black rating data



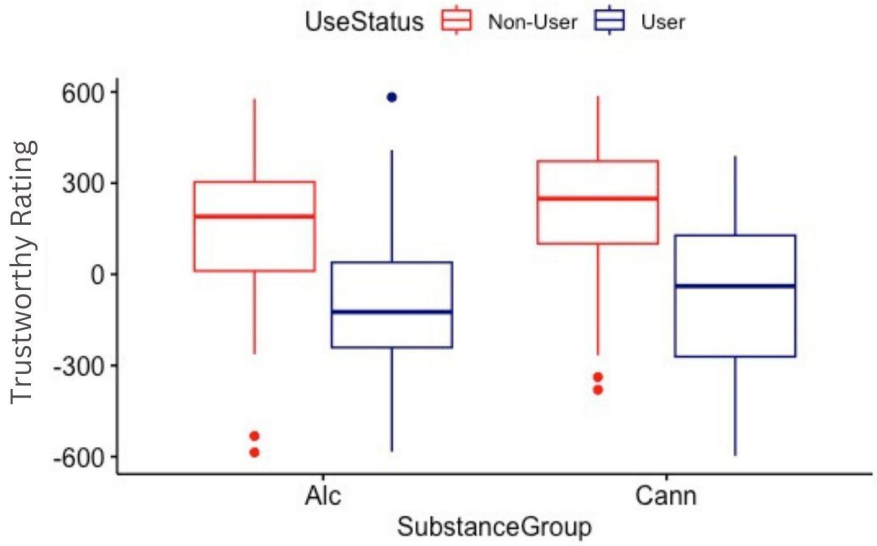
e. Latine rating data



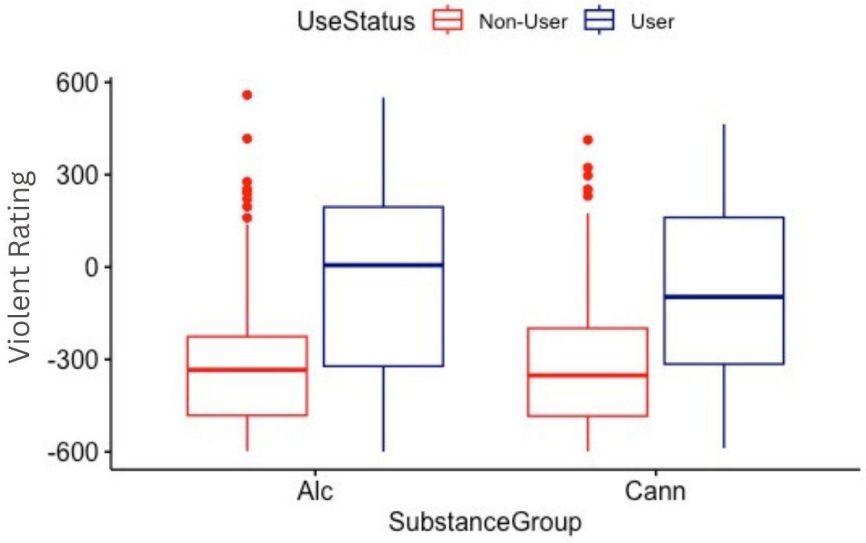
f. White rating data



g. Trustworthy rating data



h. Violent rating data



i. Warm rating data

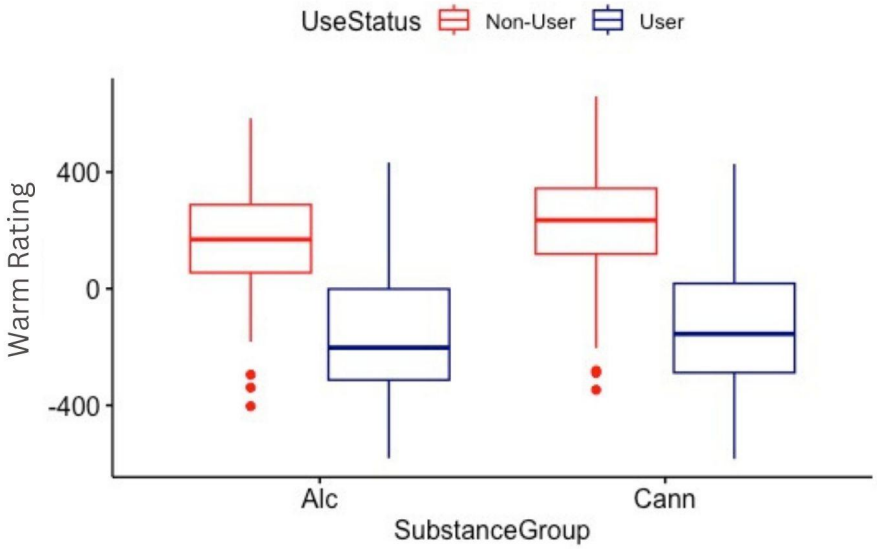
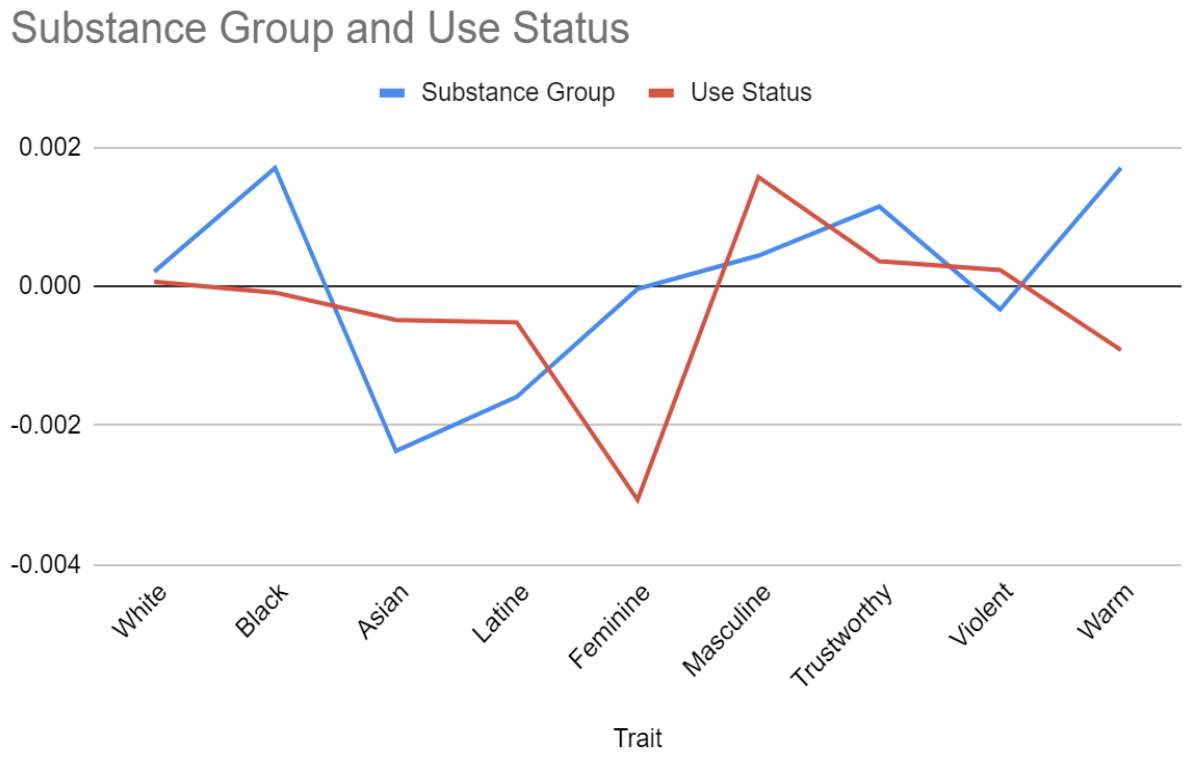


Figure 8. Graph of the descriptive discriminant analysis weights for the dependent variables in Use Status and Substance Group.



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