ABSTRACT

Title of Dissertation: RACIAL STIGMA AND SUBSTANCE USE OUTCOMES AMONG AFRICAN AMERICAN EMERGING ADULTS: A REPLICATION AND EXTENSION

Devin Butler, Doctor of Philosophy, 2025

Dissertation directed by: Edward Bernat, Associate Professor, Department of Psychology

The present dissertation employs cognitive neuroscience methods (EEG/ERP analyses) to replicate and extend a novel, cue-based paradigm developed to investigate underlying neural mechanisms involved in the immediate context of a racial stigma event. Racial discrimination is a chronic psychosocial stressor for African Americans associated with a broad range of deleterious physical and mental health outcomes, including increased rates of substance use, especially in emerging adults (Gibbons & Stock, 2017; Williams et al., 2019; Brondolo et al. 2009; Pascoe & Smart Richmann, 2009). Several studies have outlined this relationship between racial discrimination and risky behavior, but there are few lab-controlled, neuroscientific experimental paradigms that have examined this link. Discrimination has been shown to impair self-regulatory strategies and cognitive control processes; thus, we sought to leverage cognitive neuroscience approaches to assess the immediate response to a

racial stigma event, and if these responses lead to changes in emotional processing, executive function, substance cue reactivity, and reward processing. The development of the primary racial-stigma, cue-focused task served as the basis for a current NIDA K08 DA053441-01A1; PI: Risco; Mentor: Bernat. The task builds on cue reactivity and substance use literature to assess stigma-related change in brain systems relevant to risk-taking vulnerability. We sought to replicate previous findings with this paradigm, as well as extend the assessment to substance cue reactivity. Succinctly, we sought to measure changes in affective and regulatory responding both during and after exposure to racial stigma cues, aligned with previous work (Risco, Butler et al., 2020, 2023, 2025), and newly assess the impact of these modulations on drug cue reactivity. In the replication, with a larger sample, and extension, we sought to assess neural underpinnings of the link between discrimination and substance use. Results revealed two separable groups with unique sensitivities to racial stigma cues, but after exposure, a similar responding across groups. In the extension to substance cues, results were inconclusive most likely due to characteristics of the sample (i.e. well-functioning, non-using). Overall, results address a dearth in health disparities research and providing a foundation for future research studying the inextricable link between racial discrimination and risk behavior.

RACIAL STIGMA AND SUBSTANCE USE OUTCOMES AMONG AFRICAN AMERICAN EMERGING ADULTS: A REPLICATION AND EXTENSION

by

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Dedication

To Daddy and Bran, none of this happens without you guiding the way.

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List of Abbreviations

EEG: Electroencephalography

ERP: Event-related potential

TF: Time-frequency

LPP: Late Positive Potential

TD: Time domain

RSCT: Racial Stigma Cue Task

IAPS: International Affective Picture System

UP: Unpleasant

PL: Pleasant

NU: Neutral

Chapter 1: Introduction

Substance Use Prevalence in the United States

In the United States, substance use is fairly prevalent, with the National Center for Drug Abuse Statistics (NCDAS) reporting that 50% of people aged 12 and over, or roughly 138 million Americans, have used an illicit substance in their lifetime (*NCDAS*, 2023). Further, the NCDAS reports an estimated 138 million currently drink alcohol, 55 million people use marijuana, and 57 million people are reported to use tobacco or nicotine products. Critically, substance use problems and consequences are widespread throughout our society, contributing to numerous negative life outcomes related to morbidity, mortality, and overall societal costs (Vasilenko et al., 2017). Problems from substance use are also linked to productivity costs, health care costs, infectious disease, mental health problems, premature mortality, and criminal justice system interactions (*American Addiction Centers*, 2024a; CDC, 2024; *NCDAS*, 2023). Though substance use presents a heavy burden across the US, these associated consequences are not distributed evenly across the population. Disparities within and around substance use exist, as there are certain population groups, like members of the African American community, who experience disproportionate consequences related to use relative to other racial and ethnic groups (*American Addiction Centers*, 2024a). Among many inequalities, drug overdose deaths, incarceration rates, and access to treatment in particular show troubling trends and widening disparities for disadvantaged populations, even with rates of use being similar across demographics (*American Addiction Centers*, 2024a; Vasilenko et al., 2017). Substance use affects millions in this country and affects even more millions indirectly through drug-related consequences, thus calling for an intense need to investigate and understand the multitude of

factors that might contribute to these patterns of risky behavior, especially if these problems are heightened for different population groups.

African Americans and Substance Use Outcomes

African Americans are overrepresented in regards to substance use problems and consequences: though reported to have similar patterns of substance use relative to the general population, with some statistics even suggesting that African Americans have both lower frequency of substance use and higher treatment-seeking behavior relative to White American counterparts and the general population (Acevedo et al., 2018; *SAMHSA*, 2023; *American Addiction Centers*, 2024b; Vasilenko et al., 2017), disparities in associated consequences and health outcomes remain. For Black American communities, the list of disproportionate and deleterious consequences relative to White persons is exhaustive, spanning several relevant domains (e.g. legal, educational, health, social) regarding use, treatment, and outcomes. The consequences are including but not limited to: more barriers to accessing treatment, more stigma associated with use, more criminal justice consequences, more injuries and avoidable hospitalizations, greater neighborhood disadvantage, higher poverty rates, higher likelihood of being arrested, rates of drug overdose, likelihood of overdose death, greater impact of disadvantaged neighborhood, worse physical and mental health outcomes, worse employment outcomes, and overall greater unmet need for treatment, among many others (Acevedo et al., 2018; Alsebaa & Akbar, 2023; Buka, 2002; CDC, 2022; Lê Cook & Alegría, 2011; Milligan et al., 2004; *NCDAS*, 2023; *American Addiction Centers*, 2024b; Wells et al., 2001). These consequences contribute to already-staggering racial/ethnic disparities that prove to be chronic throughout a lifetime for African Americans, and do not reflect the reality of substance use equally across population groups (Grasser & Jovanovic, 2022).

Overall, African Americans are disproportionately represented in population-based data of substance use consequences. This highlights a need to better understand contributing factors to these disparate consequences, such as the neurophysiological processes and contextual vulnerabilities, associated with these patterns. There is precedent of this being a fruitful line of research, as research suggests there are social and cultural factors that impact the ability and willingness to engage in treatment, as well as the outcome of treatment for African Americans, including hiring multicultural treatment staff members, inclusion of spirituality into treatment, and easily accessible treatment locations (*NAADAC*, 2021; Brome et al., 2000; Verissimo & Grella, 2017; Wolfe et al., 2020). These studies serve as evidence of productivity in acknowledging the existence of these substance use outcome disparities, and they further highlight the potential for directly addressing unique experiences that African Americans may face relative to other populations that could lead to substance use problems in the first place. Altogether, as African Americans experience disproportionately high adverse consequences to substance use, it is imperative to advance our understanding of core mechanisms that contribute to subsequent substance use, a main goal of the current study.

Racial Discrimination: An Overview

There are numerous health disparities between Blacks and Whites, in which Blacks are socially disadvantaged relative to Whites and have worse health across a broad range of outcomes (including but not limited to substance use) that have been large and persistent over time (Williams, 2012). As identified by Williams and colleagues in a review (2019), racism—defined as a system of race-based beliefs, practices, and policies designed to serve the interests of those in power (Grasser & Jovanovic, 2022)—is a key contributor, as it is well-understood to be linked to these inequities in society and in health. This review further summarizes that

experiences of discrimination more specifically are a major avenue by which racism is linked to these disparities. Discrimination is defined as social exclusion, rejection, withholding of information, blocking/prohibition of access, or any other belief and practice acted upon on the basis of race towards a stigmatized community (Grasser & Jovanovic, 2022; Pascoe & Richman, 2009; Williams et al., 2019). It is through discrimination that African Americans receive differential negative treatment directed at them in numerous fabrics of our modern society at the individual, interpersonal, and institutional levels, ranging broadly from home rental to securing ride share service (Haeny et al., 2021; C. P. Jones, 2000; Williams et al., 2019).

Discrimination, both perceived and actual, is widely associated with negative mental health outcomes, physical health deterioration, as well as risk behavior such as substance use (Grasser & Jovanovic, 2022; Mays et al., 2007). In trying to characterize the nature of the relationship between racial discrimination and substance use, as the current study sought to address, we start with theoretical frameworks that have attempted to more broadly delineate the factors involved in outcomes and responses to racist and discriminatory experiences. Overall, among many of the prevailing theories, the research has shown that a discriminatory incident, or racial stigma event, acts as a stressor for African Americans. This incident triggers both an appraisal of the situation as well as some form of stress response, whether that be some form of adaptive or maladaptive coping response. These responses depend on numerous different factors (i.e.., individual differences, social contexts, etc.). Overall, these instances are viewed as stressful life exposures, leading discrimination to be accepted as a potent stressor for individuals (Pascoe and Smart Richmann, 2009). Discrimination is pervasive and chronically experienced across the lifespan, associated with risk of arrest, risk of cardiovascular disease, negative social experiences and ostracization, loss of resources, assault, high blood pressure, and substance use. Thus, a

careful and nuanced approach to addressing responses and related outcomes to discrimination is required (Grasser & Jovanovic, 2022; Mays et al., 2007; Williams et al., 2019). The following section will outline select theories of discriminatory stress and responding.

Responding to Racial Stigma Stress: A Review of Prevailing Theoretical Frameworks

There are several theoretical frameworks that have been put forward in attempts to model how African Americans respond to experiences of racial discrimination. These frameworks have been theorized over the years as ways to not only account for exposure to discrimination and racism more broadly, but also contextualize how individuals might perceive, respond to, and subsequently behave in the face of these racialized experiences. As discrimination is so chronic and pervasive, it intersects with several different factors, such as family, identity-formation, and across a lifetime from during youth through adulthood. Due to this intersectionality, these theories, some presented below, do not necessarily exist in isolation, instead largely complementing one another within the same overarching concept of racial discrimination and stress. Across the theories, there remains the overall goal of shedding light on the impact of racial discrimination on stress and subsequent behavior.

Mundane Extreme Environment Stress (MEES) Model

In trying to appropriately illustrate the persistent and pervasive nature of racism for Black Americans, Pierce (1974) first described the environment African Americans exist within as mundane and extreme. The mundane extreme environment stress (MEES) model outlines that Black Americans experience racial stressors (e.g., microaggressions, unstable housing, food insecurity, etc.) that are inherent through their daily lives to the frequency and extent that they become normative and mundane. However, their intensity and impact is so stressful and

exhaustively taxing that they considered extreme (C. Pierce, 1974; Carroll, 1998). The stressors are embedded in their environment, and repeated exposure diminishes African Americans' allostatic load, or cumulative physiological wear and tear due to the burden of chronic stress (Guidi et al., 2021). Overall, with its constant nature, discrimination depletes overall energy, affecting mental, physical, and emotional capacities.

A core piece of the MEES model is that racial and ethnic discrimination are inherent to the environment, and instead of focusing on acute dramatic and traumatic events, sources of racial stress can also operate on a structural and systemic level. As the current study represents a replication and extension of a cue-based paradigm designed to focus on cognitive and affective mechanisms elicited in the immediate context of a racial stigma event to understand racial stress response (Risco, Butler et al., 2020, 2025), the MEES framework highlights the importance of recognizing the pervasive nature of racial stress and its psychological and physiological impact (allostatic load increase, elevated mental health risk). The MEES framework foundationally acknowledges that the individual deterioration (socially, psychologically, behaviorally) caused by discrimination could have implications for the variability in stress response within the stigmatized community (through different coping mechanisms, stress responses, risk and resilience factors, etc.). Overall, the MEES framework aligns with the current study, as it highlights the cross-cutting nature of racial discrimination and how it inherently elicits stress in African Americans.

Racial and Ethnic Discrimination Stress Model (RED-SM)

In a more recently-proposed model that incorporates the MEES framework to capture the daily experiences of racial discrimination encountered by African Americans, Wilkins-Clark and colleagues (2024) introduced the racial and ethnic discrimination stress model (RED-SM)

(Wilkins-Clark et al., 2024). The model proposes that the mundane extreme environment, in conjunction with various protective resources, coping strategies, and racial socialization, contributes to meaning-making processes (the ways African Americans interpret and apply meaning to these discriminatory experiences, emphasizing both perception and response (Park, 2010)). These processes subsequently influence stress responses and outcomes among African Americans. By suggesting that within the mundane extreme environment, an individual's perception of a racial stigma event influences coping strategies and overall well-being, the model highlights the multifaceted nature and impact of discrimination on African Americans.

In this model, the variability in the accessible protective resources and coping strategies used (e.g. spirituality, hypervigilance, racially conscious action), as well as racial socialization messages, dictate the response to discrimination in this model. This framework is critical in the context of the current study, because RED-SM seeks to address and explain how individuals may differentially perceive, appraise, and adjust to instances of racial and ethnic discrimination. In the current study, as explored previously (Risco, Butler et al., 2025), we sought to investigate how individuals respond to racial stigma experiences, thus an interpretation of the response is vital to understand the impact of these experiences The model emphasizes the variability in stress response between and within African Americans, as well as acknowledging that response to racial stress is a continuous process. The model sheds light on the myriads of factors (environmental, external, as well as internal) contributing to variability in responses (perception, appraisal, etc.) to racial stigma. As we looked to explore how cognitive and affective responding is modulated by racial stigma events, and how this relates to substance use, it is important to acknowledge potential differences between individuals in assessing these modulations.

Racial Encounter Coping Appraisal and Socialization Theory (RECAST)

In a similar framework to RED-SM, the racial encounter coping appraisal and socialization theory, or RECAST (Anderson & Stevenson, 2019), examines individual coping mechanisms. RECAST argues that encounters with racial and ethnic discrimination must first begin with an appraisal of whether the event was discriminatory, and then a secondary appraisal process to determine how to navigate the encounter. In this pathway, individual outcomes are the result, and the relationship from the primary to the secondary appraisal process is mediated by individual differences in coping and self-efficacy. RECAST is another theory that outlines individual differences in responses to racial stress between African Americans, as there are differences in the appraisal of, and thus response to, the events.

The theory highlights that though the impact of discrimination is major and sweeping across the African American community, still there can be unique ways in which discriminatory experiences are interpreted and responded to. This is similar to the goal of the current project: we sought to replicate and extend a paradigm that examines neural cognitive and affective processing during and after exposure to racial stigma events to index a stress response. Further, we wanted to assess if this stress response modulates substance cue neural response. RECAST, like the RED-SM and MEES, does not detail at the neural level how these differences may be indexed, but they all share a commonality in positing that while racial stress is potent and frequent, racial stress response, for a bevy of reasons, may not be uniform across individuals. RECAST aligns with the current study's understanding the widespread nature of racial stigma events, and with the goal of assessing racial stress response, albeit through different methodological practices and specific outcomes. The theory elaborates that individuals may interpret and respond to racial stress events uniquely. The acknowledgement of variability in

response to racial discrimination within the African American community is vital to measuring processes that might address these stress responses, as we sought to do in this study.

Phenomenological Variant of Ecological Systems Theory (PVEST)

In a more all-encompassing framework aimed at highlighting identity formation in marginalized youth, Margaret Spencer introduced the Phenomenological Variant of Ecological Systems Theory, or PVEST (Spencer et al., 1997; Spencer et al., 2003). PVEST is a culturally-informed development model that views racial discrimination as a risk factor that increases minority youth's vulnerability for adverse consequences if appropriate coping strategies and support skills are not developed (Spencer, 2005; Spencer et al., 2003; Spencer MB, 2006). In the PVEST framework, identity development is foundational for future behavior, and emergent identities arise out of coping with stressors like racial discrimination, as the behavior will either be adaptive or maladaptive. PVEST centers the meaning-making processes, where individuals subjectively perceive and interpret these experiences. Further, PVEST argues that these processes play a role in vulnerability, stress engagement, coping strategies, and outcomes. The value in this framework lies in the fact that it emphasizes that one's perception and meaning-making of the stressful racial experience is important, which is central to the theories behind the current work. Further, the PVEST framework explains how this perception and appraisal of the stressful racial experience interacts with individual differences in patterns of response to these experiences.

The PVEST model proposes that responses to racial stress can be constructive or destructive, and even within these responses, adaptive behaviors and maladaptive behaviors have fluidity in the valence of their effect from short term to long term. The PVEST model examines racial discrimination and uses different responding and coping strategies as a platform to explain

the link to subsequent risk behavior. The highlighting of the fluidity in responses to racial stress are relevant to the current study, as the replication and extension investigated modulations in affective and regulatory responding. As we assess responding to substance cues and other cognitive and affective responding in African American emerging adults in the aftermath of racial stigma, the PVEST model is a framework that considers outcomes based on unique and subjective responses to racial stigma events. Our study extends this a step further, directly assessing cognitive and affective neural mechanisms, however the PVEST provides a relevant path to understanding this frame.

Clark's Biopsychosocial Model of Racism as a Stressor

In a model that combines physiological, psychological, and social factors, Clark's Biopsychosocial Model of racism as a stressor for African Americans (Clark et al., 1999) highlights how racism leads to stress responses that subsequently contribute to health disparities for marginalized groups such as African Americans relative to other racial/ethnic groups. Based on similar theoretical foundations as aforementioned models (i.e., PVEST, RED-SM, RECAST), Clark's model draws on the work of Lazarus and Folkman (1984) that highlights the importance of perception and appraisal of racial stress events (Richard Lazarus & Susan Folkman, 1984). The work of Lazarus and Folkman highlighted coping as a way to adapt to or manage stress. In this way, perception and appraisal are central to the subsequent stress response, as racism is a chronic stressor that can have deleterious impact when interpreted negatively. In Clark's model, racism harms both physical and mental health, leading to heightened allostatic load, heightened blood pressure, immune impairment, sleep irregularities, cardiovascular disease, rumination, vigilance, depression, anxiety, etc. Importantly, in the context of the current study, Clark's model

points out that substance use is a potential outcome to experiences of racism for African Americans.

Like the other models presented, the utility of this model in the context of this current study is that it acknowledges individual variability: two people may perceive and appraise racist events differently from each other, and this relationship is at least partially dependent on their own personal history, resilience, vulnerability, and support. The model acknowledges how coping responses may be maladaptive (substance use, social withdrawal) or adaptive (support, therapy), and certain protective factors may exist (racial identity). A similar pathway is elucidated in previous work that the current study seeks to replicate and extend (Risco, Butler et al., 2023, 2025), such that we seek to examine cognitive and affective responses to racial stigma, and how these responses impact substance use vulnerability. Both Clark's model and the framing of the current study highlight the potential for negative outcomes in not just one domain, but behaviorally as well as cognitively and emotionally. The model importantly considers the intersectionality in the impact of racism while also emphasizing the lived experience, highlighting how unique that experience can be between members of the same stigmatized community.

Summary

Altogether, the current study investigates responding in the immediate context of a racial stigma event and how this exposure modulates cognitive and affective processing, including substance cue reactivity. The prevailing theories presented provide a foundational base for understanding what the literature has previously explored in terms of responses to these stigmatizing events. In the current work, this relationship clearly outlines that negative outcomes such as substance use can result from a particular stress response/coping strategy from the

experience of racial discrimination (i.e., Clark, PVEST). More importantly, these frameworks in their own way highlight the variability in perceptions, appraisal, coping, and in responses, to racial stigma events. These models are all productive means to explore when investigating not only the nature of racial and ethnic discrimination, but also subsequent responses and outcomes, and how the association between the two can impact subsequent (risk) behavior.

Model Guiding the Current Work: Stigma-Stress-Substance Use Pathway

These theories emphasize discrimination as pervasive and threatening, and highlight several factors that influence protection from or vulnerability to adverse outcomes, whether it be racial socialization, parent-child interactions, self-efficacy, etc. These models are indicative of the well-theorized literature that links racial discrimination to negative outcomes (Pascoe and Richmann, 2009), as they explain that through racism's chronic and persistent nature, coping and responses lead to worsened health and behaviors. These models astutely offer interpretation to explain individual differences in racial stigma stress response. The current work seeks to add a greater understanding of the neurophysiological underpinnings to this relationship. These models focus on responding but are limited in their capacity to directly address the cognitive and affective mechanisms involved in the experience, appraisal, and response to racial stress events. This gap in literature is what the current study seeks to investigate. Previous work has investigated this relationship, with the novel cue-based paradigm utilized being designed for this reason (Risco, Butler et al., 2020, 2023, 2025), and the current study seeks to replicate the findings while extending the investigation to substance cue reactivity. It is important to understand these models, as they are key in understanding and interpreting both the debilitating effects of racial stigma events as well as racial stress responses. Further, it is important to

acknowledge potential differences in responding to the same stigmatizing events, but the current study welcomes an objective neuroscience component to further elucidate these processes.

The current work focused on emergent adults' individual responses to racial stigma stress in the immediate context of an event both during and after exposure; this responding pertains to affective/emotional responding as well as cognitive control processes in stigma cues, non-stigma cues, and substance cues. To do this, we obtained objective neurophysiological measures known to index affective and regulatory responding, as well as substance cue reactivity. Thus, we move on to an introduction of the model that the parent project adapted in our earlier work (Risco, Butler, et al., 2025). This conceptual model, building on previous literature and frameworks, more precisely assesses neural pathways (cognitive and affective processing) involved in experiences of and responses to discrimination. These processes are then related to substance use outcomes, a focus of the current work and the framework through which our hypotheses are centered around.

The current study's parent project [i.e., findings in which we seek to replicate) (Risco, Butler et al., 2020, 2023, 2025)] is guided by an adapted model referred to as the stigma-stress-substance use pathway, proposed by Major, Mendes, and Dovidio (Major et al., 2013). Core tenets of this model outline that stigmatized individuals have an increased vulnerability to stress due to racial stigma's presence as a chronic stressor, and this perceived discrimination leads to heightened physiological reactivity (e.g., cardiovascular activity) as well as impaired self-regulatory capacity (cognitive control and executive function processes). This model posits that the impaired self-regulation motivates substance use, as it is used as a (maladaptive) coping mechanism to regulate the negative affect that stems from the stigma experience. Overall, more stigma leads to more stress which leads to more substance use.

The model by Major and colleagues features similar tenets of the aforementioned theories, but it more directly assesses the components of interest in the current study. The stigma-stress-substance use pathway relates cognitive control processes with a vulnerability to substance use through assessing the impact of discrimination on stress responding and self-regulatory capacity. The model identifies racism as a chronic and pervasive stressor, highlighting previous work (Pierce, 1974), and leverages this conclusion to relate the stress to cognitive control processes that impact the racial stress response. The current study seeks to assess this pathway, extending it to substance cue reactivity, which indexes substance use vulnerability (Parvaz et al., 2016), thus allowing us to delineate core mechanisms of the pathway. The current study utilizes EEG methodology with the framework presented by Major and colleagues as a foundation to model self-regulatory processes in response to racial stigma. Integrating the stigma -> stress -> substance use pathway with Research Domain Criteria (RDoC) (Cuthbert, 2015) constructs, the parent project sought to identify neurophysiological indices involved in responses to racial stress, and the extension presented here examined those responses in relation to substance use.

In summation, discrimination is well-established in its association with a myriad of negative health outcomes and risk behaviors, including substance use/abuse and psychological distress (e.g., depression, anxiety, externalizing behaviors, risky sex behaviors, smoking, alcohol, illicit substances) (Brondolo et al., 2015; Gibbons et al., 2014; Pascoe & Richman, 2009; Williams et al., 2019; Williams & Mohammed, 2009). The impact of racial discrimination is commonly explored in the context of the critical role of stress (and stress response). Psychological and physical responses to perceived discrimination are a stress response that prepares the body to be more reactive (Clark et al., 1999; Major et al., 2002). The stigma-stress-

substance use model provides a gateway to assessing cognitive and affective responses to racial discrimination among African Americans. In this model, the discrimination leaves the stigmatized individual more vulnerable not only to physical illness and deterioration, but disrupts and impairs self-regulation capacity, leading to an increased substance use vulnerability. In this way, the current project served to replicate and extend a paradigm that adapts this model (Risco, Butler et al., 2025), while also exploring changes in substance cue reactivity, indexed by cognitive neuroscience approaches.

The Impact of Racial Discrimination on Substance Use

Like racial discrimination, in modeling substance use, stress plays a critical role. There are tension-reduction models that argue substance use occurs through the belief in some individuals that it will relieve or alleviate negative affect and stress (Greeley & Oei, 1999; Leonard & Blane, 1986). Other models, such as negative reinforcement models (Baker et al., 2006), further this reasoning and posit that stress is associated with use to such an extent that it predicts relapse. Another set of models, falling under the overarching concept of motivational models, outline that the relationship between stress and substance use is mediated by coping motives (Cooper et al., 1995; W. M. Cox & Klinger, 1988). Common across these models is the notion that there is a clear relationship in the literature between stress and substance use, and substance use can be seen as a stress response from heightened experiences of racial discrimination (Pascoe & Richman, 2009; Williams et al., 2019). As it relates to discrimination, the prevailing assumption is that the stress associated with the discriminatory experiences leads to substance use among African Americans (Borrell et al., 2006; Clark, 2004; Landrine & Klonoff, 2000). The reviews and models put forth show that the association between discrimination and substance use for African Americans is not new, with very long-term

consequences both physically and mentally, respectively. The current study (replication and extension) attempted to leverage understanding of these models in conjunction with objective neuroscience measures to assess the underlying mechanisms of this association between discrimination and substance use.

Experiences and perceptions of discrimination problematically intersect at a multitude of domains in the daily life of a stigmatized individual. In conjunction with the well-documented physiological harm associated with discrimination, the review by Williams and colleagues (2019) showed that discriminatory experiences can lead to negative emotions that adversely affect physiological well-being, leading to distress and risk for psychiatric disorders. Discrimination is positively associated with depression, anxiety, indicators of cardiovascular disease, high risk behaviors, and fewer health-promoting behaviors. More problematically, attempts to cope with the negative emotional states triggered by discrimination can lead to increased risky behaviors like smoking and substance use. As both discrimination and substance use are harmful to African Americans, deeper examination into the neural mechanisms underlying their relationship between discrimination and substance use, as the current study addresses, would positively address potent challenges faced daily. This knowledge is seminal to providing more insights and eventual long-term resources for this socially disadvantaged group.

Examining the Impact of Discrimination on Substance Use in Emerging Adulthood

Emerging adulthood, defined as the 18–25-year-old age range, is an especially critical time to examine discrimination's impact on the African American community, especially in association with subsequent risky behaviors like substance use. Emerging adulthood represents a time of change: there is potential change from all the familiarity and comfort of the house or area the child grew up in, to a perceptually larger world outside of their immediate upbringing

(Arnett, 1994, 1998). In the context of this study, this level of change is seen in the fact that the disparities in substance use problems for African Americans relative to Whites are more pronounced in emerging adulthood (Vasilenko et al., 2017). Overall, while rates of drug use are highest across the country during emerging adulthood, with use of alcohol, cannabis, and tobacco all peaking in their twenties broadly (Vasilenko et al., 2017; NCDAS, 2020), specifically among African Americans relative to other racial and ethnic groups there is increased use (Vasilenko et al., 2017; P. Chen & Jacobson, 2012; Kandel et al., 2011; Watt, 2008). Existing literature shows there are significant amounts of experiences of racial discrimination within this age range (Denise, 2012), and these experiences are associated with increased substance use (Gibbons et al., 2007; Gibbons & Stock, 2017; Sanders-Phillips et al., 2014).

The relationship between discrimination and substance use during this period is incredibly important to understand, as emerging adulthood is an especially vulnerable time where you're at a higher risk for both short-term and long-term behavioral and mental health problems (Lei et al., 2021). In fact, this time period is critical in regards to development and manifestation of mental health disorders and other psychopathology, as most mental health disorders appear by the age of 24 (Kessler et al., 2005). This evidence shows that for emerging adults, this period is an important time for identity formation. For an emerging adult, they enter a period of more interactions with new environments. These interactions come during a time where their understanding of life, belief systems, and values can be starkly different from before (Arnett, 1998). They face new encounters, the nature of their life experiences thus change, and these impacts must be contextualized in the link between substance use and discrimination.

Thus, the combination of frequent experiences of discrimination and increased substance use makes emerging adulthood a critical time to investigate the association between substance

use and discrimination, as it may be relevant to overall psychological distress and risky behavior. The negative impacts of discrimination on the mental and physical health of African Americans have been well-studied in children and adults, but the study on the well-being and impacts in young and emerging adults must be given the same attention and focus, with Lei and colleagues (2021) underscoring that there are zero national longitudinal studies on this relationship in emerging adulthood. While their study was not longitudinal, that fact represents a dearth in this scope of research. With relevance to the current study, we feel emerging adulthood may present a time to directly explore mechanisms that underlie these negative patterns and outcomes. A review paper of children and young people by Priest and colleagues (2013) outlined that even in these young stages of life, exposure to discrimination was positively associated with a myriad of mental health issues such as depression, anxiety, aggression, internalizing and externalizing behavior, and conduct problems, while being inversely associated with positive mental health indicators (e.g., life satisfaction, resilience, self-esteem, and quality of life) (Priest et al., 2013). Even in young people, discrimination is associated with poor health practices, including substance use, thus it begs to be explored how responses to discriminatory or racially stigmatizing events can modulate any vulnerability to substance use.

Discrimination is known to evoke a stress response that leaves people vulnerable to subsequent substance use (Major et al., 2002; Clark et al., 1999). With these deleterious impacts, among African American emerging adults in particular, increased exposure to racial stigma combined with increased independence that has been associated with greater substance use vulnerability creates a perfect intersection for further exploration into mechanisms underlying these constructs. Emerging adulthood in African Americans represents a critical time of notable racial stigma stress (Denise, 2012), increased substance use (Vasilenko et al., 2017), and

increased independence and transience in life (Arnett, 1994, 1998), shining a light on an understudied avenue of research into any mechanisms that explain and contextualize the link for placing people at higher risk for these adverse outcomes and life burdens.

Cognitive and Affective Mechanisms of the Link Between Racial Discrimination and Substance Use

As outlined above, many models of both substance use and discrimination respectively focus on the role of stress (Pierce, 1974; Clark et al., 1999; Major et al., 2013; Gerrard et al., 2012). Importantly, in considering stress in the relationship between discrimination and substance use, cognitive control plays a critical role. Cognitive control is pivotal in regulating stress reactivity, recovery, and behavior (Hofmann et al., 2012; Stock et al., 2016). Cognitive control processes represent mental functions (encompassing sensory, affective, and motor processes broadly) that enable goal-directed or top-down behaviors and responses, even when conflict or competition from another force is present (Bühringer et al., 2008). Disruptions and impairments in cognitive control and the ability to self-regulate one's psychophysiological reactivity and recovery is associated with experiences of racial stigma (Brondolo et al., 2017). In line with the stigma -> stress -> substance use pathway that posits substance use results from attempts to cope with racial stress experiences (Major et al., 2013), substance use is characterized by deficits and dysfunctions with self-regulation and cognitive control processes (Wilcox et al., 2014). This review by Wilcox and colleagues highlighted that in the neuroimaging literature, substance use is associated with reduced involvement in top-down networks that mediate cognitive control. Impairments on tasks requiring decision-making, inhibitory impulse control, and feedback processing provide evidence that cognitive control functions are compromised in responses to racial stigma events as well as substance use

(Bühringer, 2008; Grasser and Jovanovic, 2022). Overall, it is well understood that substance use compromises cognitive control, and experiences of racial stigma have been seen to impair stress-response systems related to executive function and cognitive control. However, with the knowledge of stress's role in substance use and cognitive control, the understanding of underlying neural mechanisms that explain the link is limited. The link between psychophysiological activity and risky behaviors such as substance use deserves to be studied in the context of the impact of racial discrimination. Thus, further research is needed, and the current study attempts to address that dearth.

Research has shown that discrimination/stigma experiences have been linked to lower cognitive performance, decreased/inhibited self-regulation, and higher negative cognitions (Grasser and Jovanovic, 2022). Racial stigma experiences being associated with impairments in cognitive control and self-regulation is a critical reason we have chosen the stigma-stress-substance use pathway as a way to model the process of neurophysiological responding to racial stigma stress (Major et al., 2013). When exposed to a singular racial event that elicits a stress response in the targeted individual (i.e. member of the African American community), the heightened negative impact and reactivity exist in conjunction with distracting thoughts, leading to attempts at self-regulation (Cadinu et al., 2005; Inzlicht et al., 2006; Inzlicht et al., 2011). Substance use results from these attempts due to deterioration of cognitive control, thus it may be the case that if individuals are able to employ better, more efficient strategies, these cognitive control resources may not be depleted (Derks & Scheepers, 2018; Muraven & Baumeister, 2000). Assessing underlying cognitive affective mechanisms is thus crucial, as shedding new light on how regulatory responding is affected by experiences of racial stigma could aid in targeted interventions. It appears through this literature that experiences of racial discrimination

exacerbate levels of substance use through causing increased stress and leaving a person more vulnerable and susceptible to risky behavior, as self-regulatory capacity and cognitive control processes are depleted, but more neuroscientific work is needed to understand neural mechanisms underlying the association.

The link between stigma and stress is clear and well-understood, but the mechanisms that explain this relationship are less understood. Further, a great concern in the field of psychophysiological research is the systemic racism and racial biases, however unintended, particularly in regards to utilizing electroencephalography (EEG) (Choy et al., 2022). Minoritized racial and ethnic groups have been largely understudied in psychophysiological research, not only in recruitment, but also in retention and including Black individuals' data in final analyses. The gap in knowledge regarding understanding cognitive mechanisms underlying racism and risk behavior inhibits objective and targeted treatments down the line, and a historical lack of inclusion almost guarantees that the disparities and the dearth in literature remain.

Though the relationship is well-validated, much empirical support for the association with discrimination and substance use features inconsistent methodology or does not encompass the whole of the association: a lot of the research is based on self-report assessments and measures of peripheral physiological arousal (e.g., heart rate), which has its own confounds when measuring racial stigma (bias, variability, severity are hard to precisely and consistently measure in this way). As it stands, there is a significant lack of research on the neural underpinnings indexing the link between discrimination and substance use through the lens of how affective and regulatory responding are affected in the immediate context (Allen et al., 2019; Potter et al., 2019). The experimental paradigms for examining racial-stigma stress are few in number, and of the existing few, rarely are cognitive-neuroscience methods, like the ones

employed in this study, implemented. The current study sought to contribute to this literature gap, as even though research suggests racial discrimination negatively impacts self-regulatory capacities and cognitive control, neuroscience evidence is needed to more strongly assert.

Building on a Cue-Focused Paradigm for Examining the Acute Stress of Racial Stigma on Substance Use

As outlined above, there exists a substantial amount of literature that details critical observations of the link between self-reported racial discrimination and real-world risk behavior among African Americans. However, there is a lack of well-controlled, laboratory paradigms in this arena. These methods, addressed by the current study, have not been sufficiently employed, thus limiting our understanding of core cognitive and affective processes that underlie the well-understood stress reactivity, recovery, and behavior in the immediate context of a racial stigma event—as well as factors that amplify or mitigate acute effects (Risco, Butler et al., 2020, 2023, 2025).

To address this need, a racial-stigma, cue-focused task (RSCT) was developed for a current NIDA K08 [DA053441-01A1; PI: Risco; Mentor: Bernat] that built on cue reactivity and substance use literature (Risco, Butler et al., 2020, 2025). This task was designed to provide a framework for assessing stigma-related change in brain systems involved in domains relevant to racial stigma events and subsequent risky behavior/substance use (e.g., cue reactivity, executive function, and reward processing). The basis of the paradigm explains that neuroscience offers a critical lens through which we can understand how stigma, racism, and discrimination can affect the brain and mental health, as well as provide insights into later guiding and deciding what action can be taken to resolve health disparities experienced by marginalized groups. More specifically, electroencephalography (EEG) event-related potential (ERP) measures provide a

perfect platform to investigate the mechanisms underlying the discrimination and risk behavior link, as ERP measures are sensitive to cue-related arousal and attentional engagement (Littel et al., 2012). The RSCT is well-suited to address the gap in neuroscience work regarding the underlying neural mechanisms involved in the link between stigma and substance use.

The current project built on the RSCT and extended it to measure its relation to substance cue reactivity. We utilized the RSCT to replicate effects that have initially validated the paradigm (showing cognitive and affective processes are modulated by exposure to racial stigma stress (Risco, Butler, et al., 2025)) and its utility in measuring the objective neuroscientific effects of racial stress on affective and regulatory responding (Risco, Butler et al., 2020, 2023). We sought to extend the task by including an exploration of racial stress effects on neurophysiological responses to substance cues. As the RSCT task indexes cognitive affective systems modulated by racial stigma events, we sought to assess how these modulations impact drug cue reactivity in emerging adults. As the development of the RSCT addressed a gap in literature, the current study sought to replicate this validation to assess the paradigm's effects, while extending the paradigm to associate the effects with responding to substance cues.

ERP Indices of Neurophysiological Processes

There are strong opportunities to better understand cognitive mechanisms underlying the link between racial discrimination and substance use, as EEG event-related potential (ERP) methodology is well-suited to assess the constructs and relationships in this current study. EEG/ERP methodology has a number of different advantages to the techniques including but not limited to: they directly reflect neural activity, have excellent temporal precision to index early and rapid changes in neural processes, and specific components show particular responses to different types of stimuli, allowing for precise inferences of the core processes they index

(Hajcak et al., 2010). Further, research has already supported EEG/ERP analyses as validated techniques of finding objective markers of substance cue reactivity (Parvaz et al., 2016). In implementing this methodology, we will address the gap in neuroscientific work pertaining to discrimination and risk behavior, thus this study represents an innovative and forward-thinking approach to inclusivity and sensitivities when it comes to experiences of systemic, institutional, and individual discrimination against a disadvantaged population. There is a demonstrated record of using ERP measures from task protocols to index these measures (Hajcak et al., 2010; Littel et al., 2012; Schupp et al., 2004). This work is evidence of the effectiveness of utilizing EEG and ERP measures to adequately assess the concepts employed in this study. In work focused on modulating affective responding, salience and control, validated and clinically translatable measures of emotional processing, reactivity, and regulation that EEG can index are vital to producing novel research and replicable findings.

The ERPs used in this study, namely the P300 (P3), and late positive potential (LPP), have been used extensively in assessing the processing of emotional stimuli (Hajcak et al., 2010). In previous data on the initial application of the RSCT paradigm, the late positive potential (LPP) was the main ERP component of interest (Risco, Butler et al., 2020, 2023, 2025). The LPP, an objective and temporally precise marker of motivated attention to salient stimuli, follows the P300 and is much more sustained, with some characterizations of average activity defined from multiple timepoints until 2000ms post-stimulus presentation (Cuthbert et al., 2000; Foti & Hajcak, 2008). The LPP is said to reflect similar underlying processes as the P3, indexing additional and more elaborative processing of motivationally relevant stimuli (Kok, 1997). The LPP reflects sustained attention to and processing of emotional stimuli, as it is sensitive to the emotional arousal of the stimulus, and the sustained positivity is particularly enhanced to

negatively-valenced stimuli (Cano et al., 2009; Feng et al., 2014; Solomon et al., 2012). The LPP is widely understood as an index of reactivity to motivationally relevant and significant cues (Littel et al., 2012). The LPP is reflective of a pattern of reactivity to emotional stimuli, both positively and negatively-valenced. Overall, as a measure of sustained attention and responding to motivationally salient and emotional stimuli, it is an ideal ERP to measure responses to incredibly arousing, significant, and emotional discriminatory imagery presented during the RSCT. The LPP is an established index of the affective and motivational significance of a stimulus, and individuals at higher risk of substance use show larger LPP amplitudes to drug cues, relative to those with lower risk. This is reflective of the existing biases in the cognitive processing of substance-related stimuli and justifies assessment in both the replication and extension featured in the current study.

The P300, or P3, is one of the most widely studied ERP components. The P3 is defined as a broad positive deflection maximal between 300-500 milliseconds post-stimulus onset (Hajcak et al., 2010; Johnston et al., 1986; Polich, 2007). The P3 is widely understood to be involved in numerous cognitive processes, as Polich (2007) described the ERP as a basic measure of attention allocation, basic information processing, and working memory. As a prominently studied tool used to measure cognitive processing, the P300 is heightened to stimuli that are task-relevant and demand attention (Little et al., 2012). Often associated with processes like stimulus evaluation, recognition, and categorization, the P3 said to reflect mental processes that underlie endogenous attentional allocation to relevant stimuli (Donchin, 1981; Johnston et al., 1986; Polich & Kok, 1995). In this way, the P3 is said to reflect top-down processing, as it engages memory and attention mechanisms as a part of a broader information processing system (Polich,

2007, 2011), with literature even suggesting that P3 reductions are associated with cognitive deficits/impairments and more intense psychopathology (Bernat et al., 2020).

The P3 is known to be commonly used to measure cognitive resource allocation and activation of cognitive schemas to process task information (Johnson Jr., 1993). Overall, as the P3 is a widely studied ERP, it is well-characterized as a marker of selective attention, information processing, memory storage, and broad recognition (Patel & Azzam, 2005), and thus it has a strong relationship with a number of cognitive processes. From stimulus evaluation to attention and orienting responses, the P300 is a classically studied index of processing information, and modulations in amplitude are often interpreted as insightful neurophysiological markers of cognitive functioning, control, and voluntary resource allocation, reflecting overall top-down, endogenous processing. For this reason, in our replication and extension, we additionally analyzed the P300 ERP in our analyses. In the previous work, the P3 amplitude was not assessed, but in the extension, it has been included in analyses. Measuring both affective responding with LPP activity, as well as a validated measure of cognitive responding with P3 activity provides added theoretical clarity to cognitive and affective processes involved in responses to racial stress.

That the current study analyzes both the P3 and LPP is indicative of core characteristics of both components, as though they are similar in some ways, they are distinct and have separable implications in processing of racial stress. They are both commonly assessed from picture viewing tasks, validating their use in our cue-based tasks (RSCT, affective picture viewing, substance cue viewing) (Bernat, Cadwallader, et al., 2011; Hajcak & Foti, 2020). Both the P300 and LPP show increased positivity following emotional stimuli relative to neutral stimuli, but the P3 is more commonly associated with cognitive performance, whereas the LPP is

more commonly reflective of enhanced and elaborative emotional arousal. Work further supports the prevailing notion that affective modulation of the LPP measure is quite typical (Bernat, Cadwallader, et al., 2011; Cuthbert et al., 2000, 2000), but it is important to note that the P300 and LPP are not to be considered identical components, as the LPP has a different topography, sustained duration, and, the LPP is more sensitive to top-down cognitive change (Foti et al., 2009; Hajcak et al., 2010). Increased positivity to emotional stimuli during the P300/LPP is described as a marker of motivated attention/incentive salience, and Bradley and colleagues defined motivated attention as the notion that emotion directs attention and guides subsequent processing (Bradley et al., 2003). The P300/LPP showing a larger positive peak to emotional stimuli relative to neutral reflects, in part, automatic processing of emotional stimuli due to intrinsic motivational significance. Overall, the P300 and LPP are placed as candidate ERPs to measure and explore effects when related to the racial stigma cue task in the current study, to assess for both cognitive and affective modulation.

ERP Time-Frequency Work

Work from our lab has suggested that time-frequency analyses (TF), especially for behavioral tasks performed in the current study (gambling and go/no-go, explained in **Methods** section below) can better index separable functional processes than traditional time-domain measures (Bernat et al., 2005, 2015; Harper et al., 2014a, 2016). Gilmore and colleagues' (2010) suggest that conventional time-domain ERPs such as the P3 can be better represented by multiple overlapping TF components in these gambling and go/no-go tasks (Gilmore et al., 2010). TF representations of EEG/ERP may produce more optimal indices of underlying neurophysiological processes.

Conventionally, EEG data is analyzed in the time-domain, where component measures are often defined based on positive and negative voltage deflections of a signal averaged over many trials, which (mainly) represents time-locked (e.g., stimulus onset, motor or sensory events, etc.) evoked activity. While still an effective measure to capture the P3, and especially the LPP during picture-viewing tasks (Hajcak et al., 2010, 2020), activity during behavioral tasks such as gambling and go/no-go have shown differences. Time-frequency analysis (TF) parses variable spectral and temporal activity, such that research has shown that time-domain ERPs consist of numerous overlapping processes that span across ERP component windows (e.g., P3). In this way, the work has been interpreted to be reflective of evidence that conventional time-domain measures sometimes offer a more limited view of the oft-complex nature of EEG signals.

For example, TF work with theta and delta has revealed that activity in the respective frequency bands is indicative of separable processes, rather than being yoked expressions of a single underlying process. Research has suggested that theta and delta are not simply yoked expressions of a single underlying process, but rather are indicative of separable processes, often exhibiting differential relations to experimental manipulations (Harper et al., 2014a, 2016). Using this TF approach, theta and delta have been successfully represented across several tasks, including feedback processing (Bernat et al., 2015; Bernat, Nelson, et al., 2011; Liu et al., 2014; Nelson et al., 2011), and response inhibition (Harper et al., 2014b) in gambling and go/no-go tasks, respectively. TF analysis is a useful analytic tool for studying the dynamic processes underlying EEG signals.

More specifically, midfrontal theta may be a reflection of a more narrow and generic response to salient events signaling the need for enhanced cognitive control or attentional deployment, such as negative feedback evaluation (Bernat et al., 2011, Bernat et al., 2015;

Gehring & Willoughby, 2002; Nelson et al., 2011; Liu et al., 2014), and response inhibition/performance monitoring (Harper et al., 2014b; Kamarajan et al., 2004, 2006; Yamanaka & Yamamoto, 2010). Conversely, centroparietal delta activity is seen to be sensitive to a multitude of cognitive functions and task demands that serve as indices of more elaborative processes related to cognitive control and sensory processing. Delta is increased for positive outcomes during a gambling task (i.e., reward processing; Bernat et al., 2011; Nelson et al., 2011), and, unlike theta, is sensitive to both primary (gain, loss) and secondary feedback attributes (relative outcomes, monetary magnitudes; Bernat et al., 2015). Thus, theta may be part of a general performance monitoring system underlying various forms of cognitive control, which subserves efforts towards performance monitoring in a generic and reactive fashion, such as signaling the need for increased attention or conflict detection (Cavanagh et al., 2012; Cavanagh & Frank, 2014). Delta on the other hand has been understood as better, multifaceted representative of a various stimulus attributes in a more deeply evaluative way than is midfrontal theta. Delta is also increased during stimuli signaling the need for response inhibition during go/no-go tasks (Barry, 2009; Harper et al., 2014a). Given the similarity in latency and topography to the nogo-P3 component, this delta activity may reflect both motor/cognitive inhibition and stimulus context updating rather than a simple indication of conflict (Smith et al., 2008).

Altogether, this evidence offers further support for the notion of two overlapping subcomponents related to cognitive processing, and that TF analysis of theta and delta activity is a valuable methodology to help parse the unique sensitivity and relation of these subcomponents to various forms of cognitive processing.

Current Study

In terms of broader impact, the current study acknowledges that health disparities encountered by African Americans have been established as a central public health priority (Brondolo et al., 2009), and racial discrimination is a potent factor that contributes to these inequities. This deserves more exploration in neuroscientific research than it has received to date. Due to racial discrimination's cumulative effects, African Americans represent a vulnerable population to risk behavior such as substance use (Williams et al., 2019). In fact, across multiple settings and domain (e.g., health care system, the justice system, housing), Black Americans experience more racial discrimination and are more negatively affected by it than other racial/ethnic groups (Williams, 2012), and this is associated with even more pronounced destruction and erasure of self-regulatory capacity over time (Gibbons & Stock, 2017). The causal path of experiencing racial discrimination to the output of substance use has strong theoretical support, and yet the empirical evidence remains surprisingly bare, as empirical, lab-controlled paradigms are less abundant.

The current study sought to further develop and extend the RSCT. Building off of a novel RSCT paradigm [NIDA K08 DA053441-01A1; PI: Risco; Mentor: Bernat] shown to modulate cognitive and affective responding both during and immediately after exposure to racial stigma stress (Risco, Butler et al., 2020, 2023, 2025), the current study sought to replicate effects as well as extend the assessment to an exploration of how racial stigma cue exposure contributes to modulations of objective neurophysiological substance cue reactivity. The current study capitalizes on this work that effectively captured processes underlying the stigma-stress-substance use pathway. The RSCT addresses a gap in neuroscience literature, and it appropriately adapts the stigma-stress-substance use pathway to assess for changes in cognitive

control processes due to the exposure to singular racial stigma events. The current project sought to leverage this novel, cue-based paradigm to further assess its validity but to additionally relate the stigma exposure to substance use. In assessing for modulations in substance cue reactivity, we may gain insights into vulnerability to use (Parvaz at el., 2016). We sought to replicate the effects, perform additional analyses for theoretical clarity and more robust analyses overall, while additionally assessing change in responses to drug cues after exposure to racial stigma.

In this detailed way, for the replication, the current study features data collected from 3 different data collection processes (referred to from hereon as Waves). The previous work (Risco, Butler et al., 2025) features analyses from the earliest data collection effort (Wave 1). The current work features all included participants' data from Wave 1 (collected 2019-2020), as well as an additional, second data collection effort conducted later (Wave 2, collected 2022-2025). Wave 3, or SU (short for substance use, collected 2023-2024), represents the extension in which additional participants were collected to assess for effects on substance cue reactivity. These waves of participants collected were combined in analyses for the replication aims for more statistical power and validity in reproducing previously seen effects. The third data collection process (Wave 3/SU) represents a separate effort in which we collected an entirely new sample of participants to assess for substance cue effects. Altogether, the data analyzed in the current work represent an intensive effort to measure racial adversity stress and attempt to relate it to risk behavior such as substance use. We used the stigma-stress-substance use pathway with novel cognitive neuroscience methodology in a sample of African American emerging adults in order to isolate and index mechanisms related to racial stigma and substance use.

To achieve the study's aims, both in the replication and extension, we used both conventional time-domain analyses as well as advanced time-frequency analytic approaches in a

within-subject pre-post design, with the racial stigma cue exposure task serving as the primary task at the center. In the context of the current study, “pre” is used in reference to activity during cue-based and behavioral tasks before the racial stigma cue task, while “post” is in reference to the activity in the same tasks after exposure. Analyses paralleled previous data (Risco, Butler et al., 2025) in that the replication similarly sought to capture how affective and regulatory responding is modulated by experiences of racial stigma from pre to post racial stigma cue exposure, while the extension utilized the pre-post design to assess change in responding (LPP activity) to substance cues post exposure. Overall, we sought to assess specific neural processes’ (cognitive and affective responding) sensitivities to stigma cue exposure in order to parsimoniously and precisely examine how cognitive affective stress responses were impacted. To do this would enhance theoretical clarity in an area of research that highly lacks representation and investigation.

This study featured these 3 main hypotheses, 2 of which serve as replications of previously reported data (Risco, Butler et al., 2025), and the third of which represents the extension to substance cues: 1) in regards to replication of modulation in affective responding to racial stigma cue task, we aim to assess the immediate response to an experience of racial stigma stress during viewing of discriminatory imagery in the RSCT. In line with results from preliminary pilot data, we hypothesized a decrease in affective responding (smaller LPP amplitude) during the viewing of discriminatory imagery, 2) Further, in continuing replication of results from Wave 1, we aim to assess post-exposure changes in affective and regulatory responding, as indexed by the pre-post task protocol. We hypothesize that racial stigma-cues will produce significant increases in negative valence system reactivity, decreases in positive valence system reactivity, and significant decreases in cognitive control processes pre to post exposure.

Importantly, the current study additionally assessed activity during the P300 window to better capture cognitive responding, in addition to the affective responding captured by the LPP. 3) Finally, regarding the extension, we aim to assess how exposure to the RSCT modulates substance cue reactivity. We predict that racial stigma cues will produce significant increases in substance cue reactivity post exposure.

Chapter 2: Methods

Study Participants

This study, as mentioned in the **Introduction** section, was developed as replication and extension of an ongoing experiment utilizing the RSCT [NIDA K08 DA053441-01A1; PI: Risco; Mentor: Bernat], conducted within the CCN Lab. The data was collected in 3 separate efforts: Wave 1, Wave 2, and Wave 3/Substance use extension. In Wave 1, this study was approved by the Institutional Review Board (IRB) at our Institution, IRB Protocol #1187428-4. Wave 1 data was collected in the years 2019-2020. Wave 2 was separately approved by the IRB, Protocol #1920684-6, collected 2022-2025. It is important to note that the task protocols/design for Waves 1 and 2 were identical. Whereas Wave 1 featured predominantly college students, Wave 2 had a broader community sample that contained participants from the greater Washington D.C metropolitan area.

In total, the replication features analyses from a total of 155 African American young adults (94 females; M_{age}=20.32, SD_{age}=2.17). Recruitment efforts overall extended to student organizations from surrounding colleges and universities (University of Maryland, Howard University, etc.), as well as community and religious organizations. Recruitment (for Wave 2 in particular) was made on social media as well, with study fliers/advertisements posted digitally and throughout the larger area. Participants were recruited broadly in these various ways in an intensive and focused effort to reach a broad African American sample of participants, something that conventionally has led to exclusion of individuals in this population (Choy et al., 2022). Inclusionary criteria for the study, across all waves of collection, were participants that identified as Black and/or African American. This dissertation features analyses from these 155 participants to robustly assess for and analyze effects in the Racial Stigma Cue Task (RSCT),

explained below. All participants went through the RSCT, non-stigma image viewing, gambling, and go/no-go tasks to assess hypotheses regarding Aims 1 and 2. As a part of the extension aspect of this study, I collected new data with individuals meeting the same criteria, in order to assess for post-exposure modulations in substance cue reactivity, to further assess for processes that index vulnerability to substance use in this population.

For the extension that included a substance cue reactivity component, this study was approved by the University of Maryland, College Park, Institutional Review Board, IRB Protocol 2031109-5. A total of 76 participants (46 females; M age = 19.38, SD = 1.42) were recruited from undergraduate students from the University of Maryland, College Park in 2023-2024 using university listserv and email announcements, as well as the University psychology research sign-up system (SONA Systems, or SONA for short). The experimental session was preceded by an informed consent agreement. Participants were restricted to those who consented to participate, were between the ages of 18 and 25 years of age, and identified as African American and/or Black. Participants were also required to have corrected-to-normal vision, not be colorblind, and have normal hearing to ensure that all participants are able to process the relevant stimuli in a similar manner. Two participants were excluded due to a problem with the EEG recording (e.g., experimenter error and software malfunction) and 6 participants were excluded due to an excessive number of EEG artifacts (>33% of trials rejected using methods described below), resulting in 68 individuals being included in the final analyses. Participants were compensated with course credit.

Thus, 68 of the 155 are from participants recruited for the substance cue reactivity extension component. The substance use extension had an identical task protocol to Waves 1 and 2, with the addition of the substance cue viewing task added to the pre-post design. A potential

sampling difference is the fact that the substance use extension had participants that were predominantly recruited through SONA Systems, whereas Waves 1 and 2 participants were more broadly apart of the larger Washington D.C. area, and did not recruit from SONA at all. Prior to any analyses, to ensure that the 3 waves did not differ in any effects, an ANOVA was conducted with a between-groups factor, and it was not significant [$F(2, 152) = .225$, $p = .799$], giving us added confirmation/justification to combine samples for broader replication analyses. A larger sample was analyzed to assess for pre-post effects, and a smaller sample was collected to assess for any substance cue reactivity modulation.

Self-Reported Substance Use

All participants in the substance cue extension, prior to continuous EEG recording, completed self-report questionnaires that assessed substance use, alcohol use, and tobacco use. These questionnaires were brief and easily implemented within the task protocol prior to completion of the pre-post design.

Short Michigan Alcohol Screening Test (SMAST)

The Michigan Alcohol Screening Test (MAST) is a self-report screening instrument, used primarily to assess potential alcohol use problems (Selzer, 1971). The MAST was originally introduced by Selzer in 1971, containing 25 items that identify different symptoms of problematic drinking, as well as negative consequences associated with alcohol use. Soon after its introduction, professionals developed shorter versions of the MAST, due primarily to concerns of the original, 25-item version being too long. Thus, one of the most frequently studied of the shorter versions is the Short MAST, or SMAST (Selzer et al., 1975), which was used in the current study. The SMAST is comprised of 13 items, all from the original MAST items, and

responses are binary in format, dichotomously coded as yes or no. Example sample items are: "Do you feel you are a normal drinker? (By normal we mean you drink less than or as much as most other people.)", "Have you ever felt guilty about your drinking?", "Has your spouse/partner, parent, or other near relative ever worried or complained about your drinking?", "Are you able to stop drinking when you want to?", "Have you ever neglected your obligations, your family, or your work for two or more days in a row because you were drinking?"

In our sample, 52 people reported "yes" when asked the screening question "Have you ever drank alcohol (more than a sip)?" Interestingly, however, when we totaled scores, only 7 individuals answered yes to any other items signaling problematic drinking or consequences associated. This number let us know that we did not have sufficient (problematic) drinkers in this population.

Short Drug Abuse Screening Test (SDAST)

The Short Drug Abuse Screening Test, or SDAST (Skinner & Goldberg, 1986), used in the current study is a shortened 20-item version of the 28-item Drug Abuse Screening Test, or DAST (Skinner, 1982). The SDAST is a screening instrument used to assess for problematic drug use (excluding alcohol and tobacco). The items are scored dichotomously in a binary response format, such that one point is assigned for a "yes" response, save for 3 reverse-scored items in which the point is based on a no response (e.g. "Can you get through the week without using drugs (other than those required for medical reasons)?", "Are you always able to stop using drugs when you want to?", "Have you ever felt bad about your drug abuse?")

In the case of the SDAST, a higher score is indicative of more problematic drug use, implying some level of drug abuse. Importantly, regarding the SDAST, a score cutoff for problematic use is generally greater than or equal to 6 across all items. In our sample, only 30

participants responded yes to the screening question "have you ever used drugs other than those required for medical reasons?" Further, only 2 people reported total scores of 6 or above, again implying that the sample of participants in this substance cue extension did not actually capture a substance-using population.

Fagerstrom Test for Nicotine Dependence (FTND)

The Fagerström Test for Nicotine Dependence (FTND) (Heatherton et al., 1991) is a well-known screening instrument in tobacco research, with an overall aim to assess nicotine dependence. The FTND measures the intensity of an individual's addiction to nicotine. The FTND is a self-reported six-item questionnaire, with variability in answer types for respective questions: 4 of the questions are dichotomous, such that a participant chooses one of two options, and the remaining 2 questions are a choice between 4 options when measuring how many cigarettes they smoke a day and how soon after first waking they have their first cigarette. This question format yields a score that ranges anywhere from 0 to 10. Sample items include: "How soon after you wake up do you smoke your first cigarette?", "Do you find it difficult to refrain from smoking in places where it is forbidden, e.g., in church, at the library, cinema, etc.?", "Which cigarette would you hate most to give up?", "Do you smoke more frequently during the first hours of waking than during the rest of the day?". In the FTND, there is no standard cutoff for nicotine dependence, but the suggested scoring system is as follows: 1–2=very low dependence; 3–4=low dependence; 5=medium dependence; 6–7=high dependence; 8–10=very high dependence.

In our sample, only 1 person reported smoking cigarettes. Thus, it is fair to say that we did not have a population of users that reported having smoked cigarettes, drank alcohol to a problematic level, or used substances to a negatively consequential degree.

Questionnaire on Smoking Urges (QSU)

The Brief Questionnaire on Smoking Urges (QSU-Brief) used in this study is a truncated version of the full QSU, of which the original was developed by Tiffany and Drobes in 1991 (Tiffany & Drobes, 1991). The brief version was formed by Cox and colleagues in 2001 (L. S. Cox et al., 2001). The QSU-Brief is a 10-item self-report screening measure designed to assess smoking cravings and urges. Sample items include "I have a desire for a cigarette right now.", "If it were possible, I probably would smoke right now.", "I could control things better right now if I could smoke.", "All I want right now is a cigarette." In the QSU, higher scores are indicative of stronger momentary cigarette cravings and urges. Like the original, longer version, the responses are made on a 1 to 7 Likert scale, where 1 is strongly disagree and 7 is strongly agree, with respondents indicated their personal extent of agreement. In our sample, there was no self-reported agreement with smoking urges and/or craving.

EEG Procedure

A within-subject, pre-post design was implemented among a sample of African American young adults. After an informed consent process, participants completed the self-report questionnaires, and then application of EEG cap and electrodes commenced. Neurophysiological responses to non-stigma cues, drug cues, and during computer-based behavioral/performance tasks were then assessed pre-post exposure to racial-stigma cues, with EEG/ERP measurements recorded throughout the entirety of the protocol. The tasks were designed to be brief and therefore were efficiently administered before and after exposure to the racial stigma imagery. The within-subjects design was chosen (relative to between-subjects) due to greater power to detect pre-post effects.

Stimulus Presentation

Data collection was conducted in a dimly lit, sound-attenuated room. Experimental stimuli were presented on a 24-inch Dell high-definition LED color monitor, centrally placed at a viewing distance of 100 cm, using E-Prime version 3.0.

Psychophysiological Data Collection

Data was recorded using a BrainVision 96-channel actiCAP (sintered Ag–Ag/Cl; 10–20 layout) as well as a 96-channel actiCHamp amplifier (EASYCAP GmbH). Horizontal electrooculogram activity was recorded from electrodes on the outer canthus of both eyes, while vertical electrooculogram activity was recorded from electrodes placed above and below the left eye. Electrodes were filled with electrolyte gel and impedances were kept below 15 kΩ. EEG signals were vertex referenced during the recording and digitized at 500 Hz using the BrainVision Pycorder (Brain Products GmbH). The midline electrode FPZ was used as a ground and CZ was used as an online reference during recording. A PST Serial Response Box (Psychology Software Tools, Inc.) was used to collect responses to the gambling and go/no-go tasks.

EEG Processing and Data Reduction

EEG preprocessing was conducted within the MATLAB (MATLAB Version 9.3.0.713,579 (R2017b), 2017) software environment with a custom script set developed members of the CCN Lab (Dr. Bernat and Dr. Spencer Fix), containing both original and EEGLAB (Delorme & Makeig, 2004) functions. The following preprocessing steps were utilized to clean raw EEG data: 1) a 50hz low-pass filter was applied to continuous EEG data; and 2) resampled to 256 samples per second; 3) continuous data were epoched from 1s before to 2s after

stimuli presentation; 4) bad channels were identified and interpolated across all epochs if they exceeded the threshold of plus or minus 5 standard deviations within the domains of kurtosis and activity probability; 5) electrodes F9, F10, FP1, and PPO9H (with PPO9H repositioned on the left orbicularis oculi) were used to isolate and remove vertical and horizontal ocular movement and eye-blink artifacts using the Gratton regression method (Gratton, 1998); 6) superfluous channels were removed; 7) data were re-referenced to the averaged mastoids while recovering the CZ channel, 8) all channels were baseline corrected; and 9) channels which contained values 150 μV from the mean of that channel were interpolated only within the epoch that contained the extreme value.

ERP and time-frequency (TF) analyses, along with data reduction, were performed in the Psychophysiological Toolbox (Bernat et al., 2005). The initial stage of ERP analyses involved subsampling each participant's data to even epoch count across conditions (i.e., pre/post and stimulus type) and to optimize parameter estimation (Davison & Hinkley, 1997). Full epoched waveforms were averaged 25 times with a random subset of five to eight epochs (with replacement) for each task, each of which was averaged to create one evoked potential waveform for each participant and for each condition. For the unfiltered time-domain ERP analyses, data were downsampled to 128hz and amplitude was averaged across common LPP time windows (N2 = 175–250ms, P3 = 250-400ms, early wave (EW) = 333–666ms, middle wave (MW) = 667–1000ms; late wave (LW) = 1000-1500ms) (Dennis & Hajcak, 2009).

The late positive potential (LPP) is a late slow wave ERP component ranging from 350ms to 1500ms. Discussion of the LPP, commonly defined as maximal at centroparietal EEG channels (in line with the centroparietal P3), coarsely refers to the positivity beginning in and extending beyond the P300 ERP (Hajcak et al., 2010; Hajcak & Foti, 2020). Due to the

similarities and overlap, it can be difficult to parse the P300 and LPP. Thus, based on the scalp topography of the LPP in our data and the selection of centroparietal electrodes in previous studies, activity in the P3 and LPP at the CZ and CPZ electrodes were used for further analysis. Time-frequency analyses involved: 1) downsampling unfiltered and subsampled data to 32hz; 2) applying a third order butterworth filter to create frequency bands (delta 1–4hz, theta 3–9hz); 4) using a binomial reduced interference distribution variant of Cohen's class of TF transformations to decompose data into the TF domain; and then 5) averaging the resultant evoked power across common LPP time windows. Mean measurements from FCz and Cz were extracted and used for time-frequency PCA (TF-PCA; (Bernat et al., 2005) analysis described below for midfrontal theta and centroparietal delta, respectively.

Time-Frequency Components: Theta and Delta

The method used to isolate theta from delta was identical to that of Bernat et al. (2011) and Nelson et al. (2011). Specifically, the condition-averaged feedback-ERP signals were filtered in two alternative ways: 1) using a 3–9 Hz bandpass 3rd order Butterworth filter (high-pass at 3 Hz and lowpass at 9 Hz) to isolate activity in the theta frequency band and 2) using a 3 Hz lowpass 3rd order Butterworth filter (all filters implemented with the Matlab butter and filtfilt functions, Matlab version 7.4, Mathworks, Inc.) to isolate activity in the delta frequency band. Because higher-frequency activity (i.e., theta) is much smaller in amplitude than lower-frequency (delta) activity, pre-filtering the ERP allowed us to directly target the relatively weak theta component of the ERP. Next, each filtered signal (theta and delta) was transformed into a time-frequency energy distribution (surface) with the binomial reduced interference distribution variant of Cohen's class of time-frequency transforms (Bernat, et al., 2005). This was done using full epochs of −1 to 2 s, relative to stimulus onset, to provide sufficient data to resolve

frequencies at and around 1 Hz. For each of these time-frequency bands, principal components analysis was applied to an area corresponding to the 0 to 1000ms time range and 0 to 10 Hz frequency range; this yielded equivalent time windows for decomposition, but with filters having narrowed the frequency activity within the window to either theta or delta, as described above.

Principal components analysis (PCA) was used to identify the primary activation component in each frequency band (delta, theta), corresponding to the largest principal component emerging from the principal components analysis (i.e., the component accounting for the greatest proportion of shared covariance across all time-frequency points). Details for this application of PCA to time-frequency surfaces have been previously published (Bernat, et al., 2005). Briefly, this involves first vectorizing the time-frequency surfaces (e.g., concatenating each frequency row end to end) such that the columns of the data matrix index data from different time-frequency points while the rows index the condition averages (separated by subject and electrode). The PCA decomposition is then conducted using this matrix, utilizing the covariance approach and varimax rotation. The vectorized components are then reassembled into time-frequency surface matrices for interpretation.

Behavioral Tasks

Resting Task

In a standard resting task, participants were instructed to sit and relax while viewing a sign to keep their eyes fixated. The task lasted four minutes, and participants were instructed to remain still and avoid excessive eye movements.

Affective Picture, Non-Stigma Cue Viewing Task

In an affective picture-viewing task, participants passively observed (and let emotional reactions occur naturally) 24 rewarding social scenes [i.e., erotica (Kanske et al., 2013)] (Pleasant, or PL), 24 threat/mutilation images (Unpleasant, or UP), and 24 neutral (or NU) images selected from the International Affective Picture System (IAPS) (Lang et al., 1997). To maximize levels of arousal and valence for the erotic images, participants were asked if they would prefer to see images of male or female models. All images were randomized and counterbalanced for each participant.

Figure 1. Example images from the International Affective Picture System.

Substance Cue Viewing Task

Our research team has previously validated and employed an array of drug cue images for other studies conducted in the laboratory. These images are publicly available images that depict various forms of alcohol, tobacco, and marijuana. These images represent the substances in different forms and in different contexts across various manners of use. These images have been validated in previous studies regarding how clearly the image represents the substance cues, self-report valence and arousal, and image quality. Thus, participants viewed 72 images of drugs/drug-related products regarding alcohol, tobacco, and marijuana. There were 24 images of each substance. As with the IAPS images, these images were presented to participants on a computer screen for 4 seconds each. The sequence of the images was randomized across participants.

Racial Stigma Cue Task (RSCT)

To measure reactivity to racial stigma cues, participants were instructed to passively view 60 images (located by our research team from the public domain) portraying various forms of racial stigma including negative stereotypes about African Americans, cultural appropriation, cultural mockery, police brutality, racial segregation, internalized racism, racial epithets, and derogatory language. Parallel image sets have been used in previous neuroimaging research (Krendl et al., 2009, 2012, 2013). Preliminarily to the current study, an online platform was used (Risco, Butler, et al., 2020, 2025) to recruit African American adults (N=298, Mage=34.34, SDage=10.51) who rated their reactions to the images. Participants rated each image in terms of Valence (1-positive to 9-negative), Arousal (1-excited to 9-calm), and Potency of racial stigma cue (1-no stigma to 10-high stigma). In this validation of the RSCT (Risco, Butler, et al., 2020, 2025), to compare reactions to racial stigma cues, non-stigma images were included. Participants

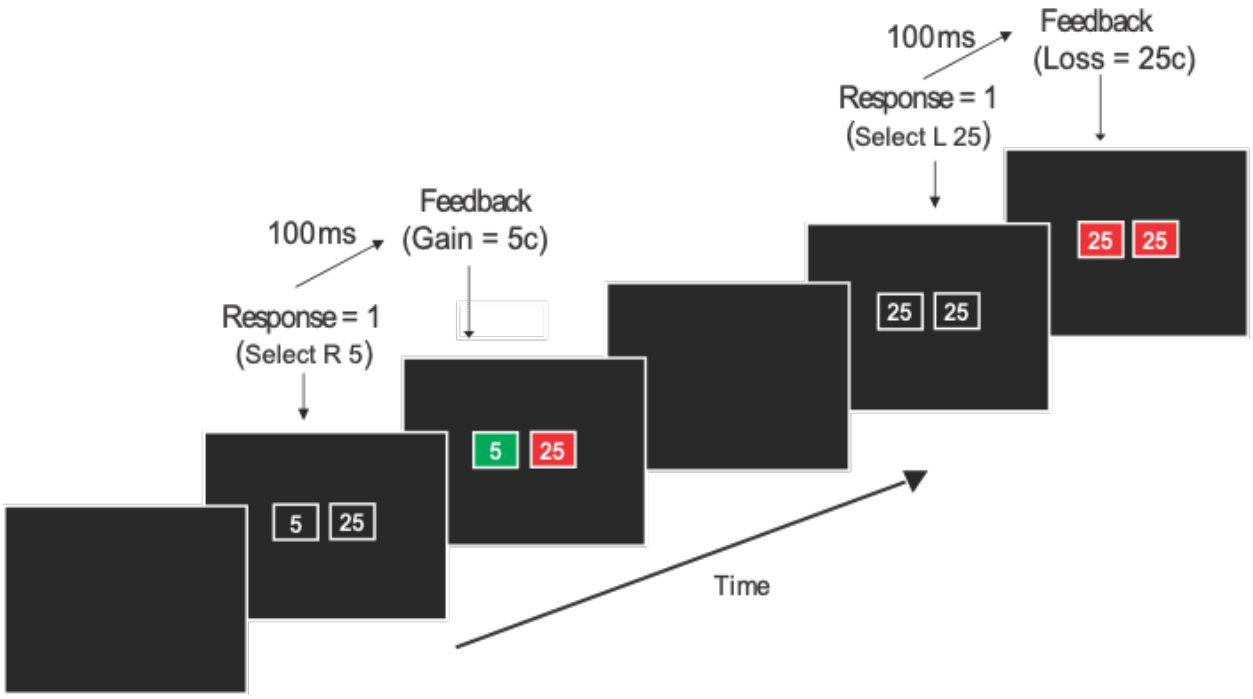
viewed 20 embedded IAPS images (Lang et al., 2005). Results from the self-reported reactions to these images showed that potency of racial stigma cues was associated with both Valence ($r=.79$, $p=.000$) and Arousal ($r=-.28$, $p=.000$). ANOVA results revealed significant differences between non-stigma IAPS cues and racial stigma cues in ratings of Valence ($F=1232.11$, $\eta p2 =.82$, $p<.001$), Arousal ($F=29.62$, $\eta p2 =.10$, $p<.001$), and Potency ($F=5230.21$, $\eta p2 =.95$, $p<.001$), such that ratings were higher in all categories for racial stigma cues relative to the non-stigma control images. These results validate the selected images as highly arousing forms of racial stigma, since the online sample reported perceiving them as such. Further, mean ratings were equal to unpleasant and significantly less than pleasant, suggesting similarly high arousal.

Gambling Task

Participants performed a modified version of the gambling task (Gehring & Willoughby, 2002), [as shown in **Figure 2**]. Each trial consisted of two adjacent squares presented side-by-side with a number (5 or 25) representing a monetary value inside each square. Participants were instructed to select one of the squares by pressing the left or right button on a button box. The squares remained on the screen until the participant made a selection through their chosen button press. After a selection was made and 100 ms passed, the chosen square turned either green or red to signify a win or a loss (with green or red as the winning color counterbalanced across participants). At the same time, the unselected square turned either green or red to indicate what the outcome of the trial would have been had that square been chosen instead. The colored feedback stimuli remained on the screen for 1000 ms, followed by a blank screen for 1000 ms preceding the onset of the next trial. All combinations of 5 and 25 (i.e., 5-5, 5-25, 25-5, and 25-25) were presented as targets, with each combination occurring an equal number of times in a

randomized sequence. The task was composed of 4 blocks of 32 trials. Before the task began, participants completed a brief practice to ensure understanding of the task.

Figure 2. Sequence of stimulus and outcome events in the gambling task.



Go/No-go Task

As an index of executive functioning (Garavan et al., 1999; Hirose et al., 2012; Konishi et al., 1999; Liddle et al., 2001; Menon et al., 2001), participants completed a go/no-go task similar to the design used by Roche and colleagues (2005), where two different white letters were displayed sequentially on a black background, and participants were asked to make a button press when the stimulus presented followed a different stimulus (go trials), but to withhold their response when the stimulus repeated the one that immediately preceded it (no-go trials; e.g., the

fourth letter in the string H-K-H-H-K) (Roche et al., 2005). No-go trials were pseudo-randomly interspersed throughout the task. 144 trials were completed, with 108 go trials and 36 no-go trials in each block (75% and 25%, respectively). The letters used were S-F. Stimulus duration was 300 ms, the response window was 1150 ms, and the inter-trial-interval was 900 ms. Participants completed a set of 20 practice trials prior to recording, but no electrocortical data was recorded. After each block, participants were presented with their overall accuracy and were allowed to rest until manually initiating the next block.

Figure 3. Sequence of stimuli events in a go/no-go task.

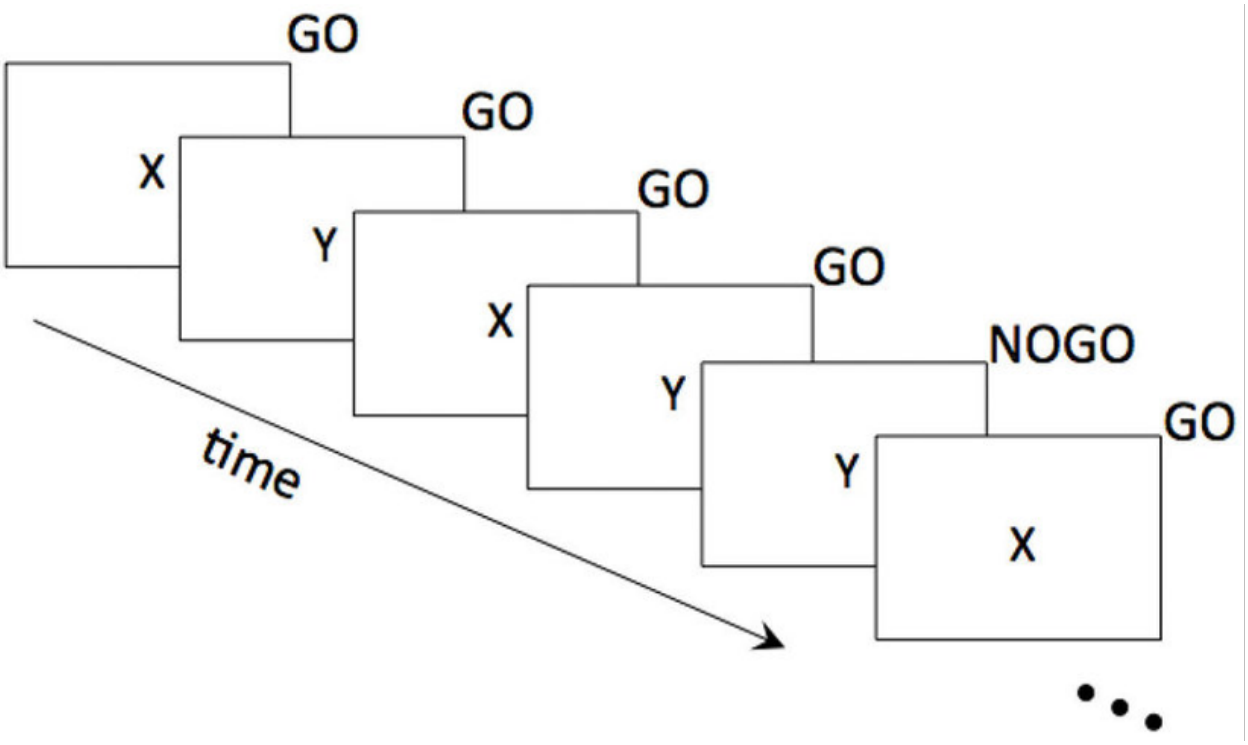
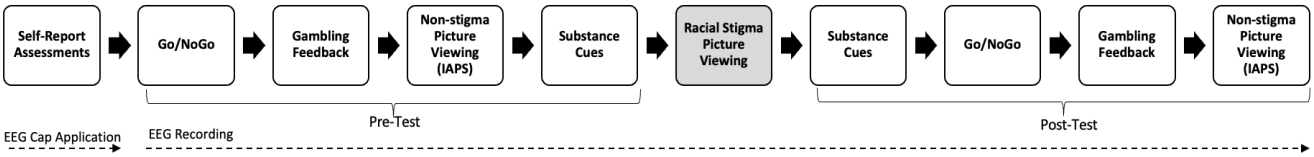


Figure 4. Task Sequence.



Data Analytic Plan

The design of the current study included assessing young adult African American participants before, during, and after, viewing photographic depictions of racial stigma episodes. Analyses assessed processing during the image presentation, as well as a comparison of responding in the proposed tasks before and after viewing. Primary analyses paralleled preliminary work (Risco, Butler, et al., 2025) to assess the first two replicatory aims: First, activity during the discrimination images will be assessed from the first block of images to the third block (Block 1 to Block 3), to assess for down-regulation of responding during the episode. Then, pre-post comparisons of activity from the picture viewing, gambling, and go/no-go tasks will be assessed. Finally, to address the third aim, the extension featured in the current study included an examination of pre-post comparisons of substance cue reactivity, measuring for post-exposure changes in responding to alcohol, tobacco, and marijuana picture cues, respectively.

Tests of affective and regulatory processing modulation after exposure to racial-stigma cues utilized within-factor, repeated measures general linear models (RM-GLM). First, a RM ANOVA was conducted with the P3 and LPP to the presented racial stigma images as the dependent variable, and Block (1 to 3) as the within-subjects independent variable, to assess for modulation of the P3 and/or LPP during exposure to the stigma images. Pre-post differences for non-stigma, gambling, and go/no-go tasks were assessed using paired-samples t-tests to compare ERP time domain and TF measures before and after racial stigma cue exposure. Additionally, a similar RM-ANOVA was conducted in the non-stigma IAPS viewing task to assess for similar ERP (P3 and LPP) modulations during the picture viewing in the conventional time domain, where picture-viewing tasks and the LPP are best assessed. To assess an association between differences in responding during racial stigma cue viewing and pre-post regulatory differences,

pre-post activity differences in the go/no-go and gambling tasks were correlated with amplitude differences from block 1 to 3 in the discrimination picture viewing task. Tests of affective and regulatory modulation of substance cue reactivity mechanisms mimicked tests conducted above, where pre-post differences were conducted with substance cue before and after racial stigma cue exposure, and those differences correlated to differences during racial stigma cue viewing.

SPSS Statistics, RStudio, and the Psychophysiological Toolbox (PTB) was used to perform all statistical analyses. In all cases, p-values of ≤ 0.05 were defined as statistically significant.

Chapter 3: Results

Replication of Effects During Racial Stigma Cue Exposure (Hypothesis 1)

In line with project aims, a set of analyses was conducted to validate the RSCT and observe modulation in affective and regulatory responding both during as well as after exposure to the discriminatory racial stigma cues. Tests were conducted to test for modulations during the RSCT from Block 1 to Block 3 viewing of images, as well as pre-post testing to assess for any changes in responding after the task. Analyses ran parallel to the previous Wave 1 data (Risco, Butler, et al., 2025) sample of 31 participants was collected and analyzed during the early period of this experiment, before the SU extension was implemented. The basic effects to come from those analyses are as follows: results showed decreases in LPP reactivity over the course of the RSCT; as well as increases from pre to post-exposure in LPP reactivity to unpleasant stimuli, while reactivity to PL and NU imagery did not change pre to post; increased theta and decreased delta to gain cues in our gambling task that measures reward/loss sensitivity; and finally, no pre-post changes in go/no-go theta and delta amplitude, but significant correlations between the decrease in LPP during the RSCT and no-go theta and delta amplitude. Thus, analyses in the current sample featured a total N of 155, including the 68 people of the SU extension that completed the multitask protocol, to more precisely analyze patterns, validate the RSCT, and assess effects robustly. Prior to all analyses, a general linear model with a between-groups factor of participants collected that experienced the substance cue viewing task versus the sample of participants that did not was conducted, and this sample factor was not significant [$F(2, 306) = .056$, $p = .946$, ηp2 = .000], assuring that there were not different effects between those that underwent the additional SU cue reactivity task and those that did not. Thus, subsequent analyses are conducted on the combined data. All significant results are reported at the $p < .05$ level.

Stigma Images (RSCT)

To assess our first hypothesis—meant to replicate preliminary data—of how responding is modulated during the viewing of the discriminatory images, we preliminarily examined the change in reactivity from Block 1 to Block 3. Pilot data from this study in our lab (with a smaller sample of 31 participants) showed a significant decrease in LPP amplitude from Block 1 to Block 3, $t(30) = 3.75$, $p < .001$, Cohen's d = .673, and thus a paired samples t-test was conducted here to assess if the same pattern remained, Surprisingly, the results revealed only a marginally significant effect of a decrease in LPP amplitude from Block 1 to Block 3, $t(154) = 1.91$, $p = .058$, Cohen's d = .153. Finding a non-significant effect during the RSCT led us to examine for individual differences in the data that might explain this lack of a significant effect across participants.

Increasing and Decreasing Reactivity During RSCT

We thus examined the data more closely, looking first at the distributions of the data. **Figure 5** presents a distribution of the amplitude change from the first block of images (Block 1) to the third block of images (Block 3) during the RSCT. This histogram shows a normal distribution of data. However, importantly, we noticed that zero is near the peak of the histogram, suggesting that similar numbers of people showed increases in LPP and decreases in LPP (a negative change score is indicative of an increase from Block 1 to 3, whereas a positive change score indicates a decrease).

We wanted to further assess whether those who fell above and below zero represent separable groups. To assess whether participants with smaller amplitudes were underrepresented in the scores, we z-scored each participant's ERP components, within-subject, in order to equalize each participant's weighting. This type of standardization has been done previously in

the ERP literature (Adams et al., 1993; Chen et al., 2023; Eroğlu & and Arman, 2023). As will be demonstrated in the paragraphs below, the z-score transform strongly supported a bimodal distribution (**Figure 6**), and these normalized scores were used in subsequent analyses.

Figure 6 presents the z-scored standardized distribution, where a bimodal distribution is apparent, with a division above and below zero. A score above and below zero is meaningful, as this means that of the 155 participants included in final RSCT analysis, 62 people had negative change scores, indicating that their reactivity from Block 1 to 3 increased, and the other 92 had positive change scores, or decreased. That the sample split in such a fashion might explain the lack of a significant effect across all subjects, as this distribution would suggest contrasting effects between the two groups. Thus, to assess if there were any differences in effects for participants that had an increase in LPP relative to those that had a decrease, a between-subjects factor was added to the general linear model.

We are adapting the nomenclature for those that had a decrease in LPP reactivity as Decreasers. To be among the Decreasers is interesting in the context of response to racial stigma stress, as a decrease in the LPP during the RSCT would be indicative of a habituation to racial stigma cues. As the LPP is generally resistant to habituation (Codispoti et al., 2006, 2007, 2016; Ferrari et al., 2011), a decrease in reactivity during responding is consistent with a self-regulatory damping process (Harrison & Chassy, 2019; Meynadasy et al., 2022). Conversely, those that elicit a higher LPP as viewing goes on from Block 1 to Block 3 are interpreted as Increasers, or individuals that may have been unable to regulate their responding, and thus produced a larger LPP, known to elicit larger potentials to emotional/emotionally-arousing stimuli (Cuthbert et al., 2000; Johnston et al., 1986; Schupp et al., 2006).

Figure 5. Histogram of Change in LPP Amplitude from Block 1 to 3.

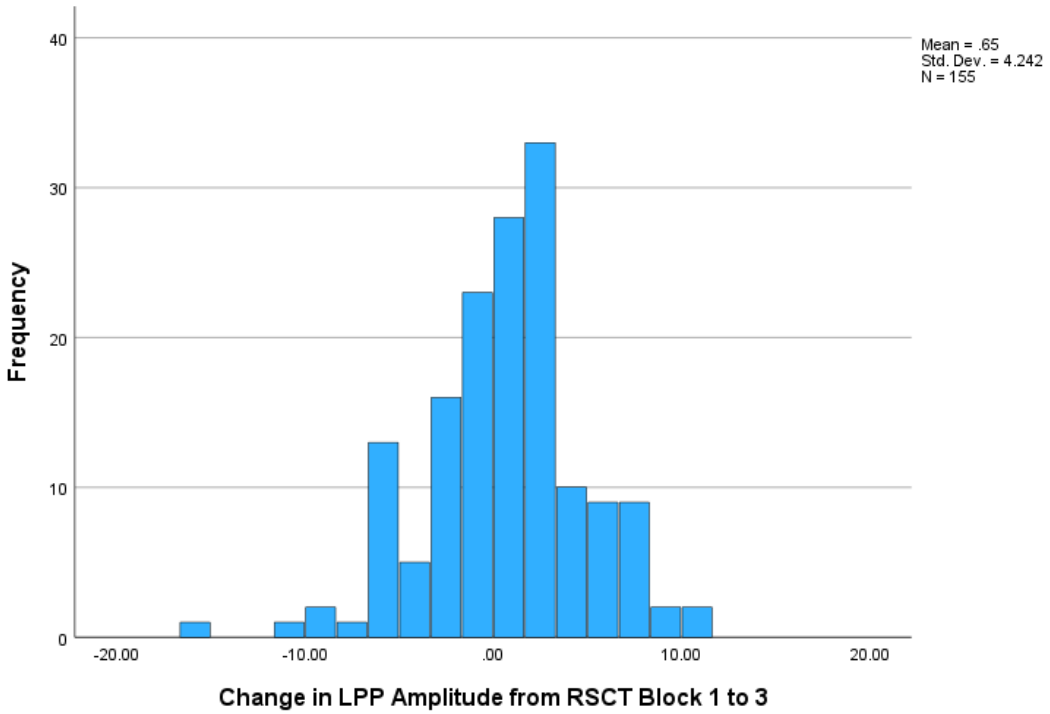
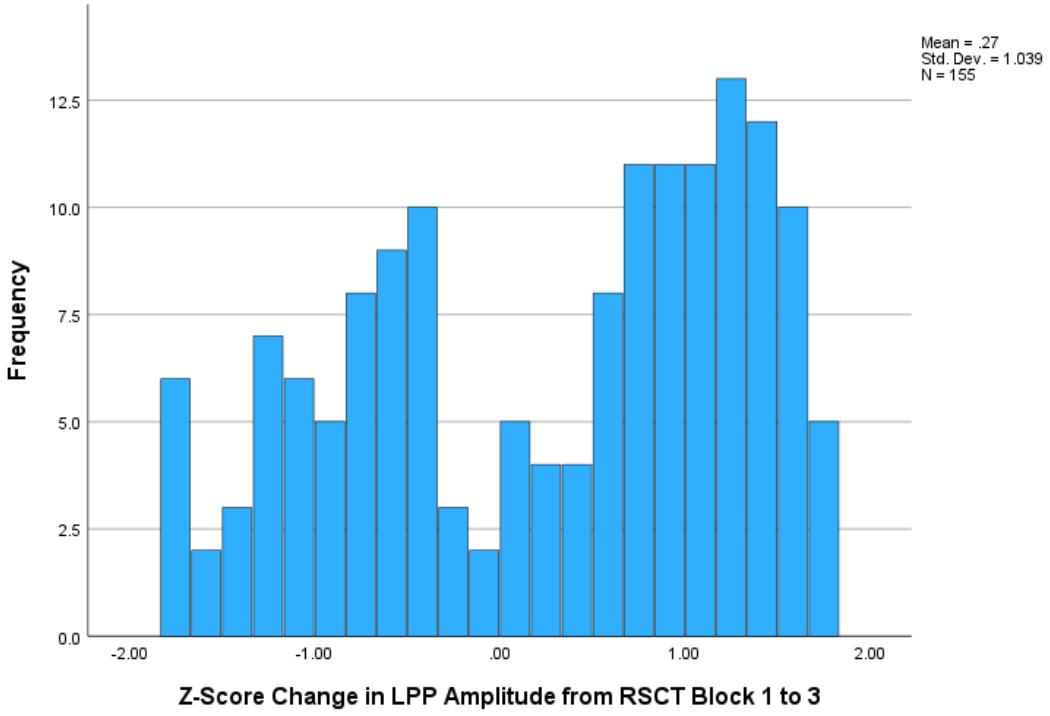


Figure 6. Histogram of Z-Score Change in LPP Amplitude from Block 1 to 3.



Assessing Activity During RSCT Using Normalized Scores

Overall, to assess for modulation of the P3 and LPP during viewing of racial stigma images, an omnibus ANOVA was performed. This was a 2 (Block: 1 to 3) x 2 (ERP Component: P3, LPP) repeated measures ANOVA (RM-ANOVA), with a between-subjects factor of Group (Increaser and Decreaser).

Table 1. Omnibus ANOVA: Component x Group x Block

	SS	MS	F(1,153)	p	ηp2
Block	.010	.010	.049	.825	.000
Component	157.05	157.05	132.11	< .001*	.463
Block x Component x Group	27.52	27.52	79.75	< .001*	.343
Error	31.48	.206			

Note: * p < .05

Results (**Table 1**) revealed that there was no main effect of Block, indicating that across all conditions and all participants, reactivity did not differ significantly between Blocks [$F(1, 153 = .049$, $p = .825$, ηp2 = .000]. There was a significant main effect of Component, suggesting that activity did differ between the P3 and LPP across all other experimental conditions [$F(1, 153) = 132.11$, $p = < .001$, ηp2 = .463]; this difference indicated that P3 activity (M = -.410, SE = .041)

was significantly smaller than LPP activity (M = .620, SE = .066) across conditions. Importantly, and more interestingly, there was indeed a Block x Group x Component interaction, indicating that the effect of Block and Component activity varied between Groups, [$F(1, 153) = 79.75$, $p = < .001$, ηp2 = .343]. The nature of the interaction is such that the two groups showed unique patterns in terms of change in amplitude from Block 1 to 3, in both the P3 and LPP ERP windows: there was significant Block 1 to Block 3 change in both P3 and LPP amplitude respectively, but in opposite directions between-group, and opposite directions between ERP. Post-hoc comparisons of means (**Figure 7; Table 2**) revealed that there was significant change in P3 amplitude from Block 1 to 3 in both the increasing and decreasing group, but in opposite directions, respectively. For the Increasers, from Block 1 to 3 results showed a decrease in amplitude, although the mean difference was marginal at $p = .052$ (**Figure 11**). For Decreasers, post-hoc comparisons revealed a significant mean increase in P3 activity from Block 1 to 3 ($p < .001$) (**Figure 9**). Overall, from the beginning of the RSCT paradigm of viewing racial stigma cues to the end, Increasers (those that showed an LPP increase from Block 1 to 3) showed a diminished P3, while Decreasers (those showing the self-regulatory process during the LPP) showed heightened activity. Put differently, the LPP Increasers showed a reduced reaction during the P3 (cognitive processing) and the LPP Decreasers showed a heightened P3 reaction (more cognitive processing).

Figure 7. P3 Activity across the RSCT for Increasers and Decreasers

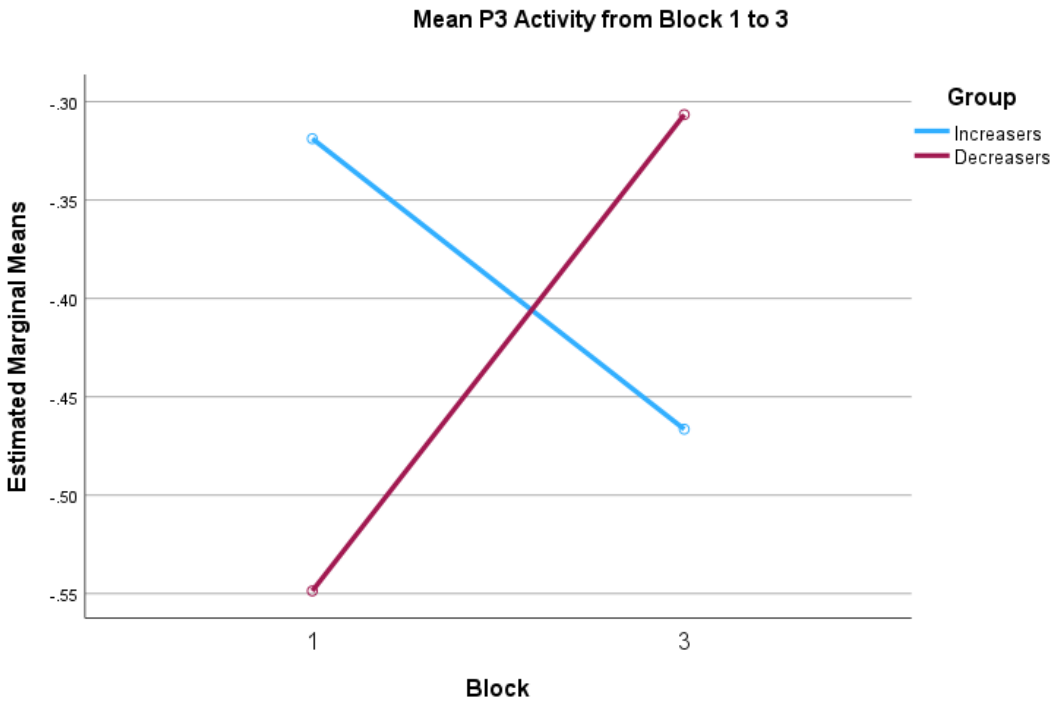


Table 2. Mean P3 Activity at Each Block

	Increasers	Decreasers
Block 1	-.319	-.549
Block 3	-.466	-.307

Note: For Increasers, the change (decrease) from Block 1 to Block 3 was marginal, as $p = .052$. For Decreasers, the change was significant, such that there was an increase in P3 activity from Block 1 to 3.

Figure 8. LPP Activity across the RSCT for Increasers and Decreasers

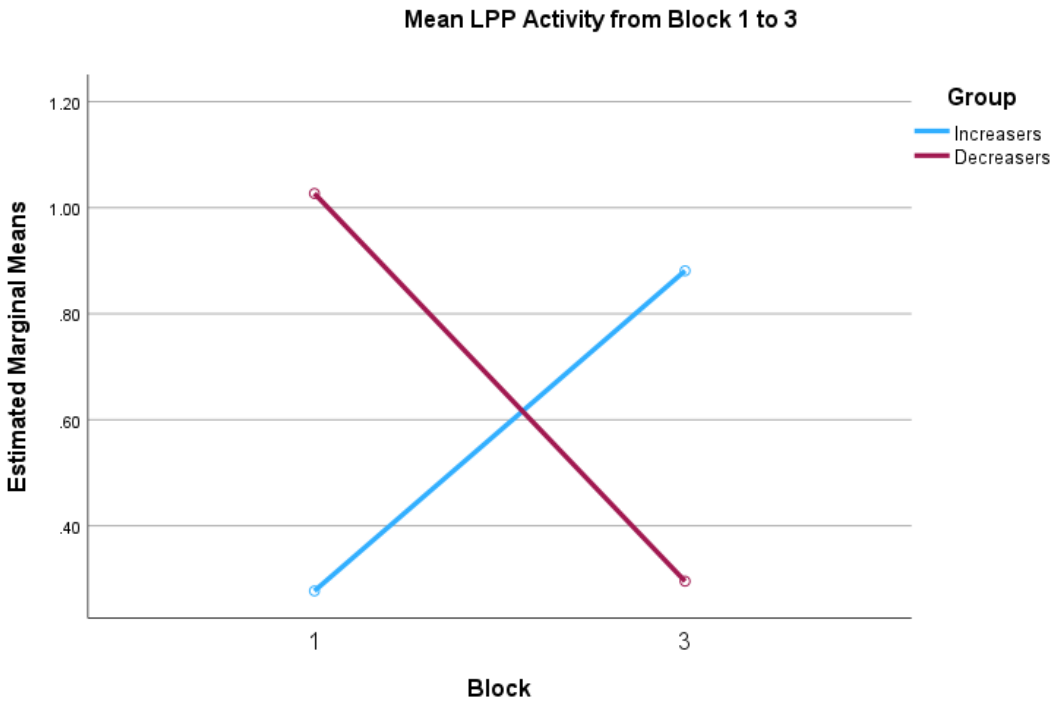


Table 3. Mean LPP Activity at Each Block

	Increasers	Decreasers
Block 1	.277	1.03
Block 3	.881*	.295*

Note: In this table, we see that Increasers showed a significant increase from Block 1 to 3 in LPP amplitude, whereas Decreasers showed a significant decrease in reactivity.

Post-hoc comparisons of means (**Figure 8; Table 3**) similarly revealed that change in LPP amplitude from Block 1 to 3 was in opposite directions as well for the two groups, respectively. In the LPP analyses, however, contrasting the directionality in the P3 windows, analyses revealed the Increasing group LPP activity significantly increasing from Block 1 to 3 (**Figure 11**), whereas the Decreaser group had significantly lower LPP amplitude from Block 1

to 3 (**Figure 10**). This is in line with the bimodal distribution that revealed the Increasers as increasing LPP amplitude over the course of viewing the discriminatory images, whereas the Decreasers showed a decreased LPP as the RSCT went on.

Altogether, the finding of a significant three-way interaction suggests that Increasers and Decreasers are responding entirely differently to the RSCT, in almost exactly opposite manners. During the P3, the Increasers have decreasing amplitudes, and then during the later wave LPP their amplitude increases, whereas the Decreasers have increased P3 and then their responding declines as time goes on. Over the course of the racial stigma cue viewing, the Increasers are having overall reduced top-down processing, as the P3 is said to reflect mental processes that underlie the deployment of attentional resources to, and evaluation of, task-relevant stimuli (Donchin, 1981; Johnston et al., 1986; Polich & Kok, 1995). This reactivity then becomes a heightened later response to intense and emotional discriminatory imagery (LPP); the Decreasers are having heightened early processing response, and then the effect abates as the stimuli continues to be presented, with this earlier processing coinciding with a smaller emotional reaction. The results here sufficiently validate the RSCT as objectively capturing affective modulation of regulatory responding.

Figure 9. Legend for ERP Plots.

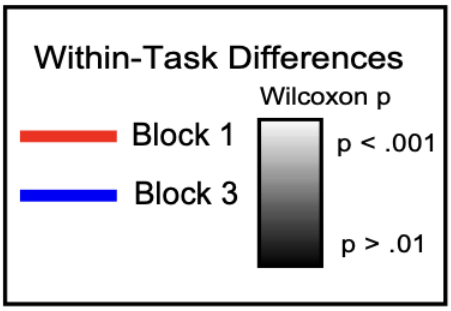
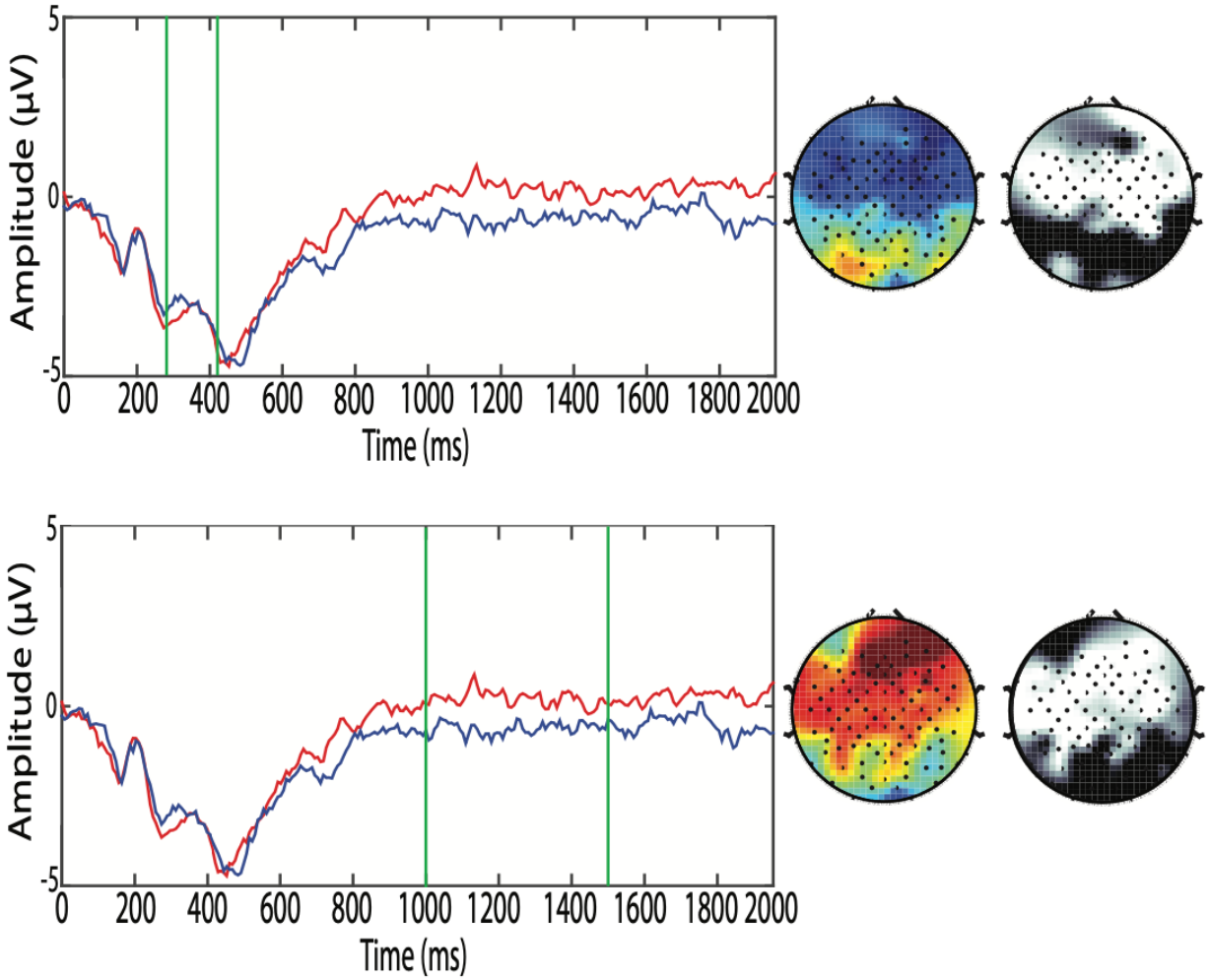
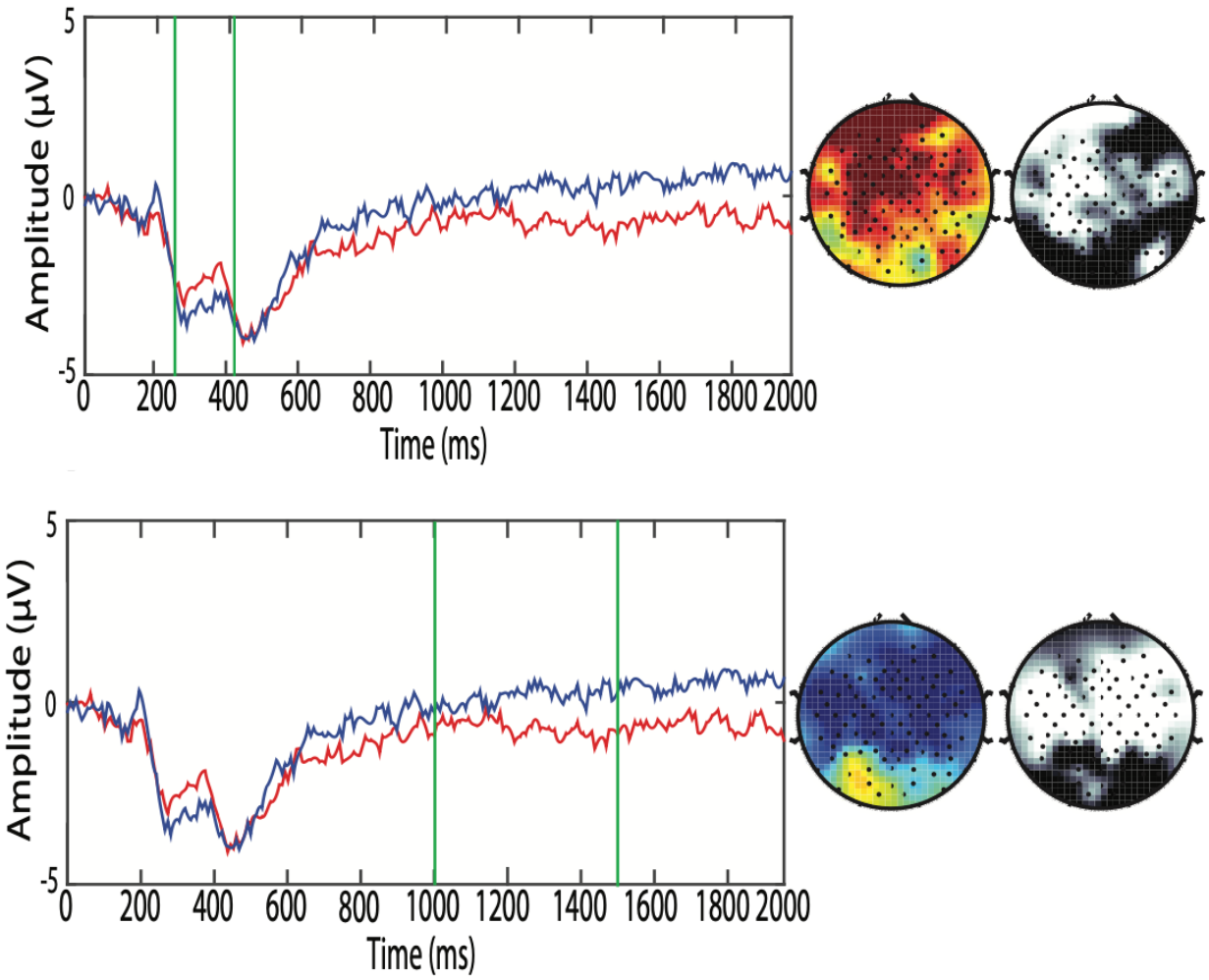


Figure 10. Decreaser Group P3 and LPP Amplitude from Block 1 to 3.



Note: Here, the first plot shows an increase during the P3, and the second plot shows a decrease later in time during the LPP from Block 1 to Block 3 of the RSCT.

Figure 11. Increaser Group P3 and LPP Amplitude from Block 1 to Block 3.



Note: This set of plots shows the contrasting effects for Increasers relative to Decreasers, as Increasers show a decrease of P3 amplitude from Block 1 to 3, whereas they then show an increase in LPP amplitude from Blocks 1 to 3.

Replication in the Multitask Protocol: Pre/Post (Hypothesis 2)

To assess hypothesis 2, meant to replicate effects (Risco, Butler, et al., 2025) regarding post-exposure changes in affective and regulatory responding in the pre-post design for affective picture viewing as well as gambling and go/no-go tasks, significance testing was conducted. Like previous analyses, the tests serve to measure reactivity to positive valence systems (gambling reward/gain feedback, pleasant imagery), negative valence feedback (negative, unpleasant

imagery, gambling loss feedback), and cognitive control (go/no-go). Similarly to the RSCT, the time-domain ERP measures in the affective picture-viewing task also utilized standardized results to ensure effects were not similarly obscured. As the time-frequency principal components analysis decompositions for gambling and go/no-go did not reveal the same patterns, analyses for those tasks utilized the non-standardized data.

Affective Picture Viewing Task

To first assess for any overall pre-post changes in affective reactivity to IAPS images, paired samples t-tests were done for each component (P3 and LPP) within each IAPS image category: unpleasant (UP), pleasant (PL), and neutral (NU). These t-tests were conducted to understand any patterns in responding, and then the findings were confirmed in the ANOVAs described and reported below. T-tests showed that there were pre-to-post exposure changes in reactivity to IAPS images, and further that these changes were mostly within reactivity to unpleasant images. During the P3, only reactivity to unpleasant imagery was modulated pre to post, $t(153) = -2.37$, $p = .019$, Cohen's d = -.191, such that reactivity to unpleasant imagery increased across participants after exposure to racial stigma cues relative to before exposure. P3 activity was not modulated to pleasant or neutral cues. During the LPP, activity was similarly modulated to unpleasant imagery again, $t(153) = 4.85$, $p < .001$, Cohen's d = .390. This suggests that during the LPP time window in the post, activity to UP imagery decreased, after an initial early increase during the P3, relative to the pre. Interestingly, though nominally smaller effects when compared to the unpleasant, reactivity to neutral cues was modulated from pre to post during the LPP as well, $t(153) = 2.86$, $p = .002$, Cohen's d = .230. Again, reactivity to pleasant cues was not significantly changed from pre to post in the LPP, similarly to the nonsignificant findings in the P3. Previous findings (Risco, Butler, et al., 2025) found that LPP reactivity to the

UP stimuli was increased from pre to post, and there was no significance for pleasant or neutral images. Thus, these findings represent novel findings relative to this previous work, as we found not only an LPP decrease, but assessment of the P300 ERP revealed an increase during this earlier component. We did not replicate previous effects.

At this juncture, we were able to conduct more analyses that had not previously been done in our initial paradigm utilization (Risco, Butler, et al., 2020; 2025). This current study newly featured the P300, and we found novel findings relative to Wave 1 not only for this time window but also different effects in this larger sample for the LPP. We also saw significant change in reactivity to neutral stimuli, further separating from previous effects. Thus, to further assess for any post-exposure changes racial stigma cues produced in affective processing, a 2 (Pre, Post) x 2 (Component: P3, LPP) x 3 (IAPS: Unpleasant (UP), Neutral (NU), Pleasant (PL)) RM-ANOVA was conducted, with a between-subjects factor for group (Increasers and Decreasers) to assess for any group-level differences. This omnibus ANOVA was assessed within and between each component ERP window similarly to the test conducted for the discriminatory task, this time taking into account the non-stigma pleasant, unpleasant, and neutral cues from the International Affective Picture System, or IAPS.

Table 4. Omnibus ANOVA: Component x IAPS x Group x PrePost

	SS	MS	F	p	ηp2
PrePost	5.69	5.69	13.92	< .001*	.083
Component	208.80	208.80	74.95	< .001*	.329

IAPS	6.98	3.49	13.07	< .001*	.079
Component x PrePost x IAPS	2.89	1.44	3.15	.044*	.020
Component x PrePost x IAPS x Group	2.96	1.48	3.23	.041*	.021
Error	140.12	.458			

Note: * p < .05

Omnibus ANOVA results (**Table 4**) revealed a main effect of pre-to-post change in amplitude, such that across all experimental conditions, amplitude significantly decreased from Pre to Post in non-stigma picture viewing [$F(1, 153) = 13.92$, $p = < .001$, ηp2 = .083]. Results also revealed a main effect of component [$F(1, 153) = 74.95$, $p < .001$, ηp2 = .329], and post-hoc comparisons of means revealed that across all conditions, amplitude was significantly higher during the LPP (M = .263, SE = .055) than during the P3 (M = -.423, SE = .036). Analyses further revealed a main effect of IAPS [$F(2, 306) = 13.07$, $p < .001$, ηp2 = .079]. Across experimental conditions, there were significant differences in reactivity to pleasant, unpleasant, and neutral cues, such that reactivity to unpleasant cues was lower relative to pleasant and neutral cues.

Importantly, as **Table 4** shows, there was also a Component x PrePost x IAPS interaction, meaning that pre-post differences between the P3, and LPP components varied between the pleasant, neutral, and unpleasant trials. This interaction allows us to directly assess

for pre-post change in reactivity within each IAPS valence category, as well as within each ERP component, respectively. The nature of the interaction reveals that there was significant change from pre to post for both the P3 and LPP separately, but the change occurred in opposite directions when comparing the two components. Further, the only significant P3 change was an increase to UP imagery, whereas the pre to post change in LPP showed a significant decrease in both UP and NU imagery. **Table 5** shows the means from pre to post during each ERP component in pleasant, unpleasant, and neutral non-stigma cue imagery.

Post-hoc comparisons revealed that pre-post differences in reactivity to unpleasant stimuli was significant at each ERP component, such that activity significantly increased during the P3, but activity decreased during the LPP. These findings are similar to those found during the discriminatory task, such that it appears the same regulatory damping process was engaged after an earlier perceptual and processing emphasis. Interestingly, this pattern of findings was largely only present for unpleasant cues, as aside from a significant LPP decrease pre to post to neutral cues, there were otherwise no pre-post differences for pleasant stimuli, and no significant P3 differences for neutral stimuli. These statistics are in line with t-test findings reported at the top of this section. In ANOVAs measuring the if these changes were different between IAPS categories, linear and quadratic terms revealed the changes in UP reactivity was significantly larger relative to change in reactivity for PL imagery, $F(1, 154) = 7.71$, $p = .006$, ηp2 = .048), and marginally bigger when compared to NU imagery reactivity, $F(1, 154) = 3.81$, $p = .053$, ηp2 = .024. Overall, these results confirm that there were changes in affective responding after exposure to racial stigma cues, relative to before viewing, and that these effects were largely within the Unpleasant imagery.

Table 5. Mean Pre-Post activity to IAPS

	Unpleasant		Pleasant		Neutral	
	Pre	Post	Pre	Post	Pre	Post
P3	-.528	-.401	-.381	-.326	-.431	-.472
LPP	.430	.019	.420	.320	.348	.039

Note: In this table, the change from pre to post was significant for both the P3 (showing an increase) and the LPP (showing a decrease) to UP imagery. There was no significant change from pre to post for PL imagery. In NU imagery, only the LPP decrease from pre to post was significant.

There was also a significant Components x PrePost x IAPS x Group interaction, suggesting that the effects were different between Increasers (those that had an LPP increase during the RSCT) and Decreasers (those that had an LPP decrease during the RSCT). **Table 6** shows a comparison of mean reactivity to IAPS images from pre to post for both Increasers and Decreasers at the P3 and LPP. The nature of the interaction reveals that there are group differences in pre-to-post change for the LPP to PL imagery, and the P3 to UP imagery, as otherwise, all other effects are identical across group. The post-hoc comparisons showed that during the LPP to UP and NU imagery, the pattern of a decrease in reactivity was the same across Increasers and Decreasers. The only significant P3 increase from pre to post was within the Increasers group to UP imagery, as all other P3 pre-to-post changes were not significant across group and PL/NU imagery. The other interesting pattern suggests that Decreasers had an overall LPP decrease, as pre to post decreases were significant for UP, PL, and NU, whereas

Increasers had significant LPP decreases to UP and NU, whereas PL had a nominal, nonsignificant increase.

Table 6. Mean Pre-Post activity to IAPS within Increasers and Decreasers.

		Unpleasant		Pleasant		Neutral	
		Pre	Post	Pre	Post	Pre	Post
Increasers	P3	-.473	-.277	-.317	-.331	-.338	-.333
	LPP	.377	-.029	.372	.474	.341	-.007
Decreasers	P3	-.584	-.525	-.444	-.321	-.524	-.611
	LPP	.483	.067	.468	.165	.354	.086

Note: In this table, we see that the change from pre to post to unpleasant imagery is significant in both the P3 (showing an increase) and the LPP (showing a decrease) for the Increasers. In the Decreasers, their reactivity to unpleasant imagery was only significantly modulated in the LPP, where it was similarly a significant decrease in amplitude. In reactivity to pleasant imagery, only the Decreasers showed a significant LPP decrease, all other comparisons were nonsignificant. In the Neutral imagery, the LPP amplitude decrease was present for both groups.

Overall, results from the non-stigma cue viewing task suggested that exposure to racial stigma cues lead to enhanced vigilance and stimuli evaluation of negatively-valenced cues, as well as a decreased LPP, indicating a reduced emotional reaction. Whereas heightened activity during the P3 would suggest a more intense perception, attention allocation, and focus on an earlier processing of the incoming stimuli, this quick processing is subsequently followed by a less emotional reaction. Though there was a group interaction, it appears the participants, with

slight between-group differences are largely implementing the same strategy during the non-stigma IAPS cue viewing. Overall, this suggests a validation of the RSCT in that the exposure to racial stigma cues did modulate affective responding, especially to UP stimuli.

Reward/Loss Sensitivity

In continuing analyses for Aim 2 to replicate multitask pre-post effects, activity during the gambling task was analyzed. To assess for any pre-post differences in processes that index reward and loss sensitivity, we examined activity at medial-frontal theta and centroparietal delta for Gain and Loss stimuli. T-test results revealed that activity in the delta frequency band decreased after exposure to racial stigma cues for gain stimuli [$t(154) = 4.02$, $p < .001$, d = .323]. As delta is sensitive to gain (Bernat et al., 2015; Bernat, Nelson, et al., 2011; Foti et al., 2015; Watts et al., 2017, 2018; Watts & Bernat, 2018), decreases in reactivity to gain stimuli suggests a shift towards loss (or away from gain). As for theta, results revealed increases in theta to gain stimuli [$t(154) = -2.01$, $p = .046$, d = -.162] after racial stigma cue exposure. As theta is sensitive to loss (Bernat et al., 2015; Bernat, Nelson, et al., 2011; Cavanagh et al., 2010; Cavanagh & Frank, 2014; Cohen et al., 2007; Crowley et al., 2014; Janssen et al., 2016; Nelson et al., 2011), observed increases to gain cues suggest reward cues become more salient. Independent samples t-tests conducted to assess between-group differences of Decreasers and Increasers were not significant, p's > .05. Thus, the findings suggest that these effects existed across all participants. Changes in theta and delta to loss stimuli were not significant. Findings here did replicate previous findings with Wave 1 data (Risco, Butler, et al., 2025). Collectively, results suggest a bias towards salience and orienting (increased vigilance) and less Reward Positivity post-exposure to racial stigma cues.

Cognitive Control

For the Go/No-Go task, indexing executive functioning (Hirose et al., 2012; Garavan et al., 1999; Konishi et al., 1999; Liddle et al., 2001; Menon et al., 2001), we similarly conducted t-tests to replicate preliminary Wave 1 findings. Here, there was a significant decrease in centroparietal delta post-exposure to go trials, $t(154) = 3.12$, $p = .002$, Cohen's d = .251; there was also a marginal increase in medial frontal theta from pre to post, $t(154) = -1.66$, $p = .099$, Cohen's d = -.133. These findings are in contrast with previous findings with the RSCT, as we previously found no significant differences for go or no-go trials from pre to post exposure to racial stigma cues. Independent samples t-tests revealed no between-group differences for these findings. These significant delta results suggest that across all participants, participants allocated less attentional processing appropriately to Go trials. There were no significant pre-post differences for No-Go theta and delta (t-test p's > .05). We then tested whether the inferred respective down-regulatory and increasing processes during exposure to racial-stigma cues (from 1st to 3rd blocks) would be associated with pre-post changes in Go/No-Go theta and delta (RDoC COG- cognitive control), and these associations were also not significant.

Overall, in assessing Aim 2, we found mixed results in terms of replicating results previously assessing the RSCT: in the IAPS viewing task and the go/no-go tasks, we found novel findings respectively. In the IAPS viewing task, we found novel effects both in newly assessing the P300 window, as well as the direction of effects. In the go/no-go task that previously saw no significance in pre-post effects, we saw significance post-exposure to go trials. In the gambling task, we did find a replication of effects, as we saw a shift towards loss processing from Wave 1 to this sample.

Extension: Assessing Post Exposure Substance Cue Reactivity (Hypothesis 3)

Substance Cue Reactivity

To assess aim 3 in our study, representing the novel extension of substance cues added to the pre-post task protocol, we tested for modulation in substance cue reactivity after exposure to racial stigma cues in the RSCT. The first two aims importantly sought to replicate findings related to post-exposure changes in cognitive and affective processing, and this extension sought to utilize substance cues to index modulations in drug cue reactivity in the context of racial stress event. LPP analyses were the focus of the extension's testing for effects, due to its implications in substance cue reactivity (Parvaz et al., 2016). T-tests were conducted for pre-post changes in alcohol, tobacco, and marijuana LPP amplitude. These findings represent novel analyses, as the previous work did not feature substance use, but with the finding of two separable groups as indexed by Increasers (LPP increase during the RSCT) and Decreasers (LPP decrease during the RSCT) during the RSCT, we were able to assess the pre-post changes on a deeper level. Pre-post T-tests were first conducted across all subjects to assess for overall changes in substance cue reactivity and then assessed within each group (Decreaser and Increaser). **Table 7** reports t-test results across participants.

Table 7. T-tests for Pre-Post changes in LPP amplitude for alcohol, marijuana, and tobacco.

Substance Cue	Pre		Post		*t*	*p*	Cohen's *d*
	M	*SE*	*M*	*SE*			
Alcohol	.98	.39	.22	.31	1.74	.087†	.210

Marijuana	-.015	.31	-.64	.37	1.80	.076†	.219
Tobacco	-.26	.33	.97	.33	-3.14	.003*	-.380

Note: * $p < .05$. † = trend-level.

Overall, pre-post t-tests (**Table 7**) revealed a significant pre-post difference for tobacco cues, $t(67) = -3.14$, $p = .001$, Cohen's d = -.380, in that there was a significant increase in reactivity after exposure to racial stigma cues. There were marginally significant effects for alcohol, $t(67) = 1.74$, $p = .087$, Cohen's d = .210, and marijuana, $t(67) = 1.80$, $p = .076$, Cohen's d = .219, respectively, such that there were decreases in LPP amplitude to these cues after racial stigma cue exposure.

Further t-tests were run with the same substance cues, now within Decreaser and Increaser group, in attempts to parse apart any effects between-groups, similarly to analyses run for the RSCT and non-stigma image viewing. Interestingly, as **Table 8** shows, within Increasers and Decreasers, the effects are similar: effects in the decreasing group are nominally smaller than in the increasing group, but largely the results show the same effects between groups as they are similar in magnitude and direction for each respective substance. In the Increasers, we see significant increases in LPP amplitude for tobacco cues, marginally significant decreases in amplitude to alcohol cues, and nonsignificant differences in amplitude pre to post for marijuana cues. In the Decreasers, we see slightly weaker effects in that the increase in tobacco cue reactivity after RSCT exposure reaches only trend-level significance, and effects for alcohol and marijuana are wholly insignificant.

Table 8. T-tests for Pre-Post changes in LPP amplitude for alcohol, marijuana, and tobacco.

	Substance Cue	Pre		Post		*t*	*p*	Cohen's *d*
		M	*SE*	*M*	*SE*			
Increasers	Alcohol	1.86	.82	.12	.57	1.87	.073†	.368
	Marijuana	.41	.47	-.34	.52	1.28	.213	.250
	Tobacco	-.53	.52	1.15	.53	-2.76	.011*	-.541
Decreasers	Alcohol	.43	.35	.28	.36	.381	.705	.059
	Marijuana	-.27	.41	-.83	.51	1.27	.212	.195
	Tobacco	-.09	.43	.85	.43	-1.86	.071†	-.286

Note: * denotes significance at the $p < .05$ level. † Denotes a marginal effect.

In independent samples t-tests, conducted to assess for any between-group differences on any LPP reactivity measures for all 3 substance cues, respectively, results were not significant, thus confirming that there were no between-group differences in substance cue reactivity (as opposed to self-reported substance use, substance cue reactivity is indexed by LPP reactivity, an objective marker of reactions to drug cues (Parvaz et al., 2016)), and the effects reflected in **Table 7** are indicative of the substance cue reactivity results across all participants. Overall, in the substance cue extension, we found that substance cue reactivity was slightly modulated after viewing the discriminatory images. While we did not see significant findings for alcohol or

marijuana cues, we did see post-exposure increases in reactivity to tobacco cues. These findings somewhat align with our hypotheses, as we had not necessarily expected to only see significance in tobacco cues Interestingly, for tobacco, in a sample where the majority of the participants do not report using tobacco, reactivity increased, and for alcohol and marijuana, there were no significant effects, though a larger proportion of participants reported at least some alcohol and illicit substance use. Our extension showed effects, which might have implications on modulations of brain systems sensitive to substance use and racial stigma, but in a relatively non-using sample, the findings should be further implemented with more problematically using populations.

Chapter 4: Discussion

Study Significance

Through the utilization of cognitive neuroscience methodology, based on EEG/ERP measures, the current study was able to assess the immediate response to a racial stigma stress event, capturing objective neural reactivity both during a racial stigma event as well as after the event. Through the replication and extension, these results assessed cognitive and affective processes related to reward sensitivity, executive control, and substance use. Responding in this immediate context has implications for self-regulatory capacity after such stressful experiences (Major et al., 2013). Further, with our findings, we get one step closer to better characterizing the link between racial stigma experiences and substance use, as modulated affective and regulatory responding in our findings suggest added neurophysiological context to an otherwise well-theorized link.

Using conventional time-domain approaches (P3 and LPP ERP components), as well as some time-frequency analysis of regional neuronal activation (medial frontal theta and centroparietal delta), underlying mechanisms involving the stigma-stress-substance use pathway were assessed (Risco, Butler, et al., 2020, 2023, 2025). We sought to further advance the RSCT's goal of enhancing theoretical clarity of these cognitive and affective processes. Though the study served as both a replication and extension, many unique features and characteristics were employed to efficiently build on the RSCT paradigm: we assessed the P3 ERP (a marker of cognitive processing), added a substance cue task, and importantly, in attempts to replicate previous findings, we found many novel effects and unique patterns. The study used a racial stigma cue-focused task (RSCT) (NIDA K08 DA053441-01A1; PI: Risco; Mentor: Bernat;

Risco, Butler et al., 2025), a novel task developed to build on substance use and cue reactivity literature, in an attempt to parse and index key cognitive and affective processes (cue reactivity, executive function, reward processing) modulated by racial stigma events. In a project that initially served to further develop the RSCT as an index of modulations to drug cue reactivity in the context of a racial stress event, we found numerous novel findings both during and after the racial stigma cue exposure. The RSCT is already a novel paradigm, and with additional analyses, a larger sample, and an extension, we found new results that contrast previous results, and we have a new substance cue task to interpret in relation. The RSCT indexed processes related to substance use, and the extension sought to more directly assess substance use vulnerability by measuring reactivity to substance cues after stigma exposure. Our novel findings in our first two aims that centered around replication serve as validation and support for the RSCT paradigm. This study's findings may still have predictive utility in terms of understanding racial stress response, which has implications for substance use.

This study's findings, particularly in the replication, represent the gap in literature regarding exploration of these mechanisms. Though health disparities faced by African Americans are very well-studied and understood, in fact being called a central public health priority (Brondolo et al., 2009), the number of studies that measure cognitive and affective processes regarding racial stigma and substance is low. This paper has outlined that the relationship between discrimination is well-theorized to be related to a stress response and perhaps coping strategies (Williams et al., 2019; Acevedo et al., 2019), but the neural underpinnings to explain this link have not been thoroughly explored. The RSCT's novelty has been seen to address that (Risco, Butler, et al., 2023, 2025), and our findings further support the task as a valid measure of assessing immediate racial stress response in order to glean new

insights. This study was able to bridge that gap and utilize this novel paradigm with the neuroscience methodology to precisely study any neurophysiological indices that might arise in this otherwise well-known association of racial stress to risk taking (Pascoe & Smart Richman, 2009; Williams & Mohammed, 2009; Williams, 2019). As discrimination is a chronic lifetime stressor that has direct associations with substance use and other risky behavior (Williams et al., 2019; Brondolo et al. 2015; Gibbons et al. 2014; Grasser and Jovanovic, 2022), this study sought to address a need for advanced neurophysiological understanding of the immediate stress effects of a racial stigma event.

Overall, as will be described in detail below, results from this study not only validate the RSCT as an appropriate index of an objective index of neural response to racial stigma events, but they also provided insights into the myriads of factors that could modulate responding to racial stigma stress. Understanding the immediate effects of racial stigma stress is critical to understanding how cognitive and affective processing is modulated in a way that leaves individuals more susceptible to risky behavior. Further, along with insights for how African Americans perceive and experience racial stress, the study results pave the way for more neuroscientific work studying these relationships, where very few experimental paradigms with this population and these relationships existed before (Grasser and Jovanovic, 2022; Choy et al., 2022). Findings from this study further support that the RSCT does indeed facilitate event-related designs to assess stigma-related change in brain systems regarding cue reactivity, executive function, and reward processing, showing in an objective way that key cognitive affective systems are modulated by racial stigma events (Risco, Butler, et al., 2025). To address such a literature gap, while providing a foundation for future insights, are incredibly advancing in the field of health disparities research, and one step closer to understanding the disparate

patterns of substance use and disproportionate consequences encountered by African American communities vulnerable to racial stigma.

Modulation During the Racial Stigma, Cue-Focused Task

Increasers

Results in this study showed that a large portion of our participants showed a decrease in the earlier P3 ERP window, and an increase in the later LPP window over the course of viewing the discriminatory images, from Block 1 to Block 3. As the P3 is involved in top-down, early perceptual processing and stimulus evaluation (Hajcak et al., 2010; Kok, 1997), our results suggest that as discriminatory picture viewing went on, this group had a reduced P3, indicative of reduced cognitive processing. The diminished P3 combined with the later increased LPP, reflective of facilitated attention to emotional stimuli and deeper processing related to the evaluation of emotional meaning (Hajcak et al., 2010; MacNamara et al., 2009; Paul et al., 2013), suggests that Increasers had more difficulty in functioning of executive control and self-regulatory capacity, with increased motivated attention to the highly arousing cues. The P3 is related to early processing and executive function, while the LPP is related to emotional reactivity, thus disruptions in these components are indicative of stigma-related change– or, more apt, disruptions for Increasers– in the emotional processing of the discriminatory imagery. As the incredibly intense and evocative discriminatory stimuli continued, the Increasers showed a disruption in emotion regulation, as the P3 and LPP both index(Lewis et al., 2007; Paul et al., 2013).

Findings of a disrupted self-regulatory capacity, emotional stimuli processing, and emotion regulation in the immediate context of a racial stigma event are in line with previous

work that has shown perceived experiences of discrimination can increase affective reactivity and diminish self-regulatory capacity (Brondolo et al., 2017; Bühringer et al., 2008; Clark et al., 1999; Major et al., 2002; Rodriguez-Seijas et al., 2015; Wilcox et al., 2014). Affective modulations of the LPP is normative (Bernat, Cadwallader, et al., 2011; Cuthbert et al., 2000; Schupp et al., 2000), and as a marker of motivated attention, increased LPP activity is seen as emotion directing attention to the stimuli and guiding processing (Bradley et al., 2003). In this context, the RSCT successfully indexed modulations in affective reactivity in the immediate aftermath of a racial stigma event, and in the case of the Increasers, how viewing this discriminatory imagery amplified their emotional response and diminished their endogenous cognitive function. This provides an insight into exactly how regulatory capacity is disrupted after experiences of racial stigma, and how these experiences are associated with increased frequency of substance use. The results, along with the presented literature, suggest that for the Increasers, the discriminatory imagery evoked an affective state where their own voluntary attentional allocation was reduced, and their involuntary emotionally salient response was strengthened.

Interpreting the current findings in the context of the theoretical frameworks for discriminatory stress and responding/coping suggests that Increasers may have a more maladaptive response to experiences of racial stress (Clark et al., 1999). That cognitive processing was diminished, and emotional reaction was heightened, in the context of the aforementioned theoretical frameworks for racial stress responding (e.g., RED-SM or MEES), the Increasers (meaning heightened LPP during the RSCT) appraised the racial stigma cues as more threatening, and their stress response was amplified (Wilkins-Clark et al., 2024; Pierce, 1974). The heightening of emotional reactivity and lessening of top-down processing could

imply, aligned with these frameworks, that the exposure to the racial stigma cues wore down the Increaser group's cognitive resources, and their subsequent responding was more emotionally intense and volitionally uncontrollable. These interpretations are sound when rooted in these specific frameworks, but our findings here prevent us from conclusively declaring the statements as so. Our findings alone do not provide enough evidence that this reactivity is maladaptive. Finding of increased emotional reaction and reduced P3 could be indicative of a sensory gating process that allowed for a different form of selective attention (L. A. Jones et al., 2016) to the emotionally-arousing discriminatory stimuli, which equated to a healthy/normative processing of the racial stigma cues. Future work must be down to more directly relate the cognitive-neuroscience methodology to these different frameworks to assess coping strategies, individual difference measures on several different factors (i.e. racial socialization messages, cultural beliefs, etc.) that the theories like REDCAST, RED-SM, PVEST, and such suggest lead to variable outcomes.

As the relationship between discriminatory stress and stress response strategy is mostly theorized, as opposed to objective neurophysiological context, our findings relate more nicely to the stigma-stress-substance use pathway, which accounts for direct cognitive and affective neural correlates. Findings for the Increasers suggests that in the face of racial stigma stress, Increasers had modulated self-regulatory responding, indexed by the lowered P3 and heightened LPP. In other words, they showed a heightened stress response and depleted self-regulation during the racial stigma cue viewing, and this is implied to leave them more vulnerable to substance use.

Decreasers

In considering the impact of racial stress on risk behavior, our findings provide evidence for the notion that physiological responses to discrimination and racial stigma are not uniform

across individuals, and the same singular stigma events that may amplify a particular stress response in some may reduce a response in others, as we saw with our sample of Increasers and Decreasers. In contrast with findings for Increasers, the group we deemed Decreasers showed an increase during the P3, and a decrease during the LPP. We interpret these findings to mean viewing the discriminatory imagery did not disrupt their emotion regulation capacity, and as they viewed more discriminatory images, the Decreasers were better able to exert cognitive control, and self-regulate. Findings of a decrease in the LPP, again an index of emotional significance, and an increase in the P3, reflective of top-down attentional allocation, are in line with a study conducted by Stock and colleagues (2018)(Stock et al., 2018). In this study, they found more experiences of racial stigma had a negative association with self-regulatory capacity and affective reactivity; while these findings were in the context of those with a strong sense of racial identity, that we find similar results show evidence of different regulatory strategies that people employ to engage with discriminatory stimuli. Decreasers in our sample were able to react to the stimuli more cognitively than affectively: their early perceptual processing increased, while their emotional reactivity decreased. Generally, both the P300 and LPP showed an increase to emotional stimuli (Bernat et al., 2011; Hajcak et al., 2010); that the P300 increased for this group but the LPP decreased suggests that the automatic processing of the emotional stimuli increased over the duration of viewing the discriminatory imagery, but the emotional significance of the stimuli was decreased.

Decreasers were better able to process and cognitively recognize the stimuli without having their attention controlled by their emotion/reducing emotional significance of the stimuli. The decreasers showed a down-regulation, damping response, where emotion regulation, attention, and stimuli evaluation and categorization processes are more deeply and intentionally

engaged, which is key when considering the fact that the LPP is generally resistant to habituation (Codispoti et al., 2006, 2007, 2016). That seeing so much discrimination imagery doesn't cause increased reaction as the cues continue suggests the mobilization of more efficient self-regulatory strategies. Theories like RECAST, MEES, or Clark's, among the others mentioned, would suggest that Decreasers may not have appraised the racial stigma event as intensely or as negatively as Increasers, or that they had some protective resources that allowed for an adaptive coping response to reduce emotional reactivity. Again, future work would have to be done to confirm this interpretation, as we would need more measures of contextual factors like protective factors or other moderating effects. In the context of the stigma-stress-substance use pathway, they may have been able to still regulate their responding, and the experience of racial stigma stress did not evoke such as intense a level of unpredictability and uncontrollability in their cognitive processing and evaluation of it. Overall, these findings suggest that decreasers are screening the stimuli effectively and more intently early, and this earlier processing thus allows them to modulate and not attribute such motivational and intrinsic emotional significance to the stimuli; they are not automatically processed as targets but instead processed in a more intentional way.

Overall Findings

Neurophysiological response to racial stress, as shown by the findings during our RSCT in this study, are determined by cognitive and affective responses. Different people, within the same racial and ethnic community, can perceive and respond to the same stigmatizing events in different ways. For one group, experiences of racial stigma intensified their reactivity, and for another, they were able to down-regulate and mitigate these intense reactions, while both groups appeared to show the same post-exposure strategies/appraisal in affective responding to non-

stigma related negatively valenced imagery. Our findings of Increasers and decreasers showing opposite responses highlight the fact that how one appraises and responds to racial stigma cues is a critical area of research, and next steps should be taken based on these findings to examine exactly what influences these factors. The current findings also replicate that there was post-task response to negatively valenced stimuli, though interestingly in a different direction than previously seen, and further showed that this response is broadly similar across both groups. These findings lay groundwork for exploring the way in which the immediate appraisal of racial stigma events might influence attentional allocation and emotional processing, which has implications for later risky behavior and substance use (Pascoe & Smart Richman, 2009; Williams & Mohammed, 2009; Williams et al., 2019).

Our findings provide further evidence for this cue-based, racial stigma task's utility indexing stress responses to singular stigma events in a well-controlled, laboratory environment with objective EEG/ERP measures, specifically with P3 and LPP measures that are known as markers of emotional stimuli processing, emotional significance, and attentional allocation. Using objective neuroscience measures, this evidence of significant effects both during and post-exposure sheds new light on the impact of racial stigma exposure on cognitive and affective processing in African American emerging adults.

Post-Exposure Changes in Processing

Our findings replicate earlier work (Risco, Butler et al., 2025) revealing significant modulations in pre-post task effects and serves as further validation of the RSCT in its validity and utility of understanding modulations of cognitive and affective processing driven by racial stigma stress. Pre-post changes in affective responding, particularly to Unpleasant cues, as well as changes in responses to gambling feedback, indexing reward sensitivity, are in line with

conclusions drawn by Derks and Scheppers (2018)— they propose that the cumulative effects of racial stigma may not simply intensify reactivity to future experiences of racial stigma, but it may additionally potentiate reactivity to other non-stigma related life stressors (Derks & Scheepers, 2018). In this way, this type of validation and knowledge is vital to using cognitive mechanisms to explain the link between racial discrimination and risk behavior.

In the IAPS picture-viewing, we saw a pattern similar to what we found for the RSCT: there was increased reactivity in the earlier P3 and then reduced LPP, and these findings were strongest to unpleasant stimuli. The previous findings did show modulations of reactivity to UP stimuli, but these effects were in the opposite direction, such that in the current study there were post-exposure decreases in LPP amplitude, whereas previous results showed post-exposure increases in LPP to UP stimuli. Not only did we find different effects here in the attempted replication, but we also newly found that the effects held across both groups (Increasers and Decreasers that showed significantly different effects during the RSCT showed the same effects relative to one another in this IAPS viewing task). These findings suggest that after exposure to the distressing racial stigma cues, when presented with more stimuli to passively process, especially when seeing more negative images, participants across groups are showing an increased emphasis on processing and stimuli evaluation, and less emotional reactivity relative to before they underwent the RSCT. This finding is representative of enhanced vigilance and more attentiveness to processing stimuli, which can be interpreted as a self-regulatory/emotion regulation response. These findings are in line with previous research that suggests experiences of stigma, racism, and/or discrimination can lead to increased vigilance for African Americans in a number of areas of their daily life, even when this heightened vigilance contributes to the

numerous Black-White health inequalities and disparities (Clark et al., 2006; Hicken et al., 2013, 2018).

In the context of mechanisms underlying the link between discrimination and risk behavior, experiences of racial stigma stress exhaust cognitive resources for African Americans, and their stress response of vigilance can be a long-term deterrent to positive health outcomes and non-risky behavior. In our study, their experience of viewing the discriminatory images served as a catalyst for processing affective stimuli afterwards, emphasizing the stimuli appraisal and evaluating what it is, then having a subsequently reduced emotional component. African Americans must contend with discrimination and racism chronically throughout their lives (Williams, 2019; Acevedo et al., 2019; Grasser and Jovanovic), and this leads to stress activation and places the body in a constant state of arousal (Clark et al., 1999, 2006; Hicken et al., 2013, 2018). Overall, these frameworks of Clark, Spencer (2006) and Hicken suggest the potentiality that in the subjective mind of African Americans that are chronically exposed to discrimination, the heightened vigilance is a chance to alleviate the exhausting burden of its effects. In truth, this proves to be deleterious to their health and ultimately increases their allostatic load and deterioration of resources. In the context of our findings, the discriminatory stigma-cue viewing casted this burden onto them, and they responded with attempts to mitigate any chance that other, non-stigma related stimuli had on furthering their negative experiences, even at their own expense and compromising of their cognitive and emotional filtering (Spencer et al., 2003). The experiences of racial stigma led to an attempt at reappraisal and exerting cognitive control, and this temporary heightened vigilance response may deplete them of their cognitive control resources (Major et al., 2013). There were some group differences, but largely the same strategy is being utilized for those that saw heightened emotional responding as those who saw a

decrease, and we take this to mean that the experience of racial stigma experienced during the RSCT helped shape the neurophysiological processes associated with heightened stress reactivity and attenuated recovery from stress, inferring heightened vulnerability to substance use.

Our findings of reductions in delta activity to gain trials, as well as increases in theta activity to gain trials replicate our earlier work (Risco, Butler, et al. 2025) and suggests a shift away from positive reward processing and an increase in processing loss. As delta activity is generally associated with reward positivity during gambling feedback tasks (Foti et al., 2015; Bernat et al., 2011; Bernat et al., 2015; (Proudfit, 2015), and theta with loss (Cavanaugh and Frank, 2014; Nelson et al., 2011; Bernat et al., 2011; Bernat et al., 2015), our findings of post-exposure changes align with interpretations of African Americans having dulled reward feedback processing and heightened salience of positive outcomes. Bernat and colleagues found theta to be indicative of salience and orienting, so as participants become less reactive to gain feedback, and the same gain feedback became more salient and attentively capturing in a way that wasn't differed from pre-exposure. These findings are in line with very recent research that suggests exposure to discriminatory stereotypes can modulate brain response to reward incentives (Welborn et al., 2020). Among a Mexican American sample and using fMRI, Welborn and colleagues found that reward processing can be modulated in the event of a racial stressor. In a task measuring reward sensitivity, finding post-racial stigma stress exposure changes in reward processing is key in providing objective neuroscientific frameworks to the link between discrimination and risk behavior. Reward cues became more salient, and collectively, results suggest a bias towards salience and orienting (increased vigilance aligning with processing of IAPS cues) and less Reward Positivity post-exposure to racial stigma cues.

Interestingly, our findings in the go/no-go task were less conclusive. The go/no-go task is meant to index inhibition and cognitive control (Hirose et al., 2012; Garavan et al., 1999; Konishi et al., 1999; Liddle et al., 2001; Menon et al., 2001), yet we did not find that activity during the task related to reactivity to the stigma cues, both between and across group. Our previous work (Risco, Butler et al., 2025) similarly did not find significant pre-post differences, and given the link between discrimination and cognitive control (Brondolo et al., 2017), future work must be done to examine the context of this specific go/no-go task in the context of experiences of racial stigma to ensure it is being assessed properly within this specific area of research.

Overall, our findings of significant post-exposure change in affective and reward responding, indexed by activity in the IAPS and Gambling tasks, serve as further validation of not only the RSCT to measure these core cognitive affective processes in the immediate context of racial stigma stress, but also highlight the need for more research that continues to explore these same underlying neural mechanisms. The research methodologies employed and results from this work are novel and not yet produced in the field of neuroscientific research (Allen et al., 2019; Potter et al. 2019), thus in studying health disparities and the serious deleterious outcomes experienced by African Americans as a result of the chronic burden of racism and discrimination, studies like this one represent first-of-its-kind research, and emphasize the critical next steps of progress for underrepresented and disenfranchised communities. These findings show that racial stress permeates through to areas and responses that are completely unrelated to race and discrimination, and for something that reaches into almost every facet of daily life for African Americans (Williams et al., 2019), this knowledge is provides a much

deeper insight into more precise manners in which behaviors, responses, and both cognitive and physiological responses are modulated.

Substance Cue Reactivity

Though we found significant effects during the RSCT, as well as significant pre-post effects to measure post-exposure change in cognitive and affective processing in the context of a racial stigma event, significant results did not emerge regarding the extension to substance cue reactivity. As results revealed significant effects for the larger pre-post task protocol, and the substantial drug cue literature that examines substance cue reactivity, it is possible that characteristics of our sample (non-users) impacted our findings. As we had a sample of largely non-users, it is possible that there existed an issue with sampling, rather than finding conclusive findings on racial discrimination and substance use being unrelated.

Perhaps even more interesting than our null finding is the fact that our sample featured only 2 people in the entirety of the 76 participants collected for the substance cue extension (or SU) with self-reported tobacco use, and only one individual's data was used in final analyses (one of the two was a part of the 8 participants' data excluded for various reasons outlined in **Methods**). In terms of alcohol, 52 participants reported at least some lifetime alcohol usage, and only 7 people positively endorsed at least one problem related to alcohol use. In terms of illicit substances, 30 people reported at least one experience using illicit substances, with only 2 individuals reporting problematic use. Our sample contained mostly non-smokers and individuals that do not report problems or negative consequences with substance use or alcohol use. Though this was not necessarily the goal outright for recruitment, we expected a larger sample of causal substance users. Given that substance use in college is normative in the United States (American Addiction Center, 2024), with one study finding that half of almost 1000

students they studied met criteria for a substance use disorder in college (Caldeira et al., 2009), we simply expected to have a wider range of using participants, as opposed to a majority of people that don't use.

The SU extension of the study ended up largely containing participants that were psychology students required to participate in an experiment for course credit. Although we recruited more broadly to other student organizations on campus, when trying to collect participants from a population as culturally and socially diverse as the African American community, we may have had a problematic sampling bias that overrepresented college students, which is well-known for issues in scientific research (Peterson & Merunka, 2014; Visser et al., 2000), and the fact that there were a substantial number of psychology students has been seen to add to the representation problem in addition (Worthy et al., 2025).

Importantly, substance use is still one of the most widespread health problems on college campuses today, despite tobacco use slightly declining, nicotine product use is surging (American Addiction Center, 2024b; (Loukas et al., 2015). In our specific sample, we may have come across a substantial number of well-functioning, responsible and non-representative college students that did not necessarily reflect the population who would have any differential adverse effects to seeing substance cue stimuli, as it is less pertinent to their daily lives. Our finding of significant increases from pre to post for tobacco cues could be contextualized in the fact that as of recently, college students do not wish to be associated with tobacco and cigarette use due to them being more aware of the health risks relative to past decades, as well as the social image and negative perception risks attached to college-aged tobacco use (Brown et al., 2011; Do et al., 2020). As opposed to this finding indexing vulnerability to substance use, finding increased tobacco reactivity could be indicative of the simple viewing of it as a negative

cue that they have come to fear and dislike more so for both health and social reasons than related to racial stigma stress, and perceiving it is as such (a negative fear cue) along with the other negative cues they viewed during the course of the experimental session. Further, this interpretation potentially explains why there were not significant effects for alcohol or marijuana cues, as these are more socially acceptable substances for college students (Duckworth et al., 2024).

Overall, there is utility in the substance cue extension that investigates directly this relationship to discriminatory stress. Future work should address the substance cue extension. College students still represent rich diversity of experience and lifestyle among African American students (St. John et al., 2005), supporting that this is still an effective demographic and age range to explore effects in. To effectively capture an audience for the substance cue extension, steps must be taken to ensure a wide range of participants are included in final analyses to sufficiently capture the desired population characteristics. While the other tasks in this paradigm and multitask protocol still provide insights to core cognitive and affective processes related to substance use (executive function, racial stress, emotion regulation, etc.), future work should confirm that our findings of a lack of a pattern in substance cue reactivity is not due to an issue with the RSCT, but instead illustrative of a sampling issue. Substance use is still rampant in colleges across the country, discrimination is pervasive in our society, and the task effectively indexed numerous other changes in other brain systems. Thus, our findings for the substance cue results may be related to sampling bias, and future work should address that.

Limitations and Future Directions

As stated, one limitation of the study is our sampling regarding the SU extension. As college student samples can present some bias in psychological research (Worthy et al., 2025),

future work could be more restrictive in its recruitment when trying to assess for substance cue reactivity in relation to the racial stigma stress indexed here. For example, this work could be proposed in more clinical populations where exclusionary criteria are a diagnosis of a substance use disorder. Otherwise, different self-report measures could be used to measure and examine the level of use of prospective participants, with hopes of guaranteeing a representative sample of substance users.

As this study found significant effects of racial stigma stress in terms of immediate reactivity as well as modulations of core neurophysiological processes, future work should leverage these findings and investigate moderators of these effects. For example, future work could explore how mental health helps explain these associations. Measures of internalizing and externalizing, or measures of racial identity, could be explored in the context of this relationship to assess how these amplify or mitigate effects of racial stigma stress (Rodriguez-Seijas, et al., 2015; Stock et al., 2018). Overall, this future work could explore any risk or protective factors that might help explain why we had one group of Increasers, and another group of decreasers, to assess how, whether related directly to racial stigma or not, different sociocultural variables might intersect with an individual's response to racial discrimination and subsequently influence substance use (Derks & Scheepers, 2018; Gibbons et al., 2020; Gray & Montgomery, 2012; Volpe et al., 2019). Incorporating more individual difference variables will help isolate relevant processes and key confounds that may help explain the findings in this paper even more precisely. The findings here are significant and, with a gap in this health disparities research still existing, provide a natural springboard for future exploration.

Further, given the literature that explores the relationship between racial stigma stress and risky behavior, future work should study whether those that have their emotional reactivity

amplified and top-down processing reduced, akin to the Increasers in the current study, would be more directly susceptible to risky behavior/substance use. Experiencing discriminatory stigma events weakens both their top-down attentional and emotional volition, suggesting they might more readily engage in substance use (Pascoe & Smart Richman, 2009; Williams & Mohammed, 2009; Williams et al., 2019; Brondolo et al. 2015; Gibbons et al. 2014).

Finally, a promising area of future research might focus on parsing apart differential impacts of specific sources of racial stress. It is at this point agreed upon that multiple forms of racism exist (Braveman et al., 2022; Kleinpenning & Hagendoorn, 1993; *Types of Racism*, 2023): for example, interpersonal, institutional, structural, and internalized racism. Our discriminatory task featured a range of discriminatory and stereotypical imagery that covered all these different forms of racism; however, future work could explore (possibly at the trial-level (Butler et al., 2024)) if certain types produced larger or smaller effects relative to other types of racism. This work could explore if participants are uniquely reactive to cue types that depict specific forms of racism, which would provide more insights into individual regulatory strategies, would consider potential cultural differences, and give deeper insights in exactly what to target when trying to more deeply address racial stress in a productive and constructive way.

Conclusion

There are deep fissures and divides in our nation at the very moment in regards to racism and discrimination; the widespread societal and public health problems of racial stigma are constantly being brought to the forefront (Nadeem, 2021). The problems associated with discrimination are vast, prevalent, and pervasive; as Grasser and Jovanovic (2022) put it, experiencing racism is a chronic and uncontrollable life stressor that can occur invariably, unexpectedly, and leave impacts that significantly and functionally impair an African

American's life outcome socially, physiologically, and psychologically. Problems of acknowledgement, exclusion, and understanding involved mechanisms for a developmentally critical group such as young adult African Americans in particular is a severe misstep in terms of lessening the disparities faced at the structural, institutional, individual, and interpersonal levels. At the individual and community-wide level, discrimination presents disruptions. When these structural inequalities contribute to stress, disease, and overall worsened life outcomes, a research gap such as this one must be addressed, lest we continue to loop into the cycle that perpetuates these same disparities.

In conclusion, this study found that individuals differentially appraised and responded to experiences of racial stigma, highlighting individual differences in reactions to racial stress. Regardless of the strategy adopted during viewing of discriminatory imagery, affective and regulatory responding was modulated after exposure to this singular racial stigma event. Though these associations have long been theorized in the literature, our study provides objective neuroscientific work that indexes these processes and gives insight into neural mechanisms that underlie the associations. This work has implications for understanding processes that facilitate the continuance of the strong associations between racial stigma and substance use for African Americans. When dealing with a stressor such as discrimination, one that exists throughout an individual's lifetime and not only gets perceived and experienced uniquely, but also presented in such a myriad of ways, it cannot be overstated how much research opportunities are available to study and how necessary and vital the research is to more deeply understanding its impacts both directly and indirectly for stigmatized individuals. While there is substantial evidence of the association between experiences of discrimination and several problem outcomes, our studies provide a solid foundational base that addresses a gap in this literature that can then be built upon

to assess key processes driving the relationship and provide future targets for addressing these health disparities.

Bibliography

Acevedo, A., Panas, L., Garnick, D., Acevedo-Garcia, D., Miles, J., Ritter, G., & Campbell, K. (2018). Disparities in the Treatment of Substance Use Disorders: Does Where You Live Matter? *The Journal of Behavioral Health Services & Research*, *45*(4), 533–549. https://doi.org/10.1007/s11414-018-9586-y

Adams, J., Faux, S. F., Nestor, P. G., Shenton, M., Marcy, B., Smith, S., & McCarley, R. W. (1993). ERP abnormalities during semantic processing in schizophrenia. *Schizophrenia Research*, *10*(3), 247–257.

Advances in Addiction & Recovery—Archive. (2021). The Association for Addiction Professionals. https://www.naadac.org/AAR-archive

Alcohol and Drug Abuse Statistics (Facts About Addiction). (2024a). American Addiction Centers. https://americanaddictioncenters.org/rehab-guide/addiction-statistics-demographics

Allen, A. M., Thomas, M. D., Michaels, E. K., Reeves, A. N., Okoye, U., Price, M. M., Hasson, R. E., Syme, S. L., & Chae, D. H. (2019). Racial discrimination, educational attainment, and biological dysregulation among midlife African American women. *Psychoneuroendocrinology*, *99*, 225–235. https://doi.org/10.1016/j.psyneuen.2018.09.001

Alsebaa, F., & Akbar, H. (2023). Health Disparities in the Diagnosis and Treatment of Substance Use Among Racial and Ethnic Minority Older Adults. *The American Journal of Geriatric Psychiatry*, *31*(3, Supplement), S41–S42. https://doi.org/10.1016/j.jagp.2022.12.198

Anderson, R. E., & Stevenson, H. C. (2019). RECASTing racial stress and trauma: Theorizing the healing potential of racial socialization in families. *American Psychologist*, *74*(1), 63–75. https://doi.org/10.1037/amp0000392

Arnett, J. J. (1994). Are college students adults? Their conceptions of the transition to adulthood. *Journal of Adult Development*, *1*(4), 213–224. https://doi.org/10.1007/BF02277582

Arnett, J. J. (1998). Learning to Stand Alone: The Contemporary American Transition to Adulthood in Cultural and Historical Context. *Human Development*, *41*(5–6), 295–315. https://doi.org/10.1159/000022591

Baker, T. B., Japuntich, S. J., Hogle, J. M., McCarthy, D. E., & Curtin, J. J. (2006). Pharmacologic and Behavioral Withdrawal From Addictive Drugs. *Current Directions in Psychological Science*, *15*(5), 232–236. https://doi.org/10.1111/j.1467-8721.2006.00442.x

Barry, R. J. (2009). Evoked activity and EEG phase resetting in the genesis of auditory Go/NoGo ERPs. *Biological Psychology*, *80*(3), 292–299. https://doi.org/10.1016/j.biopsycho.2008.10.009

Bernat, E. M., Cadwallader, M., Seo, D., Vizueta, N., & Patrick, C. J. (2011). Effects of Instructed Emotion Regulation on Valence, Arousal, and Attentional Measures of Affective Processing. *Developmental Neuropsychology*, *36*(4), 493–518. https://doi.org/10.1080/87565641.2010.549881

Bernat, E. M., Ellis, J. S., Bachman, M. D., & Hicks, B. M. (2020). P3 Amplitude Reductions are Associated with Shared Variance Between Internalizing and Externalizing Psychopathology. *Psychophysiology*, *57*(7), e13618. https://doi.org/10.1111/psyp.13618

Bernat, E. M., Nelson, L. D., & Baskin-Sommers, A. R. (2015). Time-frequency theta and delta measures index separable components of feedback processing in a gambling task. *Psychophysiology*, *52*(5), 626–637. https://doi.org/10.1111/psyp.12390

Bernat, E. M., Nelson, L. D., Steele, V. R., Gehring, W. J., & Patrick, C. J. (2011). Externalizing psychopathology and gain-loss feedback in a simulated gambling task: Dissociable components of brain response revealed by time-frequency analysis. *Journal of Abnormal Psychology*, *120*(2), 352–364. https://doi.org/10.1037/a0022124

Bernat, E. M., Williams, W. J., & Gehring, W. J. (2005). Decomposing ERP time–frequency energy using PCA. *Clinical Neurophysiology*, *116*(6), 1314–1334. https://doi.org/10.1016/j.clinph.2005.01.019

Borrell, L. N., Kiefe, C. I., Williams, D. R., Diez-Roux, A. V., & Gordon-Larsen, P. (2006). Self-reported health, perceived racial discrimination, and skin color in African Americans in the CARDIA study. *Social Science & Medicine*, *63*(6), 1415–1427. https://doi.org/10.1016/j.socscimed.2006.04.008

Bradley, M. M., Sabatinelli, D., Lang, P. J., Fitzsimmons, J. R., King, W., & Desai, P. (2003). Activation of the visual cortex in motivated attention. *Behavioral Neuroscience*, *117*(2), 369–380. https://doi.org/10.1037/0735-7044.117.2.369

Braveman, P. A., Arkin, E., Proctor, D., Kauh, T., & Holm, N. (2022). Systemic And Structural Racism: Definitions, Examples, Health Damages, And Approaches To Dismantling. *Health Affairs (Project Hope)*, *41*(2), 171–178. https://doi.org/10.1377/hlthaff.2021.01394

Brome, D. R., Owens, M. D., Allen, K., & Vevaina, T. (2000). An Examination of Spirituality among African American Women in Recovery from Substance Abuse. *Journal of Black Psychology*, *26*(4), 470–486. https://doi.org/10.1177/0095798400026004008

Brondolo, E., Blair, I. V., & Kaur, A. (2017). Biopsychosocial Mechanisms Linking Discrimination to Health: A Focus on Social Cognition. In B. Major, J. F. Dovidio, & B.

G. Link (Eds.), *The Oxford Handbook of Stigma, Discrimination, and Health* (1st ed., pp. 219–240). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780190243470.013.8

Brondolo, E., Monge, A., Agosta, J., Tobin, J. N., Cassells, A., Stanton, C., & Schwartz, J. (2015). Perceived ethnic discrimination and cigarette smoking: Examining the moderating effects of race/ethnicity and gender in a sample of Black and Latino urban adults. *Journal of Behavioral Medicine*, *38*(4), 689–700. https://doi.org/10.1007/s10865-015-9645-2

Brown, A. E., Carpenter, M. J., & Sutfin, E. L. (2011). Occasional Smoking in College: Who, What, When and Why? *Addictive Behaviors*, *36*(12), 1199–1204. https://doi.org/10.1016/j.addbeh.2011.07.024

Bühringer, G., Wittchen, H.-U., Gottlebe, K., Kufeld, C., & Goschke, T. (2008). Why people change? The role of cognitive-control processes in the onset and cessation of substance abuse disorders. *International Journal of Methods in Psychiatric Research*, *17*(S1), S4–S15. https://doi.org/10.1002/mpr.246

Buka, S. L. (2002). Disparities in health status and substance use: Ethnicity and socioeconomic factors. *Public Health Reports*, *117*(Suppl 1), S118–S125.

Butler, D., Risco C, Nahabedian S, Valenca M, Bernat E. *Time-frequency measures index associations between reactivity to racial stigma cue images and perceptions of lived experiences of discrimination.* Program No. PSTR418.15. 2024 Neuroscience Meeting Planner. Chicago IL: Society for Neuroscience, 2024. Online.

C. Pierce. (1974). The mundane extreme environment and its effect on learning. *National Institute of Education*, *Learning disabilities: Issues and recommendations for research*, 110–119.

Cadinu, M., Maass, A., Rosabianca, A., & Kiesner, J. (2005). Why Do Women Underperform Under Stereotype Threat?: Evidence for the Role of Negative Thinking. *Psychological Science*, *16*(7), 572–578. https://doi.org/10.1111/j.0956-7976.2005.01577.x

Caldeira, K. M., Kasperski, S. J., Sharma, E., Vincent, K. B., O'Grady, K. E., Wish, E. D., & Arria, A. M. (2009). College students rarely seek help despite serious substance use problems. *Journal of Substance Abuse Treatment*, *37*(4), 368–378. https://doi.org/10.1016/j.jsat.2009.04.005

Cano, M. E., Class, Q. A., & Polich, J. (2009). Affective valence, stimulus attributes, and P300: Color vs. black/white and normal vs. scrambled images. *International Journal of Psychophysiology*, *71*(1), 17–24. https://doi.org/10.1016/j.ijpsycho.2008.07.016

Carroll, G. (1998). Mundane Extreme Environmental Stress and African American Families: A Case for Recognizing Different Realities. *Journal of Comparative Family Studies*, *29*(2), 271–284. https://doi.org/10.3138/jcfs.29.2.271

Cavanagh, J. F., & Frank, M. J. (2014). Frontal theta as a mechanism for cognitive control. *Trends in Cognitive Sciences*, *18*(8), 414–421. https://doi.org/10.1016/j.tics.2014.04.012

Cavanagh, J. F., Frank, M. J., Klein, T. J., & Allen, J. J. B. (2010). Frontal theta links prediction errors to behavioral adaptation in reinforcement learning. *NeuroImage*, *49*(4), 3198–3209. https://doi.org/10.1016/j.neuroimage.2009.11.080

Cavanagh, J. F., Zambrano-Vazquez, L., & Allen, J. J. B. (2012). Theta lingua franca: A common mid-frontal substrate for action monitoring processes. *Psychophysiology*, *49*(2), 220–238. https://doi.org/10.1111/j.1469-8986.2011.01293.x

CDC. (2024, August 14). *Substance Use and Work*. Substance Use and Work. https://www.cdc.gov/niosh/substance-use/about/index.html

Chen, H., Sun, S., Li, J., Yu, R., Li, N., Li, X., & Hu, B. (2023). Personal-Zscore: Eliminating Individual Difference for EEG-Based Cross-Subject Emotion Recognition. *IEEE Transactions on Affective Computing*, *14*(3), 2077–2088. IEEE Transactions on Affective Computing. https://doi.org/10.1109/TAFFC.2021.3137857

Choy, T., Baker, E., & Stavropoulos, K. (2022). Systemic Racism in EEG Research: Considerations and Potential Solutions. *Affective Science*, *3*(1), 14–20. https://doi.org/10.1007/s42761-021-00050-0

Clark, R. (2004). Interethnic group and intraethnic group racism: Perceptions and coping in Black university students. *Journal of Black Psychology*, *30*(4), 506–526. https://doi.org/10.1177/0095798404268286

Clark, R., Anderson, N. B., Clark, V. R., & Williams, D. R. (1999). Racism as a Stressor for African Americans. *American Psychologist*.

Clark, R., Benkert, R. A., & Flack, J. M. (2006). Large Arterial Elasticity Varies as a Function of Gender and Racism-Related Vigilance in Black Youth. *Journal of Adolescent Health*, *39*(4), 562–569. https://doi.org/10.1016/j.jadohealth.2006.02.012

Codispoti, M., De Cesarei, A., Biondi, S., & Ferrari, V. (2016). The fate of unattended stimuli and emotional habituation: Behavioral interference and cortical changes. *Cognitive,*

Affective, & Behavioral Neuroscience, *16*(6), 1063–1073. https://doi.org/10.3758/s13415-016-0453-0

Codispoti, M., Ferrari, V., & Bradley, M. M. (2006). Repetitive picture processing: Autonomic and cortical correlates. *Brain Research*, *1068*(1), 213–220. https://doi.org/10.1016/j.brainres.2005.11.009

Codispoti, M., Ferrari, V., & Bradley, M. M. (2007). Repetition and Event-related Potentials: Distinguishing Early and Late Processes in Affective Picture Perception. *Journal of Cognitive Neuroscience*, *19*(4), 577–586. Journal of Cognitive Neuroscience. https://doi.org/10.1162/jocn.2007.19.4.577

Cohen, M. X., Elger, C. E., & Ranganath, C. (2007). Reward Expectation Modulates Feedback-Related Negativity and EEG Spectra. *NeuroImage*, *35*(2), 968–978. https://doi.org/10.1016/j.neuroimage.2006.11.056

Cooper, M. L., Frone, M. R., Russell, M., & Mudar, P. (1995). Drinking to regulate positive and negative emotions: A motivational model of alcohol use. *Journal of Personality and Social Psychology*, *69*(5), 990–1005. https://doi.org/10.1037//0022-3514.69.5.990

Cox, L. S., Tiffany, S. T., & Christen, A. G. (2001). Evaluation of the brief questionnaire of smoking urges (QSU-brief) in laboratory and clinical settings. *Nicotine & Tobacco Research: Official Journal of the Society for Research on Nicotine and Tobacco*, *3*(1), 7–16. https://doi.org/10.1080/14622200020032051

Cox, W. M., & Klinger, E. (1988). A motivational model of alcohol use. *Journal of Abnormal Psychology*, *97*(2), 168–180. https://doi.org/10.1037//0021-843x.97.2.168

Crowley, M. J., van Noordt, S. J. R., Wu, J., Hommer, R. E., South, M., Fearon, R. M. P., & Mayes, L. C. (2014). Reward feedback processing in children and adolescents: Medial

frontal theta oscillations. *Brain and Cognition*, *89*, 79–89. https://doi.org/10.1016/j.bandc.2013.11.011

Cuthbert, B. N. (2015). Research Domain Criteria: Toward future psychiatric nosologies. *Dialogues in Clinical Neuroscience*, *17*(1), 89–97. https://doi.org/10.31887/DCNS.2015.17.1/bcuthbert

Cuthbert, B. N., Schupp, H. T., Bradley, M. M., Birbaumer, N., & Lang, P. J. (2000). Brain potentials in affective picture processing: Covariation with autonomic arousal and affective report. *Biological Psychology*, *52*(2), 95–111. https://doi.org/10.1016/S0301-0511(99)00044-7

Davison, A. C., & Hinkley, D. V. (1997). *Bootstrap Methods and their Application*. Cambridge University Press.

Delorme, A., & Makeig, S. (2004). EEGLAB: An open source toolbox for analysis of single-trial EEG dynamics including independent component analysis. *Journal of Neuroscience Methods*, *134*(1), 9–21. https://doi.org/10.1016/j.jneumeth.2003.10.009

Denise, E. J. (2012). Multiple Forms of Perceived Discrimination and Health among Adolescents and Young Adults. *Journal of Health and Social Behavior*, *53*(2), 199–214. https://doi.org/10.1177/0022146512444289

Dennis, T. A., & Hajcak, G. (2009). The late positive potential: A neurophysiological marker for emotion regulation in children. *Journal of Child Psychology and Psychiatry*, *50*(11), 1373–1383. https://doi.org/10.1111/j.1469-7610.2009.02168.x

Derks, B., & Scheepers, D. (2018). Neural and Cardiovascular Pathways from Stigma to Suboptimal Health. In B. Major, J. F. Dovidio, & B. G. Link (Eds.), *The Oxford*

Handbook of Stigma, Discrimination, and Health (p. 0). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780190243470.013.9

Do, E. K., Fallavollita, W. L., Bonat, B., Fugate-Laus, K., Rossi, B. C., & Fuemmeler, B. F. (2020). Student Attitudes Toward Tobacco Use and Tobacco Policies on College Campuses. *Journal of Community Health*, *45*(4), 751–760. https://doi.org/10.1007/s10900-020-00790-3

Donchin, E. (1981). Surprise!… Surprise? *Psychophysiology*, *18*(5), 493–513. https://doi.org/10.1111/j.1469-8986.1981.tb01815.x

Duckworth, J. C., Abdallah, D. A., Gilson, M. S., & Lee, C. M. (2024). Alcohol and marijuana use, consequences, and perceived descriptive norms: Differences between two- and four-year college students. *Journal of American College Health*, *72*(3), 889–896. https://doi.org/10.1080/07448481.2022.2060043

Eroğlu, G., & and Arman, F. (2023). K-Means clustering by using the calculated Z-scores from QEEG data of children with dyslexia. *Applied Neuropsychology: Child*, *12*(3), 214–220. https://doi.org/10.1080/21622965.2022.2074298

Feng, C., Li, W., Tian, T., Luo, Y., Gu, R., Zhou, C., & Luo, Y.-J. (2014). Arousal modulates valence effects on both early and late stages of affective picture processing in a passive viewing task. *Social Neuroscience*, *9*(4), 364–377. https://doi.org/10.1080/17470919.2014.896827

Foti, D., & Hajcak, G. (2008). Deconstructing Reappraisal: Descriptions Preceding Arousing Pictures Modulate the Subsequent Neural Response. *Journal of Cognitive Neuroscience*, *20*(6), 977–988. https://doi.org/10.1162/jocn.2008.20066

Foti, D., Hajcak, G., & Dien, J. (2009). Differentiating neural responses to emotional pictures: Evidence from temporal-spatial PCA. *Psychophysiology*, *46*(3), 521–530. https://doi.org/10.1111/j.1469-8986.2009.00796.x

Foti, D., Weinberg, A., Bernat, E. M., & Proudfit, G. H. (2015). Anterior cingulate activity to monetary loss and basal ganglia activity to monetary gain uniquely contribute to the feedback negativity. *Clinical Neurophysiology*, *126*(7), 1338–1347. https://doi.org/10.1016/j.clinph.2014.08.025

Garavan, H., Ross, T. J., & Stein, E. A. (1999). Right hemispheric dominance of inhibitory control: An event-related functional MRI study. *Proceedings of the National Academy of Sciences*, *96*(14), 8301–8306. https://doi.org/10.1073/pnas.96.14.8301

Gehring, W. J., & Willoughby, A. R. (2002). The Medial Frontal Cortex and the Rapid Processing of Monetary Gains and Losses. *Science*, *295*(5563), 2279–2282. https://doi.org/10.1126/science.1066893

Gerrard, M., Stock, M. L., Roberts, M. E., Gibbons, F. X., O'Hara, R. E., Weng, C.-Y., & Wills, T. A. (2012). Coping with Racial Discrimination: The Role of Substance Use. *Psychology of Addictive Behaviors : Journal of the Society of Psychologists in Addictive Behaviors*, *26*(3), 550–560. https://doi.org/10.1037/a0027711

Gibbons, F. X., Fleischli, M. E., Gerrard, M., Simons, R. L., Weng, C.-Y., & Gibson, L. P. (2020). The impact of early racial discrimination on illegal behavior, arrest, and incarceration among African Americans. *American Psychologist*, *75*(7), 952–968. https://doi.org/10.1037/amp0000533

Gibbons, F. X., Kingsbury, J. H., Weng, C.-Y., Gerrard, M., Cutrona, C., Wills, T. A., & Stock, M. (2014). Effects of Perceived Racial Discrimination on Health Status and Health

Behavior: A Differential Mediation Hypothesis. *Health Psychology : Official Journal of the Division of Health Psychology, American Psychological Association*, *33*(1), 11–19. https://doi.org/10.1037/a0033857

Gibbons, F. X., & Stock, M. L. (2017). Perceived Racial Discrimination and Health Behavior: Mediation and Moderation. In B. Major, J. F. Dovidio, & B. G. Link (Eds.), *The Oxford Handbook of Stigma, Discrimination, and Health* (1st ed., pp. 355–378). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780190243470.013.17

Gibbons, F. X., Yeh, H.-C., Gerrard, M., Cleveland, M. J., Cutrona, C., Simons, R. L., & Brody, G. H. (2007). Early experience with racial discrimination and conduct disorder as predictors of subsequent drug use: A critical period hypothesis. *Drug and Alcohol Dependence*, *88*, S27–S37. https://doi.org/10.1016/j.drugalcdep.2006.12.015

Gilmore, C. S., Malone, S. M., Bernat, E. M., & Iacono, W. G. (2010). Relationship between the P3 Event-Related Potential, Its Associated Time-Frequency Components, and Externalizing Psychopathology. *Psychophysiology*, *47*(1), 123–132. https://doi.org/10.1111/j.1469-8986.2009.00876.x

Grasser, L. R., & Jovanovic, T. (2022). Neural Impacts of Stigma, Racism, and Discrimination. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*, *7*(12), 1225–1234. https://doi.org/10.1016/j.bpsc.2022.06.012

Gratton, G. (1998). Dealing with artifacts: The EOG contamination of the event-related brain potential. *Behavior Research Methods, Instruments, & Computers*, *30*(1), 44–53. https://doi.org/10.3758/BF03209415

Gray, C. M. K., & Montgomery, M. J. (2012). Links between alcohol and other drug problems and maltreatment among adolescent girls: Perceived discrimination, ethnic identity, and

ethnic orientation as moderators. *Child Abuse & Neglect*, *36*(5), 449–460. https://doi.org/10.1016/j.chiabu.2012.03.002

Greeley, J., & Oei, T. (1999). Alcohol and tension reduction. In *Psychological theories of drinking and alcoholism, 2nd ed* (pp. 14–53). The Guilford Press.

Guidi, J., Lucente, M., Sonino, N., & Fava, G. A. (2021). Allostatic Load and Its Impact on Health: A Systematic Review. *Psychotherapy and Psychosomatics*, *90*(1), 11–27. https://doi.org/10.1159/000510696

Haeny, A. M., Holmes, S. C., & Williams, M. T. (2021). The Need for Shared Nomenclature on Racism and Related Terminology in Psychology. *Perspectives on Psychological Science : A Journal of the Association for Psychological Science*, *16*(5), 886. https://doi.org/10.1177/17456916211000760

Hajcak, G., & Foti, D. (2020). Significance?... Significance! Empirical, methodological, and theoretical connections between the late positive potential and P300 as neural responses to stimulus significance: An integrative review. *Psychophysiology*, *57*(7), e13570. https://doi.org/10.1111/psyp.13570

Hajcak, G., MacNamara, A., & Olvet, D. M. (2010). Event-Related Potentials, Emotion, and Emotion Regulation: An Integrative Review. *Developmental Neuropsychology*, *35*(2), 129–155. https://doi.org/10.1080/87565640903526504

Harper, J., Malone, S. M., Bachman, M. D., & Bernat, E. M. (2016). Stimulus sequence context differentially modulates inhibition-related theta and delta band activity in a go/no-go task. *Psychophysiology*, *53*(5), 712–722. https://doi.org/10.1111/psyp.12604

Harper, J., Malone, S. M., & Bernat, E. M. (2014a). Theta and delta band activity explain N2 and P3 ERP component activity in a go/no-go task. *Clinical Neurophysiology: Official*

Journal of the International Federation of Clinical Neurophysiology, *125*(1), 124–132. https://doi.org/10.1016/j.clinph.2013.06.025

Harper, J., Malone, S. M., & Bernat, E. M. (2014b). Theta and delta band activity explain N2 and P3 ERP component activity in a go/no-go task. *Clinical Neurophysiology*, *125*(1), 124–132. https://doi.org/10.1016/j.clinph.2013.06.025

Harrison, N. R., & Chassy, P. (2019). Habitual use of cognitive reappraisal is associated with decreased amplitude of the late positive potential (LPP) elicited by threatening pictures. *Journal of Psychophysiology*, *33*(1), 22–31. https://doi.org/10.1027/0269-8803/a000202

Heatherton, T. F., Kozlowski, L. T., Frecker, R. C., & Fagerstrom, K.-O. (1991). The Fagerström Test for Nicotine Dependence: A revision of the Fagerstrom Tolerance Questionnaire. *British Journal of Addiction*, *86*(9), 1119–1127. https://doi.org/10.1111/j.1360-0443.1991.tb01879.x

Hicken, M. T., Lee, H., Ailshire, J., Burgard, S. A., & Williams, D. R. (2013). "Every Shut Eye, Ain't Sleep": The Role of Racism-Related Vigilance in Racial/Ethnic Disparities in Sleep Difficulty. *Race and Social Problems*, *5*(2), 100–112. https://doi.org/10.1007/s12552-013-9095-9

Hicken, M. T., Lee, H., & Hing, A. K. (2018). The weight of racism: Vigilance and racial inequalities in weight-related measures. *Social Science & Medicine*, *199*, 157–166. https://doi.org/10.1016/j.socscimed.2017.03.058

Hirose, S., Chikazoe, J., Watanabe, T., Jimura, K., Kunimatsu, A., Abe, O., Ohtomo, K., Miyashita, Y., & Konishi, S. (2012). Efficiency of Go/No-Go Task Performance Implemented in the Left Hemisphere. *The Journal of Neuroscience*, *32*(26), 9059–9065. https://doi.org/10.1523/JNEUROSCI.0540-12.2012

Hofmann, W., Schmeichel, B. J., & Baddeley, A. D. (2012). Executive functions and self-regulation. *Trends in Cognitive Sciences*, *16*(3), 174–180. https://doi.org/10.1016/j.tics.2012.01.006

Inzlicht, M., McKay, L., & Aronson, J. (2006). Stigma as Ego Depletion: How Being the Target of Prejudice Affects Self-Control. *Psychological Science*, *17*(3), 262–269. https://doi.org/10.1111/j.1467-9280.2006.01695.x

Janssen, D. J. C., Poljac, E., & Bekkering, H. (2016). Binary sensitivity of theta activity for gain and loss when monitoring parametric prediction errors. *Social Cognitive and Affective Neuroscience*, *11*(8), 1280–1289. https://doi.org/10.1093/scan/nsw033

JOHNSON Jr., R. (1993). On the neural generators of the P300 component of the event-related potential. *Psychophysiology*, *30*(1), 90–97. https://doi.org/10.1111/j.1469-8986.1993.tb03208.x

Johnston, V. S., Miller, D. R., & Burleson, M. H. (1986). Multiple P3s to Emotional Stimuli and Their Theoretical Significance. *Psychophysiology*, *23*(6), 684–694. https://doi.org/10.1111/j.1469-8986.1986.tb00694.x

Jones, C. P. (2000). Levels of racism: A theoretic framework and a gardener's tale. *American Journal of Public Health*, *90*(8), 1212. https://doi.org/10.2105/ajph.90.8.1212

Jones, L. A., Hills, P. J., Dick, K. M., Jones, S. P., & Bright, P. (2016). Cognitive mechanisms associated with auditory sensory gating. *Brain and Cognition*, *102*, 33–45. https://doi.org/10.1016/j.bandc.2015.12.005

Kamarajan, C., Porjesz, B., Jones, K. A., Choi, K., Chorlian, D. B., Padmanabhapillai, A., Rangaswamy, M., Stimus, A. T., & Begleiter, H. (2004). The role of brain oscillations as functional correlates of cognitive systems: A study of frontal inhibitory control in

alcoholism. *International Journal of Psychophysiology*, *51*(2), 155–180. https://doi.org/10.1016/j.ijpsycho.2003.09.004

Kamarajan, C., Porjesz, B., Jones, K., Chorlian, D., Padmanabhapillai, A., Rangaswamy, M., Stimus, A., & Begleiter, H. (2006). Event-Related Oscillations in Offspring of Alcoholics: Neurocognitive Disinhibition as a Risk for Alcoholism. *Biological Psychiatry*, *59*(7), 625–634. https://doi.org/10.1016/j.biopsych.2005.08.017

Kanske, P., Schönfelder, S., & Wessa, M. (2013). Emotional modulation of the attentional blink and the relation to interpersonal reactivity. *Frontiers in Human Neuroscience*, *7*. https://doi.org/10.3389/fnhum.2013.00641

Kessler, R. C., Berglund, P., Demler, O., Jin, R., Merikangas, K. R., & Walters, E. E. (2005). Lifetime Prevalence and Age-of-Onset Distributions of DSM-IV Disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry*, *62*(6), 593–602. https://doi.org/10.1001/archpsyc.62.6.593

Kleinpenning, G., & Hagendoorn, L. (1993). Forms of Racism and the Cumulative Dimension of Ethnic Attitudes. *Social Psychology Quarterly*, *56*(1), 21–36. https://doi.org/10.2307/2786643

Kok, A. (1997). Event-related-potential (ERP) reflections of mental resources: A review and synthesis. *Biological Psychology*, *45*(1), 19–56. https://doi.org/10.1016/S0301-0511(96)05221-0

Konishi, S., Nakajima, K., Uchida, I., Kikyo, H., Kameyama, M., & Miyashita, Y. (1999). Common inhibitory mechanism in human inferior prefrontal cortex revealed by event-related functional MRI. *Brain: A Journal of Neurology*, *122 (Pt 5)*, 981–991. https://doi.org/10.1093/brain/122.5.981

Krendl, A. C., Heatherton, T. F., & Kensinger, E. A. (2009). Aging minds and twisting attitudes: An fMRI investigation of age differences in inhibiting prejudice. *Psychology and Aging*, *24*(3), 530–541. https://doi.org/10.1037/a0016065

Krendl, A. C., Kensinger, E. A., & Ambady, N. (2012). How does the brain regulate negative bias to stigma? *Social Cognitive and Affective Neuroscience*, *7*(6), 715–726. https://doi.org/10.1093/scan/nsr046

Krendl, A. C., Moran, J. M., & Ambady, N. (2013). Does context matter in evaluations of stigmatized individuals? An fMRI study. *Social Cognitive and Affective Neuroscience*, *8*(5), 602–608. https://doi.org/10.1093/scan/nss037

Landrine, H., & Klonoff, E. A. (2000). Racial segregation and cigarette smoking among blacks: Findings at the individual level. *Journal of Health Psychology*, *5*(2), 211–219. https://doi.org/10.1177/135910530000500211

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1997). Motivated attention: Affect, activation, and action. In *Attention and orienting: Sensory and motivational processes* (pp. 97–135). Lawrence Erlbaum Associates Publishers.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2005). *International affective picture system (IAPS): Affective ratings of pictures and instruction manual*. NIMH, Center for the Study of Emotion & Attention Gainesville, FL. https://scholar.google.com/scholar?cluster=2574082857464686576&hl=en&oi=scholarr

Lei, Y., Shah, V., Biely, C., Jackson, N., Dudovitz, R., Barnert, E., Hotez, E., Guerrero, A., Bui, A. L., Sastry, N., & Schickedanz, A. (2021). Discrimination and Subsequent Mental Health, Substance Use, and Well-being in Young Adults. *Pediatrics*, *148*(6), e2021051378. https://doi.org/10.1542/peds.2021-051378

Leonard, K. E., & Blane, H. T. (1986). *Psychological Theories of Drinking and Alcoholism* (H. T. Blane & K. E. L. PhD, Eds.). The Guilford Press.

Lewis, M. D., Todd, R. M., & Honsberger, M. J. M. (2007). Event-related potential measures of emotion regulation in early childhood. *NeuroReport*, *18*(1), 61. https://doi.org/10.1097/WNR.0b013e328010a216

Liddle, P. F., Kiehl, K. A., & Smith, A. M. (2001). Event-related fMRI study of response inhibition. *Human Brain Mapping*, *12*(2), 100–109. https://doi.org/10.1002/1097-0193(200102)12:2<100::aid-hbm1007>3.0.co;2-6

Littel, M., Euser, A. S., Munafò, M. R., & Franken, I. H. A. (2012). Electrophysiological indices of biased cognitive processing of substance-related cues: A meta-analysis. *Neuroscience & Biobehavioral Reviews*, *36*(8), 1803–1816. https://doi.org/10.1016/j.neubiorev.2012.05.001

Liu, Y., Nelson, L. D., Bernat, E. M., & Gehring, W. J. (2014). Perceptual properties of feedback stimuli influence the feedback-related negativity in the flanker gambling task. *Psychophysiology*, *51*(8), 782–788. https://doi.org/10.1111/psyp.12216

Loukas, A., Batanova, M., Fernandez, A., & Agarwal, D. (2015). Changes in use of cigarettes and non-cigarette alternative products among college students. *Addictive Behaviors*, *49*, 46–51. https://doi.org/10.1016/j.addbeh.2015.05.005

MacNamara, A., Foti, D., & Hajcak, G. (2009). Tell me about it: Neural activity elicited by emotional pictures and preceding descriptions. *Emotion*, *9*(4), 531–543. https://doi.org/10.1037/a0016251

Major, B., Mendes, W. B., & Dovidio, J. F. (2013). Intergroup relations and health disparities: A social psychological perspective. *Health Psychology: Official Journal of the Division of*

Health Psychology, American Psychological Association, *32*(5), 514–524. https://doi.org/10.1037/a0030358

Major, B., Quinton, W. J., & McCoy, S. K. (2002). Antecedents and consequences of attributions to discrimination: Theoretical and empirical advances. In *Advances in Experimental Social Psychology* (Vol. 34, pp. 251–330). Elsevier. https://doi.org/10.1016/S0065-2601(02)80007-7

Mays, V. M., Cochran, S. D., & Barnes, N. W. (2007). Race, Race-Based Discrimination, and Health Outcomes Among African Americans. *Annual Review of Psychology*, *58*(1), 201–225. https://doi.org/10.1146/annurev.psych.57.102904.190212

Menon, V., Adleman, N. E., White, C. D., Glover, G. H., & Reiss, A. L. (2001). Error-related brain activation during a Go/NoGo response inhibition task. *Human Brain Mapping*, *12*(3), 131–143. https://doi.org/10.1002/1097-0193(200103)12:3<131::AID-HBM1010>3.0.CO;2-C

Meynadasy, M. A., Brush, C. J., Sheffler, J., Mach, R., Carr, D., Kiosses, D., Hajcak, G., & Sachs-Ericsson, N. (2022). Emotion Regulation and the Late Positive Potential (LPP) in Older Adults. *International Journal of Psychophysiology : Official Journal of the International Organization of Psychophysiology*, *177*, 202–212. https://doi.org/10.1016/j.ijpsycho.2022.05.013

Muraven, M., & Baumeister, R. F. (2000). Self-regulation and depletion of limited resources: Does self-control resemble a muscle? *Psychological Bulletin*, *126*(2), 247–259. https://doi.org/10.1037/0033-2909.126.2.247

Nadeem, R. (2021, August 12). Deep Divisions in Americans' Views of Nation's Racial History – and How To Address It. *Pew Research Center*.

https://www.pewresearch.org/politics/2021/08/12/deep-divisions-in-americans-views-of-nations-racial-history-and-how-to-address-it/

NCDAS: Substance Abuse and Addiction Statistics [2023]. (2023). NCDAS. https://drugabusestatistics.org/

Nelson, L. D., Patrick, C. J., Collins, P., Lang, A. R., & Bernat, E. M. (2011). Alcohol impairs brain reactivity to explicit loss feedback. *Psychopharmacology*, *218*(2), 419–428. https://doi.org/10.1007/s00213-011-2323-3

Park, C. L. (2010). Making sense of the meaning literature: An integrative review of meaning making and its effects on adjustment to stressful life events. *Psychological Bulletin*, *136*(2), 257–301. https://doi.org/10.1037/a0018301

Parvaz, M. A., Moeller, S. J., & Goldstein, R. Z. (2016). Incubation of Cue-Induced Craving in Adults Addicted to Cocaine Measured by Electroencephalography. *JAMA Psychiatry*, *73*(11), 1127–1134. https://doi.org/10.1001/jamapsychiatry.2016.2181

Pascoe, E. A., & Richman, L. S. (2009). Perceived Discrimination and Health: A Meta-Analytic Review. *Psychological Bulletin*, *135*(4), 531–554. https://doi.org/10.1037/a0016059

Patel, S. H., & Azzam, P. N. (2005). Characterization of N200 and P300: Selected Studies of the Event-Related Potential. *International Journal of Medical Sciences*, *2*(4), 147–154.

Paul, S., Simon, D., Kniesche, R., Kathmann, N., & Endrass, T. (2013). Timing effects of antecedent- and response-focused emotion regulation strategies. *Biological Psychology*, *94*(1), 136–142. https://doi.org/10.1016/j.biopsycho.2013.05.019

Peterson, R. A., & Merunka, D. R. (2014). Convenience samples of college students and research reproducibility. *Journal of Business Research*, *67*(5), 1035–1041. https://doi.org/10.1016/j.jbusres.2013.08.010

Polich, J. (2007). Updating P300: An Integrative Theory of P3a and P3b. *Clinical Neurophysiology : Official Journal of the International Federation of Clinical Neurophysiology*, *118*(10), 2128–2148. https://doi.org/10.1016/j.clinph.2007.04.019

Polich, J. (2011). Neuropsychology of P300. In E. S. Kappenman & S. J. Luck (Eds.), *The Oxford Handbook of Event-Related Potential Components* (p. 0). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780195374148.013.0089

Polich, J., & Kok, A. (1995). Cognitive and biological determinants of P300: An integrative review. *Biological Psychology*, *41*(2), 103–146. https://doi.org/10.1016/0301-0511(95)05130-9

Potter, L. N., Brondolo, E., & Smyth, J. M. (2019). Biopsychosocial correlates of discrimination in daily life: A review. *Stigma and Health*, *4*(1), 38–61. https://doi.org/10.1037/sah0000120

Priest, N., Paradies, Y., Trenerry, B., Truong, M., Karlsen, S., & Kelly, Y. (2013). A systematic review of studies examining the relationship between reported racism and health and wellbeing for children and young people. *Social Science & Medicine*, *95*, 115–127. https://doi.org/10.1016/j.socscimed.2012.11.031

Proudfit, G. H. (2015). The reward positivity: From basic research on reward to a biomarker for depression. *Psychophysiology*, *52*(4), 449–459. https://doi.org/10.1111/psyp.12370

Racial/Ethnic Differences in Substance Use, Substance Use Disorders, and Substance Use Treatment Utilization Among People Aged 12 or Older (2015-2019) | CBHSQ Data. (2023). SAMHSA. https://www.samhsa.gov/data/report/racialethnic-differences-substance-use

Richard Lazarus & Susan Folkman. (1984). *Stress, Appraisal, and Coping*. Springer Publishing Company.

Risco, C. M., Butler, D., Fix, S., & Bernat, E. (2025). Development and validation of a novel cue-based paradigm for examining cognitive-affective reactivity to racial stigma.[Manuscript in preparation]. Department of Psychology, University of Maryland.

Risco, C. M., Butler, D., Fix, S., Vivino, A., Reece, T., Pease, M., Birgin, A., Quiroga, K., Reardon, N., Leininger A., Davis, K., & Bernat, E. (May, 2020). *Development and Validation of a Novel Cue-Based Paradigm for Examining Cognitive-Affective Reactivity to Racial Stigma.* Poster session presented at the annual meeting of the Association for Psychological Science (virtual poster session).

Risco, C. M., Butler, D., Rodriquez, K. N., Herrera, L. G., Fix, S., & Bernat, E. (2023, November). *Validation of a novel, cue-based task to index cognitive-affective reactivity to racial stigma among African American young adults: Implications for substance use outcomes* [Poster Abstract]. 2023 Society for Neuroscience, Washington, D.C., United States.

Roche, R. A. P., Garavan, H., Foxe, J. J., & O'Mara, S. M. (2005). Individual differences discriminate event-related potentials but not performance during response inhibition. *Experimental Brain Research*, *160*(1), 60–70. https://doi.org/10.1007/s00221-004-1985-z

Rodriguez-Seijas, C., Stohl, M., Hasin, D. S., & Eaton, N. R. (2015). Transdiagnostic Factors and Mediation of the Relationship Between Perceived Racial Discrimination and Mental Disorders. *JAMA Psychiatry*, *72*(7), 706. https://doi.org/10.1001/jamapsychiatry.2015.0148

Sanders-Phillips, K., Kliewer, W., Tirmazi, T., Nebbitt, V., Carter, T., & Key, H. (2014). Perceived Racial Discrimination, Drug Use, and Psychological Distress in African American Youth: A Pathway to Child Health Disparities. *Journal of Social Issues*, *70*(2), 279–297. https://doi.org/10.1111/josi.12060

Schupp, H. T., Cuthbert, B. N., Bradley, M. M., Cacioppo, J. T., Ito, T., & Lang, P. J. (2000). Affective picture processing: The late positive potential is modulated by motivational relevance. *Psychophysiology*, *37*(2), 257–261. https://doi.org/10.1111/1469-8986.3720257

Schupp, H. T., Flaisch, T., Stockburger, J., & Junghöfer, M. (2006). Emotion and attention: Event-related brain potential studies. In S. Anders, G. Ende, M. Junghofer, J. Kissler, & D. Wildgruber (Eds.), *Progress in Brain Research* (Vol. 156, pp. 31–51). Elsevier. https://doi.org/10.1016/S0079-6123(06)56002-9

Schupp, H. T., Junghöfer, M., Weike, A. I., & Hamm, A. O. (2004). The selective processing of briefly presented affective pictures: An ERP analysis. *Psychophysiology*, *41*(3), 441–449. https://doi.org/10.1111/j.1469-8986.2004.00174.x

Selzer, M. L. (1971). The Michigan alcoholism screening test: The quest for a new diagnostic instrument. *The American Journal of Psychiatry*, *127*(12), 1653–1658. https://doi.org/10.1176/ajp.127.12.1653

Selzer, M. L., Vinokur, A., & van Rooijen, L. (1975). A self-administered Short Michigan Alcoholism Screening Test (SMAST). *Journal of Studies on Alcohol*, *36*(1), 117–126. https://doi.org/10.15288/jsa.1975.36.117

Skinner, H. A. (1982). The drug abuse screening test. *Addictive Behaviors*, *7*(4), 363–371. https://doi.org/10.1016/0306-4603(82)90005-3

Skinner, H. A., & Goldberg, A. E. (1986). Evidence for a Drug Dependence Syndrome Among Narcotic Users. *British Journal of Addiction*, *81*(4), 479–484. https://doi.org/10.1111/j.1360-0443.1986.tb00359.x

Solomon, B., DeCicco, J. M., & Dennis, T. A. (2012). Emotional picture processing in children: An ERP study. *Developmental Cognitive Neuroscience*, *2*(1), 110–119. https://doi.org/10.1016/j.dcn.2011.04.002

Spencer, M. B. (2005). Crafting identities and accessing opportunities post-Brown. *American Psychologist*, *60*(8), 821–830. https://doi.org/10.1037/0003-066X.60.8.821

Spencer, M. B., Dupree, D., & Hartmann, T. (1997). A Phenomenological Variant of Ecological Systems Theory (PVEST): A self-organization perspective in context. *Development and Psychopathology*, *9*(4), 817–833. https://doi.org/10.1017/S0954579497001454

Spencer, M. B., Fegley, S. G., & Harpalani, V. (2003). A Theoretical and Empirical Examination of Identity as Coping: Linking Coping Resources to the Self Processes of African American Youth. In *Beyond the Self*. Routledge.

Spencer MB. (2006). Phenomenology and ecological systems theory: Development of diverse groups (Chapter 15). In *Handbook of child psychology. Theoretical models of human development.* (6th ed., Vol. 1, pp. 829–893). New York: Wiley.

St. John, E. P., Paulsen, M. B., & Carter, D. F. (2005). Diversity, College Costs, and Postsecondary Opportunity: An Examination of the Financial Nexus between College Choice and Persistence for African Americans and Whites. *The Journal of Higher Education*, *76*(5), 545–569.

Stock, M. L., Gibbons, F. X., & Beekman, J. B. (2016). Social exclusion and risky health decisions: Substance use cognitions and behaviors. In *Addictions: A social psychological perspective* (pp. 76–97). Routledge/Taylor & Francis Group.

Stock, M. L., Gibbons, F. X., Beekman, J. B., Williams, K. D., Richman, L. S., & Gerrard, M. (2018). Racial (vs. Self) affirmation as a protective mechanism against the effects of racial exclusion on negative affect and substance use vulnerability among black young adults. *Journal of Behavioral Medicine*, *41*(2), 195–207. https://doi.org/10.1007/s10865-017-9882-7

Substance Abuse Statistics for African Americans. (2024b). American Addiction Centers. https://americanaddictioncenters.org/rehab-guide/addiction-statistics-demographics/african-americans

Tiffany, S. T., & Drobes, D. J. (1991). The development and initial validation of a questionnaire on smoking urges. *British Journal of Addiction*, *86*(11), 1467–1476. https://doi.org/10.1111/j.1360-0443.1991.tb01732.x

Types of Racism: Internal, Interpersonal, Institutional, and Structural. (2023, March 1). YWCA Seattle | King | Snohomish. https://www.ywcaworks.org/blogs/ywca/types-racism

Vasilenko, S. A., Evans-Polce, R. J., & Lanza, S. T. (2017). Age trends in rates of substance use disorders across ages 18-90: Differences by gender and race/ethnicity. *Drug and Alcohol Dependence*, *180*, 260–264. https://doi.org/10.1016/j.drugalcdep.2017.08.027

Verissimo, A. D. O., & Grella, C. E. (2017). Influence of Gender and Race/Ethnicity on Perceived Barriers to Help-Seeking for Alcohol or Drug Problems. *Journal of Substance Abuse Treatment*, *75*, 54–61. https://doi.org/10.1016/j.jsat.2016.12.013

Visser, P. S., Krosnick, J. A., & Lavrakas, P. J. (2000). Survey research. In *Handbook of research methods in social and personality psychology* (pp. 223–252). Cambridge University Press.

Volpe, V. V., Lee, D. B., Hoggard, L. S., & Rahal, D. (2019). Racial Discrimination and Acute Physiological Responses Among Black Young Adults: The Role of Racial Identity. *Journal of Adolescent Health*, *64*(2), 179–185. https://doi.org/10.1016/j.jadohealth.2018.09.004

Watts, A. T. M., Bachman, M. D., & Bernat, E. M. (2017). Expectancy Effects in Feedback Processing are Explained Primarily by Time-frequency Delta not Theta. *Biological Psychology*, *129*, 242–252. https://doi.org/10.1016/j.biopsycho.2017.08.054

Watts, A. T. M., & Bernat, E. M. (2018). Effects of reward context on feedback processing as indexed by time-frequency analysis. *Psychophysiology*, *55*(9), e13195. https://doi.org/10.1111/psyp.13195

Watts, A. T. M., Tootell, A. V., Fix, S. T., Aviyente, S., & Bernat, E. M. (2018). Utilizing time-frequency amplitude and phase synchrony measure to assess feedback processing in a gambling task. *International Journal of Psychophysiology*, *132*, 203–212. https://doi.org/10.1016/j.ijpsycho.2018.04.013

Welborn, B. L., Hong, Y., & Ratner, K. G. (2020). Exposure to negative stereotypes influences representations of monetary incentives in the nucleus accumbens. *Social Cognitive and Affective Neuroscience*, *15*(3), 347–358. https://doi.org/10.1093/scan/nsaa041

Wilcox, C. E., Dekonenko, C. J., Mayer, A. R., Bogenschutz, M. P., & Turner, J. A. (2014). Cognitive control in alcohol use disorder: Deficits and clinical relevance. *Reviews in the Neurosciences*, *25*(1), 1–24. https://doi.org/10.1515/revneuro-2013-0054

Wilkins-Clark, R. E., Gray, C. N., & Ferraro, A. J. (2024). Development of the racial and ethnic discrimination stress model. *Journal of Family Theory & Review*, *16*(2), 374–391. https://doi.org/10.1111/jftr.12550

Williams, D. R. (2012). Miles to Go Before We Sleep: Racial Inequities in Health. *Journal of Health and Social Behavior*, *53*(3), 279–295. https://doi.org/10.1177/0022146512455804

Williams, D. R., Lawrence, J. A., Davis, B. A., & Vu, C. (2019). Understanding how discrimination can affect health. *Health Services Research*, *54*(S2), 1374–1388. https://doi.org/10.1111/1475-6773.13222

Williams, D. R., & Mohammed, S. A. (2009). Discrimination and racial disparities in health: Evidence and needed research. *Journal of Behavioral Medicine*, *32*(1), 20–47. https://doi.org/10.1007/s10865-008-9185-0

Wolfe, M. K., McDonald, N. C., & Holmes, G. M. (2020). Transportation Barriers to Health Care in the United States: Findings From the National Health Interview Survey, 1997–2017. *American Journal of Public Health*, *110*(6), 815–822. https://doi.org/10.2105/AJPH.2020.305579

Worthy, L. D., Lavigne, T., & Romero, F. (2025). *Sampling Bias*. https://open.maricopa.edu/culturepsychology/chapter/bias/

Yamanaka, K., & Yamamoto, Y. (2010). Single-trial EEG Power and Phase Dynamics Associated with Voluntary Response Inhibition. *Journal of Cognitive Neuroscience*, *22*(4), 714–727. https://doi.org/10.1162/jocn.2009.21258