KIER, ALEXA K. M.S. “Think about us”: Addressing racial biases in current EEG cap design. (2024)
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Background: Professionals in the health sciences strive to enhance health outcomes, however, the design of certain medical and scientific technologies, such as electroencephalography (EEG) systems, illustrates how racial disparities limit the generalizability of the research findings to Black and African American populations. Specifically, the design of EEG systems, often relying on a fitted cap and gel for strong brain signaling, fails to accommodate the various hair types and styles commonly found among Black and African American populations. Therefore, the purpose of this study was to (Aim 1) evaluate feasibility of using the current EEG cap for assessing acceptability, appropriateness, practicality, and implementation in Black student-athletes and (Aim 2) explore the feedback and suggestions from Black student-athletes to discuss current EEG measurements and refine recruitment strategies and data collection protocols for EEG in sport research. Black student-athletes (n = 34) were surveyed to gather demographics and hair style/type information. Additionally, survey questions related to EEG cap feasibility (e.g., acceptability, appropriateness, practicality, and implementation) were asked. Data analysis revealed that overall, Black student-athletes exhibited a tendency towards dissatisfaction with the current EEG cap design being acceptable (M = 2.62, SD= 1.03), particularly regarding issues such as gel application and the overall design's compatibility with various hair types. Perceptions regarding the practicality of implementation varied, with concerns about difficulty in cap placement (M = 2.76, SD = 1.03) and anticipated time spent on hair care post-usage (M = 4.09 hours, SD = 2.08). Additionally, while there was some willingness to participate in studies using the EEG cap design (n = 12, 35%), responses indicated a mixed attitude, with a significant portion expressing reluctance (n = 17, 50%) or

neutrality (*n* = 5, 15%) towards participation. Participants were invited to complete a follow-up focus group to further explore their feedback and suggestions. The focus group results (n = 2) revealed that participants wanted researchers to "think about them," expressed disheartenment at the continuous treatment, called for a more urgent approach to inclusivity, and requested greater transparency about EEG measurements for potential participants. Furthermore, the participants conveyed a mix of disappointment and resignation towards ongoing marginalization, emphasizing the necessity for transparency and honesty in research practices to demonstrate respect towards participants and address systemic biases effectively. Additionally, it revealed the urgent need for active consideration and inclusion of Black athletes in research processes and technology development, highlighting the importance of diversity and equitable access to foster inclusivity and scientific advancement. Participants In conclusion, this study highlights the critical need to address and dismantle the racial biases present in current EEG cap designs and methodologies.

“THINK ABOUT US”: ADDRESSING RACIAL BIASES IN CURRENT EEG CAP DESIGN

by

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Approved by

Dr. Eric S. Drollette
Committee Chair

DEDICATION

This thesis is dedicated to all those who have provided unwavering support for my endeavors in addressing and rectifying racial disparities. Above all, I dedicate this thesis to myself, my friends, family, and the Black community, resilient in confronting the systemic racial barriers and inequities deeply ingrained in our society.

APPROVAL PAGE

This thesis written by Alexa K. Kier has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

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CHAPTER I: INTRODUCTION

Health science research is highly valued and in demand in society due to its significance in providing crucial information and discoveries for improving healthcare as well as preventing and treating illnesses (Erosheva et al., 2020). Conversely, there is a concerning health disparity in both research and clinical settings due to systemic racism in the development and implementation of various research and medical instruments that have resulted in a deep-seated division in society. Health disparities or inequalities refer to the inequitable and preventable variations in health outcomes witnessed among different populations, social groups within a community, or across a spectrum based on social status within a population (McCartney et al., 2019). Specifically, the development and evolution of electroencephalography (EEG), has resulted in significant disparities in healthcare and treatment, particularly among Black or African Americans (Choy et al., 2022). Electroencephalography (EEG) is a non-invasive technique used to measure the brain's neural activity. By placing electrodes on the scalp, it's possible to record post-synaptic potentials generated by exchange of neurotransmitters between neurons. EEG captures the summation of groups of neurons with simultaneous changes in potential, offering valuable insights into brain function and activity (Soufineyestani et al., 2020). However, Black or African Americans have phenotypical thick hair that is maintained utilizing several protective hairstyles. Given that EEG depends on limited obstruction to the scalp, it is evident that common hair types and styles among Black or African Americans interfere with brain signal quality since EEG fails to accommodate for this specific phenotype (Etienne et al., 2020; Webb et al., 2022). Moreover, hair holds significant cultural and identity-based importance for many women of African descent as it challenges Eurocentric norms. Thus, requiring Black

participants to adhere to Eurocentric hair standards in order to facilitate EEG data collection can have negative cultural implications. In fact, this racial bias is especially concerning with the growing potential of research utilizing EEG to assess cognitive measurements in athletes (Fang et al., 2022; Wang et al., 2019). Despite the potential benefits of EEG understanding neural functioning, studies have consistently shown the lack of racial/ethnic demographic reporting. The premise that Black athletes are underrepresented in EEG, sport research and are less likely to undergo EEG testing remains conjecture. Importantly, this problem extends to clinical practice as Black athletes are at a predisposition to misdiagnoses, underdiagnoses, and the prescription of inappropriate treatments (Webb et al., 2022). This thesis aims to address this significant gap in current EEG research methodologies by focusing on inclusivity. Considering the intricate technicalities associated with EEG, such as the importance of electrode-scalp contact, this study investigates the impact of Black student-athletes hair on the feasibility, acceptability, and appropriateness of EEG research methodologies. In addition, this study is built upon a strong methodological foundation that integrates quantitative and qualitative research methods, facilitating a comprehensive and multifaceted examination of the research problem.

CHAPTER II: REVIEW OF LITERATURE

Recent advancements in neuroscience have revolutionized our understanding of brain function, yet these strides often rest upon a foundation of systemic racism that has marginalized Black communities. Systemic racism encompasses a range of laws, policies, and discriminatory beliefs that have long targeted individuals of color (Braveman et al., 2022). The term "anti-black racism" specifically denotes the discrimination faced by individuals of African descent (Rodríguez et al., 2021). Historically, scientific research in the United States has been tainted by racist ideologies, with pseudoscientific practices used to justify racial inequalities. This legacy of exploitation has left a lasting impact, contributing to the mistrust of scientific research within Black communities and perpetuating racial disparities. This chapter delves into the profound influence of anti-Black racism on research practices, the underrepresentation of Black researchers, funding disparities, and the pervasive racial biases in EEG research.

History of Anti-Black Racism in Research

In recent years, the field of neuroscience has seen remarkable advancements in methodologies and technologies, enabling a deeper understanding of complex research questions. However, these advancements have often been built upon structures of systemic racism, leading to adverse effects on marginalized communities (Ricard et al., 2023). Throughout the history of the United States, supporters of anti-Black racism and white supremacy have manipulated scientific authority to justify racial inequality. Pseudoscientific methods promoted the supposed biological superiority of white individuals that has left a lasting impact on present society. In the mid-19th century, the scientific community played a role in legitimizing society's racist ideologies. Scientists of the time contended that individuals of African descent were inherently

inferior, portraying them either as a degenerate form of human or as an entirely separate servant class (Jackson & Weidman, 2005). In the 1840s, some of the earliest cases of unethical research practices were recorded. During this time, Dr. James Marion Sims, a gynecologist, conducted experimental gynecological procedures and surgeries on young enslaved African American women. Shockingly, these procedures were administered without the use of anesthesia. Among the victims were three documented teenage girls, Anarcha, Betsy, and Lucy, who were enslaved and subjected repeatedly to these painful procedures after being purchased by Sims (Gamble, 1997). Furthermore, one of the most well-known examples contributing to the prevalent mistrust within the Black community is the Tuskegee syphilis study, spanning 40 years. This study exploited hundreds of Black men as test subjects without their consent, denying them autonomy and necessary treatment due to the racial bias that dehumanized them (Scharff et al., 2010). Regrettably, the Tuskegee syphilis study represents just one of numerous medical experiments that inflicted profound pain, harm, suffering, and even mortality on Black Americans, reflecting a deeply troubling history of systemic racism and medical exploitation. It is crucial to acknowledge the historical roots of anti-Black racism and its profound influence on research practices. Systemic racism encompasses a range of laws, policies, and discriminatory beliefs that have long targeted individuals of color (Braveman et al., 2022). The term "anti-black racism" specifically denotes the discrimination faced by individuals of African descent (Rodríguez et al., 2021). Tragically, there have been documented cases of Black individuals enduring heinous abuse and exploitation in research, resulting in significant harm and fatalities (Spigner, 2007). Early scientific experiments often aimed to justify the mistreatment and exclusion of Black populations (Kuria, 2014). Furthermore, a significant critique has been the heavy reliance on samples primarily drawn from western, educated, industrialized, rich, and democratic (WEIRD)

populations (Henrich et al., 2010). This pattern of exclusion is not limited to the past but is also prevalent in current neuroscience research, with Black, Indigenous, and other People of Color (BIPOC) individuals, as well as women, being underrepresented (Taffe & Gilpin, 2021). Black women, who face compounded marginalization due to the intersection of race and gender, are particularly underrepresented in neuroscience research (Choy et al., 2022; Kuria, 2014; Webb et al., 2022). This exclusion persists despite evidence suggesting that Black participants are indeed willing to engage in research (Manns-James & Neal-Barnett, 2019; Wendler et al., 2005). Furthermore, these historical and ongoing experiences continue to shape research practices, whether subtly, inadvertently, or overtly.

Lack of Black Researchers

The issue of racial disparities and systemic racism within the scientific community extends beyond the research subjects and into Black professionals. For example, the representation of Black and Brown researchers and engineers remains disproportionately low compared to their white counterparts. According to the National Science Foundation, a mere 8% of the science and engineering workforce comprises Black or African American individuals, while the vast majority, nearly two-thirds, is white. Moreover, in terms of doctoral degrees in science and engineering, only 7% are awarded to Black or African American individuals, while 70% go to white individuals (*National Science Foundation*, 2023). Understanding this is crucial, as greater representation among researchers could potentially mitigate some of the racial biases and disparities in research (Choy et al., 2022). The underrepresentation of Black researchers mirrors the lack of diversity within research teams, which hinders the cultivation of cultural humility, awareness, and anti-racist training among white researchers (Bhui et al., 2007; Lim et al., 2008). This lack of diversity perpetuates biases in research studies and contributes to the

creation of less inclusive or welcoming environments for marginalized participants, along with reduced efforts to recruit Black participants and address diversity and equity (Crooks et al., 2021; Gilpin & Taffe, 2021; Rai et al., 2022). As the first Black researcher in a leadership role at the Exercise & Neurocognitive Health Laboratory, I recognized an unsettling reality: a pervasive lack of cultural awareness resulting in racial biases within the lab. My journey was fueled not only by passion but by an urgent sense of frustration and activism, driving me to dismantle these biases and compel non-Black colleagues to confront their own color-blindness. This mission extends far beyond the confines of the ENH Lab; it permeates every room I enter, underscoring the imperative for accountability, dialogue, and actionable change in all spaces. Furthermore, increasing diversity among research teams utilizing EEG that perpetrates racial biases could lead to more practical improvements in the methodology, design, and participant experience. Hence, the lack of Black researchers is not the result of a lack of candidates, but the difficulties and vicious cycle of racial barriers when trying to establish a career.

Funding Disparities Among Black Researchers

Enduring racial disparities significantly affect multiple dimensions of academic science, presenting comprehensive challenges for Black researchers. These challenges manifest in various ways, including hindrances in career advancement and limitations in accessing research funding opportunities. Tackling disparities among participants necessitates addressing the underlying issues. In the realm of academic science, securing grant funding is pivotal for a researcher's success. Grant funding not only impacts research productivity, publication numbers, and prestige but also influences future grant opportunities (Taffe & Gilpin, 2021). The two primary federal funding agencies, the National Science Foundation (NSF) with a budget of $9.9 billion, and the National Institutes of Health (NIH) with a staggering $48 billion, reflect the significant financial

resources at play (*Grants & Funding*, 2022.; *National Science Foundation*, 2022). However, the distribution of research funding exposes racial inequities. NIH indicate a notable pattern indicating that African American/Black principal investigators (PIs) tend to focus primarily on research concerning minority health and associated disparities (Gilpin & Taffe, 2021). The National Institute on Minority Health and Health Disparities (NIMHD) receives around 15% of applications from Black/African American PIs, three times higher than any other institute at the NIH (Lauer et al., 2021). Despite this, there remains an overreliance on minority scientists to address scientific and historical barriers with limited resources and support (Ricard et al., 2023). Regrettably, the NIMHD receives one of the lowest funding rates of all the Institutes and centers at the NIH, receiving a mere 0.8% of the overall allocation (Gilpin & Taffe, 2021). In 2023, NIMHD enacted $525 million, whereas the highest-funded institutes such as the National Cancer Institute and National Institute on Aging enacted approximately $7.3 and $4.4 billion (NIH). Additionally, data on NIH grants indicates that White PIs are 1.7 times more likely to secure funding compared to African American/Black PIs, while the National Science Foundation (NSF) reports a 1.2 times higher funding rate for White PIs over African American/Black PIs. Moreover, data from the NSF spanning 1999 to 2019 illustrates that White PIs consistently receive funding rates 8.5% higher than the overall rate, whereas Asian, Black, and non-white PIs face funding rates consistently below the overall rate by 21.2%, 8.1%, and 11.3%, respectively (Chen et al., 2022). Similar disparities have been observed in other funding agencies such as the National Aeronautics and Space Administration (NASA) and the UK-based research philanthropy Wellcome Trust, where white applicants are 1.5 and 1.9 times more likely to receive funding compared to Black applicants (Espinosa et al., 2019; Wellcome, 2021). This confluence of factors creates a scenario where research topics proposed by Black scientists, as

well as health issues significantly impacting Black individuals in the United States, remain inadequately represented within the federal research grant portfolio. Collectively, the lack of Black researchers and funding disparities among Black researchers has negatively impacted the ability to bridge the racial biases in EEG research.

Racial Biases in EEG Research

The use of EEG, a popular technique for measuring brain activity, heavily relies on the adherence between electrodes and the scalp. Establishing a reliable electrical connection between individual electrodes and the participant's scalp is imperative for EEG devices. This connection is often facilitated through the use of a gel-based wet cap, where conductive gel is applied within the pocket of each electrode to ensure adequate contact. The effectiveness of the recorded EEG data is significantly influenced by the quality of this electrode-scalp connection. Gel-based sensors are commonly preferred due to their capacity for maintaining a stable and long-lasting connection. Notably, wet or gel-based sensors have demonstrated a heightened ability to sustain a consistent connection for extended periods, contributing to the reliability and longevity of EEG data recordings (Soufineyestani et al., 2020). The EEG signal amplitude operates within the microvolts range, making it susceptible to various forms of interference, known as "artifacts," which must be effectively filtered out to preserve the crucial neural processes essential for various applications. Algorithms are employed to eliminate non-brain-related artifacts. These may include artifacts stemming from eye movements, muscle movements, cardiac activity, body movements, AC electrical and electromagnetic interferences, as well as technical artifacts, all of which are commonly identified and removed through dedicated filtering techniques (Jiang et al., 2019).

However, significant obstacles, such as hair, can compromise data quality and lead to the exclusion of vital information. Unlike artifacts, hair cannot be filtered because of the lack of signal reception. For Black individuals with thick, coarse hair, braids, locs, twists, cornrows, or weaves, the design of the cap, resembling a swim cap, may not accommodate their hair. This bias is particularly critical due to the texture, density, and styling of Black hair, affecting electrode placement and reducing the signal-to-noise ratio (Webb et al., 2022). Consequently, the bias linked to hair in EEG creates a detrimental cycle of ongoing exclusion of Black participants, unintentional discarding of data, skewed research outcomes, and disparities in treatments and diagnoses for Black individuals based on EEG findings (Etienne et al., 2020). Another aspect perpetuating this cycle is the challenge faced by Black individuals in participating in EEG studies due to the conductive gel used. This gel is crucial for ensuring low impedance and an optimal signal-to-noise ratio, but it typically ends up in majority of the participants' hair, particularly problematic for African American or Black hair. The haircare regimen required to retain and manage such hair can take anywhere from 2 to 3 hours on average for standard maintenance and up to 4 to 8 hours for protective styles like braids or twists (Davis-Sivasothy, 2011; Keeks Reid, 2021). Understandably, the prospect of redoing their hair due to the EEG gel can be discouraging for many Black individuals.

Furthermore, hair is a powerful symbol of identity for many women of African descent. Recent studies show a growing trend among African American women to embrace their natural hair, moving away from chemical relaxers. Throughout U.S. history, Black hair has been deemed acceptable only when altered to fit long and straight standards, aligned with mainstream beauty ideals (Johnson & Bankhead, 2013). Current perspectives challenge these Eurocentric standards, with Black women rejecting the notion that their natural hair is problematic or unattractive.

Instead, there's a movement of celebration and acceptance of natural hair. This shift is accompanied by the adoption of protective styles, maintaining the hair's natural state while offering benefits such as reduced daily manipulation, protection, and time savings (Asbeck et al., 2022), especially as Black athletes are constantly busy. This cultural change reflects a broader acknowledgment of diverse beauty forms, challenging historical norms that marginalized natural Black hair. Collectively, this can be evident that the perspective Black student-athletes have on their hair holds significant emotional and symbolic value. Therefore, expecting Black participants to conform to Eurocentric hair standards for the ability to collect EEG data is culturally detrimental.

Although biases in EEG procedures may be unintentional, the "colorblind" approach adopted by many White researchers further marginalizes Black individuals. This approach directly affects EEG research results, as the inadequately diverse research samples restrict the generalizability of findings beyond the sample. Additionally, participants become conscious that their exclusion is linked to their hair, impacting their overall experience. Furthermore, it is essential to recognize that Black culture, particularly hair, differs significantly from White culture. The lack of cultural awareness or antiracist training in the context of EEG testing hampers researchers' ability to recognize and address the biases they inadvertently perpetuate (Penner et al., 2023). While the current EEG process does not necessitate any knowledge of hair, some researchers acknowledge the limitations in accommodating various hair types and styles commonly found among Black individuals. White researchers often lack an understanding of the diverse textures of African American or Black hair, the various protective hairstyles commonly worn by Black individuals, the underlying reasons for these styles that serve to safeguard their hair, and the concept of "shrinking," which occurs due to factors like humidity, gel, water, or

sweat coming into contact with their hair. Training initiatives should incorporate respectful and empathetic discussions with Black participants about their hair to facilitate data collection without causing discomfort (Louis et al., 2022). Additionally, researchers and institutions should aim at creating more diverse teams of students, staff, and faculty to promote diverse ideas and comfortable spaces for varying backgrounds. Unfortunately, the prevailing practices in health research tend to be biased, oppressive, and exclusionary, largely due to a lack of cultural awareness and sensitivity (Crooks et al., 2021; Penner et al., 2023; Rai et al., 2022). Furthermore, researchers acknowledge the presence of racial biases within EEG research as they pursue their scientific objectives, yet there has been little documented effort to address the issue. Nonetheless, the imperative for inclusive methodologies becomes even more pronounced when considering the adverse impact and underrepresentation of various marginalized groups within the Black community, including Black athletes, who may choose to abstain from participation if racial bias is recognized.

Underrepresentation and Absence of Reporting in EEG and Sport Research

The prevailing racial bias in EEG research has resulted in a significant gap in the theoretical application of findings to Black individuals. The lack of EEG data concerning Black participants may stem from their exclusion or the inadvertent discarding of their data. Regrettably, minoritized races and ethnicities remain notably underrepresented in the broader EEG literature. Undoubtedly, this can significantly reduce generalizability making the findings less applicable to Black populations (Penner et al., 2023). Generalizability is important because findings can be extended to a broader population. However, the continuous marginalization and underrepresentation of Black individuals in EEG research can lead to entirely false conclusions, health disparities, and negatively impacted quality of life (Brown et al., 2023). Penner and

colleagues (2023) conducted an evaluation of an ERP meta-analysis focusing on adult neural responses to infant and child faces, where only 21.6% (N = 165) out of 763 mothers were identified as Black or African American across 18 studies. Similarly, a search conducted by Choy and colleagues (2022) on EEG studies involving neurotypical adults and various minority populations found that out of 81 articles, only 5 reported the inclusion of Black participants. These findings underscore the existing disparities in the representation of minoritized races and ethnicities in EEG research. Further highlighting the issue, Goldfarb and Brown (2022) conducted a review of 536 articles on MRI and EEG studies, revealing that out of the total, only 20 MRI studies documented their lack of diversity, while none of the EEG studies reported race or ethnicity. This discrepancy becomes even more pronounced in the realm of sports research, as EEG gains popularity as a tool for measuring brain activity. Among 22 EEG studies related to sports-related concussions, only one study reported a sample composed entirely of white participants (Conley et al., 2018; Corbin-Berrigan et al., 2020). The lack of reporting and the scarcity of data regarding Black participants in sports research using EEG serve as yet another example of how certain sub-groups are affected by these implications. The failure to ensure study representativeness and report demographic data perpetuates the hidden racial bias within EEG research.

Racial Statistics in Professional and Collegiate Sports

The utilization of EEG in sports research is rapidly gaining traction, making it crucial to emphasize the need for inclusivity in this domain. To grasp the significance of diversity in EEG for sports research, it is essential to consider the racial composition of athletes across various levels, including youth, high school, collegiate, and professional sports. The statistical data serves as a reminder that the sports world is far from being exclusively white. According to the

2021-22 NCAA Demographic Database, the proportion of White student-athletes across all divisions stands at 62% (326,017), while Black student-athletes constitute 16% (83,305). Notably, in some of the most popular sports in the United States, such as football and basketball, the percentage of Black athletes is particularly high. In men's basketball, the NCAA reported 44% (8,428) Black athletes and 38% (7,223) White athletes across all divisions. Similarly, women's basketball comprises 30% (5,066) Black athletes and 50% (8,409) White athletes overall, with Division 1 women's basketball boasting a higher percentage of Black athletes. In football, the overall percentage comprises 40% (30,555) Black athletes and 44% (34,079) White athletes, with Division 1 football recording 48% (14,709) Black athletes and 36% (11,082) White athletes (*NCAA Demographics Database*, 2022.). Professional sports also reflect substantial diversity, with 71.8% of NBA players identified as Black or African American, alongside 17.4% who are White. The WNBA Racial Report Card highlights 70.3% Black athletes and 18.9% White athletes, while the NFL comprises 56.4% Black athletes and 24.9% White athletes (*Racial & Gender Report Card*, 2022). These statistics underscore the critical importance of adopting a culturally inclusive approach when investigating any neurocognitive outcomes in athletes using EEG. It is evident that a significant proportion of athletes in some of the most prominent sports are Black. Therefore, embracing diversity in research methodologies, including EEG, is paramount, as these statistics clearly demonstrate.

Usefulness of EEG in Sport Research

The field of EEG research still faces significant challenges in fostering inclusivity and effectively applying its theoretical insights to Black individuals. However, once EEG research becomes truly inclusive, it has the potential to emerge as a useful noninvasive tool for measuring brain function in athletes across diverse populations. Given its capacity to examine various

aspects of brain activity, EEG can substantially contribute to the realm of sports research. With its ability to assess different dimensions of cognitive profiles in athletes, EEG can aid in the evaluation of traumatic brain injuries, concussions, attentional processes, inhibitory function, motor-related processing, sleep patterns, emotional regulation, and mental states (Fang et al., 2022). By incorporating EEG, researchers can gain invaluable insights into the neural mechanisms underlying intensive training and the sports environment. As such, EEG stands poised to play a pivotal role in enhancing our understanding of the intricate interplay between brain function and athletic performance.

In conclusion, the history of anti-Black racism in research, coupled with the enduring disparities in funding, representation, and inclusion, underscores the critical need for a paradigm shift within the EEG research community. Overcoming racial biases and fostering inclusivity requires concerted efforts to acknowledge and address historical injustices, cultivate diverse research teams, and develop culturally sensitive methodologies. By embracing diversity, increasing representation, and prioritizing inclusivity, EEG research can fulfill its potential as a powerful tool for understanding brain function in athletes across diverse populations, ultimately contributing to more equitable and impactful outcomes in both neuroscience and sports research.

CHAPTER III: METHODOLOGY

Despite the limited research on the racial biases of EEG, existing literature primarily reflects the perspectives of researchers (Choy et al., 2022; Etienne et al., 2020; Louis et al., 2022; Penner et al., 2023; Webb et al., 2022). While many researchers acknowledge the limitations and biases associated with the current EEG cap design, there is a notable absence of studies investigating the feedback and suggestions of potential Black participants concerning EEG cap design, recruitment strategies, and data collection. Therefore, this study aimed to achieve 2 primary objectives through survey and focus group methods: (Aim I, Phase I) evaluate the key areas of focus for feasibility of conducting a study using the current EEG cap for Black student-athletes and (Aim II, Phase II) explore the feedback and suggestions from Black student-athletes to discuss current EEG measurements and refine recruitment strategies and data collection protocols for EEG in sports research. Thus, feasibility encompassed aspects of acceptability, appropriateness, practicality, and implementation. These parameters served as a critical lens to gauge the suitability of the current EEG cap design for subsequent testing, and allowed researchers to evaluate the potential of ideas and findings, assessing their adaptability and sustainability in relevance to the research objectives (Bowen et al., 2009). Lastly, using focus groups in conjunction with survey data yielded more comprehensive insights into the perceptions and motivations of a target audience, surpassing the capabilities of quantitative surveys alone (Acocella, 2012; Tolley et al., 2016). By adopting an exploratory approach, the outcomes of this study have the potential to underscore the necessity for the development of an inclusive EEG cap. This study has the potential to prompt changes in current EEG protocols among researchers

and emphasize the need to continue exploring the broader feedback and suggestions from the Black population regarding the current EEG measurement.

Participants and Procedure

A total of 34 Black athletes (M = 20.93) were recruited for this study from various universities through the distribution of flyers and announcements, following the guidelines of the Institutional Review Board at the University of North Carolina at Greensboro. Individuals who agreed to share data for research purposes provided their consent by agreeing to proceed using an online survey conducted via Qualtrics (Provo, UT). The study utilized purposeful sampling to identify participants best suited to address the research questions, selecting individuals with specific characteristics or experiences relevant to the study's focus (Patton, 2002). Inclusion criteria for the participants included being between the ages of 18-25, currently enrolled as a student-athlete at a university and identifying as Black or African American. Additionally, a smaller subset of participants from the larger pool had the opportunity to participate in the focus group, essential for delving deeper into their feedback and understanding. Using snowball sampling, two Black women student-athletes participated in the focus group. Both participants were Division I athletes, with Participant 1, Ophelia, playing women’s basketball and Participant 2, Charlotte, being a member of the women’s track and field team. This group facilitated the exploration of intricate thought processes and behaviors, leveraging group dynamics that stimulated in-depth discussions and idea generation as participants built upon each other's input (Krueger, 2014). Furthermore, the adaptability of focus group questions allowed for modifications aligned with evolving information needs, and with efficient coordination, execution, and analysis, the focus group was completed within a relatively short timeframe, barring any unexpected recruitment challenges (Tolley et al., 2016).

Using a mixed-methods approach encompassing qualitative and quantitative cross-sectional observational design, Black student-athletes engaged in an online survey administered via Qualtrics online survey software and disseminated through the athletic department. The survey encompassed several domains, including informed consent, demographic information, historical, current, and anticipated future hair types and styles, alongside the Bankhead-Johnson Hair Esteem Scale. Participants were then presented with comprehensive visuals, including images and a video detailing the components and procedures associated with the current EEG system. Subsequently, participants responded to a series of questions gauging the key areas of feasibility of the demonstrated EEG cap. Survey participants were eligible to enter their email for a $20 Amazon gift card upon completion. Participants were recruited to participate in a focus group. Prior to the focus group, participants reviewed the consent procedures through a hyperlink embedded within the email. During the focus group, the participants were asked to provide a brief overview of their current and preferred hairstyles. Ophelia indicated that she currently had locs and often styled them with extensions. In contrast, Charlotte mentioned that she was currently wearing a quick weave style but also alternates between her natural hair and braided styles. To ensure familiarity with the equipment, both participants were shown pictures and a video of the EEG cap, the same materials utilized in the survey. The instructional video detailed the process of using a syringe to apply gel into each electrode of the EEG cap. Supplementary images provided various perspectives of the EEG cap positioned on a Black mannequin, the syringe and gel used, and the appearance of the hair following the gel application into the electrodes. Participants received concise explanations regarding the functionality of the EEG cap. The focus group, conducted with a subset of 2 Black student-athletes, took place online and

lasted approximately 60 minutes. Participants in the focus group were compensated with $30 upon their completion of the session.

Measures

Demographic Measures

A questionnaire was distributed to the participants to assess demographics including sport, age, race/ethnicity, gender identity, religion, and sexual orientation. The purpose of assessing these demographics was to provide a wider range of intersectionality's of Black athletes that may contribute to their oppression and underrepresentation in research. Moreover, demographic outcomes were collected to control for participants that did not fit the inclusion criteria.

Hair Measures

In addition to demographic information, each participant completed Qualtrics questionnaires developed to assess hair type, past, present, and future hair styles, and hair self-esteem. For these measures, the participants' preferences for hairstyles were adapted from a previous study (Horace, 2022). The purpose of this questionnaire was to understand the commonalities of the hair types and styles that Black athletes choose to have in maintaining, protecting, and strengthening their hair. This measure was used to gain relevant knowledge of the sample and provide a foundation for more in-depth investigations for the development of an inclusive EEG cap. The choices for the questionnaire included: Natural (not chemically processed, usually worn curly or in a natural state), Straightened (chemically/relaxed), Straightened (heat), Bald, Fade, Afro, Wigs, Weaves, Braids or Twists (using synthetic hair), Braids or Twists (not using synthetic hair), Cornrows, Locs, and Other (please specify). Participants indicated how often (in percentages) they have worn their hair over the last 2 years

for each of the 12 styles, selected their current hair type and/or style they have on the day of completing the survey, and indicated (in percentages) the type or style they plan to wear over the next 2 years for each of the 12 styles.

Bankhead-Johnson hair esteem scale (Johnson & Bankhead, 2013)*:* The Bankhead-Johnson Hair- Esteem scale, consisting of 10 items and utilizing a 4-point Likert scale, measured positive feelings toward one's natural hair. Participants were provided responses, ranging from strongly agree (4) to strongly disagree (1), to statements like “On a whole, I am satisfied with my hair” and “I feel that my hair is beautiful as any other person’s.” Originally designed by Johnson and Bankhead (2013) for 529 Black women, the scale lacked sufficient psychometric information. To address this, the researcher piloted the scale and established a reliability of .84. Modeled after the Rosenberg Self-esteem scale (1965), the Hair-Esteem scale uses a similar scoring system. Respondents answered each of the 10 questions by choosing from options: Strongly Agree (= 4), Agree (= 3), Disagree (= 2), or Strongly Disagree (= 1). Notably, items 1, 3, 4, 7, and 10 are reverse-coded. The sum of the mean scores for all questions ranged from 0 to 30, with scores between 15 and 25 within the normal range. Scores below 15 indicated low hair esteem.

Current EEG Design Protocol

After completing the hair measures, participants were provided with a brief written introduction to EEG, facilitated by the use of artificial intelligence (AI) chatbot (i.e., ChatGPT) for a simplified and easily comprehensible explanation. This approach aimed to ensure quick and straightforward understanding that was unbiased by the LR, particularly for participants lacking prior knowledge of EEG. The LR inserted the query, "Can you provide an overview of EEG using a wet cap for readers without prior knowledge?" into ChatGPT to obtain an AI-generated

response, which was subsequently revised for biases by a professional in EEG (not the LR) and integrated into Qualtrics (see Appendix A). Subsequently, participants were presented with visual aids, including five different angled images of the EEG cap (front, back, left side, right side, and angled), one image of the fine tip syringe, one images of the gel, four images depicting the hair after cap removal with gel, and a short 12-second video illustrating the EEG cap setup procedure.

Current EEG Cap Design Feasibility Questionnaire

Participants completed the next questionnaire after viewing the information about the current EEG design prototype. Questions were developed to assess the key aspects of feasibility defined by Bowen and colleagues (2009) and Weiner and colleagues (2017). Weiner et al. (2017) developed The Acceptability of Intervention Measure (AIM) and Intervention Appropriateness Measure (IAM) based on Proctor et al.'s (2011) implementation outcomes framework, focusing on feasibility and its sub-categories of acceptability and appropriateness. Additional specific questions were developed to assess practicality and implementation identified by Bowen et al., (2009).

- Acceptability: Do the stakeholders' (Black student-athletes) find the current EEG cap design agreeable or acceptable?
- Appropriateness: How well does the current EEG cap design fit into the practice setting? How well does the Current EEG cap design address specific issues?
- Practicality: How do the efficiency, effectiveness, participant engagement, and cost implications influence implementing the current EEG cap design within existing means and resources?

- Implementation: To what extent can the current EEG cap design be successfully delivered to Black student-athletes?

Each item in the measure was rated on a scale including 1 ("strongly disagree") to 5 ("strongly agree"), 1 ("very difficult") to 5 ("very easy"), and 1 ("very unlikely") to ("very likely"). Additional numerical ratings included 0 days to 7 days and 0 hours to 10 hours, indicating the number of hours it would take to wash and redo their hair after wearing the EEG cap and the number of days participants are willing to come into a lab and wear the EEG cap. From the questionnaire, feasibility sub-areas of acceptability, appropriateness, practicality and implementation were calculated from specific questions. Each criterion (acceptability, appropriateness, practicality, and implementation) was determined by averaging scores obtained from the corresponding Likert scale for a comprehensive evaluation.

Focus Group

Participants (N=2) were asked to participate in an online focus group after the completion of the survey. The inclusion criteria for the focus group included Black student-athletes currently enrolled at a university. In preparation for the focus group discussion, a practiced facilitator familiarized the participants with the study's objectives and consent forms via a follow-up email. The LR, a Black female master's student from UNC-Greensboro, led the session, and an expert qualitative researcher assisted in the session by note-taking. The discussion was approximately 60 minutes and video and audio recorded. Participants names were protected using pseudonyms. The focus group questions were structured into five primary sections, addressing (a) EEG cap design, (b) Recruitment of Black athletes, (c) Data collection on Black athletes, and (d) feedback regarding the development of an inclusive EEG cap. See Appendix B for focus group questions.

Data Analysis

In the data analysis phase, descriptive statistics such as mean, median, mode, standard deviation, and range, were used to summarize the survey data. The key areas of focus for feasibility were determined if the average scores indicated agreement or strong agreement to the corresponding questions. The focus group session was video, and audio recorded and translated verbatim. Participants were allocated identification names for reporting purposes. To analyze the data with rigor, transparency, and trustworthiness, open axial coding, member checking, and researcher triangulation were employed.

Positionality Statement

In this study, I, as the lead researcher (LR), acknowledge the critical importance of understanding my positionality in shaping both the data collection and analysis processes. As a Black woman facing challenges related to EEG cap design due to my hair type and preferred protective styles, my personal experiences profoundly influence my approach to this research. These experiences have led me to be hesitant to participate in EEG studies utilizing gel, a common component in such research. Furthermore, drawing from my knowledge of signal-to-noise ratio and EEG signals, I have raised concerns regarding the feasibility of the current EEG cap design. To ensure the integrity of the research process, I implemented strategies aimed at bolstering the trustworthiness, quality, and credibility of the qualitative findings, as outlined by Patton (2014). One such strategy involved crafting this positionality statement, which serves as a tool for introspection, which allowed me to examine my personal assumptions and perspectives throughout the research process. My positionality statement articulates my lenses and influences, helping to contextualize my comprehension, interpretation, and acceptance of the research findings (Holmes, 2020). Additionally, to manage my biases and experiences and prevent them

from unduly influencing the data collection and analysis, I have adopted methodological triangulation. This approach involved integrating findings from surveys, focus groups, and existing literature to evaluate the narrative conveyed by the data. Furthermore, I have employed investigator triangulation by involving multiple analysts in the data analysis process. A secondary analyst assisted in reviewing transcript sections and debriefing focus group reflections, which allowed for cross-checking of our work and enhanced the rigor of the analysis (Adler, 2022). Through these measures, I was committed to upholding the integrity and validity of this mixed-methods research study.

CHAPTER IV: RESULTS

The presented chapter encompasses the findings from both the survey and the focus group sessions. Phase I details the quantitative data obtained from the survey, while Phase II provides a comprehensive analysis of the qualitative data derived from the focus group discussion.

Phase I

Demographics

Demographic information for all participants is presented in Table 1. Initially, 41 participants (n = 34 female; n = 6 male) began the survey. However, 34 participants (82.9% of the potential sample) who are currently enrolled Black student-athletes met the criteria and completed the entire online survey and were therefore included in the data analysis. Specifically, statistics based on the final sample (n = 34) are represented for all key areas of focus. The ages of participants ranged from 18 to 24 years, with an average age of 20 years (M = 20.93, SD = 1.67). A total of six different sports were represented, with the majority of Black student-athletes participating in basketball (58.5%).

Table 1. Demographics Information

	n	*%*
Race/Ethnicity		
Black/African American	37	90.2%
Not Black/African American	3	7.3%
Athlete Status		
Currently Enrolled Student-Athlete	40	97.6%
Gender		
Male	6	14.6%
Female	34	82.9%
Age		
18 - 20	19	46.4%
21 - 24	21	51.3%
Sexual Orientation		

Heterosexual/Straight	26	63.4%
Homosexual/Gay/Lesbian	11	26.8%
Bisexual	2	4.9%
Other	1	2.4%
Religion		
Catholic	3	7.3%
Christian	31	75.6%
No Religious Affiliation	6	14.6%
Grade		
Freshman	6	14.6%
Sophomore	6	14.6%
Junior	12	29.3%
Senior	9	22%
Fifth Year	4	9.8%
Graduate	3	7.3%
Sport		
Basketball	24	58.5%
Cross Country/Track and Field	2	4.9%
Football	5	12.3%
Soccer	1	2.4%
Softball	1	2.4%
Volleyball	7	17.1%

Black Student-Athletes Current Hair Style/Type

Participants reported their current hair type and style from the options listed in Appendix C. The majority indicated that their hair is in its natural state, defined as unprocessed and typically worn in its curly or natural form (n = 12, 29.3%). Notably, no participants reported using chemical straightening methods or being bald, while a small proportion (n = 1, 2.4%) reported straightening their hair with heat. Additionally, a significant portion of respondents reported wearing braids with synthetic hair (n = 10, 24.4%), with a smaller proportion choosing braids without synthetic additions (n = 2, 4.9%). The use of braids and locs (n = 9, 22%) emerged as the most common current styling choices. A smaller percentage of participants (n = 2, 4.9%) reported wearing styles such as fades, wigs, and cornrows. Minimal responses were observed for afros, weaves/sew-ins, and waves (see Table 2).

Table 2. Summary Statistics of Current Hair Styles and Types

	n	*%*
Natural	12	29.3%
Straightened (Chemically/Relaxed)	0	0%
Straightened (Heat)	1	2.4%
Bald	0	0%
Fade	2	4.9%
Afro	1	2.4%
Wig	2	4.9%
Weaves/Sew-In	1	2.4%
Braids (Using synthetic hair)	10	24.4%
Braids (Not using synthetic hair)	2	4.9%
Cornrows	2	4.9%
Locs	9	22%
Other: Waves	1	2.4%

Black Student-Athletes Past and Future Hair Styles/Types

The list of hair types and styles detailed in Appendix C was distributed uniformly among participants to record the percentages corresponding to their previous and anticipated future hair styles and types. In the past, the most prevalent style was wearing hair in its natural state (n = 20), followed closely by braids or twists with synthetic hair (n = 18). Straightened styles achieved through heat application were also common (n = 14). Other frequently reported styles included braids or twists without synthetic hair (n = 11), locs (n = 10), cornrows (n = 7), and afros (n = 6). Weave and chemically straightened styles each acquired lower frequencies (n = 5, n = 4 respondents). Fewer participants indicated fade (n = 4), wig (n = 3), and bald (n = 1) hair styles.

Anticipating future styling preferences, a parallel trend persisted, with the highest projected style being the continuation of natural hair styling (n = 21), followed by the sustained selection of braids or twists with synthetic hair (n = 21). Consistency is observed in the

prevalence of locs (n = 12), alongside a persistent interest in straightened heat styling (n = 11). The intention to pursue braids or twists without synthetic hair (n = 11) and weaves (n = 10) remained prominent. Notably, there was an increase towards wearing wigs (n = 7) in the future compared to the past. Other styles, fades, and chemically straightened hair exhibited relatively stable frequencies between past and future preferences.

Black Student-Athletes Hair-Esteem

Utilizing the Bankhead-Johnson Hair-Esteem Scale, the cumulative mean score for all questions (M = 26.24) indicated a high level of hair-esteem among participants. Detailed summary statistics for each question are presented in Table 3. Further analysis involved the categorization of five positively framed hair-esteem questions and the remaining five negatively framed questions, which were reverse-coded. The findings revealed that for questions associated with positive hair-esteem (M = 3.29, SD = 0.52), 52% of participants strongly agreed and 39% agreed. Conversely, regarding questions concerning negative hair-esteem (M = 1.92, SD = 0.50), 30% strongly disagreed and 49% disagreed (refer to Figures 1a and 1b).

Table 3. Summary Statistics for Bankhead Johnson Scale

	M	*SD*	*n*	Mode
On a whole, I am satisfied with my hair.	3.31	0.58	35	3
*At times I think my hair is no good at all.	2.24	0.65	34	2
I feel that my hair has a number of good qualities.	3.43	0.50	35	3
I am able to care for my hair as well as most other people.	3.09	0.82	35	3
*I feel I do not have much to be proud of about my hair.	1.59	0.56	34	2
*I certainly feel my hair is useless at times.	1.77	0.73	35	2
I feel that my hair is beautiful as any other person’s.	3.29	0.68	34	3

*I wish I could have more respect for my hair.	2.6	0.98	35	2
*All in all, I am inclined to feel that my hair has failed me.	1.6	0.60	35	2
I take a positive attitude toward my hair.	3.32	0.589	34	2

1 = Strongly Disagree 2 = Disagree 3 = Agree 4 = Strongly Disagree

Note: Reverse coded questions are indicated with *.

Figure 1a. Black Athletes Perception of Having Positive Self-Esteem

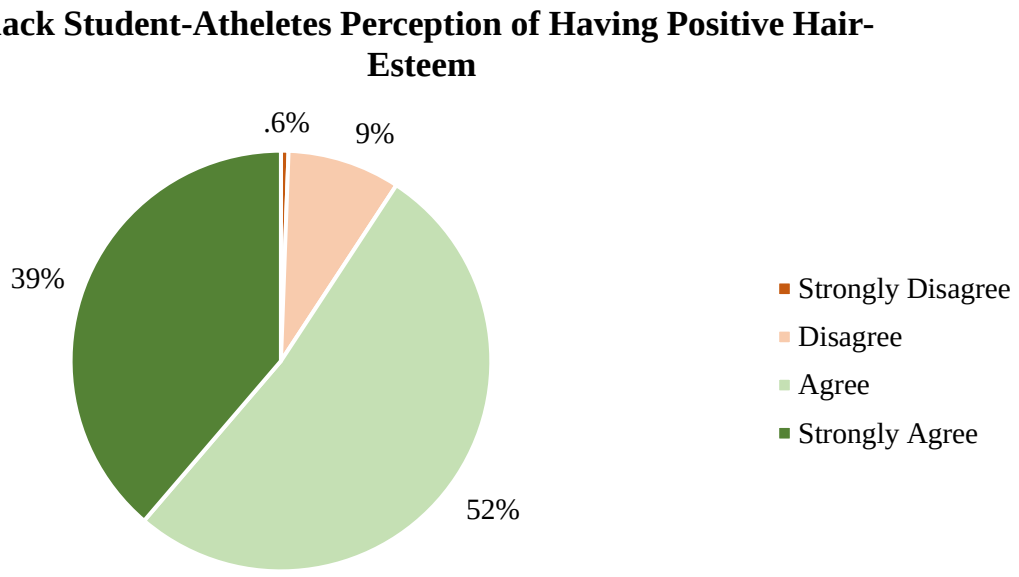
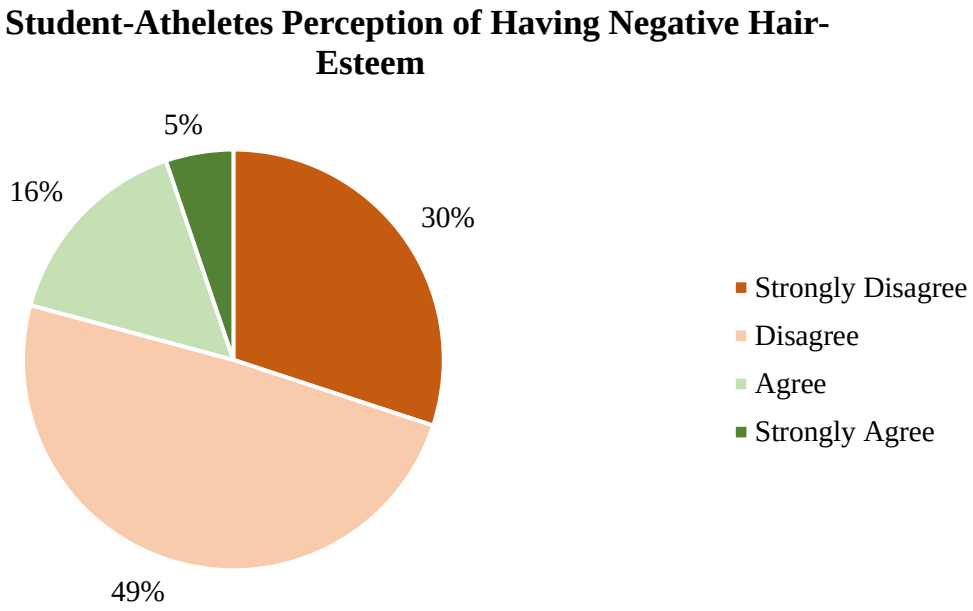


Figure 1b. Black Athletes Perception of Having Negative Self-Esteem



Feasibility of the Current EEG Cap Design on Black Student-Athletes

Table 4a outlines each feasibility aspect is further detailed below, with comprehensive results. Furthermore, the key findings pertaining to each specific area of feasibility, including acceptability, appropriateness, practicality, and implementation are presented in Table 4b. Supplementary figures corresponding to each question can be found in Appendix D.

Table 4a. Full Statistics for Findings withing Each Feasibility Area

Acceptability	*M*	*SD*	*n*	Mode	Strongly Disagree	Disagree	NAND	Agree	Strongly Agree
I like the overall cap design for my hair.	2.59	1.10	34	2	6	11	9	7	1
I would accept gel being in majority of my hair.	2.38	1.23	34	2	9	13	6	5	2
The use of gel for the current EEG wet-cap meets my approval.	2.88	1.75	34	4	5	8	9	10	2
The cap design seems doable with my hair type/style.	2.62	1.26	34	4	9	7	7	10	1
Appropriateness	*M*	*SD*	*n*	Mode	Strongly Disagree	Disagree	NAND	Agree	Strongly Agree
The EEG design seems fitting for all hair types and styles	2.53	1.24	34	1	9	9	6	9	1
The use of gel seems suitable for all hair types and styles	2.65	1.32	34	4	9	8	5	10	2
The EEG cap design seems applicable to all hair types and styles	2.53	1.31	34	1	11	6	6	10	1
The current EEG cap design seems like the right choice to use for all hair types and styles.	2.59	1.23	34	1	9	7	8	9	1
Overall, the use of gel seems reasonable.	3.06	1.23	34	4	4	9	5	13	3

Practicality	*M*	*SD*	*n*	Mode	Strongly Disagree	Disagree	NAND	Agree	Strongly Agree	
The cap design seems easy to get over my entire scalp for data collection use.	2.79	1.30	34	4	8	7	4	14	1	
Getting to my scalp with fine tip syringes seems possible	3.06	1.25	34	4	6	5	6	15	2	
					Very Difficult	Difficult	NDNE	Easy	Very Easy	
Rank how difficult it would be for the EEG cap to be placed over your hair to the correct placement	2.44	1.05	34	2	7	12	8	7	0	
					1 Hour	2 Hours	3 Hours	4 Hours	5 Hours	6 Hours
How many hours do you think it will take to wash and redo your hair after wearing the EEG cap with gel?	4.09	2.08	34	3	7	10	7	3	3	4
Implementation	*M*	*SD*	*n*	Mode	0 Days	1 Day	2 Days	3 Days	4 Days	5 Days
How many days out of 7 do you think is reasonable to come to the lab and wear the EEG cap with gel?	2.76	1.39	34	2	7	10	6	7	3	1
					Very Unlikely	Unlikely	NLNU	Likely	Very Likely	
How likely is it that you will participate in a study using the current EEG cap with the gel that was described?	2.65	1.39	34	1	10	7	5	9	3	

Note: NAND represents Neither Agree nor Disagree; NDNE represents Neither Difficult nor Easy; NLNU represents Neither Likely nor Unlikely

Table 4b. Summary Statistics for Findings within Each Feasibility Area

	M	*SD*	*n*	Mode
Acceptability				
Do Black student-athletes find the current EEG cap design agreeable or satisfactory?	2.62	1.03	34	2.75
Appropriateness				
How well does the current EEG cap design fit into the practice setting? How well does the current EEG cap design address specific issues?	2.67	1.16	34	4
Practicality				
How does ease or difficulty influence implementing the current EEG cap design within existing means and resources?	2.76	1.03	34	2
How do cost implications influence implementing the current EEG cap design within existing means and resources?	4.09 hrs.	2.08	34	3
Implementation				
To what extent are Black student-athletes willing to participate in a study using the current EEG cap design?	2.76	1.39	34	2
To what extent will Black student-athletes participate over a week in a study using the current EEG cap design?	2.65 days	1.39	34	1

Note: Averages based on grouping items from Table 4a. correspond to overarching research questions.

Acceptability

In assessing the acceptability of the current EEG cap design to be agreeable or acceptable, among Black student-athletes, the mean rating was found to be M = 2.63 (SD = 1.03). Specifically, approximately 63% of Black student-athletes disagreed or strongly disagreed that they would accept gel in their hair (*M* = 2.38, *SD* = 1.23). Approximately 50% of Black student-athletes disagreed or strongly disagreed that they like the overall cap design for their hair (*M* = 2.59, *SD* = 1.10).

Appropriateness

The appropriateness of the current EEG cap design in the practice setting and its effectiveness in addressing specific issues were evaluated by participants. The overall mean rating for appropriateness was $M = 2.67$ ($SD = 1.16$), indicating a minor level of agreement among participants. Participants' perceptions suggested a tendency towards disagreement with the effectiveness of the current EEG cap design within the practice setting and its ability to address specific issues. However, across all items approximately 35% of the responses suggested agreement. The mean ratings for statements assessing the fit of the EEG design for all hair types and styles, the suitability of gel application, and the applicability of the EEG cap design varied between 2.53 and 2.65, indicating a tendency towards disagreement or neutrality. Similarly, the mean rating for the statement regarding the perceived right choice of the current EEG cap design for all hair types and styles was $M = 2.59$ ($SD = 1.23$). However, the mean rating for the overall reasonableness of gel use was slightly higher, with $M = 3.06$ ($SD = 1.23$).

Practicality

The practicality of implementing the current EEG cap design within existing means and resources was evaluated based on participants' perceptions of ease or difficulty as well as cost implications. The overall mean for participants perception of ease or difficulty was M = 2.76 ($SD = 1.03$). With a mean closer to the midpoint of the scale (1-5), participants' responses suggested a nuanced perspective, indicating disagreement or neither strong agreement nor strong disagreement with the statement. Specifically, approximately 56% of Black student-athletes indicated EEG cap placement over their hair to be very difficult or difficult. However, 50% of Black student-athletes indicated that they agreed or strongly agreed that getting to their scalp with fine tip syringes is possible.

Regarding cost implications, participants were asked to estimate the amount of hours they anticipated it would take to wash and redo their hair after wearing the EEG cap with gel (M = 4.09, SD = 2.08). This result indicated that participants generally anticipated spending a significant amount of time on hair care after wearing the EEG cap with gel. The relatively high mean estimation suggested that most respondents expected the process to take several hours. However, the mode response of 3 hours suggested that there is some variability in participants' estimations, with a notable portion expecting a shorter time frame for hair care.

Implementation

The extent to which the current EEG cap design could be successfully delivered was assessed under participants' willingness to participate as well as the number of days over a 7-day period. The willingness of Black student-athletes to participate in a study using the current EEG cap design (M = 2.76, SD = 1.39) indicated that Black student-athletes' willingness leaned closer towards unlikeliness or neutrality rather than strong agreement. Approximately 50% of Black student-athletes rated that it is either unlikely or very unlikely that they would participate in a study using the current EEG cap. Conversely, 35% of Black student-athletes rated that is it either likely or very likely that they would participate.

Participants were asked to indicate how many days out of a week they considered reasonable to come to the lab and wear the EEG cap with gel (M = 2.76, SD = 1.39). The distribution of responses indicated that while most participants considered 1 day out of 7 to be reasonable (n = 10, 29%), there was also variability in their opinions, with responses ranging from 0 (n = 7, 21%) to 5 days (n = 1, 3%).

Phase II

This focus group aimed to provide a deeper understanding and explanation of the feedback and suggestions regarding current EEG protocols. The participants shared their powerful voices, ensuring their perspectives will resonate beyond the confines of this discussion. Based on an analysis of the data, several key themes emerged: Think About Us, We Matter Too, Disheartened Yet Not Surprised, Urgency Will Lead to Inclusivity, and Transparency Shows Respect. These themes encapsulate the core insights and sentiments expressed by the participants. Detailed descriptions of these themes are presented in Table 5.

Table 5. Themes and Descriptions

Theme	**Description**
Think About Us, We Matter Too	Participants advocated for the active consideration and inclusion of Black athletes in research process and technology development.
Disheartened Yet Not Shocked	Participants expressed a mix of disappointment and resignation towards ongoing marginalization and exclusion in research practices, despite becoming accustomed to such treatment.
Urgency Will Lead to Inclusivity	Recognizing that prioritizing diverse representation and equitable access in research will ultimately enhance inclusivity and advance scientific progress.
Transparency Shows Respect	The significance of being honest and upfront with participants about the limitations and challenges of research tools.

Think About Us, We Matter Too

Participants were prompted to explain their initial reactions to the EEG cap design. Both expressed a willingness to try wearing the cap. Ophelia remarked, "I feel like I'd be down to try it." Charlotte agreed with Ophelia but raised concerns about the EEG cap's suitability for various hair types and styles. She stated:

> The only thing I would probably think of would be… I know there's plenty of people, at least that I know, that might get like hair conscious and like if their hair is up for practice, sometimes they don't be liking to take it down either. If it's because they like, have to work real hard to slick it up, or you know they're just not comfortable with, like wanting to redo whatever molded style they have, that would probably be the only thing that I would think of.

Throughout the entirety of the focus group, both participants emphasized the importance of being acknowledged and valued in EEG research. They discussed the critical need for representation, not only as individuals but also in terms of the various hairstyles they wear. Charlotte highlighted the significance of this representation based on her experiences in various athletic environments:

> Everybody just innately, I think, has the right to be able to understand what's going on with them or how to understand even if it's not them, if it's, if it's their teammate. And that helps you to be a better teammate, or maybe more empathetic. But I just think it like, it goes even deeper than sports or whatever. I think just even, I think it even feeds into learning how to treat people and consider people.

Both participants repeatedly emphasized the phrase, "think about us," when discussing the progression of inclusivity in EEG research. Ophelia articulated this sentiment, stating:

> Think about us, think about us when you're making those caps, thinking about all the different hairstyles. Make it inclusive and to know that we wanna, like I said, we want to know what's going on. We don't wanna be kept out the loop. We don't wanna be casted out to the side. You know, if you're gonna do, if they're gonna do stuff, you know, and do research, it should be for everybody.

Charlotte agreed with Ophelia and elaborated further:

> Think about us like, especially if you can't relate, get people that can and like it's kind of like storytelling too. Don't think just because you're the majority, you just know things or because you've seen people with your eyes.

Ophelia and Charlotte advocated for the active consideration and inclusion of Black athletes in research processes and EEG development.

Disheartened Yet Not Shocked

Throughout the focus group, Ophelia and Charlotte expressed their feelings regarding the lack of inclusivity in the current EEG cap design and the underrepresentation of Black athletes in research. They were provided with a brief overview of the recruitment and data collection process for EEG studies, highlighting the exclusion and discarding of data due to hair types and the preference for straight, product-free hair. Four words and their synonyms were repeatedly mentioned: "disappointed" (4 times), "disheartened" (3 times), and "tired" (3 times). Conversely, the terms "not shocked" and "used to" were each stated 3 times. When asked about their initial feelings after the overview, both women conveyed a sense of desensitization to the information. Ophelia remarked, "Normally, I guess. It feels some type of way especially knowing that like you know, being a Black woman and stuff like we can’t really have certain hair types." Similarly, Charlotte shared, "I feel like, you know, being a Black woman, I'm used to, like, that information. It wouldn't shock me necessarily." Despite their familiarity with the treatment of

Black athletes and individuals, Ophelia and Charlotte further expressed their sense of hurt. Ophelia elaborated:

> Definitely not inclusive. It wouldn't make me feel good knowing that I couldn't do all the research because of my hair and then… some of my teammates and stuff like they, you know, they have different hairstyles and stuff. So knowing that there's not a cap that can fit, you know, all types of hairstyles. It kind of would make me feel like, dang.

Charlotte agreed with the irritation and exasperation felt in response to systemic biases and shortcomings within the research community:

> It definitely makes me annoyed and I don't feel positively about it just because I think, again, I hate to be repetitive, but you know, this is like a repetitive thing. You know, it's something that we have to get used to and it's like, ok, well, dang, like, the way that we come out the womb is not deemed like respectable or as important as other people just being their natural selves. And it's also disheartening because, I mean, you know, medicine is livelihood, you know. So, the fact that we're getting excluded from anything that has to do with health or just further research about the body as understanding our body…it's definitely disheartening to hear. Again, it's not shocking or anything new, but it's just like dang.

Multiple times throughout the focus group, both women not only expressed their personal feelings but also extended their perspectives to encompass the entire population of Black athletes and how they are affected. Ophelia articulated her disappointment by highlighting, "the fact that we make up a large percent of the sports and we have, you know, the least amount of research…is just really disappointing, it is." Building upon Ophelia's sentiments, Charlotte adopted a historical perspective to reinforce her viewpoint:

> I feel like sports is one of the first places where Black people were viewed as anything or was able to be viewed as contributors. And it's like really y'all are gonna continue to try

> to… as much as we put on the table in sports for years and years and years… continue to try to, you know, isolate us and marginalized us and ignore us.

Throughout, both participants expressed the irritation, disappointment, and exasperation in response to systemic biases and shortcomings within EEG research.

Urgency Will Lead to Inclusivity

Participants acknowledged a prevailing lack of urgency for inclusivity and equity in EEG research. However, they stressed that increasing urgency and prioritizing inclusivity would significantly advance scientific progress. Charlotte offered her perspective on this issue, stating:

> It's like deflating, too, because it just gives… we're just not that big of a priority. But it's just like there's been a lot of breakthroughs, and otherwise it's just hard for me to believe that, like, there's this highest sense of urgency when it comes to including people of color, especially Black people. I find it really hard to believe that everybody's being as urgent as possible…because I feel like when you're human and you're just here, innately, you deserve to be backed up by everything else. Like there's no reason why anyone, human or one type of human, should have access to XYZ and another one just doesn't because they're not the same type of human. I think that's really tone deaf and it's really stale and… it's really just centuries ago, so…think large or much larger than you think you need to be thinking and like, get the people that you're doing this for in the room to facilitate, you know, the progression of, you know what you're making.

The women continuously stated the critical need for inclusive research practices to avoid misdiagnosis and to improve health outcomes. For example, Ophelia stated:

> You know, we would like to have research done as well to understand some things and I think that's important… So, I would like for us to be, you know, represented more in research. So we can actually have some more answers and even with like, you know, sickle cell traits and stuff like that because they're, you know, I have it and I know like a lot of my teammates and stuff have it, but we don't really know what's going on because,

> like, we're underrepresented…We need to do that so we can really figure out what's going on and stuff and then we can have our own diagnosis and not be misdiagnosed or not just, you know, feel like pushed to the side and stuff because they don't have the right things to make sure that we are included.

Overall, the critical need for inclusive research practices to avoid misdiagnosis and to improve health was exemplified by both participants.

Transparency Shows Respect

Both participants consistently underscored the importance of honesty and transparency with participants regarding the limitations and challenges associated with the EEG cap. When discussing the issue of data being discarded due to low quality caused by hair without the participant's knowledge, Charlotte emphasized the significance of transparency, stating:

> I feel like a patient or a person that's volunteering their time to help develop the research has a right to know about how this certain device is affecting them rather than just, you know, just not being completely upfront because I think that goes a long way.

Additionally, both participants suggested acknowledging the lack of inclusivity in the recruitment process while emphasizing progress towards inclusivity. Ophelia suggested addressing this by stating, "saying that you know until there's another cap developed, that would probably like ease the tension." Charlotte echoed Ophelia's sentiment, emphasizing the importance of transparency and progress stating, “I was gonna say emphasizing that there is work being done to continue to be more equitable and more inclusive.” Charlotte further discussed the need for cultural sensitivity in instructing Black participants on the most effective way to prepare their hair for the EEG cap:

> I feel like at the very least maybe leaving a more open-ended decision for the participant I guess so instead of maybe being like, you know, come with your hair straightened or

> XYZ maybe be like maybe use that as a suggestion. But before that kind of just be like, you know, we would prefer that we have easy access to the scalp…and then be like hairstyles that we have been familiar with working with and they've proven to give us good results is you know, hair straight or whatever instead of making it kind of seem more like an obligation…to change naturally who they are.

Overall, both women exhibited eagerness to contribute to scientific advancement and understanding. However, they emphasized the critical need for cultural sensitivity in research practices, specifically in communication and the development of research tools. Furthermore, they highlighted the necessity of creating a more culturally inclusive EEG cap to ensure equitable participation and representation in EEG research.

CHAPTER V: DISCUSSION

The existing literature underscores the imperative to dismantle racial biases inherent in the current EEG cap design. This study aimed to explore the key areas of focus for feasibility of conducting a study using the current EEG cap for Black student-athletes and to gather feedback on the current EEG measurement methods utilized in sports research. Additionally, it sought to refine recruitment approaches and data collection protocols related to EEG in the context of sports research. Survey responses from Phase I of this study indicate that the current EEG cap design is generally not feasible for use with many Black student-athletes based on participant feedback related to acceptability, appropriateness, practicality, and implementation. This investigation represents the first attempt to evaluate the feasibility of the current EEG cap from the perspective of potential Black participants. Hence, it was crucial to assess feasibility in a manner that addresses the specific needs of Black individuals (Bowen et al., 2009; Weiner et al., 2017). Despite ongoing efforts to address these issues, this study highlights an urgent need for continued and intensified focus on improving EEG measurement methodologies to better serve Black individuals. This commitment is essential to achieve optimal outcomes in both the exploration and advancement of EEG technologies and their application in diverse populations.

The survey results indicated that Black student-athletes had overwhelmingly positive hair-esteem, with 91% either strongly agreeing or agreeing with all questions regarding positive hair-esteem. Conversely, 79% of Black student-athletes either disagreed or strongly disagreed with questions related to negative hair-esteem. Consistent with previous research, the significance of Black hair extends beyond aesthetics; it is deeply symbolic and intertwined with various dimensions of Black culture and life (Dawson et al., 2019). Thus, it can be hypothesized that individuals with higher hair-esteem and a strong sense of cultural pride are less likely to

want to damage or alter their hair type or style. However, the direct relationship between hair-esteem and the willingness to wear the EEG cap with gel needs further evaluation to enhance understanding and clarity.

When examining the dimensions of feasibility in terms of acceptability, appropriateness, practicality, and implementation, Black student-athletes provided valuable insights that can guide improvements to the current EEG cap design. This study is particularly revealing as EEG researchers have already recognized the persistent and alarming racial biases present in EEG methodologies (Brown et al., 2023; Choy et al., 2022; Etienne et al., 2020; Penner et al., 2023; Ricard et al., 2023; Webb et al., 2022).

The first feasibility area investigated in this study was the acceptability of the current EEG cap design among Black student athletes. The findings revealed that approximately half of the participants expressed some form of disagreement regarding the cap's acceptability (n = 68, 50%) across all relevant questions. Conversely, only 28% of the responses indicated some level of acceptability with the design. These results suggest that while there is a mild level of acceptability, a significant proportion of Black student athletes do not find the gel or the cap design agreeable or acceptable. The consequences of poor acceptability are far-reaching and can impact various domains, including healthcare interventions, psychological treatments, and educational programs. In this context, issues related to acceptability can directly affect the feasibility of the EEG cap. If Black student athletes perceive the cap as unacceptable, they may be less likely to adhere to recommendations or fully benefit from the intended outcomes of EEG studies (Magwood et al., 2019). This situation perpetuates a cycle of underrepresentation and limits the generalizability of research findings to Black individuals.

A similar trend was observed regarding the appropriateness of the EEG cap. Survey responses indicated a higher percentage of disagreement than agreement, suggesting that the cap is not deemed appropriate for universal practice settings. Questions regarding appropriateness focused on how well the EEG cap fits into general use across diverse participants. The findings highlight that the current design does not adequately meet the needs of all participants. Using appropriate methods is an ethical imperative in research. Ensuring the appropriateness of EEG methodology demonstrates respect for participants' various characteristics and needs, ultimately leading to more reliable and valid conclusions (Brown et al., 2023; Crutzen et al., 2021).

The practicality of the current EEG cap design was another crucial aspect explored in this study, focusing on factors such as ease or difficulty of use and cost implications. Participants' perceptions regarding the ease of accessing their scalp using fine-tip syringes were evenly split, with 50% agreeing that it was feasible. However, concerns arose regarding the difficulty of fitting the EEG cap over their hair to achieve correct sensor placement, with only 32% expressing levels of ease. This issue is significant because the cap must cover the entire scalp, and the sensors are designated to specific locations. Unfortunately, EEG electrodes are not designed to accommodate the characteristics of Black hair, or the various hairstyles commonly worn by Black individuals (Brown et al., 2023). Consequently, there are challenges in placing the electrodes properly, contributing to practical difficulties in EEG data collection among Black individuals. Findings also shed light on the cost implications associated with wearing the current EEG cap design. Participants were asked about the amount of time it would take for them to wash and redo their hair after wearing the EEG cap with gel. While the average time reported was approximately 4 hours, several participants indicated significantly longer durations, with at least seven responses ranging from 5 to 10+ hours. This aligns with a *Cosmopolitan* article

(2024) authored by a Black woman, which highlights that getting braids as a protective hairstyle can take anywhere from 4 to 10 hours, while maintaining natural Black hair can require between 30 minutes to 3 hours. As a Black researcher with personal experience in managing Black hair, I find these numbers to be highly reliable. Furthermore, the requirement of applying gel to all electrodes of the EEG cap to meet strict impedance thresholds (Choy et al., 2022), adds another layer of impracticality. Spending significant time on hair maintenance post-cap removal, coupled with the potential exclusion of data due to impedance issues, renders the current EEG cap design not practical for Black individuals.

Examining the implementation of the current EEG cap among Black student athletes revealed valuable insights. While the majority found it reasonable to visit the lab and wear the cap with gel at least once a week (79%), reluctance towards participating in studies using the current cap design was evident (50%). However, 34% expressed willingness to participate. The frequency with which participants wear an EEG cap in a study is determined by the specific design, data collection protocol, and research objectives. The required number of sessions may vary to ensure comprehensive data collection and to meet the study's goals. For instance, Kimura et al. (2023) conducted a study in which participants wore the EEG cap for 10 consecutive days, allowing for continuous monitoring and data collection. In contrast, Munia et al. (2017) examined the effects of concussions through three EEG trials, each separated by a 30-day interval, to assess longer-term neurological changes. When interpreting these findings in conjunction with the results from the other areas of focus, a compelling narrative emerges. It appears that while Black student athletes may be generally willing to participating in research studies, their hesitance towards the current EEG cap suggests a broader issue of inclusivity and accommodation. This could potentially be because of the various hair types and styles associated

with Black athletes. The lack of feasibility of the EEG cap design for Black individuals, as evidenced by the challenges related to acceptability and practicality, likely contributed to this reluctance. Researchers must prioritize inclusive design to ensure equitable participation and enhance research validity. Failure to address these concerns risks alienating certain demographic groups and undermining the validity and generalizability of research findings (Goldfarb & Brown, 2022).

The findings from the focus group shed light on several crucial aspects concerning the inclusivity and equity in EEG research, particularly from the perspectives of Black women athletes, as highlighted by Ophelia and Charlotte. The themes of 'Think About Us, We Matter Too', 'Disheartened Yet Not Shocked', 'Urgency Will Lead to Inclusivity', and 'Transparency Shows Respect' encapsulate the nuanced discussions and concerns raised by the participants. A finding emerging from the study is the willingness and openness of Black student athletes to participate in research studies. This aligns with previous research indicating that, despite legitimate concerns and apprehensions, Black individuals have consistently demonstrated a readiness to engage in research endeavors (Glass et al., 2015; Hughes et al., 2017; Lillard et al., 2022). However, trust emerges as a critical factor influencing the willingness of Black individuals to participate in research activities. Trust in healthcare providers, institutions, and the research process itself has been identified as a key facilitator of participation (Connor et al., 2022). Measures such as providing safety assurances, transparently reporting results to participants, and ensuring overall transparency in the research process are essential elements that bolster trust and encourage Black individuals' engagement in clinical research (Rogers et al., 2018). Conversations with participants Ophelia and Charlotte underscored a lack of trust in the current EEG protocol. Instances where Black participants' data were discarded without their

knowledge due to hair-related issues highlight a lack of transparency in the research process. Moreover, the failure to address apparent racial biases towards Black individuals as researchers represents a significant breach in trust. These insights underscore the importance of transparency, accountability, and inclusivity in research practices to foster trust and facilitate meaningful participation among Black individuals. Moving forward, it is imperative for researchers to prioritize building and maintaining trust with Black communities through transparent and inclusive research practices to ensure equitable participation and contribute to the advancement of scientific knowledge.

Moreover, both participants, Ophelia and Charlotte, conveyed a profound familiarity with exclusionary practices and systemic biases historically directed against Black individuals. This recognition underscores a critical aspect of systemic racism: its insidious nature, often overlooked or unnoticed by those it affects. Systemic racism operates at multiple levels within society, deeply ingrained and pervasive, making it challenging for individuals, including Black individuals, to fully recognize its presence and impact (Cobbinah & Lewis, 2018). Ophelia and Charlotte's assumption that the EEG cap would accommodate Black hair reflects a common expectation grounded in the normalization and cultural blindness perpetuated by researchers, further obscuring the systemic roots of racism and perpetuating its harmful effects on Black communities (Solanki et al., 2023). Their emotional assertion, "think about us," resonates with a fundamental truth: Black athletes, like all individuals, should not feel devalued or othered because of their skin color or associated characteristics. Charlotte's statement regarding the lack of urgency in dismantling racial biases encapsulates a critical aspect of addressing systemic racism. While acknowledgment of racial disparities exists among many White EEG researchers, there often lacks a sense of urgency in rectifying these biases. However, conversations with

Black researchers and medical professionals emphasize a heightened urgency driven by firsthand experiences and a deep understanding of the systemic barriers faced by Black individuals. Given the well-documented racial disparities in research funding and the underrepresentation of Black researchers (Chen et al., 2022; Taffe & Gilpin, 2021; National Science Foundation, 2023), it is imperative for White counterparts to cultivate cultural awareness and prioritize action-oriented approaches to address the invasive research practices that perpetuate racial biases.

Charlotte expressed a profound statement during the focus group, emphasizing the importance of including those directly impacted in decision-making processes: "Don't think just because you're the majority, you just know things or because you've seen people with your eyes…get the people that you're doing this for in the room to facilitate, you know, the progression of, you know what you're making." This statement resonates with existing research, highlighting the critical role of representation in research teams. The underrepresentation of Black researchers mirrors the lack of diversity within research teams, hindering the cultivation of cultural humility, awareness, and anti-racist training among white researchers (Bhui et al., 2007; Lim et al., 2008). This lack of diversity perpetuates biases in research studies and contributes to the creation of less inclusive or welcoming environments for marginalized participants, along with reduced efforts to recruit Black participants and address diversity and equity (Crooks et al., 2021; Gilpin & Taffe, 2021; Rai et al., 2022). It is imperative to recognize that no one understands Black hair like a Black person. The development of an inclusive EEG cap or more equitable EEG protocols cannot progress without the intelligence, experience, and understanding of Black scientists and participants. As Charlotte aptly stated, including Black individuals in research teams enhances problem-solving capabilities, fosters creativity and innovation, improves the quality of work, minimizes bias, and leads to more effective solutions to complex

challenges. Other recommendations provided by Ophelia and Charlotte for researchers to adopt more cultural sensitivity within EEG measurement include:

- **Acknowledge the Limitations of Current EEG Cap Designs:** Clearly communicate to Black participants during the recruitment process the existing limitations of the current EEG cap designs. Emphasize ongoing efforts and research aimed at developing more inclusive EEG designs that better accommodate diverse hair types and styles.
- **Hair Management Recommendations**: Instead of mandating that Black participants straighten their hair or avoid using hair products, present these as recommendations. Provide a list of specific hairstyles known to be compatible with the EEG cap, based on empirical evidence, to guide participants in optimizing the quality of their EEG recordings without compromising their hair health or cultural expression.
- **Transparency in Data Analysis**: Ensure transparency in the data analysis process by informing participants if their data is excluded from the analysis and providing specific reasons for such exclusion. This practice fosters trust and maintains the integrity of the research process.
- **Involve Black Researchers and Participants in Design Improvements**: Actively involve Black researchers and participants in the development and evaluation of EEG cap designs. Their insights and experiences are crucial for creating more inclusive and effective EEG technology that accommodates a wider range of hair types and styles.

Furthermore, Black athletes want to be considered not merely as participants in the advancement of research but because their existence and health are fundamentally important. Despite the persistent biases in EEG and health research, Black athletes have become accustomed to these

challenges but remain frustrated by them. Nevertheless, fostering honesty and transparency in research practices will drive progress in the right direction. Addressing the lack of urgency in achieving equitable representation is essential for advancing equity in the field.

Limitations

While this study offers novel insights, several limitations warrant consideration. Firstly, the study's participant criteria was restricted to currently enrolled Black student athletes aged between 18 and 25 years. This narrow demographic scope limits the generalizability of the findings to broader age groups and identities within the Black population. Future research endeavors should aim to include a more diverse range of age groups and identities to provide a comprehensive understanding of EEG cap feasibility across the Black population. Secondly, the study faced a gender imbalance, with only six male participants and no male representation in the focus group. Given the significant presence of Black men in athletics, this lack of representation hinders the comprehensiveness of perspectives. Future studies should prioritize recruiting a more balanced gender representation to ensure a more inclusive examination of EEG cap feasibility among Black athletes. This study did not explore the direct impact of various hair types and styles on Black participants' perceptions of the current EEG cap. Future research should examine the differential effects of specific hair types among Black participants and their underlying reasons for these perceptions. Furthermore, the focus group comprised only two participants, limiting the range of perspectives and experiences shared. While both participants provided valuable insights, recruiting a larger and more diverse focus group would facilitate a richer understanding of EEG cap feasibility among Black individuals. Lastly, participants were unable to physically inspect the EEG cap, which may have impacted their ability to provide informed feedback. Future studies should consider providing participants with the opportunity to examine

the EEG cap firsthand to enhance their understanding and enable more informed decision-making. In light of these limitations, future research endeavors should continue to explore the feasibility of current EEG cap designs among Black populations, incorporating feedback and suggestions from a more diverse range of Black participants to ensure comprehensive and inclusive findings.

Conclusions

In conclusion, this study underscores the imperative to dismantle racial biases inherent in current EEG cap designs and methodologies. By exploring the feasibility of existing EEG cap designs and gathering feedback from Black student-athletes, valuable insights were gained that can guide improvements in EEG measurement methods, recruitment approaches, and data collection protocols, particularly in the context of sports research. Survey responses and focus group discussions highlighted significant concerns regarding the acceptability, appropriateness, practicality, and implementation of the current EEG cap design among Black individuals. The findings reveal that the current EEG cap design does not adequately meet the needs of Black individuals, leading to challenges in participant acceptance, adherence, and data collection. Issues such as difficulty fitting the cap over Black hairstyles, time-consuming hair maintenance post-cap removal, and the impracticality of applying gel to all electrodes contribute to the lack of feasibility for Black individuals. These challenges underscore the urgent need for inclusive design practices in EEG research to ensure equitable participation and enhance research validity. Moreover, the study sheds light on the systemic biases present in EEG methodologies and the broader research landscape. Black participants' experiences and perspectives highlight the need for greater cultural awareness, diversity, and inclusion within research teams. The absence of Black researchers and participants hinders the cultivation of cultural humility, awareness, and

anti-racist training among predominantly white research teams, perpetuating biases and creating less inclusive research environments. Moving forward, it is essential to prioritize inclusivity, equity, and cultural responsiveness in EEG research. This requires collaborative efforts to develop more inclusive EEG cap designs and methodologies, involving Black researchers and participants in the process. By fostering diversity, equity, and inclusion within research teams and methodologies, we can enhance the quality, relevance, and impact of EEG research in diverse populations. Ultimately, addressing racial biases and promoting inclusivity in EEG research is essential for advancing scientific knowledge, improving health outcomes, and promoting social justice.

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APPENDIX A: CHATGPT GENERATED DESCRIPTION OF EEG

Current EEG Design Protocol

To improve your understanding of the current EEG cap, ChatGPT, will offer a brief explanation of EEG. Following that, please review the images and videos to help you answer the upcoming questions more effectively.

An EEG (electroencephalogram) using a wet cap is a non-invasive and painless way to measure the electrical activity in the brain. Let's break it down:

- What is EEG? EEG is a way to record the electrical patterns or signals produced by the brain's activity. It helps us understand how the brain works.
- The Wet Cap: The wet cap is a hat-like device with 64 (other caps can have sensor ranges up to 256 sensors) small sensors attached. These sensors are designed to pick up the electrical signals from your brain.
- How It Works: After putting on the wet cap, a conductive gel is applied to all 64 of the sensors using fine tip syringes. This gel helps transmit the electrical signals more effectively. The sensors make contact with your scalp. It's painless and feels like wearing a swim cap.
- What It Tells Us: EEGs are used for various purposes, such as studying sleep patterns, diagnosing certain brain conditions, and even researching how our brains respond to different activities.

Next will be pictures and a video to help you better visually understand the EEG cap design.

APPENDIX B: FOCUS GROUP QUESTIONS

EEG design: Initial reactions and feedback of EEG cap and gel

1) After seeing the cap and the gel on the slide show, what are your initial thoughts?
2) What is your reaction to [gel] being across your scalp?
3) Does the gel have any impact on your decision to participate?
4) Out of a week, 7 days, how many days are you willing to come to the lab and wear the EEG cap with the gel?
5) Do you think this current EEG cap design is an appropriate choice for researchers to measure brain function across all hair types and styles?

Data Collection: Black athletes being included but excluded in EEG section/data analysis (have to throw out the data)

1) How would being excluded in the EEG portion of [a] study, but complete everything else make you feel?
2) Sometimes if the data is [not good quality] because of hair [style] or hair type, researchers will "secretly" throw it out. What are your thought about this?
3) How does it make you feel that the broader Black population is being excluded [in EEG research] at some time or point because of [their] hair.
4) What is a way that [researchers] can tell a Black participant you can participate in all the other measures, but not the EEG cap until a more culturally inclusive cap is developed?
5) What is a way that we as researchers can be culturally sensitive in telling a Black participant how to wear their hair for the EEG cap?

Recruitment: General underrepresentation of Black athletes and individuals in research

1) Why do you all think it is important to have diverse samples in research?
2) How does it make you feel that Black athletes are underrepresented in sport, overall, research?
3) Due to underrepresentation, it is unlikely to be able to take the findings in research and apply it to everyone. Clinically, this can lead to misdiagnoses, underdiagnoses, or inappropriate treatments. Hearing this, how does it make you feel?

Participant Response to Intervention (Inclusive EEG cap): Relevancy of intervention

1) What are some ways, if a culturally inclusive cap is being developed that researchers can make it [to be] more accommodating?
2) What are your thoughts on the need for an inclusive EEG cap?
3) What is your advice to either EEG companies or labs or anyone who uses EEG at attempting to create an inclusive EEG cap?

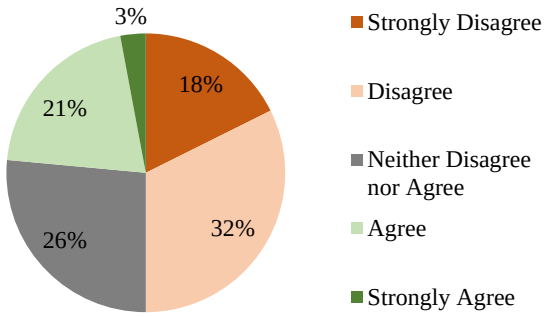
APPENDIX C: LIST OF HAIR TYPES AND STYLES

Hair Types and Styles for Survey
a. Natural (not chemically processed, usually worn curly or in a natural state)
b. Straightened (heat or chemically straightened)
c. Bald
d. Fade
e. Afro
f. Wigs
g. Weaves
h. Braids or Twists (using synthetic hair)
i. Braids or Twists (not using synthetic hair)
j. Cornrows
k. Locs
l. Other (please specify)

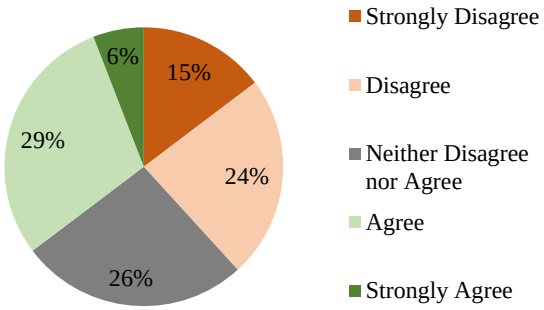
APPENDIX D: PIE CHART DISTRUBUTION FOR EACH FEASIBILITY QUESTION

Acceptability

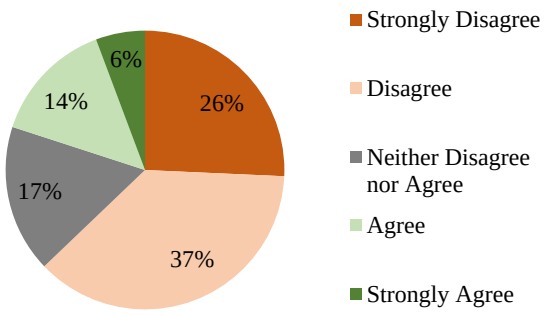
I like the overall cap design for my hair.



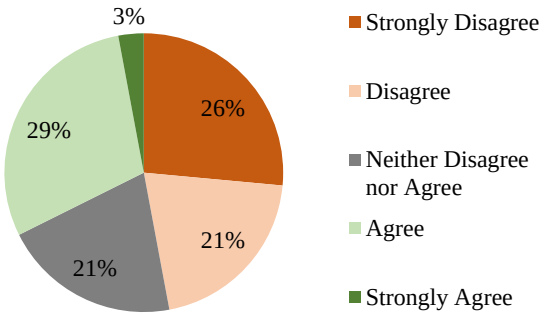
The use of gel for the current EEG wet-cap meets my approval.



I would accept gel being in majority of my hair.

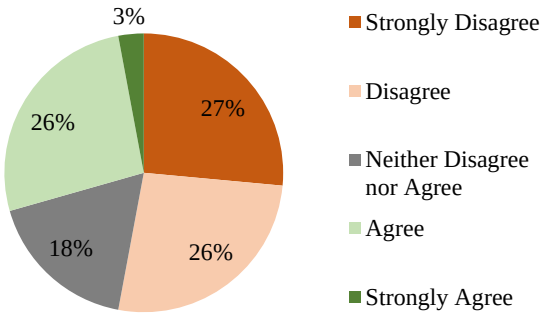


The cap design seems doable with my hair type/style.

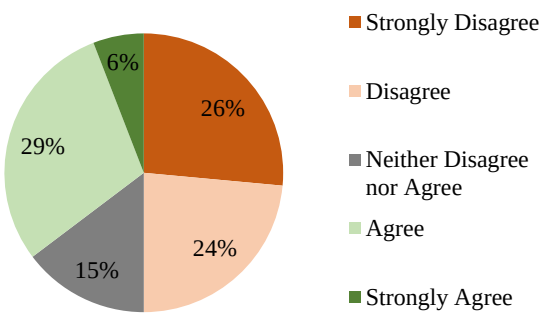


Appropriateness

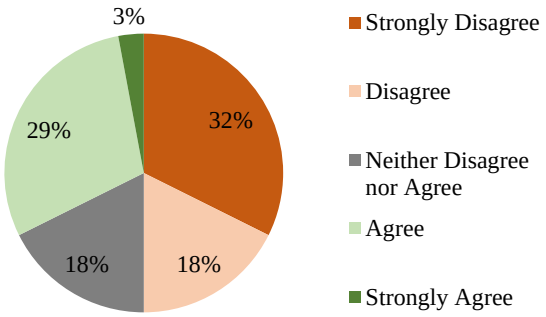
The EEG design seems fitting for all hair types and styles



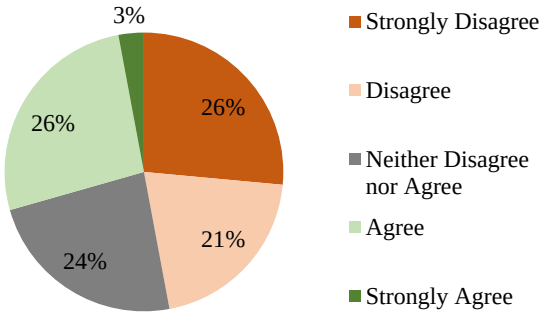
The use of gel seems suitable for all hair types and styles



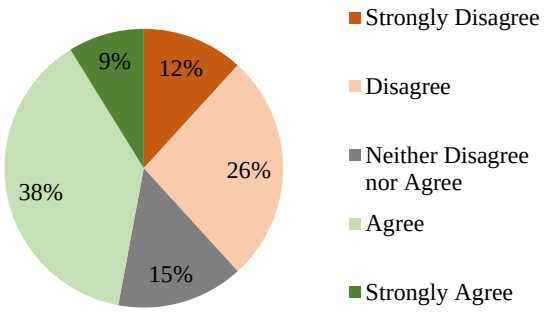
The EEG cap design seems applicable to all hair types and styles



The current EEG cap design seems like the right choice to use for all hair types and styles.

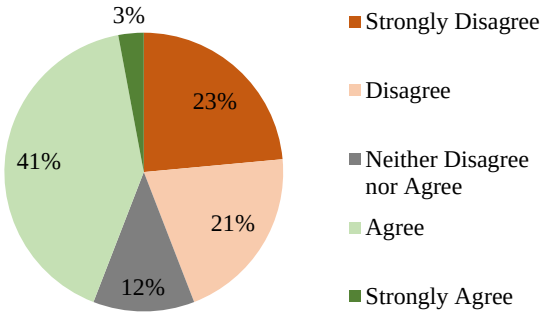


Overall, the use of gel seems reasonable.

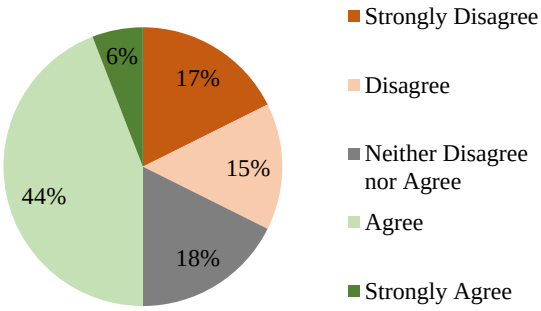


Practicality

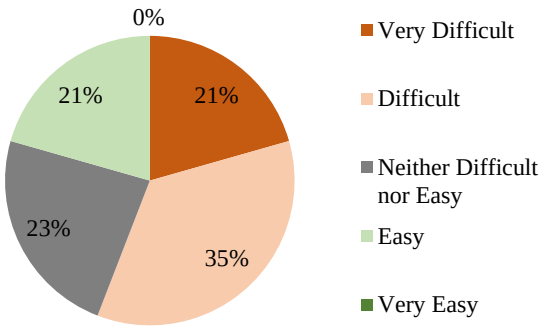
The cap design seems easy to get over my entire scalp for data collection use.



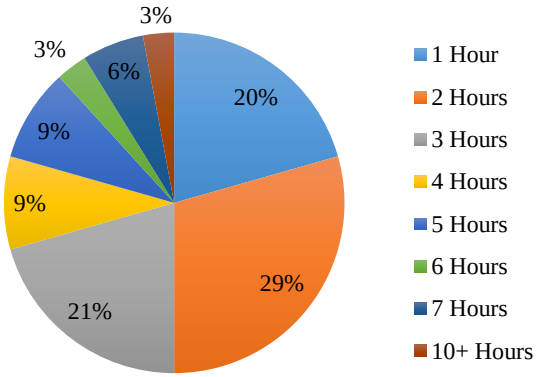
Getting to my scalp with fine tip syringes seems possible.



Rank how difficult it would be for the EEG cap to be placed over your hair to the correct placement.

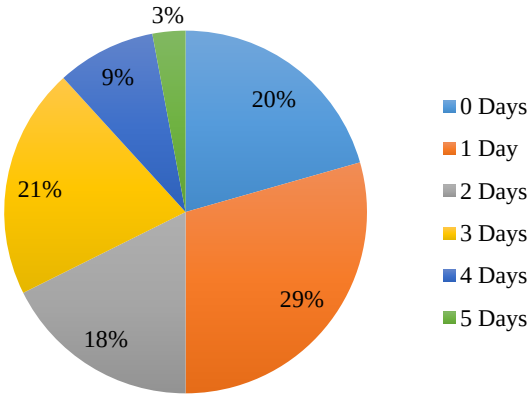


How many hours do you think it will take to wash and redo your hair after wearing the EEG cap with gel?



IMPLEMENTATION

How many days out of 7 do you think is reasonable to come to the lab and wear the EEG cap with gel?



How likely is it that you will participate in a study using the current EEG cap with the gel that was described?