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UNDER PRESSURE: HOW STRESS AND BIAS SKEW EYEWITNESS MEMORY

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UNDER PRESSURE: HOW STRESS AND BIAS SKEW EYEWITNESS MEMORY

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Abstract

Examining eyewitness identification is vital because it significantly influences wrongful convictions. The accuracy of eyewitness memory is highly vulnerable to distortions influenced by factors such as stress and biases. Specifically, explicit racial bias among White observers predicts false identifications of Black faces. However, research shows mixed effects of implicit racial bias, especially in stressful conditions. This study explored how stress interacts with implicit racial bias to exacerbate the cross-race effect in eyewitness lineup identifications. Participants ($N = 80$) completed the Race IAT and Symbolic Racism Scale to assess implicit and explicit biases and viewed a crime video (under control, low, or high stress conditions). Participants then chose a suspect (or not) from a lineup of White or Black faces and rated their confidence regarding their selections. Eyewitness identification accuracy was analyzed using binary logistic regression with implicit racial bias, stress, and target race as predictors. The results did not support the hypothesis, and there were no significant interactions regarding eyewitness identification accuracy. However, a significant main effect of bias for confidence was found. These results contribute to the ongoing eyewitness memory literature and demonstrate the importance of continued research into the potential roles of individual and situational factors in influencing eyewitnesses' accuracy and confidence.

Under Pressure: How Stress and Bias Skew Eyewitness Memory

The rise of forensic DNA testing over the past couple of decades has shed light on the frequency of wrongful criminal convictions (Norris et al., 2019). Researchers estimate that there have been 1,934 instances of wrongful convictions, using data from 1989 to 2016 on DNA evidence from individuals who have and have not been exonerated. Eyewitness identification plays a prominent role in criminal justice (Vitriol et al., 2019; Wells et al., 2020). However, eyewitness errors significantly contribute to wrongful convictions (Norris et al., 2019). Specifically, eyewitness misidentifications contributed to more than half (72.2%) of the first set of DNA exoneration data (Norris et al., 2019). It is crucial to investigate factors that may shape eyewitness identification accuracy to address eyewitness misidentifications.

Background

Implicit Bias and Eyewitness Decisions

Some of the factors influencing eyewitness identification accuracy include implicit biases and the type of lineup procedure. Implicit biases can affect individual attitudes and judgments (Saluja & Bryant, 2021). Implicit biases are the unconscious attitudes and stereotypes individuals hold that contribute to their decision-making and perceptions. Individuals rely on stereotypes when they are unsure of situations and must make quick personal decisions (Spencer et al., 2016).

The Implicit Association Test. A commonly used measure of implicit bias is the Implicit Association Test (IAT; Greenwald et al., 1998). The IAT has been critiqued and praised as a measure of implicit bias (Sukhera et al., 2019). The IAT has been viewed positively for its ability to reduce the likelihood of faking, and it is considered internally

consistent and reliable for test-retest purposes. Moreover, in general, methodological variations of the IAT do not tend to significantly affect scores. However, critics of the IAT voice concerns about construct validity (i.e., the measure's ability to actually assess implicit biases), predictive power (i.e., discriminative behavior), and generalizability to the population at large.

Signal Detection Theory. The theoretical basis for interpreting the IAT is Signal Detection Theory (Lee & Penrod, 2019). Signal Detection Theory considers four possible outcomes regarding a decision about a stimulus: a "hit" (correctly identifying the presence of the stimulus), a "miss" (failing to detect the presence of a stimulus), a "false alarm" (incorrectly reporting that a stimulus is present when it is absent), and a "correct rejection" (correctly reporting that a stimulus is absent when it is absent). Signal Detection Theory provides a mathematical framework to understand the IAT by distinguishing the strength of participants' associations between signals (e.g., good/bad, White/Black). It uses a d score to identify a signal amongst the noise (i.e., to distinguish between the sensitivity of responses and changes in biases with the stimuli).

Police Lineups

Simultaneous lineups. The two common types of police lineups include sequential and simultaneous presentations (Gronlund et al., 2014). Simultaneous lineups present all suspects at the same time and involve individuals who did not commit the crime, called fillers, with one person as the suspect. The manner of presentation often involves a photograph of the lineup. Following the lineup photograph, the eyewitness can identify the suspect or dismiss the lineup overall. If the eyewitness rejects the lineup, they conclude that the suspect is not present in the lineup. Simultaneous lineups result in

“relative” judgments by which eyewitnesses tend to pick the suspect that most closely matches their memories (Ferguson, 2020); therefore, they have historically been criticized for resulting in high levels of false alarms.

Sequential lineups. In contrast, sequential lineup presentations involve presenting the lineup members individually, one at a time (Gronlund et al., 2014). Eyewitnesses decide whether the suspect is present in the photograph before seeing the following photograph. These lineups are found to result in “absolute” judgments whereby eyewitnesses judge the lineup member directly to their memories of the suspect rather than to each other. As such, they have historically garnered more support than simultaneous lineups by cognitive psychologists and other advocates for criminal justice reform.

Comparing simultaneous and sequential lineups. Differences in eyewitness identification accuracy are present when using simultaneous or sequential police lineups. As noted, historically, sequential lineups were considered better at reducing eyewitness identification errors than simultaneous lineups (Seale-Carlisle et al., 2019). However, recent research has been mixed as to which lineup procedure enhances the accuracy of eyewitness identification. Simultaneous lineups are more discriminative than sequential lineup presentations, meaning that eyewitnesses may be better at discerning whether the target is present or absent in the lineup when presented with them (Colloff et al., 2021). Simultaneous lineups have led to both more correct eyewitness identifications and more misidentifications than sequential lineups; in fact, sequential lineups have led to fewer misidentifications than simultaneous lineups because they prevent reliance on relative

judgments (Sporer, 2001; Vitriol et al., 2019). Discriminability is higher when relative rather than absolute judgments can be made.

Eyewitness Memory and Stress

Memory processes. The fundamental processes of memory include encoding, storing, and retrieving information (Marr et al., 2021). Encoding involves assimilating information, whereas storing involves consolidating and maintaining the information in long-term memory. Retrieving the information occurs when this stored information is successfully accessed and utilized, and this can be done either through recall or recognition. Memory recall requires active search within stored memories without the aid of specific cues, whereas recognition memory depends on cues to facilitate retrieval. Recognition typically relies on the sense of familiarity, whereby the cued information resembles the original encoding context.

In eyewitness identification procedures, witnesses initially observe and encode perpetrators' appearances at crime scenes (Marr et al., 2021). This information is subsequently stored in long-term memory. When witnesses are later asked to identify suspects, they view lineups of individuals (usually containing a suspect identified by law enforcement). Viewing lineups functions as a visual recognition cue, activating witnesses' stored memories to determine whether someone in the lineup matches the witnesses' initial observations. Essentially, recognition involves matching a cue, such as the faces in a lineup, to previously stored memories for identification. Conversely, eyewitness memory recall commonly refers to the process of providing information about the observed crime to law enforcement and offering testimony to the court regarding the event, without reliance on specific visual cues.

Stress and memory. There is a complex relationship between stress and memory. Research on stress and memory accuracy in both basic and applied research shows mixed results: in some cases, stress can improve accuracy, whereas in others, stress can impair memory (Deffenbacher et al., 2004; Morgan et al., 2004; Valentine & Mesout, 2009). For example, stress at the time of encoding negatively affects recognition accuracy, especially in facial identification (Deffenbacher et al., 2004).

However, fundamental (basic) memory research offers a more nuanced view than this straightforward negative one, revealing that stress has varied effects on memory performance. Although research specifically on facial recognition accuracy is limited, findings on recognition tend to focus on basic memory tasks such as items, words, and objects rather than faces (Marr et al., 2021). Stress can work to enhance, rather than impair, recognition accuracy. In fact, meta-analyses indicate that the effects of stress differ across memory types (Marr et al., 2021). Both eyewitness and basic memory research highlight that memory depends heavily on context and the nature of the task, with factors such as environmental conditions and task demands influencing memory strength (detail, retrieval, and accuracy).

In forensic settings, stress has been shown to have mixed effects on different aspects of eyewitness memory. Specifically, in some stressful situations, eyewitness testimony and identification accuracy are affected differently: stress can boost recall accuracy but reduce recognition accuracy (Gering et al., 2023). Overall, eyewitness memory research indicates that stress negatively impacts eyewitness recognition and recall (Marr et al., 2021), whereas fundamental memory research consistently suggests that stress generally increases recall accuracy, with effects on recognition mixed.

Methodological discrepancies. Research indicates that mixed findings on stress and memory may be partially understood by methodological discrepancies (Marr et al., 2021; Shields, 2020). Specifically, in the field of eyewitness memory research, stimuli often involve mock crimes and rely on self-report measures to assess stress. In the fundamental memory research field, various methodological factors are considered, such as physiological stress validation, consistency in the time of day when studies are conducted, the interval between stress at encoding and the memory task, the type and severity of the stressor used, and potential sex differences (Wolf, 2009). Overall, when retention intervals, the time between encoding and retrieval, are longer (such as 24 hours in past studies) following high stress at encoding, cortisol levels tend to decrease, which is theorized to support memory consolidation. As a result, memory retrieval generally becomes easier, leading to increased recognition and often recall (Marr et al., 2021). However, in some situations, stress can lower identification accuracy, as shown in studies conducted under high-stress conditions, such as threatening environments or interrogations (Morgan et al., 2004; Valentine & Mesout, 2009). These differences due to methodology emphasize how context may influence memory performance.

Confidence-Accuracy relationship

The exploration of the confidence-accuracy relationship in eyewitness contexts is important for gaining a broad understanding of how factors such as stress and implicit racial bias may impact the accuracy of lineup decisions and an eyewitness's confidence in their memory-related decisions. Stress has a stable effect on confidence, such that in stressful contexts, confidence remains a consistent predictor of accuracy, suggesting that when individuals are aware of their stress-induced state, they may provide a more

reasonable assessment of their confidence than they would otherwise (Davis et al., 2019). That is, even under varying levels of stress, confidence may continue to be a valuable predictor of accuracy despite the general consensus across eyewitness memory literature that stress tends to reduce eyewitness identification accuracy (Deffenbacher et al., 2004; Marr et al., 2021; Pezdek et al., 2021).

However, research exploring the cross-race effect in lineup identification accuracy has demonstrated that, in some cases, eyewitness confidence is often overestimated in cross-race lineups under high-stress contexts (Dodson & Dobolyi, 2016). Specifically, under cross-race identifications, when eyewitnesses do not deliberately think through their identification decisions and rely on guesswork, eyewitnesses' accuracy does not always correlate with their confidence because the eyewitnesses' choices could have resulted from random chance. Additionally, the relationship between confidence and accuracy in same-race identification contexts shows a consistent positive association, such that recognition accuracy is related to confidence (Dodson & Dobolyi, 2016; Pezdek et al., 2021), especially if lineup administrators collect confidence ratings directly after lineup identifications (Nguyen et al., 2017). This finding provides valuable insights for eyewitness research as well as applied forensic and legal settings because jury members may view eyewitness evidence given under high confidence as more credible than evidence obtained under low confidence.

The Cross-Race Effect (CRE) in Face Recognition

A common misconception among people outside the academic scientific community is that face recognition is always accurate and trustworthy; however, eyewitnesses' memories for faces can be influenced by their perceptions. Specifically,

when eyewitnesses perceive, they often take in information related to age, gender, race, emotion, and threat detection in others. These bits of extra information added to person perception are evident in the frequency of misidentifications in the justice system and other areas.

The cross-race effect (CRE) is a phenomenon whereby individuals are better at recognizing and recalling faces of people from their own race or in-group race than those from other races or out-group races (Meissner & Brigham, 2001; Sporer, 2001). Research has taken a multifaceted approach over time to examine the cross-race effect, showing that perceptual learning may contribute to our understanding of why the cross-race effect occurs, and social-cognitive theories suggest that the effect can occur from increased reliance on social category-based processing. That is, the cross-race effect may occur through perceptual expertise and social-cognitive processes (Young et al., 2012).

Perceptual expertise. Here, perceptual expertise refers to how individuals often get better at recognizing people's faces when they have more experience being around those individuals, and this continues to develop across the lifespan (Young et al., 2012). Often, these individuals surround themselves with people who are in the same racial category as they are, either by chance or by choice; therefore, the cross-race effect occurs when they have more difficulty recognizing individuals of the cross-race (CR) than those within their same race (SR).

Social cognitive framework. Researchers have also used the social cognitive framework to expand their understanding of the cross-race effect by offering insights into how social categorization and motivation are interconnected in this phenomenon (Sporer, 2001; Young et al., 2012). For example, when individuals encounter others from their

racial group (in-group), they tend to focus on facial details that make each individual unique, such as mouth and eye shape, by using facial individuation. In contrast, when individuals meet someone from a different racial group (an out-group), they are more likely to rely on social categorization than they otherwise would. Social categorization is the process by which individuals classify group members based on broad traits like age, gender, social class, and race. Often, this reliance on social categorization results in shallow encoding, meaning weaker memory traces and superficial processing, which can lead to an overreliance on category-based processing (Sporer, 2001). This social categorization is frequently influenced by stereotypes and racial attitudes, which guide cognitive processing.

In summary, the perceptual expertise and social cognitive accounts are both widely accepted explanations for the cross-race effect (Young et al., 2012). To get a more cohesive understanding, it is best to utilize a hybrid approach that combines these accounts. The perceptual expertise perspective emphasizes the importance of perceptual familiarity, whereas the social cognitive approach helps explain how social group categorizations and cognitive motivations shape memory.

Cognitive dual process theories offer a valuable framework for understanding how perceptual expertise and social cognitive accounts are important in examining the cross-race effect. Specifically, dual process theories emphasize that automatic processing occurs quickly and superficially, while controlled processing is more effortful, slower, and involves deeper encoding (Meissner et al., 2005; Young et al., 2012). Generally, perceptual expertise accounts highlight how individuating facial information is processed, and social categorization emphasizes how motivation based on perceived social groups

influences whether automatic or controlled processing is used (Meissner et al., 2005; Young et al., 2012). One explanation for this phenomenon is that cognition generally seeks shortcuts when possible, unless signaled to increase attention. As a result, when these processes are used, cognition tends to rely on preexisting social attitudes to categorize individuals, as this requires fewer cognitive resources than fully processing new information.

Out-group homogeneity effect. A prominent phenomenon, the out-group homogeneity effect, occurs when a perceiver of ingroups sees members of outgroups and categorizes individuals by their social group (Meissner & Brigham, 2001). That is, category-based perception, based on the assumption that members of outgroups are all the same, can serve as a visual cue that signals to their memory processes to rely on automatic processing, which is bad at detailed facial encoding. This is important because it helps researchers understand how social categorization across racial and ethnic groups can lead to facial recognition errors in everyday and legal contexts. In the everyday context, the cross-race errors are less detrimental; however, when it comes to the criminal justice system, the stakes are extremely high.

Motivation, attention, and the cross-race effect. Research on motivational and attentional mechanisms shows that when people are instructed to individuate outgroup members or are given a reason to pay closer attention to their unique, distinctive facial features, the cross-race effect is reduced (Marsh et al., 2016). In other words, increasing motivation to individuate faces can improve memory for outgroup faces. Additionally, the cross-race effect is mitigated when perceivers are motivated to see the out-group as

sharing a social identity with them, highlighting the vital roles perception, motivation, attention, and social categorization play in this phenomenon.

Implicit Racial Bias and the Cross-Race Effect

Eyewitness memory is a crucial part of the criminal justice system, but it is susceptible to various biases. Explicit and implicit racial biases can increase the likelihood of false identification by White observers of Black suspects in simultaneous lineups in some situations (Vitriol et al., 2019). Additionally, the unconscious activation of crime-related stereotypes decreases the ability of White perceivers to correctly identify Black faces, although their accuracy with White faces remains stable. These findings suggest that there is a systematic relationship between explicit racial attitudes and false identification, but the evidence for implicit bias is mixed. That is, although increases in explicit racial attitudes predict increases in false identifications for Black (but not White) faces, increases in implicit racial attitudes are only weakly (and inconsistently) predictive when the activation of crime-priming stereotypes are made salient and occur prior to and close to the time of encoding. In that way, priming of crime-related concepts may create a contextual environment that heightens the salience of race–crime associations, thereby activating implicit racial attitudes that impair recognition accuracy and increase false identifications of Black faces. Interestingly, implicit racial attitudes may be driven more by context rather than by a stable trait.

Current Study

As noted, prior work examining implicit biases, stress, and the cross-race effect has focused on the process by which crime-related stereotypes serve as a context in which increased categorical-based cognitive processing occurs and attention towards those

crime-related stereotypes increases (Deffenbacher et al., 2004; Sporer, 2001). Given this, stress may serve as an additional context that amplifies the relationship between implicit racial bias and eyewitness identification accuracy, as both contexts tend to rely on increased automatic categorical processing (Sporer, 2001).

Priming of crime-related stereotypes may serve as a context that increases the salience of racial stereotypes, thereby activating implicit racial attitudes that play a role in false identifications of Black faces (Vitriol et al., 2019). Because previous work has focused on the specific context of crime-related stereotypes, the current study examines stress as the process whereby stereotypes and accuracy are understood.

Furthermore, situational stressors are known to impair cognitive performance, especially in tasks requiring detailed memory recall (Deffenbacher et al., 2004). In high-stress environments, people may rely more on heuristics such as racial stereotypes than in low-stress environments to make decisions, increasing the likelihood of errors in cross-race identification (Shapiro, 2009). In actual crime situations, witnesses often experience stress due to the nature of the environment, whether it is witnessing a violent crime, seeing a weapon, or being in a high-stakes legal situation in which their testimony could determine someone's fate (Loftus et al., 1987). In high-stress situations, individuals may not have the cognitive resources to carefully individuate suspects' facial features, leading to increased category-based processing (i.e., focusing on race rather than specific facial characteristics; Sporer, 2001).

The current study seeks to extend past research (cf. Vitriol et al., 2019) by exploring the relationship between implicit racial biases and eyewitness identification by examining how situational factors, such as stress and environmental context, impact the

cross-race effect (CRE). This study builds on the finding that nonconscious stereotypes impact face recognition accuracy, but will also extend the research by examining how specific situational stressors might exacerbate or mitigate these biases (Davis et al., 2019; Morgan III et al., 2004; Shapiro, 2009; Valentine & Mesout, 2009; Vitriol et al., 2019).

It is expected that White participants in high stress conditions will make more errors than White participants in control or low stress conditions (H1); White participants choosing from a Black-face (out-group) lineup will make more errors than individuals choosing from a White-face (in-group) lineup (H2); and White participants with high implicit bias will make more errors than individuals with low implicit bias (H3). Finally, it is expected that an interaction of high implicit bias, cross-race identification, and high stress conditions will interact to produce identification errors (H4). Stress conditions will generally exacerbate the cross-race effect, leading to bigger differences in accuracy for Black suspects than White suspects than accuracy under no stress conditions (Marsh et al., 2016). Thus, stress could exacerbate the cross-race effect, in which individuals are already less accurate at distinguishing faces of racial out-groups than those of racial in-groups. Examining the impact of stress on the relationship between implicit racial biases and eyewitness identification provides novel insights into both the eyewitness memory and racial bias literatures.

Method

Participants

One hundred and twenty-eight students, faculty, and staff at a large Midwestern university completed the study. Of the 128 participants, 62.50% identified as White, non-Hispanic, 9.40% identified as Hispanic or Latino/a, 8.60% identified as Black or

African American, 7.80% identified as Asian, 7.0% identified as American Indian or Alaska native, 3.90% identified as Multiracial, 0.80% identified as other. Only participants who identified themselves as White (not Hispanic or Latino/a; $N = 80$) were included in the final sample to examine the influence of implicit racial biases in White individuals in cross-race face recognition scenarios, matching the demographic characteristics of those in previous research (cf. Vitriol et al., 2019). Participants responded to a solicitation provided through Sona-Systems (a student recruitment system that tracks participation in exchange for course credit; 30.00%), a university-wide e-mail blast (57.50%), through a friend or colleague (10.00%), and other (2.50%). Adults aged 18 and under were ineligible to participate. The average age of the participants was 32.05 years ($SD = 15.73$).

Of the 80 participants, 36.30% identified as cisgender male, 51.20% identified as cisgender female, 1.30% identified as transgender male, 3.80% identified as transgender female, and 7.50% identified as gender variant/gender non-conforming. Regarding sexual orientation, 3.80% identified as exclusively gay/lesbian, 2.50% identified as mostly gay/lesbian, 13.80% percent identified as bisexual or pansexual, 68.80% identified as straight/heterosexual, 7.50% identified as mostly heterosexual, and 3.80% identified as other.

Participants reported their current legal marital status as single/never been married (53.80%), married (35.00%), legally separated (1.30%), divorced (5.00%), widowed (2.50%), or other (2.50%). Regarding the education level, participants reported some high school or less (1.30%), high school diploma or GED (21.30%), some college, but no

degree (32.50%), associates or technical degree (2.50%), Bachelor's degree (26.30%), or a graduate or professional degree (MA, MS, MBA, PhD, JD, MD, DDS etc.; 16.30%).

Participants reported their religious affiliation as Atheist (13.80%), Agnostic (8.80%), Pagan (1.30%), Unitarian/Universalist (2.50%), Taoism (1.30%), Buddhism (2.50%), Judaism (1.30%), and other (6.30%). The largest number of participants reported being Christian (62.60%). Participants reported attending religious services an average of 1.88 times per month ($SD = 2.95$).

Materials and Stimuli

Baseline measures. Baseline stress and mood levels were assessed using a brief measure created for this study. Participants rated the extent to which they were currently experiencing five feelings: Annoyed, Stressed, Happy, Tired, and Depressed. They rated their current emotional state on a scale from 0 (Not at all) to 100 (Very Much). This measure was used to assess stress at the beginning of the study and immediately following the stress condition for a manipulation check.

Implicit and Explicit Racism. The study implemented a race-based Implicit Association Test (IAT; see Appendix A) to assess implicit racial attitudes (Greenwald et al., 1998). The Race IAT was administered on the Project Implicit website (which is hosted by the Harvard Project Implicit), and the stimuli used in the test were also developed and displayed there (Xu et al., 2014). The IAT involves a word association/sorting task by which participants are given instructions to press a letter on their keyboard to sort words and faces (Good/White, Bad/Black) to the left or right of their computer screens. After several practice trials, the instructions change the sorting criteria (Good/Black, Bad/White) to assess differences in sensitivity to the stimuli, using

d-scores calculated from reaction time differences in the sorting task (Greenwald et al., 1998; Greenwald, Nosek, & Banaji, 2003). The website converts these scores to a range of -3 to +3, whereby higher absolute values reflect higher levels of implicit bias.

Participants receive the feedback of their scores directly from the website upon completion of the task. Specifically, the feedback ranges as follows: a strong preference for Black faces over White faces (-3), a moderate preference for Black faces over White faces (-2), a slight preference for Black faces over White faces (-1), No preference (0), a slight preference for White faces over Black faces (1), a moderate preference for White faces over Black faces (2), and a strong preference for White faces over Black faces (3).

Participants' explicit racism was measured using the Symbolic Racism Scale (SR2K; Henry & Sears, 2002; see Appendix B). The eight-item scale assesses subtle contemporary racial attitudes towards Black individuals across four themes. These themes include work ethic and responsibility for outcomes (e.g., "It's really a matter of some people not trying hard enough" and "if Blacks would only try harder, they could be just as well off as Whites"), excessive demands (e.g., "Some say that Black leaders have been trying to push too fast. Others feel that they haven't pushed fast enough. What do you think?"), denial of continuing racial discrimination (e.g., "How much of the racial tension that exists in the United States today do you think blacks are responsible for creating?"), and undeserved advantage ("Over the past few years, Blacks have gotten less than they deserve"). The scale primarily uses a 4-point Likert scale to rate items, ranging from 1 (strongly disagree) to 4 (strongly agree); however, some items use a different response format to prevent agreement bias. Higher scores on the symbolic racism scale indicated

greater levels of symbolic racism. The Symbolic Racism scale demonstrated good internal consistency in the original 1999 UCLA study ($\alpha = .79$; Henry & Sears, 2002).

Stress Manipulation. To examine the effect stress has on eyewitness identification accuracy, participants viewed either a high stress video, a low stress video, or no video (no stress, control). Participants were randomly assigned to one of three stress conditions (high-stress, low-stress, or no-stress). Participants who were assigned to either high or low-stress conditions viewed the 360-degree virtual reality video that matched their condition. The high-stress video was designed to elicit acute stress, and the low-stress video was designed to induce low stress. The participants were instructed to ensure that their audio was turned on and that they needed to view the video completely without pausing or skipping. Additionally, the instructions indicated that participants were free to explore the environment by clicking and dragging their mouse in any direction they chose, designed to create an immersive virtual reality experience through a web-based 360-degree video. As a manipulation check, self-reported stress was collected by repeating the same baseline stress and mood measure from the beginning of the study after each stress condition (high, low, and no stress video (control) condition) which is in line with prior eyewitness research (Davis et al., 2019).

The stress-induction video stimuli was selected from the Jena Eyewitness Research Stimuli (JERS) database (Kruse & Schweinberger, 2023). The high-stress participants viewed the scary scene video. In the low-stress video, participants viewed the peaceful forest video. In the no-stress (control condition) participants did not view a video. The stress condition videos (e.g., High stress and low stress) were embedded into the Qualtrics survey software, which was displayed on participants' computer screens.

High Stress. Participants in the high-stress condition viewed a 360 Virtual reality video designed to elicit acute stress. The video was 2 minutes and 48 seconds in duration. The environment in the video depicts a dark, dimly lit industrial basement with three hallways, which have a few wooden gates. The video begins with eerie music and all participants can see is a landscape video with several empty hallways. The video audio makes eerie sounds that increased and decreased in frequency, and at 23 seconds, a gate located in the far-right hallway of the video, a person in black hooded clothing and a white face mask peeks out into the hallway. At 42 seconds, another individual in an identical appearance with black hooded clothing and a white face mask begins to lurk out into the hallway. At minute 1:04, a hooded individual pops out, and individual 2 pops out at 1:10. At 1:15, the audio makes a rattle, and at 1:19, the lights switch off, then on at 1:21, off at 1:23, on at 1:25, off at 1:29, 1:32 on, 1:35 figure 1 peaks out more, from 1:39-1:41 the lights flicker 4 times, at 1:50 the lights turn off, the music continues but gets more rapid at 1:57 and at 2:00 the lights flicker, and at 2:00 there are 2 screams, at 2:05 the lights turn off, at 2:08 the lights turn on and an individual is standing in the middle, from 2:08-2:16 the music speeds up, at 2:16 steps towards the video abruptly and then steps back at 2:19 and the lights turn off, at 2:21 the individual in the far right hallway is standing in the distance and then the music fades until 2 minutes and 36 seconds where that individual begins to run towards the video and a screaming noise occurs twice.

Low Stress. Participants in the low-stress condition watched a 360-degree virtual reality video, in the same format as in the high-stress condition. The video lasted 2 minutes and 49 seconds. It showed three different parts of a peaceful forest, with the same background audio throughout. The audio included nature sounds and intermittent

bird chirping. The first scene was a wooded forest area from 0:00 to 1:09; the second was a greenery-focused forest area from 1:09 to 2:09; and the last was another wooded forest area from 2:09 to 2:49.

Control. Participants in the control/no-stress group did not view a stress-induction video. Instead, they received the same baseline mood and stress measure as the high and low stress conditions and proceeded to the next part of the study.

Crime Video. Participants were randomly assigned to view one of two crime videos. The content of the video was identical, such that the same theft occurred, and the perpetrators performed the same actions and remained looking forward at the screen, which provided a frontal facial view for approximately 3 seconds. The participants viewed a crime video with either a Black perpetrator or a White perpetrator for the same length of time (approximately 26 seconds). Additionally, the videos show the perpetrator as being approximately 13 feet away from the camera. Additionally, only one person, who was the perpetrator, was shown throughout the entire video. Specifically, in both crime videos, the perpetrator comes through a door and walks into an empty hallway with a briefcase. Next, the perpetrator's profile view of their face is shown when she sits down with their body facing towards the side of the camera. Next, the perpetrator approaches a set of two empty chairs where a black bag is sitting on one of the chairs. The perpetrator proceeds to look around and then grabs a laptop or tablet out of the black bag that is sitting on the chair and puts the device in their briefcase. After putting the item in her bag, she looks towards the camera for approximately 3 seconds and then gets up and walks through the door in the hallway to leave.

Lineup Identification Outcome. Participants viewed one of two simultaneous target-absent photo lineups. One lineup consisted of faces of only Black females (see Figure 1) and the other lineup consisted of faces of only White females (see Figure 2).

Figure 1.

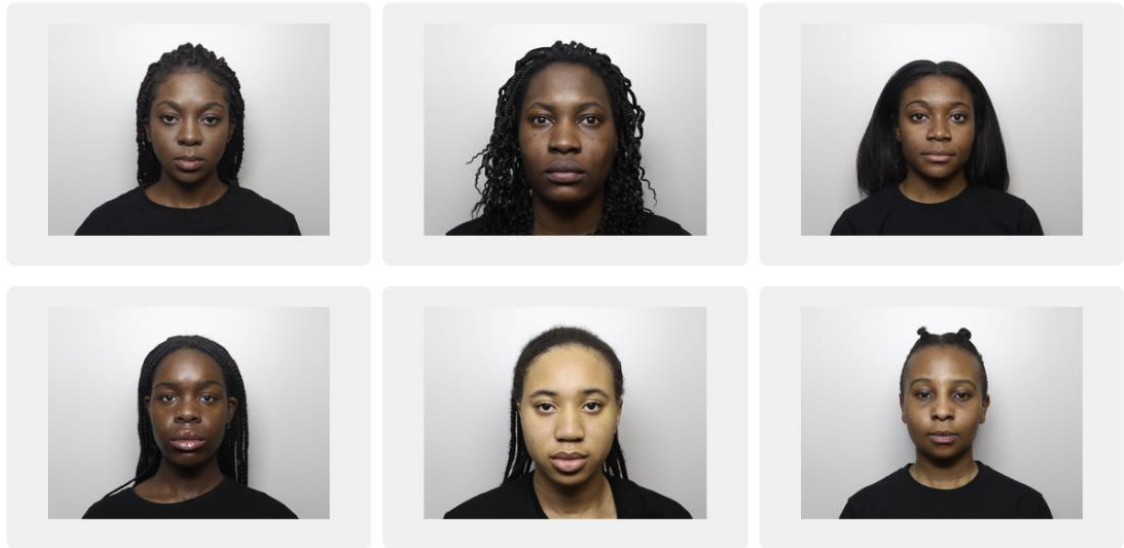
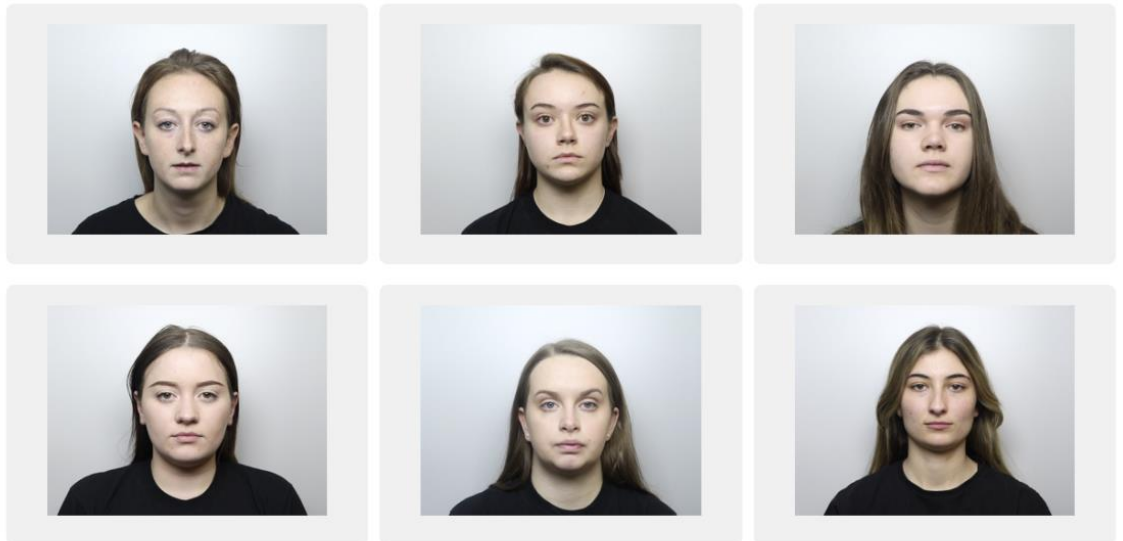


Figure 2.



Note. The lineup images were recorded using a booth on loan from the Video Identification Parade Electronic Recording (VIPER) Bureau, West Yorkshire Police, England. These images have not been quality assured by the VIPER Bureau, and the authors accept full responsibility for their quality. The people depicted are actors, not actual culprits or lineup members in real criminal cases. All actors consented to publication of their photograph in academic journal articles.

The photo lineup included six faces of individuals that resembled each other, and one face was chosen as the innocent suspect, which most closely resembled the culprit from the crime video based on preexisting similarity statistics. Both lineup identities were selected from the eyewitness identity lineup database (Fitzgerald et al., 2025). To ensure that the lineups were reliable and valid, they were constructed using preexisting similarity index data and discriminability scores from past research. Both lineups were constructed in a 3 x 2 photo array format, with three facial photos on the top row and three on the bottom row. Pictures of the faces were taken against a white background. The background and photo formats were repeated across conditions to maintain reliability.

Participants either selected a photo from the lineup (incorrect identification) or indicated that the culprit was not present (correct identification/rejection). Participants then rated their confidence regarding their identifications/rejections. Confidence was assessed on a scale from 0% (Not at all confident) to 100% (completely certain). The directions asked how confident they were that their lineup decision was correct.

Procedure

Participants were told that the purpose of the study was to examine how people perceive and recall information, with the aim of investigating how situational factors affect memory and decision-making. After a brief description of the study's purpose, participants indicated their consent and were informed that the study would take a maximum of 60 minutes to complete. Participants began the study by providing their baseline stress and mood levels (see Figure 3). Next, participants were randomly assigned to complete self-report measures not included in the present analysis. Participants then completed the Symbolic Racism Scale to examine explicit racial attitudes (Henry &

Sears, 2002). Next, participants completed the Race Implicit Association Test (IAT; Xu et al., 2014) on the Project Implicit website to assess implicit racial attitudes.

Specifically, participants were given instructions on Qualtrics that stated the following:

“Please click on the following link <https://implicit.harvard.edu/implicit/takeatestv2.html> and follow the instructions on the website to complete the test labeled ‘Race IAT.’ NOTE that on the next page of this study, you will be asked to select the category that best matches the feedback you received at the end of the Race IAT before continuing in this study. DO NOT close this window/exit this browser when you are prompted to complete the task.”

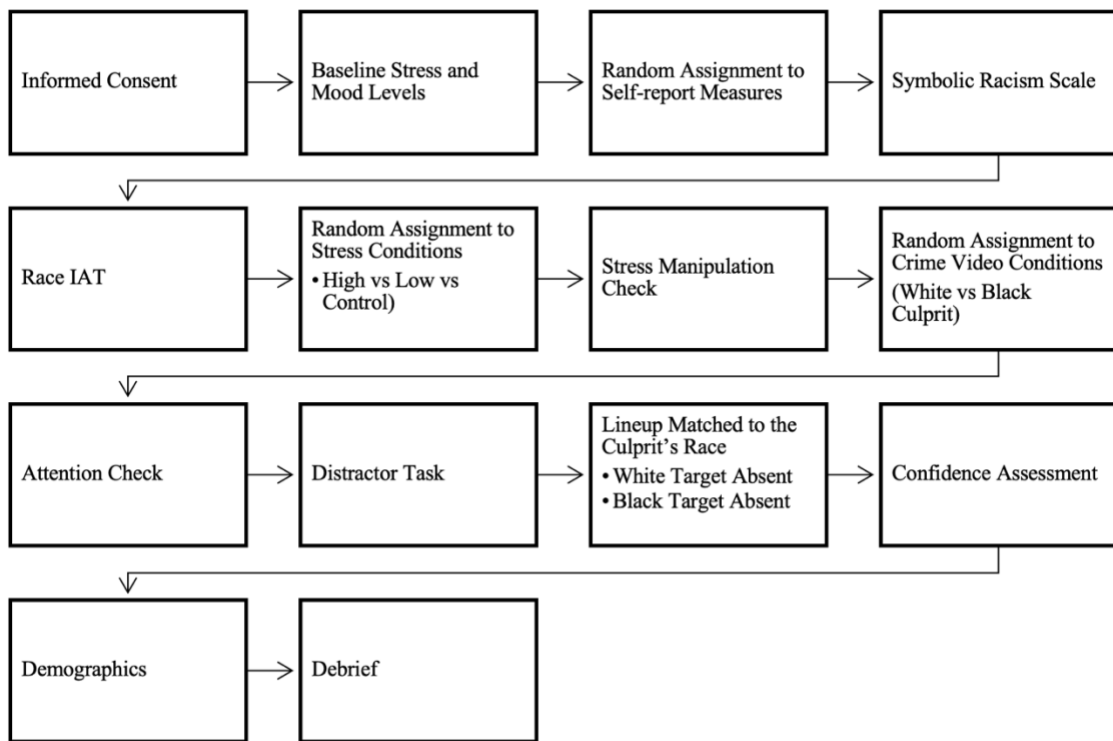
When participants completed the Race Implicit Association Test on Project Implicit, they were instructed to return to the Qualtrics survey to select the answer choice that best matched the feedback they received on the Race IAT. After participants completed selecting the answer that best matched their feedback on the Race IAT on Qualtrics, participants were randomly assigned to one of three stress conditions: a high stress video, a low stress video, or a control (no stress) video (Kruse & Schweinberger, 2023). Following each stress condition, participants were given the stress and mood measure again, which served as a manipulation check for stress. Next, participants were randomly assigned to one of two crime videos with either a white culprit or a black culprit from ELI (Fitzgerald et al., 2025). After viewing the crime video, participants were asked to indicate the race of the perpetrator in the video as an attention check and then completed a distractor task.

Next, participants were randomly assigned to view the crime video of either a Black or a White female culprit. Following the video, participants viewed a target-absent

simultaneous lineup that matched the race of the culprit in the video they saw, identified or rejected a suspect, and rated their confidence. Participants then completed a series of demographic questions assessing their age, race, gender, sexual orientation, education, occupation, political ideology, religion, sleep duration from the previous night, mental-health history, prior experience with police identification procedures, previous exposure to witnessing a crime, and level of cross-racial contact. Finally, participants were debriefed, thanked, and provided with contact and counseling resource information.

Figure 3

Procedure Flowchart Diagram



Note. Flowchart outlining the sequential steps of the experimental procedure, including random assignments, stress manipulations, and outcome assessments.

Results

A point-biserial correlation was conducted to assess the association between implicit racial bias, dichotomized as 0 = no and 1 = yes, and explicit racial bias, measured as the sum of symbolic racism scores. The analysis showed a nonsignificant, weak positive relationship between implicit and explicit racial bias, with $r_{pb}(78) = .16$ and $p = .16$. This suggested that implicit racial bias scores were not significantly associated with explicit racial bias, highlighting the distinctiveness of both bias constructs.

A binary logistic regression was conducted to assess how well implicit racial bias, stress, and target race predict eyewitness identification accuracy. Specifically, the analysis examined how the predictors influence the likelihood of making a correct rejection versus an incorrect/false identification from the lineup. Implicit racial bias was coded as “BiasedY/N” = yes vs no, “StressPresent” = stress presence (high stress) vs absent (low stress and no stress video). Target race “LineupRace” (White or Black lineup), eyewitness identification accuracy “Lineup_Accuracy” (0 = correct rejection; 1 = Incorrect / False ID). If the participant was coded as incorrect or false ID, participants selected a face from the lineup or selected “I don’t know.”

The overall model for identification (see Table 1) was not statistically significant $\chi^2(7) = 9.57, p = .21$. The model explained between 11.33% (Cox & Snell R^2) and 16.7% (Nagelkerke R^2) of the variability in eyewitness identification accuracy. The -2 Log likelihood was 80.41. The Hosmer-Lemeshow test was not statistically significant, $\chi^2(5) = 0.00, p = 1.00$, suggesting the model is a good fit for the data. 75% of the model’s cases were correctly classified.

Implicit racial bias was not a statistically significant predictor of identification accuracy, $B = -0.84, SE = 0.82, p = .30, OR = 0.43, 95\% CI [0.09, 2.14]$. This suggests

that when implicit racial bias was present, the odds of making a false identification were 57% lower than when it was absent; however, this effect was not statistically significant.

Table 1

Binary Logistic Regression Predicting False Identification

Predictor	B	SE	OR	95% CI for OR	<i>p</i>
Implicit Bias	−0.842	0.818	0.431	[0.087, 2.142]	.30
Stress	20.024	14210.363	—	—	1.00
Target Race	0.431	0.853	1.538	[0.289, 8.181]	.61
Bias × Stress	−18.569	14210.363	—	—	1.00
Bias × Race	−0.544	1.233	0.58	[0.052, 6.502]	.66
Stress × Race	−20.535	14210.363	—	—	1.00
Bias × Stress × Race	19.262	14210.363	—	—	1.00
Constant	1.179	0.572	3.25	—	.04

Note. Outcome variable: 0 = correct rejection; 1 = false identification. Implicit bias, stress condition, and target race were coded categorically. Dashes indicate uninterpretable or unstable odds ratios in the logistic model.

Stress was not a statistically significant predictor of identification accuracy. The presence of stress showed a large coefficient, $B = 20.02$, $p = 1.00$, $OR \approx 497$ million, 95% CI [0.00, -].

Lineup race was also not a significant predictor of identification accuracy, $B = 0.43$, $p = .613$, $OR = 1.54$, 95% CI [0.29, 8.18]. This indicated that participants were

about 1.5 times more likely to make a false ID in Black lineups than in White ones; however, this effect was not statistically significant.

The three-way interaction between implicit racial bias, stress, and target race was not statistically significant, $B = 19.26$, $SE = 14,210.36$, $p = .999$, $OR \approx 2.3 \times 10^8$, 95% CI [0.00, -]. Given the very big odds ratio and missing upper bound of the confidence interval, it suggests that the sample size was likely too small to make reliable estimations and conclusions about how the interaction between implicit racial bias, stress, and target race predicts the likelihood of making a correct rejection or incorrect/false identifications in a lineup. Overall, the results did not support the hypothesis, and there were no significant interactions regarding eyewitness identification accuracy.

Exploratory Analyses

Given the lack of statistical significance in the primary analysis, a hierarchical regression was conducted to assess how the independent variables, when centered, influence eyewitness confidence. Implicit racial bias, stress, and target race was entered in model 1 and accounted for a significant portion of variance, $R^2 = .11$, $F(3, 76) = 3.22$, $p = .03$. A significant main effect of bias on confidence was found, $\beta = .33$, $t(134) = 4.57$, $p = .003$, such that as bias increased, confidence increased. Additionally, a trending three-way interaction among bias, stress, and target race, predicting confidence was found, $F(7, 72) = 2.00$, $p = .067$, $R^2 = .16$. Overall, these results contribute to the ongoing eyewitness memory literature and demonstrate the importance of continued research into the potential roles of individual and situational factors in influencing eyewitnesses' accuracy and confidence.

Discussion

The current study investigated the influence and interaction of implicit racial bias, stress, and target race on eyewitness accuracy. Specifically, a binary logistic regression was conducted to assess whether implicit racial bias, stress, and target race predict the likelihood of making either a correct rejection or an incorrect/ false identification. According to the binary logistic regression, the individual predictors, such as implicit racial bias, stress, and target race, were not statistically significant and did not predict eyewitness identification accuracy. Given this, a hierarchical regression was utilized to assess eyewitness confidence using the same variables: implicit racial bias, stress, and target race, after being centered on the mean. Bias significantly predicted eyewitness confidence, and there was a trending three-way interaction among implicit racial bias, stress, and target race, which may become more statistically significant if a larger sample were obtained. Overall, despite the main hypothesis being denied, these findings provide both scientific and legal contributions to the community.

Eyewitness identification accuracy is paramount in police investigations (Vitriol et al., 2019; Wells et al., 2020). The current study seeks to generalize to the broader population of eyewitnesses and lineup identification procedures. This study has the potential to inform eyewitness identification procedures. Understanding how situational stressors and environmental context interact with implicit racial bias and eyewitness identification is beneficial, given the continued use of these procedures (Gronlund et al., 2014). Future studies should explore how implicit bias, situational stressors, environmental context, and eyewitness identification interact in a field setting.

Past research (cf. Vitriol et al., 2019) examined how racial attitudes and lineup presentation format affect eyewitness identification accuracy in the context of cross-racial

identifications; however, little research has explored how the interaction of stress and implicit bias may amplify the CRE in simultaneous lineups.

Low identification accuracy may partly be explained by the study's use of Qualtrics, an online research platform that allows participants to participate outside a laboratory setting. Therefore, participants watched a mock crime video in which they saw a culprit (encoding phase), and later they were asked to decide whether the culprit in the video was also in the lineup that took place toward the end of the study. This lineup could have occurred in a different environment and context than at the beginning of the study, when they first learned what the culprit might look like. As a result, participants' accuracy could have been decreased due to the context of where the study took place.

Potential Limitations

The small sample size increased the study's internal validity; however, it likely affected the statistical analysis. Given this, future research should continue this investigation with the aim of obtaining a larger sample than what was used in the current research. Further, implicit racial bias was collected through participants' self-reports of their feedback, which may have affected the validity of their bias scores. Specifically, when given feedback on racial stereotypes, participants may feel the need to disguise their results, aligning with social consensus.

The pre-recorded mock crime videos use a scenario of a woman stealing a purse off a chair; this was intended to be neutral in terms of emotionality/valence so that stress effects from the stress induction were not confounded with the effects of the video. Specifically, if both the stress induction and crime video stimuli elicited emotionality, logical conclusions about the effect of stress on eyewitness identification accuracy likely

could not have been drawn, because distinguishing which stimuli contributed to the participants' emotional state would not have been possible. The duration of encoding (time participants viewed the crime video) was repeated across conditions to limit the effect of estimator variables, which are aspects outside of the control of the criminal justice system that could affect the validity of eyewitness accounts (Wells, 1978). However, eyewitness encoding situations are variable in the real world, as individuals experience viewing different types of crimes that vary in length and emotional intensity. Some crimes are more stress-inducing (violent crimes), while others are less stress-inducing (non-violent crimes). As a result, the current study lacks ecological validity because it emphasizes control of outside variables. Future studies could examine various types of crimes and different viewing conditions to assess their influence on implicit racial bias, stress, and eyewitness identification accuracy.

The current study utilized an interdisciplinary approach to gain a broader understanding of various aspects of psychology. Specifically, the findings have implications for cognitive, forensic, and social psychology. Eyewitness identification evidence should be interpreted with caution, as multiple factors can influence identification accuracy. These factors include stress, racial attitudes, and facial identification procedures. In forensic contexts, sequential lineups may result in fewer false identifications than simultaneous lineups because they rely more on absolute judgments than relative ones (Sporer, 2001; Vitriol et al., 2019). Therefore, favoring sequential over simultaneous lineups in police procedures could help decrease false identifications, especially in cross-race situations. This is based on the theory that when

viewing a member of an outgroup, people are more likely to rely on relative rather than absolute judgments (Sporer, 2001; Vitriol et al., 2019).

Perception plays a significant role in the cross-race identification phenomenon and implicit racial bias (Young et al., 2012). Such that both are influenced by facial perception. As a result, it is important to put forth training that targets perceivers becoming more likely to utilize detailed facial processing in cross-race scenarios, which focuses on individuation, one of the mechanisms that has been found to be useful in reducing the effect of cross-race identifications and subsequent implicit racial bias levels (Lebrecht et al., 2009). Research has identified two notable mechanisms by which the cross-race effect could be mitigated. These include increasing contact and further experience with individuals of other racial and ethnic groups. Therefore, social intervention and education into such phenomena may help mitigate the negative racial stereotypes and bias that they have on individuals' perceptions of people. Intervening from a societal level would be a positive step forward and starting with legal interventions would be a valuable first start towards that direction.

The findings of this study have policy implications for lineup procedures. For example, to mitigate the effect stress may have on eyewitness identification accuracy, the time between witnessing a crime and lineup identification should be extended. However, future research should examine the optimal time between viewing the crime and bringing the witness in to make an identification.

Implementing racial bias awareness training in law enforcement may help educate law enforcement agents and officers about their potential implicit and explicit racial attitudes, which may help them navigate their actions with lineup construction, as well as

provide them with the knowledge on how to navigate eyewitness identifications and overall lineup procedures. Additionally, educating law enforcement on stress effects could contribute to an improvement in investigative and lineup procedures and practices overall. In that, officers and agents will become more informed with the collection of eyewitness evidence. Such that, investigators can utilize findings from stress research to inform how they interview and interrogate suspects and witnesses, as well as how they create an environment for lineups.

To reduce the impact of eyewitness misidentification, it is crucial to educate judges and juries about the reliability and validity of eyewitness evidence. Introducing expert testimony that provides an overview and explanation of factors influencing the evidentiary value of eyewitness accounts could greatly benefit the criminal justice system. For example, informing the system about variables like cross-race identification, implicit racial bias, and stress could help reduce the weight placed on eyewitness testimony, thereby decreasing the likelihood of wrongful convictions. To summarize, the findings emphasize the importance of developing modifications to current eyewitness identification practices to reduce ongoing racial disparities in legal outcomes.

Future Research

The current study examined the effect of stress among three conditions (no stress (control), low stress, and high stress). Future research should explore whether moderate stress amplifies or mitigates the effects of implicit racial bias on eyewitness identification accuracy. Based on the Yerkes Dodson law that moderate levels of arousal can increase memory accuracy, it is likely that when stress is induced that meets the moderate arousal threshold, eyewitness identification accuracy may also increase due to an increase in

attention (Gering et al., 2023). As a result, moderate arousal or stress may reduce the potential effects of implicit racial bias. Future research should further validate the stress-induction materials by measuring participants' behavioral and physiological responses before, during, and after viewing stress-inducing stimuli.

One of the strengths of the current study is that it was conducted through an online platform (Qualtrics), which offered participants flexibility in when they could take the study. However, despite this strength, it does present the drawback of not being in a controlled laboratory setting, which could have increased the validity of the study. Future studies should conduct this research in a controlled experimental setting. Furthermore, the current study set out to examine the effects of stress on eyewitness accuracy as well as the interaction of implicit racial bias on eyewitness accuracy to provide insight for various avenues of research and law enforcement policies and procedures. To further advance and contribute to this field of study, future research should conduct implicit racial bias, stress, and eyewitness memory research in a field setting to increase generalizability.

Future research should extend the ELI and JERS database for crime and lineup task materials (Fitzgerald et al., 2025; Kruse & Schweinberger, 2023). Specifically, crime and lineup materials for individuals should be created so that the crime videos feature varying levels of stress for the specific identities, allowing stress to be studied across the entire eyewitness procedural context. For instance, material that includes crime videos featuring various violent and non-violent conduct, along with validated behavioral and physiological stress-induction content in those videos, could enhance ecological validity in future studies and yield meaningful insights for eyewitness research.

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Appendix A

Race-based Implicit Association Test (Greenwald et al., 1989)

1. Classify the items for the two target categories (20)
2. Classify the items for the two attribute categories (20)
3. Classify items for all four categories, one attribute and one target category assigned to each of the two keys, using the assignment of categories to left and right keys as in Blocks 1 and 2 (20).
4. Same as Block 3 (40).¹²
5. Classify the two target categories, reversing the key assignments of Block 1 and having more trials than in Block 1 (30).
6. Classify items for all four categories, using the reversed key assignments of the target categories as in Block 5 (20).
7. Same as Block 6 (40).



Appendix B

The Symbolic Racism 2000 Scale

1 = Strongly agree, 2 = Somewhat agree, 3 = Somewhat disagree, 4 = Strongly disagree

1. It's really a matter of some people not trying hard enough; if blacks would only try harder they could be just as well off as whites.

<1> Strongly agree

<2> Somewhat agree

<3> Somewhat disagree

<4> Strongly disagree

2. Irish, Italian, Jewish and many other minorities overcame prejudice and worked their way up. Blacks should do the same.

<1> Strongly agree

<2> Somewhat agree

<3> Somewhat disagree

<4> Strongly disagree

3. Some say that black leaders have been trying to push too fast. Others feel that they haven't pushed fast enough. What do you think?

<1> Trying to push very much too fast

<2> Going too slowly

<3> Moving at about the right speed

4. How much of the racial tension that exists in the United States today do you think blacks are responsible for creating?

- <1> All of it
- <2> Most
- <3> Some
- <4> Not much at all

5. How much discrimination against blacks do you feel there is in the United States today, limiting their chances to get ahead?

- <1> A lot
- <2> Some
- <3> Just a little
- <4> None at all

6. Generations of slavery and discrimination have created conditions that make it difficult for blacks to work their way out of the lower class.

- <1> Strongly agree
- <2> Somewhat agree
- <3> Somewhat disagree
- <4> Strongly disagree

7. Over the past few years, blacks have gotten less than they deserve.

- <1> Strongly agree
- <2> Somewhat agree
- <3> Somewhat disagree
- <4> Strongly disagree

8. Over the past few years, blacks have gotten more economically than they deserve.

- <1> Strongly agree
- <2> Somewhat agree
- <3> Somewhat disagree
- <4> Strongly disagree