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The Effects of Target Facial Stimuli Race, Emotional Expression, and Time Delay on Facial Recognition Memory

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38 pages.

Emotional expression, race, and length of time between initially seeing the face and subsequent recognition potentially contribute to face recognition. In this study, race and emotional expression of the facial stimuli, and time delay between study and test were manipulated. A sample of 91 participants was recruited from Illinois State University. Participants completed a study session and two test phases evaluating facial recognition performance of racially Black and White facial stimuli. Target images from the RADIATE face stimulus set (Conley et al., 2018; Tottenham et al., 2009) were used in this study. Faces were presented with either a happy or angry emotional expression. Participants experienced both no time delay and a 15 min delay between study and test to assess short-term and long-term recognition. A significant main effect of time delay was found with higher recognition at the immediate test than after the 15 min delay. A significant main effect of emotion was found with higher recognition for angry emotional expressions than happy expressions. Lastly, a significant two-way interaction was found for facial stimuli race and emotional expression; angry White faces had higher recognition than the other three conditions. However, the predicted delay by expression interaction was not found. These results are discussed in the context of racial demographic, the cross-race effect (CRE), and WEIRD samples.

KEYWORDS: Facial recognition, race, emotional expression, forgetting

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M.S.

CONTENTS

TABLES

FIGURES

CHAPTER I: PROBLEM STATEMENT

Facial recognition is a common aspect of human life; we do it all the time. Humans generate a database of about 10,000 faces during their lifetime (Jenkins et al., 2018). With so many faces in any one person's memory, existing patterns in facial recognition memory tasks are important to investigate. Furthermore, certain emotions may be more or less salient than other emotions with regard to memory for faces. The literature to date has produced mixed findings on whether positive or negative emotional expressions are remembered better. The mixed findings could be in part due to the variability in the methodology used by different researchers.

Most studies of facial recognition involve a study phase with a list of faces to view and a recognition phase where the same and different faces are judged as old or new. Facial recognition study designs typically incorporate a time delay between the study and test phases. However, different researchers implement different delays ranging from immediate delays (Jackson et al., 2009) up to a 25 min delay (Ackerman et al., 2006; D'Argembeau et al., 2003; Pazderski & McBride, 2018) and even longer delays lasting days or weeks, particularly in eyewitness testimony research. Furthermore, the literature has produced mixed results on the impact of emotional expression in the faces studied. More specifically, the extant literature reports both positive and negative emotional expression advantages (e.g. Ackerman et al., 2006; D'Argembeau et al., 2003; D'Argembeau & Van der Linder, 2007; Pazderski & McBride., 2018). Finally, the effect of race on facial recognition has not been studied enough to draw strong conclusions, especially with regard to the impact of emotional expression and delay. Over the course of this thesis, I will review the effects of emotional expressions and of time delay on facial recognition, while also considering the lack of racial diversity within the studies that have examined these factors.

CHAPTER II: EMOTIONAL EXPRESSION AND FACIAL RECOGNITION

One aspect of facial recognition that has received attention in research studies is the effect of emotional expression. A key question is: Which emotional expressions contribute to better recognition of faces and why does this occur? Across emotional expression studies there is support for both positive and negative emotion advantages in facial recognition. Perceiving positive emotional expressions suggest friendliness, agreeability, and optimism from the person being viewed. Perceiving negative emotional expressions suggest unfriendliness, irritation, and potential danger from the person being viewed. The question becomes: Are people more or less likely to remember a happy face, exuding positivity, or an angry face, exuding negativity?

D'Argembeau et al. (2003) reported a recognition advantage for happy faces over angry faces. Participants were either placed in an incidental (no knowledge of the coming memory test) or intentional (knowing a memory test is coming) learning condition and were asked to recognize those studied happy and angry target faces with a novel, neutral expression at test. In the incidental learning condition, participants were asked to state how old the target facial stimulus individual appeared to be. Incidental learning did not produce a difference in recognition across the happy and angry expression conditions - participants who were incidentally exposed to target facial images did not recognize the faces from the study phase better as a result of the emotional expression depicted. When the learning was intentional, however, participants better recognized target faces expressing happiness in the study phase. Participants who were exposed to target facial images and were told there would be a memory test, recognized the faces from the study to test phase better as a result of the type of emotional expression depicted; in particular, in this study, the ability to recognize happy faces was greater than that for angry faces. These results suggest that emotional expressions can influence facial encoding and recognition abilities.

In a follow-up study, D'Argembeau and Van der Linden (2007) used incidental learning tasks to draw participants' attention to characteristics of the individual within the target photos. In the first experiment, the researchers tested if recognition was affected by where on the face the participants' attention was directed based on the encoding instructions. During the study phase, participants were divided into one of three encoding conditions and asked to rate (a) the size of the target photo's nose, (b) how intelligent the person in the target photo appeared, or (c) the intensity of the emotional expression; ratings were made on a three-point scale. The target facial stimuli displayed either happy or angry emotional expressions. During the test phase of Experiment 1, participants viewed facial stimuli from the study phase with additional new facial stimuli. All of the facial images presented during the test phase, both studied and unstudied, were displaying a novel, neutral expression. Participants indicated if the facial stimuli were presented during the study phase or not. If participants indicated viewing a face during the study phase, they were also asked to report if the target face displayed a happy or angry expression at study.

D'Argembeau and Van der Linden (2007) found better facial recognition memory for happy expressions compared to the targets with angry expressions. Further, facial identity was best remembered by participants who judged intelligence and emotional intensity than those who judged the size of the nose. It could be suggested that participants were more likely to recognize faces when they were being asked to infer something beyond the physical attributions seen in the image. More so, intelligence is not directly observable from an image while judging the size of a nose is.

D'Argembeau and Van der Linden's (2007) Experiment 2 implemented a similar procedure to Experiment 1. Participants rated facial stimuli on perceived intelligence, nose size, or intensity of emotion displayed using three-point scales during the study phase. During the test phase participants indicated if they "remember," "know," or "guess" that the face was studied when they made an "old" response. The results for overall recognition showed a happy expression advantage for facial recognition memory. Further, during the condition in which participants rated target faces on perceived intelligence, remember responses were higher for faces displaying happy faces than for angry faces. Thus, across the two experiments a happy face advantage was reported.

Other researchers have also found a happy face advantage in facial recognition. Shimamura et al. (2006) reported that neutral and happy expressions presented during incidental learning conditions were better recognized than angry, surprised, or fearful expressions. In a study by Bridge et al. (2010), participants were exposed to a happy or sad scenario before viewing each neutral target face. An example of a sad encoding scenario used in the study phase is "Tom's best friend died;" an example of a happy encoding scenario is "Mary was awarded a scholarship." In a later surprise test phase, participants indicated if they had observed the target facial stimuli during the study phase or not. Bridge et al. (2010) showed that even when presented with neutral expressions, faces studied with happy stories at study were better remembered at test than neutral faces studied with sad stories.

In contrast to these studies showing a positive emotion advantage, other researchers have reported a negative emotion advantage in facial recognition. Jackson et al. (2009) included target facial stimuli displaying neutral, happy, or angry emotional expressions in their study, but the participants were asked to study and recognize the faces in a visual short-term memory task instead of a recognition test after a delay. They found that target faces displaying anger were more likely to be remembered than happy faces when tested immediately. The researchers proposed that participants might be more inclined to recognize angry faces for short delays due to the target face appearing threatening and being more physiologically arousing than happy faces, both of which are important in evaluating an immediate threat.

Fox et al. (2000) similarly reported a negative emotional advantage in a task using arrays of target stimuli with angry, happy, and neutral expressions. Participants were asked to identify the face that was not like the others, instead of recognizing faces they had seen before. For example, participants were tasked with identifying an angry or happy expression within three neutral expressions. The researchers then compared the reaction times for selecting angry expressions from neutral expressions with reaction times for selecting happy expressions from neutral expressions. They found that across all trial types, participants had faster reaction times when selecting an angry face out of an array than when selecting a happy face out of an array. This result suggests faster identification of angry faces but not necessarily better memory for angry faces.

Ackerman et al. (2006) used target photos that displayed either a neutral or angry expression using a racially diverse set of target images. Most studies have used White faces as the stimuli with the exception of Shimamura et al.'s (2006) study, where Asian and White faces were included. In Ackerman et al.'s (2006) study, participants were asked to identify the target facial stimuli, which were either racially Black or White, in a recognition test. Unlike other studies, pairs of faces were presented simultaneously. Encoding of the faces was incidental – participants were not told about the memory test at study. This study implemented a between-subjects design in order to establish if a cognitive constraint, of viewing two facial images at the same time, resulted in an out-group heterogeneity effect. Their rationale was that angry other-race faces would require immediate processing, which would lead to higher recognition, than same-race faces.

The participant sample for Ackerman et al. (2006) was composed of all White individuals. Interestingly, participants were better able to recognize White neutral target faces than Black neutral target faces. This result shows a cross-race effect (CRE) for the neutral faces, as the White participants in the study recognized White faces more often than Black faces when a neutral expression was depicted. However, they found that White participants had better recognition memory for Black angry faces than White angry faces. This result shows an inverse CRE for angry Black faces, as the more recognized faces were of a different race than the race of the participants. An inverse CRE is conceptually similar to an out-group heterogeneity effect. The logic of the out-group heterogeneity effect reasons that racially out-group members are processed as an individual rather than grouped together broadly under a racial category. Further, White participants recognized Black angry faces better than Black neutral faces, indicating that angry Black faces produced high recognition for the participants in this study.

The salience of the emotional expression of the target stimuli was dependent on the race of the target. When the expression was neutral, racially White targets had higher recognition than Black targets. But, when the expression was angry, Black targets had higher recognition than White targets. Recognition was different depending on the emotional expression and race of the target face.

Ackerman et al.'s (2006) study is one of the only studies to examine the combined effects of emotional expression and race on facial recognition memory. In the current study, I further examined the effects of race and emotional expression on facial recognition.

CHAPTER III: EFFECT OF TIME DELAY

Another factor that has varied in studies on facial recognition is the delay between study and test. Time has critical implications for memory research. If participants are being asked to remember stimuli for any amount of time, the amount of time between study and test is an important factor within the experiment due to the possibility of variable amounts of forgetting. Most relevant to this thesis is the effect of time delay on facial recognition.

The studies reviewed thus far have implemented various time delays. For example, D'Argembeau et al. (2003) reported the happy emotion advantage with a 5 min time delay between study and test. Time delay was held constant with participants in either intentional or incidental encoding groups. Happy faces were recognized more often after this delay compared to an angry emotional expression. D'Argembeau and Van der Linden (2007) reported a happy emotion advantage with a 1 min time delay between study and test. However, Ackerman et al.'s (2006) results showed that faces displaying anger were better recognized than neutral faces across a delay of 5 min in which the distractor task involved watching a film clip.

Shimamura et al. (2006) implemented an immediate recognition test with no delay and found a happy face advantage. Bridge et al. (2010) gave participants a distractor task of counting backwards for 30 s in between the study phase and recognition test. They found that when neutral facial stimuli were paired with a positive scenario, facial stimuli were recognized significantly more often than neutral stimuli paired with a negative scenario. Jackson et al. (2009) implemented a 1 s delay between study and test of the faces and found an angry face advantage. Thus, delay does appear to be an important factor in the expression effects, but the effects have not consistently correlated with length of delay.

Pazderski and McBride (2018) addressed the delay inconsistencies in a study of facial recognition testing memory for angry and happy faces across delays ranging from 15 s to 25 min. The goal of the study was to manipulate delay within a single study to examine the interaction between delay and emotional expression. They predicted that there would be no main effect of emotional expression in facial recognition. However, they predicted an interaction between delay and emotional expression based on a review of the past results. That is, they predicted that recognition would be better for faces with angry expressions at shorter delays and happy expressions at longer delays.

The results supported their hypothesis. Pazderski and McBride (2018) reported an angry face advantage for delays less than 3 min and a happy face advantage for delays longer than 3 min (recognition was similar for the two expressions at the 3 min delay). These results support the idea that emotional expression affects the rate at which faces are forgotten. However, the target faces for this study were homogeneously White and the racial demographics of the participant sample was not included. Therefore, it is unclear if racially heterogeneous faces would show the same results, particularly given Ackerman et al.'s (2006) results showing different recognition performance for Black and White faces based on their emotional expression. The goal of the current research was to replicate Pazderski and McBride's (2018) using Black and White facial stimuli.

CHAPTER IV: CONSIDERING RACE IN RECOGNITION RESEARCH

Psychologists have proposed that all humans have the ability at birth to display basic emotions (Ekman, 1999). Going beyond biological innateness, researchers can consider how an individual's or group's culture influences emotional expression. Subsequently, we could consider how facial recognition varies with emotional recognition. Given the composition of predominately White participants in psychological research samples (Schulz et al., 2018), extending primary attention to other races less prominently researched will give more generalizability to psychological constructs, along with more information about particular racial groups and cultures.

According to Schulz et al. (2018), a majority of psychological research includes samples of western, educated, industrialized, rich, and democratic individuals (WEIRD samples). This issue is extremely important, considering that the United States has a diverse landscape ethnically, racially, and culturally, and is becoming increasingly diverse over time (Jensen et al., 2021). If the samples of participants and stimuli in psychological research are primarily White, what do we really know about psychological concepts as they apply to non-White individuals? Cultural traditions and lifestyles impact individuals and groups in a variety of ways; lumping so many diverse people into a comprehensive category limits generalizability of our psychological knowledge. In short, there is potential knowledge to be tapped into and further research areas to be explored by considering the diversity of our human samples and the stimuli used in psychological studies.

It is important to consider the effects of race on facial recognition because of the historic issues of systemic racism and the present-day effects of ongoing inequality for minoritized persons in the United States. Unintentional implicit racial bias has been observed in research with samples of White participants while generalizing those results to a population larger than the sample encompasses. One such example of racial bias can be found in facial recognition software (Bacchini & Lorusso, 2019; Lunter, 2020). Homogenous testing samples and stimuli are one likely reason for racial bias in facial recognition software. The implications of the facial recognition software being trained on a particular race creates inequality within the software for other races using or being subject to the software's capabilities. For example, Bacchini and Lorusso (2019) discuss the implications of facial recognition software being trained with White faces and not effectively identifying Black faces, yet the facial recognition software is used as evidence to identify suspects and incarcerate individuals. A disproportionate number of minoritized persons are incarcerated compared to 10% of the prison population that is racially White (Bureau of Justice Statistics, 2019). Thus, the current study focused on the effect of race represented in the facial stimuli participants are tested with to investigate and discuss patterns in recognition memory.

The CRE shows that individuals are most likely to individuate, and thus better recognize, members of their own race, while categorizing or grouping members from other races, leading to worse recognition due to inattention to out-group specific facial features (Tanaka et al., 2004). One reason for the CRE may be limited exposure to other race faces, leading to better recognition of faces of the individual's own race. Individuating faces aids in the encoding process of a face. If a person does not individuate other-race faces, those other-race faces will be less accurately recognized compared to same-race faces. The CRE is also known by other names, such as the cross-race bias, own-race bias, and other-race bias, but for the rest of this thesis the CRE terminology will be used. In Ackerman et al.'s (2006) study, where White participants recognized White target stimuli with a neutral expression better than Black target stimuli with a neutral expression, the CRE was supported. However, Black facial stimuli were better recognized than White facial stimuli when the emotional expression was anger. These findings contrast with the CRE and show that emotional expression can moderate the CRE, since an inverse CRE was observed in White participants when facial stimuli of another race were emotionally displaying anger.

Smith et al. (2015) investigated the effects of categorizing target facial stimuli using an intersectional approach. For example, gender, race, and emotional expression were the chosen categories for the target images. A happy Black woman and an angry White man are two examples of the three categories that were combined to create a target image. Participants in this study were asked to categorize target faces by either race or gender. Emotional expression was incidental, meaning participants were not overtly made aware of the emotional expressions of the target facial stimuli being presented. The racial composition of the sample was 56% identifying as White, 38% identifying as non-White, and 6% choosing not to identify. The researchers were interested in whether the emotional expression of the target photos would affect the race or gender categorization. When participants were asked to categorize facial stimuli by race, response times were faster than when they were asked to categorize the faces by gender.

In the condition where participants categorized target faces by race, the researchers predicted a disordinal interaction; they predicted faster categorization for angry Black faces and happy White faces than happy Black faces and angry White faces, but the results were only marginally significant. Overall, Black faces were more quickly recognized than White faces. The sample's demographic was homogeneous with majority of participants self-identifying as White, female, and young.

CHAPTER V: VARIABILITY IN FACIAL STIMULI

The aforementioned studies report various sources for the facial stimulus images used in the experiments. Ackerman et al. (2006) did not specify a database where their target facial images were taken from but did specify the racial identities of the facial stimuli. Smith et al. (2015) used four different facial stimulus databases with White and Black faces for their study. D'Argembeau et al. (2003) took facial images from four different databases and did not specify the races of target images. Fox et al. (2000) implemented schematic drawings of happy and angry faces. Shimamura et al. (2006) used facial stimuli from the Japanese and Caucasian Facial Expressions of Emotion (JACFEE) set (Matsumoto & Ekman, 1988). D'Argembeau and Van der Linden (2007), Bridge et al. (2010), and Pazderski and McBride (2018) used facial stimuli images from the Karolinska Directed Face Emotion set (Goeleven et al., 2008), which contains only White target images. Jackson et al. (2009) used facial stimuli from the Ekman Pictures of Facial Affect set, which is also exclusively White. The current study implemented facial stimuli from the RADIATE face stimulus set (Conley et al., 2018; Tottenham et al., 2009), which includes Latinx, Asian, Black, and White faces. The racial demographics selected were Black and White for the current study.

CHAPTER VI: THE CURRENT STUDY

Due to the lack of racial diversity in facial stimuli included in previous studies, in the current study, I re-examined the emotional expression by delay interaction found by Pazderski and McBride (2018) with Black target faces and White target faces to determine if race affects this interaction. The effects of emotional expression (happy and angry) were examined because research has shown that White participants recognize angry Black faces more accurately than angry White faces (Ackerman et al., 2006). In addition to the racial and emotional expression differences of the target facial stimuli, the impact of time delay on facial recognition was considered. Thus, the current study manipulated the race of the target faces, the emotional expression of the faces, and the study-test delay.

Based on the demographic profile of Illinois State University, my hypotheses were based on obtaining a majority White participant sample.

(1) I predicted a significant main effect of facial stimulus race on recognition accuracy based on the CRE found in past research (Ackerman et al., 2006; Tanaka et al., 2004). Specifically, I predicted that overall, the majority White participants would recognize White target faces better than Black target faces.

(2) I predicted a significant interaction between delay and emotional expression on recognition accuracy. Better recognition was expected for angry faces than for happy faces, but only at the short delay. At the long delay, happy faces should be recognized better than angry faces. This predicted interaction is based on Pazderski and McBride's (2018) results.

(3) I predicted a significant interaction between emotional expression, race, and delay. Specifically, the disordinal interaction between emotional expression and delay found

by Pazderski and McBride's (2018) results was expected to be replicated for White target faces (see Figure 1). However, I predicted that for the Black target faces, angry faces would be recognized better than happy faces at both delays (Figure 2). This prediction was based on Ackerman et al.'s (2006) results showing a recognition advantage for angry Black faces when the participants are White.

Figure 1

Predicted two-way interaction between emotional expression and time delay for White faces

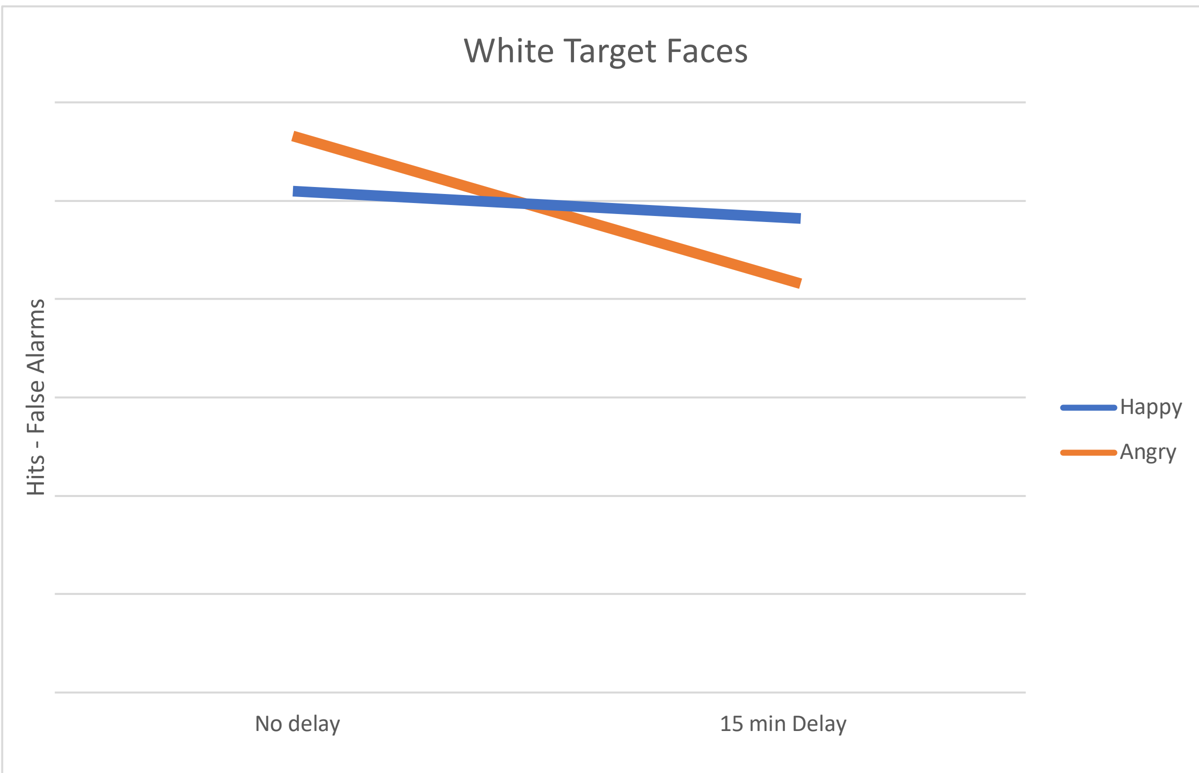
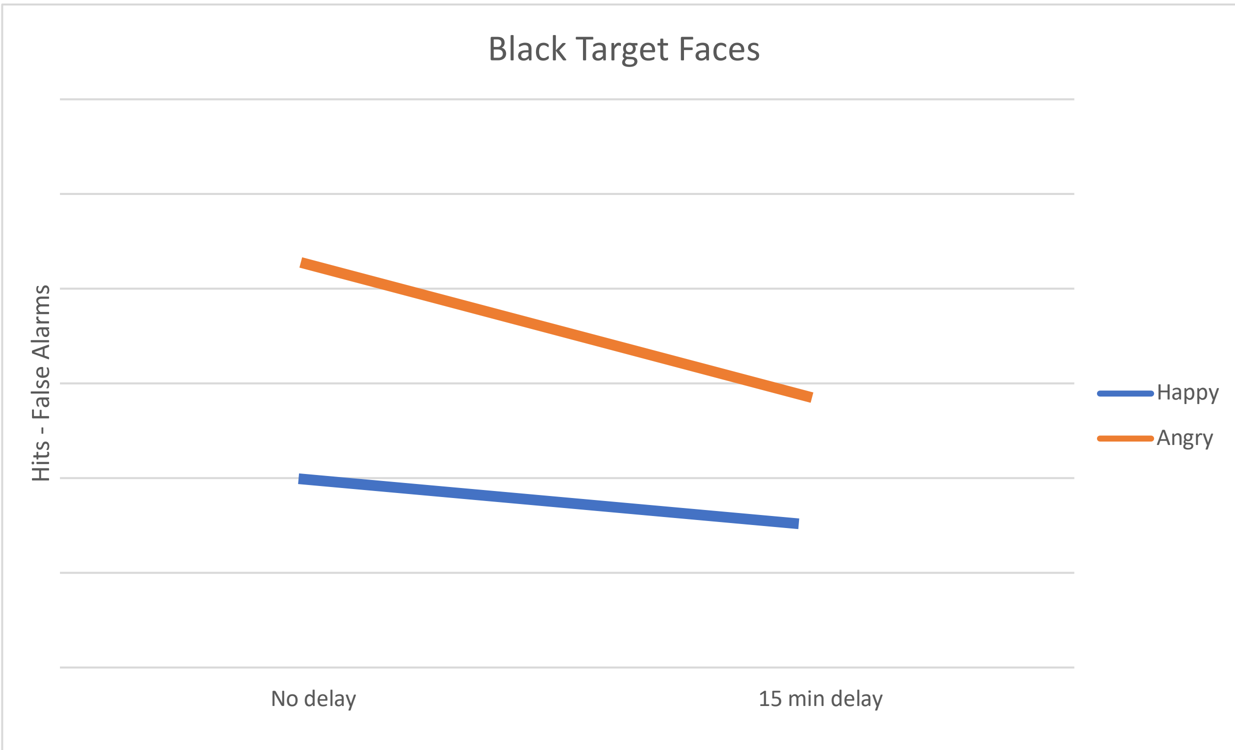


Figure 2

Predicted two-way interaction between emotional expression and time delay for Black faces



CHAPTER VII: METHOD

Participants

The participants were 108 Illinois State University students. Participants were 18 years or older. Fifteen participants were excluded for going past the allotted hour and a half time limit for the study and two participants were excluded for incorrectly responding on 25% or more of the math verification problems during the distractor task. A G-Power (Faul et al., 2007) analysis for the within-subjects interaction effects assuming power of at least .80 and a small to medium effect size (Cohen's f = .20) indicated a sample requirement of 60 to 75 participants to ensure sufficient power for that effect size. Therefore, the remaining data set including 91 participants was sufficient to meet the minimum sample size.

Participants' ages ranged from 18-30 with 87.9% in the 18-21 age group, 8.8% in the 22-25 age group, and 3.3% in the 26-30 age group. Participants were primarily female, with 93.4% female, 4.4% male, and 2.2% preferred not to answer. Participant racial demographic was 2.2% Asian American, 6.6% Black/African American, 7.7% Hispanic/Latinx, 80.2% White, and 3.3% two or more races. Participants primarily spoke English as their first language at 91.2%.

Design

The study implemented a 2 X 2 X 2 within-subjects design. The first independent variable was the race of the target faces shown to the participants. Race was depicted via images of target faces with dark and light skin tones. The second independent variable was emotional expression, which also had two levels: happy and angry. Images were selected from the Racially Affective Expression (RADIATE) face stimulus set (Conley et al., 2018; Tottenham et al., 2009). The third independent variable was recognition test time delay. The tests were administered immediately after the study portion and after a delay of 15 min after the first test. Recognition scores served as the dependent variable and were calculated as proportions of Hits minus False Alarms.

Materials

The Racially Diverse Affective Expression (RADIATE) face stimulus set

The RADIATE face stimulus set (Conley et al., 2018; Tottenham et al., 2009) comprises more than 1,700 individual images. Three-quarters of the models included in RADIATE are from minority racial groups. Four races are included in this set: Black, Latinx, Asian, and White. The 109 models depicted in the images consist of 56 women and 53 men ranging in age from 18 to 30 years old. The RADIATE face set comprises eight emotional expressions with open and closed mouth variations. Images were captured with models in front of a white wall and with a white scarf under the chin and around the neck for standardization across the collection of photos.

From the RADIATE face stimulus set, 48 faces were selected at random for the present study from two racial categories. Of the selected facial images, 12 faces were Black women, 12 faces were Black men, 12 faces were White women, and 12 faces were White men. Half of each combination of race and gender showed a happy closed mouth expression and the other half an angry open mouth expression. The images were randomly split into two balanced sets for counterbalancing across old and new conditions and across two test delays with equal numbers of faces in each gender, race, and expression category in each set.

Procedure

I used the Gorilla Experiment Builder (Anwyl-Irvine et al., 2020) to create and run my experiment. Data were collected between Jan. 14, 2022, and Feb. 20, 2022. Participants were recruited through Sona Systems at Illinois State University and compensated with course credit.

Participants viewed 30 faces for the study phase, including 6 facial stimuli images to combat any primacy or recency effects. In each test phase, participants viewed half of the facial images from the study phase with an additional 12 new facial images. This assignment of faces to conditions is shown in Table 1, including counterbalancing across participants. The order of facial image presentation in the study and test sessions was randomized for each participant to avoid any order effects across presentation of the faces.

Table 1

Assignment of target facial images in study design

Condition	Study Phase	Immediate Test	15 min Delayed Test
1	Set A: 24 faces	12 faces from Set A (old)	Remaining 12 faces from Set A (old)
		12 faces from Set B (new)	Remaining 12 faces from Set B (new)
2	Set B: 24 faces	12 faces from Set B (old)	Remaining 12 faces from Set B (old)
		12 faces from Set A (new)	Remaining 12 faces from Set A (new)

All participants completed a standardized procedure. After providing informed consent, participants were initially presented with the study list of 30 faces, 24 study faces, 3 primacy faces, and 3 recency faces. An intentional encoding scheme was implemented, such that participants were asked to pay attention to the faces for a later test. Target images were shown for 10 s each. After the study phase, participants were given instructions for the first test phase. During each test phase, participants viewed 12 images from the study phase and 12 new images from the other set of faces. Participants were asked to indicate if they had seen the presented image in the study phase or not by pressing the “q” or “p” keys, respectively. Faces remained on the screen until a choice was made. Upon finishing the first test phase participants completed a distractor task of a demographic questionnaire and 40 math verification problems timed for 15 min. Participants were then given instructions to complete the second test phase using the same instructions and procedures. After the delayed test phase participants were debriefed and thanked for their time.

CHAPTER VIII: DATA ANALYSIS AND RESULTS

A 2 X 2 X 2 repeated-measures analysis of variance was used for data analysis. The independent variables were Race of the target face (Black and White), Emotional Expression of target face (happy and angry), and Time Delay from study to test (immediate and 15 min). The dependent variable was facial recognition score (Hits minus False Alarms [FA]). Table 2 includes the mean proportion of Hits and FA for each condition, respectively. An alpha of .05 was used for all analyses.

Table 2

Hits and false alarms for each condition from Test 1 and Test 2

Condition	Test 1 Hits Mean (*SD*)	Test 2 Hits Mean (*SD*)	Test 1 FA Mean (*SD*)	Test 2 FA Mean (*SD*)
White Happy	.58 (*.19*)	.53 (*.19*)	.65 (*.18*)	.62 (*.16*)
White Angry	.66 (*.14*)	.56 (*.20*)	.55 (*.19*)	.56 (*.22*)
Black Happy	.62 (*.19*)	.58 (*.21*)	.55 (*.21*)	.58 (*.20*)
Black Angry	.61 (*.17*)	.55 (*.18*)	.60 (*.19*)	.56 (*.20*)

A significant main effect of time delay was found, $F(1, 90) = 11.36$, $p = .001$, such that higher recognition scores were found for the immediate test ($M = 0.03$, $SE = 0.02$) than the delayed test ($M = -0.02$, $SE = 0.02$). Due to typical forgetting, higher recognition at the immediate test was expected and observed.

A marginally significant main effect of race of the target stimulus face was found, $F(1, 90) = 3.50$, $p = .065$, with Black faces ($M = 0.03$, $SE = 0.02$) producing higher recognition scores than White faces ($M = -0.01$, $SD = 0.02$). An inverse CRE was observed, where the majority

White participant sample recognized targets of another race better than their own race. The main effect of facial stimuli race contrasted with Hypothesis 1, showing the opposite pattern from what was predicted.

A significant main effect of emotional expression was also found, $F(1, 90) = 9.64$, $p = .003$, with angry faces ($M = 0.04$, $SE = 0.02$) producing higher recognition scores overall than happy faces ($M = -0.02$, $SE = 0.02$). Angry faces are likely to produce higher recognition due to the visual cue of impending threat, but an interaction between expression and delay was expected for White faces.

A significant interaction between target stimuli race and emotional expression was found, $F(1, 90) = 37.42$, $p < .001$. A simple effects analysis was conducted to further investigate the target race and emotional expression interaction and found that for White faces, angry faces showed higher recognition ($M = 0.06$, $SE = 0.02$) than White happy faces ($M = -0.09$, $SE = 0.02$), $F(1, 90) = 33.72$, $p < .001$. However, for Black faces, there was no significant difference between happy ($M = 0.04$, $SE = 0.02$) and angry faces ($M = 0.01$, $SE = 0.02$), $F(1, 90) = 2.00$, $p = .16$.

A marginally significant three-way interaction of time delay, emotional expression, and race was also found, $F(1, 90) = 3.10$, $p = .082$. See Figures 1 and 2 for the predicted two-way interactions for White and Black faces, respectively, and Figures 3 and 4 for the observed two-way interactions for White and Black faces, respectively. Table 3 provides the *M* and *SE* of the conditions from the three-way analysis.

Figure 3

Observed two-way interaction between emotional expression and time delay for White faces

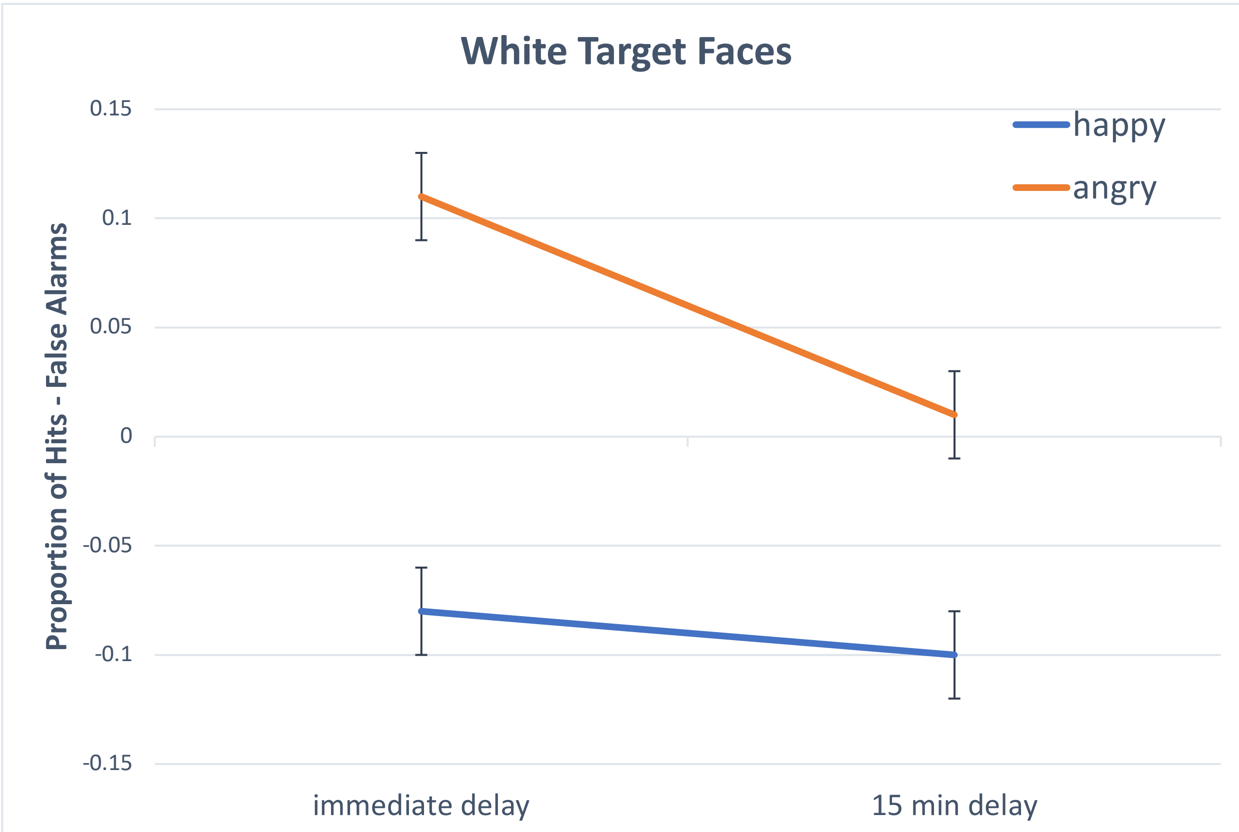


Figure 4

Observed two-way interaction between emotional expression and time delay for Black faces

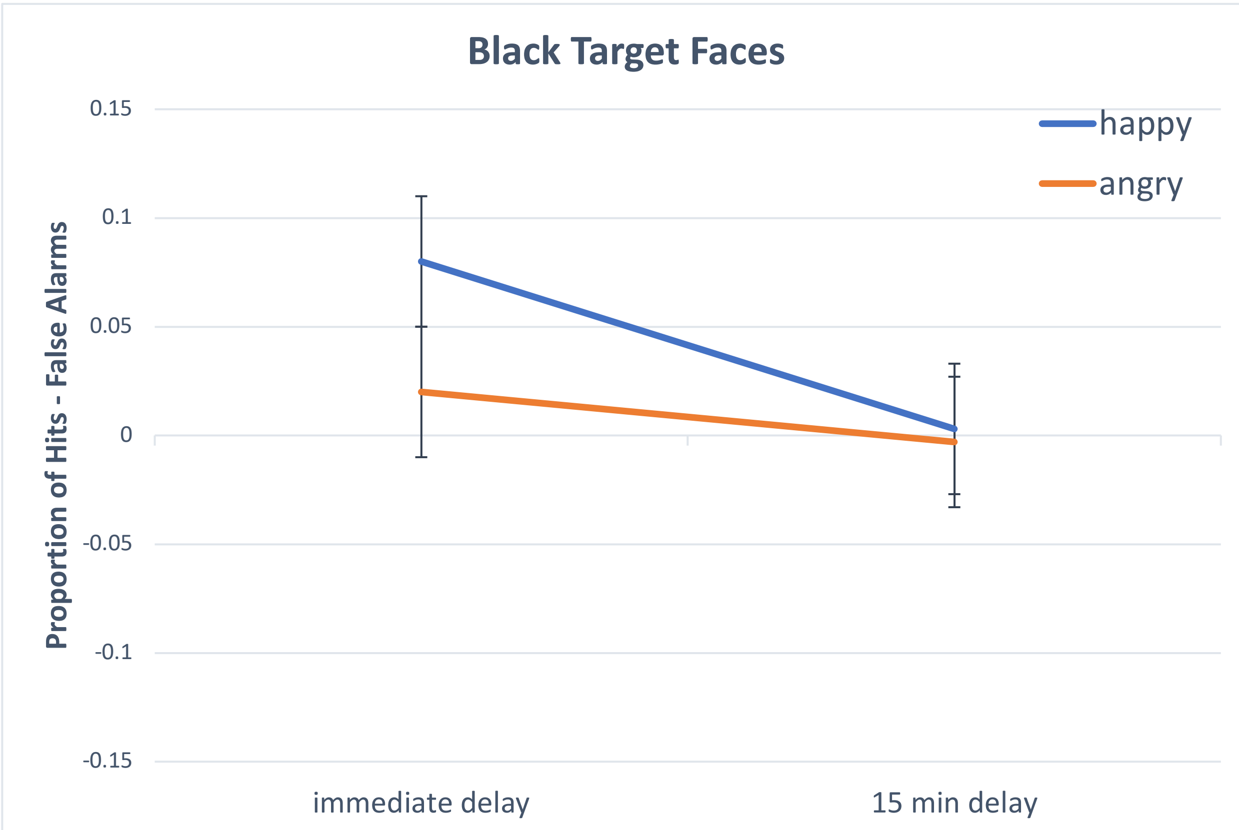


Table 3

Recognition score means and standard errors for the race, emotional expression, and time delay conditions

Condition	Test 1 Mean (*SE*)	Test 2 Mean (*SE*)
White Happy	-.08 (*.03*)	-.10 (*.03*)
White Angry	.11 (*.03*)	.01 (*.03*)
Black Happy	.08 (*.03*)	.003 (*.03*)
Black Angry	.02 (*.03*)	-.003 (*.03*)

I predicted a replication of the interaction between delay and expression from Pazderski and McBride's (2018) interaction for White targets (see Figure 1). That is, higher angry than happy face recognition was expected for the short-term delay with lower angry than happy face recognition at the longer delay. The observed interaction for White target faces (Figure 3) showed more accurate recognition for angry faces at both the immediate and 15 min delays.

I also predicted higher recognition for angry Black target faces (see Figure 2) because of anger drawing attention to potential impending threat and Ackerman et al.'s, (2006) results showing a recognition advantage for angry Black faces, with higher angry face recognition at both delays. The observed interaction for Black target faces (Figure 4) showed a reversal of the angry expression advantage found for White faces at the immediate delay. However, happy and angry expressions for Black target faces were not significantly different at the 15 min delay. Therefore, neither Hypothesis 2 nor Hypothesis 3 was supported. No other interactions were significant, all p's > .065.

As part of an exploratory analysis, the 2 x 2 x 2 ANOVA was conducted again with only participants reporting their race as White (n = 73). This sample size is within the parameters of the power analysis. However, there were no changes in the results. Thus, the pattern of results could be explained by the homogeneity of participant race in the current study.

CHAPTER IX: DISCUSSION

My study sought to address the gap in the facial recognition literature regarding memory for emotional expressions depicted by White and Black faces with a largely White participant sample. A marginally significant main effect of race was found with higher recognition scores for Black than White faces. However, the interaction between race and expression showed that, although the emotional expression effect for the Black faces was not significant, there was higher recognition of angry White faces than happy White faces. These findings suggest that emotional expression can affect the CRE. In the current study, Black faces were better recognized overall than White faces, supporting an inverse CRE. In contrast, Ackerman et al. (2006) reported that angry Black faces were better recognized than angry White faces when placed under a cognitive constraint of viewing two images simultaneously, whereas the current study found no effect of emotional expression on memory for Black faces while angry White faces were better recognized than happy White faces. There are methodological differences between the Ackerman et al. (2006) study and my study. Ackerman et al. (2006) placed a cognitive constraint within their study design. They asked participants to study two target faces simultaneously, one White and one Black. My study showed one image at a time on the screen followed by another in a subsequent presentation. The additional processing of two facial images at once led to greater out-group heterogeneity. Adding a cognitive constraint to my study might have changed the way participants processed the facial stimuli according to emotional expression and race, which may have been more aligned with Ackerman et al.'s (2006) findings.

I also predicted a significant main effect of facial stimulus race on recognition accuracy based on the CRE found in past research (Ackerman et al., 2006; Tanaka et al., 2004). Specifically, I predicted that all other things being equal, White participants would recognize

White target faces better than Black target faces based on the CRE. The results of the present study do not support this prediction. Participants, who were predominantly White, recognized Black faces marginally better than White faces. Thus, a trend toward an inverse CRE was found. Therefore, Hypothesis 1 that White faces would be better recognized than Black faces was not supported.

Ackerman et al. (2006) had a racially White participant pool and found that angry Black targets were more recognized than angry or neutral White targets. A possible reason Hypothesis 1 was not supported could be due to the trending and progressive focus on diversity, equity, and inclusion (DEI) in society and organizations alike. Many years have passed since the United States has abolished slavery and yet, reparations are still necessary to balance racial inequality. Attention has been drawn to the critical need for DEI within society and organizations within that society through movements like "Black Lives Matter," for example.

Hypothesis 2 was also not supported. As a follow-up study to Pazderski and McBride's (2018) results, I predicted better recognition for angry faces than for happy faces, but only at the short delay and particularly for White faces (Hypothesis 3). The current results showed that recognition of angry faces was higher than happy faces overall. One of the differences between my study and Pazderski and McBride's (2018) study was that my study included Black and White target facial images from the RADIATE face stimulus set (Conley et al., 2018; Tottenham et al., 2009), whereas their study included only White target facial images from the Karolinska Directed Emotion Face set (Goeleven et al., 2008). However, even when analyzing memory for White faces separately, this delay by expression interaction was not found. Thus, the addition of another race in the face study set may have changed the way participants processed the faces at encoding and retrieval.

Another difference between the two studies is that my study was conducted online using Gorilla, whereas the previous study was conducted in person in a lab setting. During the delay portion of my study, participants completed math verification problems, whereas in the previous study, the participants worked on a Sudoku puzzle. These methodological differences between the two studies could be another reason for not replicating the results from the original Pazderski and McBride (2018) study. Any of the changes between the original study and my follow-up study could explain the results of the two studies. In order to determine which particular methodological change is responsible for the differing results, another follow-up study would need to be conducted. For example, an in-person facial recognition study using racially Black and White target images from the RADIATE database could help rule out the setting effect on the results.

Hypothesis 3 predicted a significant three-way interaction between delay, emotional expression, and target race, which was found with marginal significance. When considering the results for White target faces, better recognition was seen for the emotional expression of anger than happiness. The predicted delay by expression interaction for White target faces suggested that angry White faces would show higher recognition than happy faces at the short delay and lower recognition than happy faces at the longer delay. The observed pattern for White faces was unlike the predicted interaction. This could be due in part to the different face stimulus sets implemented, the addition of Black facial stimuli, or even because of the salience of a negative emotional expression such as anger. As an emotional expression, an angry face predicts danger or something being wrong. Individuals with the ability to better remember an angry face would have a better chance of increasing survival in the long run.

When considering Black target faces, the results show similar recognition for happy and angry Black target faces at the two delays. Participants did not show differences in recognition of the Black target faces according to emotional expression. This means that regardless of whether the target depicted a happy or angry expression, participants recognized the Black faces at the same rate. I predicted that angry Black faces would have higher recognition than happy Black faces. The observed pattern for Black faces was not congruent with the predicted interaction. This result could be explained in part by the increasing awareness of DEI mentioned above. However, Ackerman et al. (2006) reported an inverse CRE with angry target faces, solidifying the need for subsequent facial recognition studies investigating the effects of race, emotional expression, and time delay, to further understand out how the factors interact.

A largely young, White, and female participant sample elected to participate in my study. It is difficult to make any generalizations about the results because of the homogenous sample, although this sample's demographic is typical in psychological research conducted within higher education. With this sample, the results largely report on a particular portion of the population. A follow-up study could be conducted on Amazon's Mechanical Turk (MTurk) to obtain a more diverse sample of participants and test the effect of participant race on facial recognition. The limitation of MTurk is funding. Those with a study on MTurk pay for that service, making availability and use for students less optimal or convenient.

It is difficult to draw many specific conclusions considering the factors of race, emotional expression, and time delay with only my study. I have suggested many follow-up studies to further investigate how these factors relate to each other in regard to facial recognition. More so, I have suggested how to allow for more generalized results, particularly through a diverse sample of participants and also use of facial stimuli. Thus, more research should be done in this specific area to better understand how these factors affect facial recognition.

CHAPTER X: LIMITATIONS AND FUTURE DIRECTIONS

One limitation of this study was that it was conducted online. Participants were able to take the study in their own space and time of their choosing. Due to the nature of online studies, participants might not have been as focused as they would be in a laboratory setting. The low (and sometimes negative) recognition scores suggest this may have been the case. Participants were instructed to pay attention during the experiment, but it is difficult to know how well this instruction was followed. Math verification accuracy was used as an attention check in my study, but this measure did not address attentional focus during study and test of the faces. An interesting way to combat this limitation might be to track participants eye-movements during the study.

Another issue is that the sample of participants was limited racially and according to gender. A large majority of the participants were young adults who were White and female. While this demographic is typical in psychological research, it does limit the generalizability of the results. WEIRD samples are normative in psychological research, which is why a focus on DEI within cognitive research would be beneficial in testing the effects of race and culture on known effects. Further, shifting focus to inclusivity within higher education would not only benefit marginalized groups, but also allow for greater generalizability within psychological research in terms of the diversity of participant samples. Another option is to include members of the general population through online testing using MTurk or incentives to recruit a more diverse sample.

The current study included Black and White target facial stimuli. Including only two races for target faces excludes many other potential races to be studied. Based on Ackerman et al.'s (2006) study, the limited literature regarding facial recognition of diverse faces, and my personal interest, Black and White faces were chosen for this experiment. Future facial recognition research would be more generalizable if target facial stimuli were more diverse and included more than two races. The RADIATE face stimulus set includes target images of racially White, Black, Asian, and Latinx models (Conley et al., 2018; Tottenham et al., 2009). A follow-up study could include all four racial categories included in the study design. A facial stimulus database that includes more than the aforementioned four racial categories would also be beneficial for future research.

Another limitation of my study was the consistency of the target images used in the study, particularly the impact of the intensity of the emotional expressions depicted by the models and how well the models aligned with their category label (race and expression). For example, they may have varied in the degree with which the target is displaying an emotion or to what degree the target aligns with the racial category. A way to address this issue would be to run a pilot study evaluating the perceptions of intensity of the target image's emotional expression and how well the target fits into a racial category prior to choosing stimuli for a recognition study.

The emotional expressions of happiness and anger were selected in the hopes of replicating Pazderski and McBride's (2018) delay by emotional expression interaction. Continued research on the emotional expressions of happiness and anger would allow for deeper knowledge about the encoding of those expressions, especially when race is a factor within the study. Happiness and anger are contradictory emotions that observably produce varying recognition of faces of different races. Other emotional expressions might produce different results that future studies would do well to investigate further. Future research should consider various emotional expressions and how those expressions relate to facial recognition. Focusing on only two emotional expressions leaves out many other emotions, but once enough research has been conducted with happiness and anger, broadening the emotional expressions being researched would be advantageous. Future researchers might investigate the effects of emotional valence and emotional arousal on facial recognition. Emotional valence refers to the extent to which an emotion is negative or positive while emotional arousal refers to the intensity of the emotion. The emotional valence of happiness and anger are opposites, but the emotional arousal of happiness and anger might be different.

In conclusion, my hypotheses were generally not supported with no replication of the Pazderski and McBride (2018) interaction results and a trend toward an inverse CRE. Based on the current results, it can be concluded that target race does have an effect on facial recognition with emotional expressions, but more research and investigations of how race, emotional expression, and time delay influence facial recognition must be done to fully understand this finding. Further, there is more knowledge to be acquired by placing a focus on race in facial recognition. There are implications for eyewitness testimony, facial recognition software, psychological research, higher education practices, and workplace hiring. If the scientific understanding of how individuals of different races are recognized is studied more thoroughly, larger scale changes for equality can be made.

An example of a larger scale change might be diversifying the demographic within businesses and the higher education system. With the knowledge of the homogeneous demographic of businesses and the higher education system, there is value in the effects of DEI. Through changes within hiring and acceptance committees, more minority group members will hold space within both businesses and higher education at equal rates as racial majority counterparts. With a more diverse employee and student demographic overall, the overall wellness of the organization would benefit due to the experiences and strengths of minoritized groups, those who are less often considered or included. Through facial recognition studies we are able to investigate how what factors influence how someone perceives someone else. With an emphasis on racial inclusion and equality in psychological studies, both through the participant sample and target images, future results from facial recognition research have greater generalizability and potential applications.

Another larger scale change could be found within the judicial system. Minority individuals are incarcerated at a higher frequency than the racial majority. This could be due in part to facial recognition technology and even how those in the racial minority are perceived. Those creating facial recognition technology are of the racial majority and are not valuing DEI enough. This affects those in the racial minority. Those in the racial minority are affected by the limitations of the facial recognition technology while the racial majority is not. This perpetuates racial inequality. Eyewitness testimony is limited by the recognition ability of those witnesses. It has been shown that racial out-group members are recognized differently and are less individuated than racial in-group members. Because of this, there is room for improvement by the judicial system when considering eyewitness testimony accounts. My suggestion for a focus on the importance of DEI is one of the ways racial inequality could be combatted. My study is an example of including diversity in the conversation.

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