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Perceptual identification and the cross-race effect

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The current research examined whether the cross-race effect (CRE) was evident in perceptual identification tasks and the extent to which certain boundary conditions moderated the effect. Across two experiments, a significant CRE was observed in measures of accuracy and response latency. As predicted, Experiment 1 showed that the CRE was exacerbated when encoding time was brief and test set size was increased. Experiment 2 replicated the effect of set size, but also showed that the CRE was more pronounced when the retention interval was lengthened. The theoretical and practical implications of the results are discussed.

Keywords: Cross-race effect; Perceptual identification; Visual search; Face identification; Working memory.

In 2006, the Rewards for Justice program, sponsored by the US State Department (www.rewardsforjustice.net), promoted the search for terrorists at airports when it distributed "Faces of Global Terrorism" posters containing photographs of the 26 Most Wanted Terrorists. These posters, familiar to many who pass through airport security checkpoints, were intended to familiarize passengers and security agents with these individuals in the hopes that they might be identified. Upon arrival in Iraq in 2003, members of the United States Army were given a set of playing cards featuring the faces of then President Saddam Hussein's top officials, members of the Baath Party, and Revolutionary Command Council—all of whom were considered a high priority for identification and apprehension. The intent, once again, was to

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familiarize Army personnel with these individuals such that when they were on patrol they would be able to identify and apprehend the wanted individuals. These photographic aids are designed to support the successful identification of known terrorist suspects, but is it possible that individuals may yet be limited in their ability to perceptually identify individuals of another, less familiar race or ethnicity?

The *cross-race effect* (CRE) is the phenomenon that individuals identify and recognize faces of their own race or ethnicity more accurately than faces of a less familiar race or ethnicity (Malpass & Kravitz, 1969; Meissner & Brigham, 2001). The differential performance between own- and other-race faces is primarily evidenced in a greater proportion of false alarms to other-race faces and superior discrimination of own-race faces, though a more conservative response criterion is sometimes evidenced for own-race faces (Meissner & Brigham, 2001). This phenomenon has been demonstrated across a wide variety of racial and ethnic groups, including United States Whites and Blacks (Malpass & Kravitz, 1969), British and South African Whites and Blacks (Chiroro, Tredoux, Radaelli, & Meissner, 2008; Wright, Boyd, & Tredoux, 2001, 2003), Asian participants (Chance, Turner, & Goldstein, 1982; Ferguson, Rhodes, & Lee, 2001), German and Turkish groups (Sporer, 2001), Canadian First Nations (Jackiw, Arbuthnott, Pfeifer, Marcon, & Meissner, 2008), and Hispanics (MacLin, MacLin, & Malpass, 2001; Platz & Hosch, 1988). Of practical importance, cross-racial identifications are not just a laboratory phenomenon. Behrman and Davey (2001) conducted an archival study of real criminal cases that included eyewitness identifications. Their research showed that cross-race eyewitness situations were not only frequent, but eyewitnesses act in ways consistent with laboratory findings on the CRE.

Although evidence of CRE has been shown in real-world archival studies, it has been almost exclusively studied using long-term recognition memory paradigms. For example, the vast majority of experiments have studied the CRE using a standard recognition paradigm or an eyewitness line-up identification paradigm. In fact, only one study in the Meissner and Brigham (2001) meta-analysis examined the effect using a perceptual identification paradigm (Lindsay, Jack, & Christian, 1991). We generally understand the CRE based upon long-term recognition memory paradigms, but it is also important to understand the CRE in the context of perceptual identification tasks. Since the attacks of 9/11, increased pressures have been placed upon border and transit security personnel to improve their detection and identification of suspected terrorists and other illegal individuals seeking to enter the United States. Whether attempting to match suspected individuals based upon "wanted" images taken years ago or more simply identifying whether an individual matches his/her passport photograph, many of these identification tasks will necessarily involve the perception of faces differing in racial or ethnic background. The question then becomes: Might we see evidence of the cross-race effect in such perceptual identification tasks, and under what conditions is this effect most likely exacerbated?

To date, only a handful of studies have examined the CRE using a perceptual identification paradigm. Lindsay et al. (1991) first demonstrated that the CRE is present in perception using a delayed match-to-sample task. Consistent with findings in the long-term recognition paradigms, participants were more accurate in correctly identifying own-race faces. Levin (2000) used a perceptual discrimination paradigm (ABX method in which participants had to identify a previously presented face) and a visual search paradigm (in which participants were required to search for a particular race of face) to examine the relationship between the CRE in memory and categorical perception, with results suggesting that racial categorization may play a role in the recognition deficit that individuals show for other-race faces. Walker and Tanaka (2003) also found the CRE in perceptual encoding using a same-different matching task with White and East Asian face morphs. Walker and Hewstone (2006; see also Walker & Hewstone, 2008) replicated this finding using a same/different task with White and South Asian face morphs, and also found that contact with other-race persons (as measured by a self-report questionnaire) significantly predicted other-race performance. Finally, Sporer, Trinkl, and Guberova (2007) observed the CRE with Turkish and Austrian children who completed a face matching task, though the authors found no association between performance and a measure of interracial contact. Taken together, these studies suggest that the CRE is not only evidenced in long-term recognition memory, but also perhaps at earlier perceptual encoding stages involved in visual working memory (see Baddeley, 2000).

Given the practical importance of understanding the CRE, the current experiments sought to further assess whether the CRE might be evidenced in perceptual identification tasks invoking visual working memory processes and to better understand the boundary conditions that might underlie the effect. For example, could manipulations to study time, retention interval, or test set size exacerbate the CRE observed in perceptual identification tasks? Given recent research suggesting that encoding and representational issues are important in understanding the CRE (Marcon, Susa, & Meissner, 2009; Meissner, Brigham, & Butz, 2005; see also Meissner & Brigham, 2001), it was predicted that such manipulations would interact with the CRE such that a larger effect would be seen when encoding and representational processes are taxed.

Although the majority of previous research used delayed match-to-sample tasks to assess the role of the CRE, the current studies employed a perceptual identification paradigm in which a face was presented, followed immediately by a pattern mask and then an array of test faces. Participants' task was simply to identify the studied face in the test array as quickly as possible. Given that so few studies have examined the CRE using a perceptual identification paradigm, the current studies sought to both demonstrate the CRE and assess its boundary conditions. Experiment 1 assessed the extent to which participants exhibit a greater CRE when encoding time is shortened and/or when test set size is increased. Experiment 2 assessed whether an increased retention interval and an increased set size at test would lead to a larger CRE.

EXPERIMENT 1

Method

Participants. A total of 24 Hispanic participants (21% male; mean age = 25.38 years) from the University of Texas at El Paso completed this experiment. All participants were recruited from the participant pool and awarded research credit for their time.

Materials. Hispanic and African-American faces from a database maintained by the second author were used to create 256 perceptual identification trials. Two poses of each face were available, one with the participant smiling (used as the target face at study) and the other with a neutral expression (used in the test presentation). Clothing was cropped out of each photograph. A Visual Basic program was created to present the trials and instructions to participants, and to record all responses.

Design and procedure. A 2 (race of face: Hispanic vs. African-American) × 4 (encoding time: 100, 500, 1000, or 1500 ms) × 4 (set size: 2, 4, 6, or 8) within-subjects design was employed. The perceptual identification tasks were grouped into four blocks of 64 trials, and these blocks were counterbalanced across participants. Different photographs were presented at study and at test, thereby allowing us to assess face identification (rather than photo identification). Within each block, no faces appeared more than once and faces used as targets were never presented as a distractor face. Different faces were used as targets for each trial and these target faces were not repeated across trials. Set size and race of face were randomized within each block.

Upon beginning the experiment, participants were given a practice session to acquaint them with the perceptual identification task. Participants were instructed that they would be shown a target image and then an array of other images. They would then be required to use the computer mouse to run the arrow over the target image as quickly and as accurately as possible. After participants completed the practice session, the actual experimental trials commenced. Participants viewed the target face for either 100 ms, 500 ms, 1000 ms, or 1500 ms, depending upon what block of trials they were completing. Immediately following the study presentation a pattern mask appeared for 100 ms, followed by a 200 ms retention interval (blank screen) that preceded presentation of the test array of two, four, six, or eight faces. Before each trial, the cursor was fixed in the middle of the screen so that the starting point was the same across trials. Additionally, the position of target faces in the test array was randomized within each trial. The target face and array of test faces were the same race, with race of face manipulated across trials. A sample trial is depicted in Figure 1. After completing the experimental portion, participants were asked to provide demographic information, debriefed, and thanked for their participation.

Results and discussion

Identification accuracy. Accuracy was calculated as the proportion of trials in which the participant correctly identified the target face, as all trials included the target present in the test array. Across all trials, mean accuracy was 85.80% ($SD = 0.05$), and performance was significantly below ceiling, $t(23) = 12.86$, $p < .001$. Given that there was sufficient variability in the data, a 2 (race of face: Hispanic vs. African-American) × 4 (encoding time: 100, 500, 1000, or 1500 ms) × 4 (set size: 2, 4, 6, or 8) repeated measures analysis of variance was used to examine the effects of the manipulated variables on accuracy. As expected, there was a significant main effect of race of face on accuracy, $F(1, 23) = 11.25$, $p < .01$, $r_{HB} = .80$, $d = .43$, such that participants were more accurate for own-race faces ($M = 0.87$, $SD = 0.04$) than other-race faces ($M = 0.84$, $SD = 0.07$).[1] Significant main effects of encoding time, $F(3, 69) = 16.76$, $p < .001$, $\eta_p^2 = .42$, and set size, $F(3, 69) = 62.18$, $p < .001$, $\eta_p^2 = .73$, were also found indicating that accuracy improved as encoding time increased and set size decreased.

Three significant interactions were observed: Race of face × Encoding time, $F(3, 69) = 2.74$, $p < .05$, $\eta_p^2 = .11$; Race of face × Set size, $F(3, 69) = 2.78$, $p < .05$, $\eta_p^2 = .11$; and Encoding time × Set size, $F(9, 207) = 2.98$, $p < .01$, $\eta_p^2 = .16$. Our focus here is on the predicted CRE interactions. Difference scores were computed in order to examine the influence of the encoding time and set size manipulations on the size of the CRE. As predicted, a significant linear contrast was found for encoding time, $F(1, 23) = 8.46$, $p < .01$, $\eta_p^2 = .27$, suggesting that the CRE increased as the amount of time participants encoded a target face decreased. As displayed in Figure 2, significant CREs were observed at the 100 ms, $t(23) = 3.38$, $p < .01$, $r_{HB} = .65$, $d = .58$, and 500 ms,

[1] Effect size for within-subject comparisons involving race of face were computed using Dunlap, Cortina, Vaslow, and Burke's (1996) formula for computing d with correlated designs (Equation 3, p. 171), with $d = t_C\ [2\ (1—r)\ /\ n]^{1/2}$. The correlation between performance on Hispanic and Black faces (r_{HB}) is also provided.

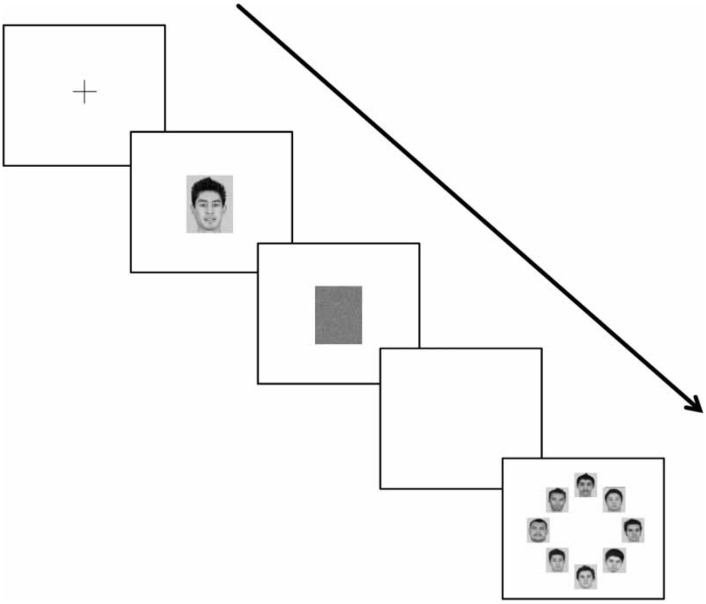

Figure 1. Visual representation of the perceptual identification paradigm employed in Experiments 1 and 2.

$t(23) = 2.76$, $p < .05$, $r_{HB} = .41$, $d = .62$, encoding conditions, but were not observed when encoding time was 1000 ms, $t(23) = 0.08$, *ns*, $r_{HB} = .45$, $d = .02$, and 1500 ms, $t(23) = 1.43$, *ns*, $r_{HB} = .79$, $d = .19$. A significant linear contrast was also found for set size, $F(1, 23) = 5.04, p < .05$, $\eta_p^2 = .18$, indicating that the CRE increased as the number of faces in the target array increased. As displayed in Figure 3, significant CREs were observed when set size was six, $t(23) = 2.97$, $p < .01$, $r_{HB} = .59$, $d = .55$, and eight, $t(23) = 2.77$, $p < .05$, $r_{HB} = .45$, $d = .59$, but not when set size was two, $t(23) = 0.83$, *ns*, $r_{HB} = .54$, $d = .16$, or four, $t(23) = 0.003$, *ns*, $r_{HB} = .25$, $d = .00$.

Response latency. Response latency was calculated for correct trials, with outliers excluded from the analysis. A 2 (race of face: Hispanic vs. African-American) × 4 (encoding time: 100, 500, 1000, or 1500 ms) × 4 (set size: 2, 4, 6, or 8) repeated measures ANOVA on participants' response latencies revealed a significant main effect for race of face, $F(1, 23) = 5.74$, $p < .05$, $r_{HB} = .86$, $d = .26$. Participants were quicker in responding accurately to own-race faces ($M = 1.24$, $SD = 0.19$) than other-race faces ($M = 1.29$, $SD = 0.19$). A significant main effect of set size was also observed, $F(3, 69) = 238.41$, $p < .001$, $\eta_p^2 = .91$, such that participants took longer in

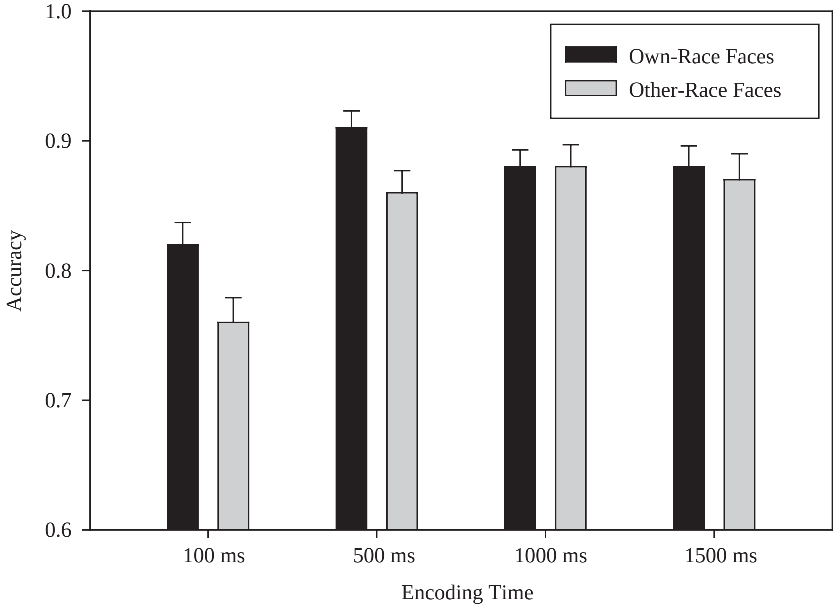

Figure 2. Influence of encoding time on accuracy for own-race vs. other-race faces in Experiment 1. Error bars represent standard error values.

responding accurately as set size increased. No other significant main effects or interactions were observed.

EXPERIMENT 2

Method

Participants. Sixty-nine Hispanic participants (39% male; mean age = 19.42 years) from the University of Texas at El Paso participated in the current study.

Materials. Similar to Experiment 1, the same Hispanic and African-American faces were used as stimuli for the current experiment. Two poses of each photo were used in 256 perceptual identification trials.

Design and procedure. A 2 (race of face: Hispanic vs. African-American) × 4 (retention interval: 10, 400, 1400, or 2400 ms) × 4 (set size: 2, 4, 6, or 8) within-subjects design was employed. The perceptual identification tasks were grouped into four blocks of 64 trials, and these blocks were

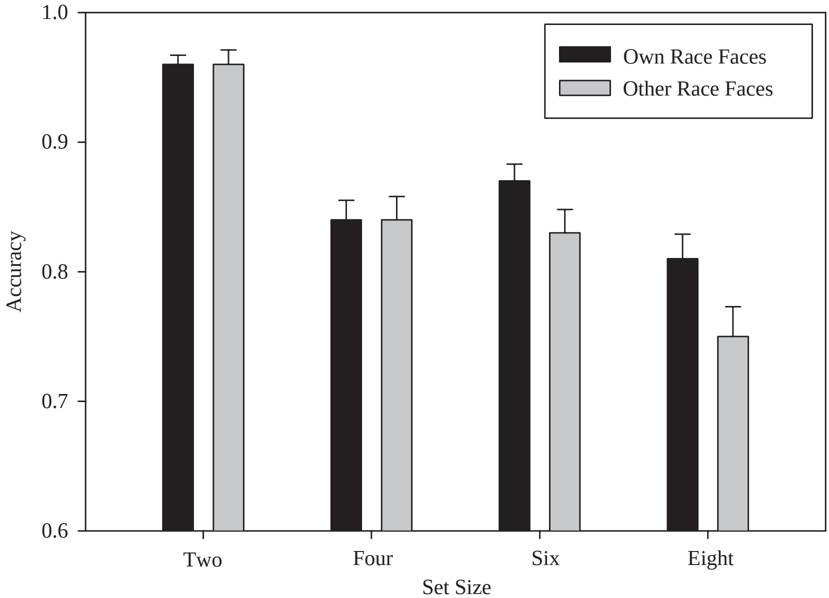

Figure 3. Influence of set size on accuracy for own-race vs. other-race faces in Experiment 1. Error bars represent standard error values.

counterbalanced across participants. All procedures were identical to Experiment 1 with the following exceptions.

Across trials, encoding time was held constant at 500 ms; the retention interval was manipulated to involve 10 ms, 400 ms, 1400 ms, or 2400 ms. Search set size was again manipulated, such that participants completed trials of sizes two, four, six, and eight faces in the array.

Results and discussion

Identification accuracy. Across all trials, mean accuracy was 80.08% ($SD = 0.11$), and, similar to Experiment 1, performance was significantly below ceiling, $t(68) = 14.59$, $p < .001$. Given that there was enough variability in the data, a 2 (race of face: Hispanic vs. African-American) × 4 (retention interval: 10, 400, 1400, or 2400 ms) × 4 (set size: 2, 4, 6, or 8) repeated measures analysis of variance was used to examine the effects of the manipulated variables on accuracy. A significant main effect of race of face was found, $F(1, 69) = 11.23$, $p < .001$, $r_{HB} = .89$, $d = .19$, such that participants were more accurate for own-race faces ($M = 0.81$, $SD = 0.11$) than other-race faces ($M = 0.79$, $SD = 0.13$). Both the retention interval, $F(3, 204) = 7.48$, $p < .001$,

$\eta_p^2 = .10$, and set size, $F(3, 204) = 144.66$, $p < .001$, $\eta_p^2 = .68$, main effects also proved significant, indicating that accuracy decreased with longer retention intervals and larger set size arrays.

Two significant interactions were also observed: Race of face × Retention interval, $F(3, 204) = 2.60$, $p = .05$, $\eta_p^2 = .04$; and Race of face × Set size, $F(3, 204) = 13.20$, $p < .001$, $\eta_p^2 = .16$. Consistent with Experiment 1, we assessed the size of the CRE across each manipulation. As predicted, a significant linear contrast was found for cross-racial difference scores on the retention interval manipulation, $F(1, 68) = 4.35$, $p < .05$, $\eta_p^2 = .06$, such that the magnitude of the CRE increased as the amount of time between the presentation of the target face and the test array increased. As displayed in Figure 4, the largest CRE occurred with the longest retention interval of 2400 ms, $t(68) = 4.15$, $p < .001$, $r_{HB} = .85$, $d = .27$. A significant CRE was also observed at the retention interval of 400 ms, $t(68) = 2.05$, $p < .05$, $r_{HB} = .80$, $d = .16$, but not at 10 ms, $t(68) = 0.69$, *ns*, $r_{HB} = .77$, $d = .06$, or 1400 ms, $t(68) = 1.53$, *ns*, $r_{HB} = .80$, $d = .12$. Significant linear, $F(1, 68) = 14.60$, $p < .001$, $\eta_p^2 = .18$, quadratic, $F(1, 68) = 12.10$, $p < .001$, $\eta_p^2 = .15$, and cubic contrasts, $F(1, 68) = 13.42$, $p < .001$, $\eta_p^2 = .17$, were found for the set size

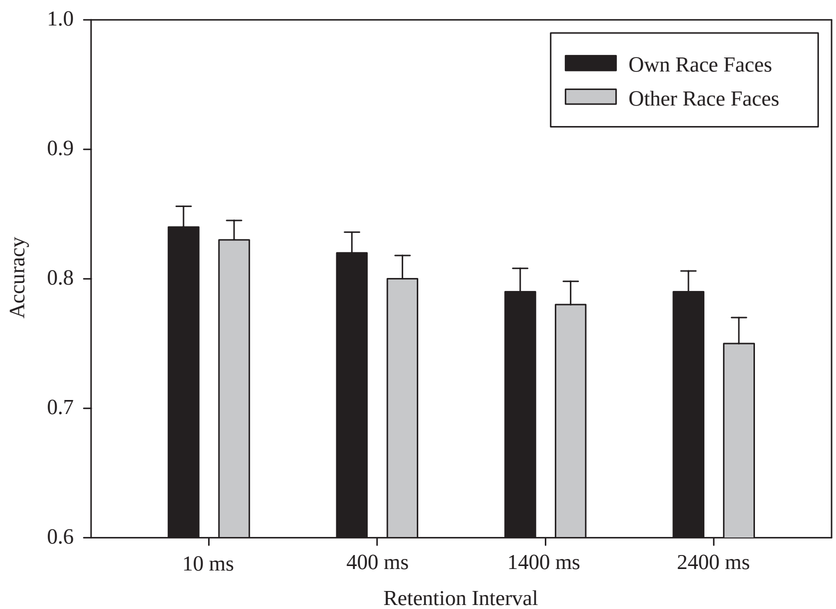

Figure 4. Influence of retention interval on accuracy for own-race vs. other-race faces in Experiment 2. Error bars represent standard error values.

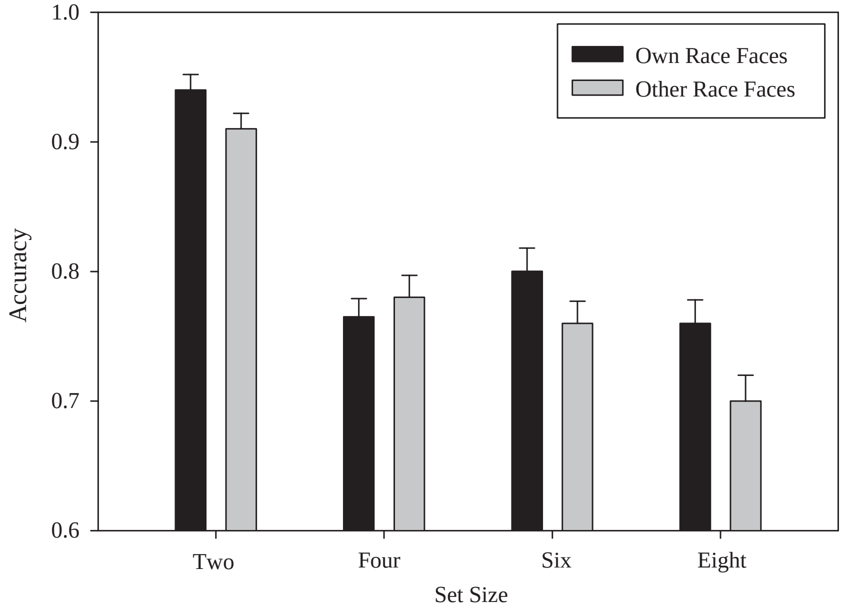

Figure 5. Influence of set size on accuracy for own-race vs. other-race faces in Experiment 2. Error bars represent standard error values.

manipulation. Although the largest CRE was observed at set size of eight (see Figure 5), significant CREs were found at set sizes of two, $t(68) = 2.94, p < .01, r_{HB} = .77, d = .24$, six, $t(68) = 3.00, p < .01, r_{HB} = .82, d = .22$, and eight, $t(68) = 4.25, p < .001, r_{HB} = .74, d = .37$.

Response latency. Reaction time in the current experiment was calculated consistent with Experiment 1. A repeated measures ANOVA revealed a significant main effect of race of face, $F(1, 68) = 6.17, p < .05, r_{HB} = .90, d = .28$. Participants were quicker to respond accurately to own-race faces ($M = 1.45$ s, $SD = 0.32$ s) than to other-race faces ($M = 1.49$ s, $SD = 0.33$ s). Both the retention interval, $F(3, 204) = 31.76, p < .001, \eta_p^2 = .32$, and set size, $F(3, 204) = 420.92, p < .001, \eta_p^2 = .86$, main effects were significant, indicating that participants took longer to respond when set size and retention interval increased. The analysis revealed one significant interaction: Retention interval × Race of face, $F(3, 204) = 4.51, p < .01, \eta_p^2 = .06$. Consistent with the accuracy data, the CRE in response latency was exacerbated as the retention interval was lengthened.

GENERAL DISCUSSION

The purpose of this study was to assess whether the CRE might be present in perceptual identification tasks and to assess the conditions under which the CRE could be exacerbated. Previous research on the CRE has largely focused on long-term recognition memory (Evans, Marcon, & Meissner, 2009; MacLin et al., 2001; Meissner & Brigham, 2001), and studies that have documented the CRE in tasks that are influenced by visual working memory processes have not previously assessed its boundary conditions (Levin, 2000; Lindsay et al., 1991; Sporer et al., 2007; Walker & Hewstone, 2006, 2008; Walker & Tanaka, 2003). Previous research has suggested that decreasing study time and increasing retention intervals in long-term face recognition memory can induce a more pronounced CRE (Meissner & Brigham, 2001). The current experiments addressed whether the boundary conditions of encoding time, retention interval, and set size at test might similarly increase the magnitude of the CRE in a perceptual identification task. Across both experiments, our results replicated the CRE in a perceptual identification task indicating that participants were more accurate (and responded more quickly) when identifying own-race faces than other-race faces. As predicted, Experiment 1 showed that the CRE was exacerbated when encoding time was brief and test set size was increased. Experiment 2 replicated the effect of set size, but also showed that the CRE was more pronounced when the retention interval was lengthened.

Taken together, these findings suggest that taxing memory processes at encoding or as a function of retention interval, or increasing perceptual confusion at test, can increase the magnitude of the CRE in a perceptual identification task. Such findings are consistent both with recent studies suggesting that encoding and representational issues are important in understanding the CRE (Marcon et al., 2009; Meissner et al., 2005) and with face space models that account for the effect through properties of representational distribution (Byatt & Rhodes, 1998; Sporer, 2001; Valentine, 1991, 2001). From a practical perspective, checkpoint identifications made by law enforcement personnel or border security agents may be subject to inaccuracies produced as a function of cross-racial or cross-ethnic interactions; however, promoting greater study time and one-on-one interactions (i.e., limiting set size) should reduce the likelihood of the effect. In contrast, asking agents to search through crowds for "known terrorists" that they have been asked to remember is likely to increase false positive identifications and reduce accuracy of detection.

The current study was limited to some extent by its inclusion of only Hispanic participants (due to the constraints of the available participant pool), which prevented us from testing for true crossover interactions that are typically present in CRE studies. Although we have no reason to believe that the results would fail to generalize to other racial or ethnic groups, future research on this issue would appear warranted. Another potential limitation of this study was the failure of the reaction time data to fully correspond with the accuracy data. The main effect of race of face comported with the accuracy data and previous studies, but most of the response latency interactions failed to prove significant. This could be due to any number of factors, including variability in the extent to which individuals could move the mouse in any particular direction. Nevertheless, our focus remains on the accuracy data, which was not subject to ceiling effects.

Future research would also be useful to examine how variations in facial identity (such as disguise or changes in hairstyle; e.g., Davies & Flin, 1984) might influence perceptual identification or moderate the CRE. For example, states in the US vary on the number of years one is allowed to maintain one's same photograph on a driver's license, and US Passports are valid through a 10-year period. It is likely that ageing may increase the difficulty of a perceptual identification and thereby exacerbate the CRE. In addition, the practical significance of longer retention intervals should also be explored, as it may relate to the practice of encoding a target face and searching for that face throughout one's daily interactions with various individuals. Given recent security concerns and a renewed focus on border security, it would appear that the body of research on facial identification should be expanded to include factors that moderate perceptual identification, especially in the context of own- and other-race faces.

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