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RACE, AROUSAL, ATTENTION, EXPOSURE, AND DELAY
An Examination of Factors Moderating Face Recognition

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A large percentage of people recently exonerated by DNA evidence were imprisoned on the basis of faulty eyewitness identification. Many of these cases involved victims and suspects of different races. Two studies examined the recognition of Hispanic and Black target faces by Hispanic participants under nonoptimal viewing conditions. When viewing time decreased, recognition performance for same- and other-race faces systematically shifted downward. Recognition accuracy for faces of both races decreased under conditions of high negative arousal and attention load; however, recognition of same-race faces was differentially affected by attention distractors. Face recognition accuracy was not affected by a delay between initial presentation of the faces and the face recognition test. An understanding of how recognition of other-race persons differs from that of same-race persons can assist by reducing misidentifications and ensuring that the perpetrator rather than an innocent person is imprisoned.

Eyewitness testimony often serves as direct evidence in a courtroom setting and can have a strong influence on juries (Loftus, 1974; Penrod & Cutler, 1995). Unfortunately, eyewitness identification is imperfect and can at times lead to the conviction of innocent people, as evidenced by a series of recent DNA exoneration cases. Breakthroughs in DNA testing have facilitated the isolation of factors that lead to false imprisonment. Of 62 cases examined, 52 involved mistaken identifications (Connors, Lundregan, Miller, & McEwan, 1996; Scheck, Neufeld, & Dwyer, 2000). In 69% of the misidentification cases, the victim was White, whereas in 57% of those cases the exonerated defendant was Black, which indicates that a proportionally greater number of misidentifications occurred across racial lines.

This finding may come as no surprise to anyone familiar with the phenomenon commonly known as the *own-race effect, cross-race effect,* or *own-race bias* (Chance & Goldstein, 1996; Malpass & Kravitz, 1969; Brigham & Malpass, 1985), which posits that people perform poorly when attempting to recognize a person of a different race (Meissner & Brigham, 2001). A large body of literature exists that examines factors affecting the recognition of own-race faces, such as distinctiveness of the face, sex of the face, age of the witness, attention, arousal, exposure, and delay between observation and testing; however, only 18% of the

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studies reviewed compared performance across faces of different races (Shapiro & Penrod, 1986). It is important to fully understand the factors that moderate other-race face recognition, otherwise one may assume that these factors affect the recognition of both same-race and other-race faces in a systematic manner unless the contrary is demonstrated.

The cross-race effect is the phenomenon whereby people are better able to recognize persons of their own race as compared with those of other races. This effect has been widely studied in terms of its implications for eyewitness identification. For example, a review of research on differential recognition of own-race versus other-race faces revealed that approximately 80% of the participants in those studies demonstrated the cross-race effect (Bothwell, Brigham, & Malpass, 1989). In one particular field study (Platz & Hosch, 1988), it was demonstrated that Hispanics were better at recognizing same-race faces as compared with Black faces by a magnitude of 39%. This should be cause for concern; if people in general are poor at recognizing others of a different race, and many eyewitness identifications occur across racial lines, knowledge and an understanding of this phenomenon is critical both to the researcher and to the legal practitioner. At the very least, we should take particular care when eyewitness identification crosses racial lines (*People v. McDonald,* 1984).

The cross-race effect is a robust phenomenon (Malpass & Kravitz, 1969; for reviews of the cross-race literature, see Bothwell, Brigham, & Malpass, 1989; Chance & Goldstein, 1996; Meissner & Brigham, 2001), though there is still debate regarding its cognitive and social underpinnings (Meissner & Brigham, 2001). However, little information is available on the factors moderating the cross-race effect, such as delay and exposure time (Meissner & Brigham, 2001), and less is known about the effects of arousal and the attentional factors involved in *weapon focus,* the phenomenon whereby the presence of a weapon diverts attention from other aspects of a scene. Furthermore, only a few studies have demonstrated that Hispanic participants are susceptible to the cross-race effect with Black faces (MacLin & Malpass, 2001; Platz & Hosch, 1988; Teitelbaum & Geiselman, 1997). The studies presented here evaluated these understudied aspects of the phenomenon, using Hispanic research participants.

Factors such as attention, arousal, exposure, and delay are known to be estimator variables in eyewitness performance (Wells, 1978). *Estimator variables* are those that cannot be changed once the eyewitness event has occurred, such as the event's duration (Shapiro & Penrod, 1986). Although the circumstances of viewing an event or a crime cannot be changed once it is witnessed, a full understanding of how estimator variables moderate face recognition is important to our understanding of eyewitness accuracy. Because eyewitness testimony often constitutes direct evidence in court cases (Wells et al., 1998), knowing more about how faces of another race are recognized in non-optimal circumstances will allow lawyers, the courts, and juries to emphasize or deemphasize the importance of eyewitness reports on the basis of the viewing conditions.

Optimal Viewing Conditions

In a quantitative review of the face recognition literature, Shapiro and Penrod (1986) found that as viewing conditions become more "optimal," recognition performance (the ability to correctly identify previously seen faces) improves. Some factors that affect optimal viewing conditions are the amount of time a person has to view the face and the amount of time that lapses between the initial viewing and the test of memory.

Exposure Time

The amount of time a person has to view a face affects his or her subsequent ability to recognize that face. This notion has been empirically examined with faces and is typically referred to as *exposure* or *study time.* In a study examining memory for facial features of same-race faces, researchers had participants view slides with changed versions of each face. Participants either viewed each slide for 20 s or 3 s. Participants who viewed the slides for 20 s recognized the faces better on a subsequent recognition task (Reynolds & Pezdek, 1992). Other investigators have found similar results for same-race faces; in essence, increased exposure time increases recognition accuracy for faces (Laughery, Alexander, & Lane, 1971).

Additionally, longer exposure time (8 s instead of 3 s) has been found to improve recognition of unusual faces in particular but to have no effect on typical faces (Light, Kayra-Stuart, & Hollander, 1979, Experiment 2).[1] In other words, it appears that distinctive faces (or novel or complex faces, which other-race faces may be for some people) are more easily recognized when they are viewed for longer durations. On the other hand, decreased exposure time lowers recognition rates by increasing false identifications ("that's the guy," when in fact it is not) (Light et al., 1979; Shepherd, Gibling, & Ellis, 1991). A meta-analysis of exposure time across a series of independent studies examining memory for other-race faces confirmed that increased viewing time of the face enhanced recognition (Meissner & Brigham, 2001).

The "real world" relevance of studies showing the effect of exposure time on face recognition lies in the reality that witnesses will often have seen the face of a suspect for varying lengths of time before they are asked to make identifications. Understanding how different exposure times may influence face recognition performance has implications for eyewitness identification of suspects.

Delay

Another factor that may be of importance when considering what may facilitate or impede cross-race identification is the delay between initial presentation of a stimulus and subsequent recognition. In other words, how might the passing of time between seeing a suspect and identifying that suspect at a later time affect the accuracy of that witness's identification? Longer delays between the time of initially viewing a face and the memory test decrease recognition rates for same-race faces (Shepherd, Gibling, & Ellis, 1991). Other researchers have examined the impact of varying the delay between viewing and memory testing on eyewitness identifications involving witnesses and suspects of different races. A longer delay between stimulus presentation and recognition leads to an increase

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[1]Faces were rated as "typical" or "unusual" by a group of independent judges.

in false identifications (Barkowitz & Brigham, 1982). In other words, the more time that passes between seeing a face of another race and being asked to identify that face, the greater the likelihood of a false identification. However, delay does not appear to affect the cross-race effect (i.e., identification of other races is still poor), but it does lead to an increase in false identifications (Chance & Goldstein, 1987). On the other hand, long periods of delay have been shown to have little effect on the recognition of well-known faces, such as school acquaintances, as opposed to strangers (Bahrick, Bahrick, & Wittlinger, 1975).

Attention and Arousal

Other factors that reduce optimal viewing and may moderate the cross-race effect but have not been examined extensively are attention and arousal. Attention, the concentration of mental effort (Solso, 2001), may vary considerably in eyewitness situations. These varying levels of attention are important to examine in laboratory studies to evaluate their impact on the cross-race effect. Arousal, a general drive state that maintains an individual's capacity and ability to perceive events and exert mental effort (Solso, 2001), is also a critical variable in assessing what levels of arousal are optimal or detrimental to the facial identification process.

Several studies have found a negative relationship between arousal and level of face recognition performance (for a review, see Deffenbacher, 1984). In a real-life setting, the effects of attention and arousal on face recognition performance were examined for participants scheduled to receive immunizations. During and after the immunizations, participants' pulse rates were recorded. Participants were asked to return for a follow-up examination. On their return for the second appointment, participants were asked to provide details about the face of the nurse who had administered the injection and the face of the nurse's aide, whom the participants had encountered shortly after the shot. Next, participants were asked to select the face of the nurse and the aide from a lineup consisting of six photographs. Half of the time, the target face was included in the lineup. The researchers found that pulse rates were lower when measured by the aide than by the nurse who had administered the injection. Additionally, recall of details and recognition of the face in target-present lineups was more accurate for the aide, with whom participants exhibited a lower level of arousal, than for the nurse who had given the injection (Peters, 1988). These findings indicate that people who are in higher states of arousal do not recognize faces as well as when they are under lower states of arousal.

The Special Case of Weapon Focus

Attention and arousal are thought to be responsible for another type of face recognition deficit commonly referred to as *weapon focus* (Johnson & Scott, 1976; Maass & Koehnken, 1989; Pickel, 1998, 1999; Steblay, 1992). Weapon focus refers to the phenomenon whereby a witness or victim of a crime who views a weapon used in the commission of the crime, such as a gun or knife, experiences a decrement in face recognition performance. The two major factors that have been identified as contributing to weapon focus are attention and arousal (Kramer, Buckhout, & Eugenio, 1990; Maass & Koehnken, 1989).

When a weapon is present, people tend to direct their attention to the weapon rather than to the face of the perpetrator (Loftus, 1979). Arousal can have the effect of enhancing recognition performance, because the main cognitive functions of arousal are to maintain an individual's capacity to perceive events and to jump start the attention process. However, high levels of arousal can prove overwhelming and distracting and result in a decrement in recognition performance (Yerkes & Dodson, 1908). Additionally, arousal and attention may interact, causing a person to attend to the weapon and to narrow attentional focus, resulting in cue utilization (Easterbrook, 1959). The *cue utilization hypothesis* proposes that in order to perform a task, external cues must be used. The more complex the task, the greater the number of cues that require monitoring. As arousal increases past a certain level, performance will decrease. When the level of arousal increases, the range of cues monitored is reduced, thus peripheral cues (in this case the face) are ignored and go unmonitored.

The impact of attention and arousal on other-race versus same-race recognition memory was evaluated by Tooley, Brigham, Maass, and Bothwell (1987). They induced a high level of arousal in White participants with the threat of electric shock combined with a "blast" of white noise, and they directed the participants either to look at the face, hand, background, or the whole image of the person. Half of the latter images included guns. Arousal and attention in this circumstance did not interact to affect recognition performance. Furthermore, participants in this study had better recognition for the previously seen images when the weapon was present and the faces were of Black men. When response bias was accounted for, overall, images of Whites were better recognized than those of Blacks. These findings indicate that factors known to degrade face recognition performance for same-race faces may not always affect performance in the same manner for other-race faces.

Experiment 1

Experiment 1 examined the effects of viewing time (exposure) and delay between training and testing. Recognition performance (the correct identification of previously seen faces) should be best in situations in which the research participant has maximal exposure and minimal delay. A 5 s exposure with no delay should yield higher recognition rates than a 0.5 s exposure with a 30 min delay. Increasing the exposure time from 0.5 s to 5 s should improve overall recognition performance (Light et al., 1979; Shepherd et al., 1991). By increasing delay, recognition performance should decrease (Chance & Goldstein, 1987; Podd, 1990). Finally, increased exposure should increase the cross-race effect (Anthony, Cooper, & Mullen, 1992), whereas an increase in delay should have no effect on cross-race recognition (Chance & Goldstein, 1987). The scenario we tested involves a hypothetical situation in which an eyewitness looks briefly at a suspect's face for either 0.5 or 5 s. Furthermore, we evaluated the effect of the amount of delay that the eyewitness experiences before being given the opportunity to identify the face—either no delay (immediately) or, say, 30 min—on his or her ability to correctly identify the suspect.

Method

Participants. Sixty-four Hispanic participants from the University of Texas at El Paso (UTEP) psychology subject pool participated in this experiment for partial course credit. All participants were treated in accordance with the ethical standards and the code of ethics outlined by the American Psychological Association (1992).

Stimuli. Sixty male faces (30 Black and 30 Hispanic) were selected from a large database of digitized facial photos. Images were selected so that no face had unusual identifying features, such as scars, moles, freckles, or variant hairstyles. The background of the facial images was edited to maintain a uniform color across all images, and all clothing was masked with the same uniform color as the background, so that the face images revealed only the head and neck. Finally, the images were sized to 217 pixels high by 201 pixels wide with a resolution of 72 dots per inch (dpi).

Apparatus. A *Visual Basic 6.0* program was designed to display the images in the center of a computer monitor set at 800 by 600 pixels and to collect the participants' responses.

Design. Both the amount of time the facial image was presented on the computer screen (exposure) and duration between the presentation of the faces and the recognition phase (retention interval) were manipulated in this experiment. During the training phase, face images were displayed for either a 5-s or a 0.5-s exposure time. Half of the participants were required to wait 30 min before beginning the testing phase, whereas the other half of the participants commenced with the testing immediately after the training phase. Hence a 2 (Exposure: 0.5 s and 5 s) $\times$ 2 (Delay: immediate and 30 min) $\times$ 2 (Race: Hispanic face or Black face) mixed factorial analysis of variance design with race as a within-participant factor was used.

Procedure. Participants were randomly assigned to participate in one of four experimental conditions: (a) 0.5-s exposure, no delay; (b) 5-s exposure, no delay; (c) 0.5-s exposure, 30-min delay; and (d) 5-s exposure, 30-min delay. Before the training phase, participants received instructions that they would be shown a series of faces and later would be asked questions about them. During the training phase, 20 Hispanic and 20 Black facial images were displayed in a random order with the restriction that no face of the same race was displayed three or more consecutive times. Depending on the experimental condition, images were displayed for either 0.5 s or 5 s before they were removed from the computer screen. After a 3-s interstimulus interval (ISI) in which no faces were visible to the participant, the next face in the sequence was displayed, until all 40 faces were displayed.

Following the training phase, participants either immediately began the testing phase (in which they had the opportunity to identify faces as having been seen before or not) or were given crossword puzzles to solve for 30 min prior to the testing phase, depending on the delay condition to which they were assigned. Half of the Hispanic faces and half of the Black faces were randomly chosen for removal from the stimulus set and replaced with images of 10 new Hispanic faces and 10 new Black faces. In the testing phase, participants were instructed that they would be shown more pictures of faces and that half of the faces would be "old" faces that they had seen before and half of the faces would be "new," previously unseen faces. Participants were instructed to press the left arrow key on the keypad if the face was previously seen (old) or to press the right arrow key if the face had not been previously seen (new). Facial images in the testing phase were presented for 5 s with a 8-s ISI and were placed in a new random order with the restriction that no three faces of the same race were presented consecutively. Additionally, no three "old" or "new" faces were presented consecutively.

Once participants had viewed and responded to all 40 faces, they were debriefed as to the nature of the study, thanked for their participation, and dismissed.

Table 1
Possible Outcomes of an "Old"–"New" Recognition Task

Recognition stimulus	Participant's response	
	"Old" response	"New" response
"Old," previously seen	Correct identification (Hit)	False rejection (1 − Hits)
"New," not seen previously	False alarm (FA)	Correct rejection (1 − FA)

Results and Discussion

Participants' recognition performance was examined for Hispanic faces and Black faces using the statistic *A*-prime (A'), a nonparametric measure based on signal detection theory. Signal detection measures are used to adjust for the participant's ability to differentiate between previously seen faces and new ones, thus taking into account a bias for each type of response. Correct identifications (hits) and false alarms (indicating the face was old when in fact it was new) (see Table 1) were averaged across participants for Hispanic faces and Black faces. These values were then used to calculate A' using Rae's (1976) computational formula.[2] High A' scores approaching 1 indicate superior face recognition performance, whereas A' scores near 0.5 represent performance at a near-chance level.

Overall, a cross-race effect was found, as evidenced by a main effect for race of face, $F(1, 60) = 30.09$, $p < .001$. Hispanic faces were more accurately recognized ($M = .84$) than Black faces ($M = .71$). Additionally, faces presented for 5 s were recognized better ($M = .87$ and .77 for Hispanic faces and Black faces, respectively) than when faces were presented for 0.5 s ($M = .81$ and .66 for Hispanic faces and Black faces, respectively; see Figure 1; see Table 2 for detailed results).

Recognition performance was superior for longer exposure times (5 s) than for brief presentation (0.5 s), $F(1, 60) = 8.71$, $p < .001$. These findings are consistent with research that has found a positive relationship between recognition performance and exposure time when similarity between target pairs is high (Read, Vokey, & Hammersley, 1991). Additional research has found an increase in the number of correct identifications as well as a decrease in false identifications for unusual faces when exposure is increased (Light et al., 1979). As can be seen in Figure 1, decreasing the length of exposure has an equivalent effect on Black faces and Hispanic same-race faces. To examine this effect, the difference between A' for Hispanic faces and Black faces was calculated for each participant. A one-way analysis of variance (ANOVA) examining these differences across race of face indicated that there is no significant difference between these values

[2] The computational formula (Rae, 1976) for A' where F = false alarms and H = hits is when $H \geq F$; $A' = (H^2 + F^2 + 3H - F - 4FH)/[4H(1 - F)]$ or when $H < F$; $A' = (H - H^2 + F - F^2)/[4F(1 - H)]$.

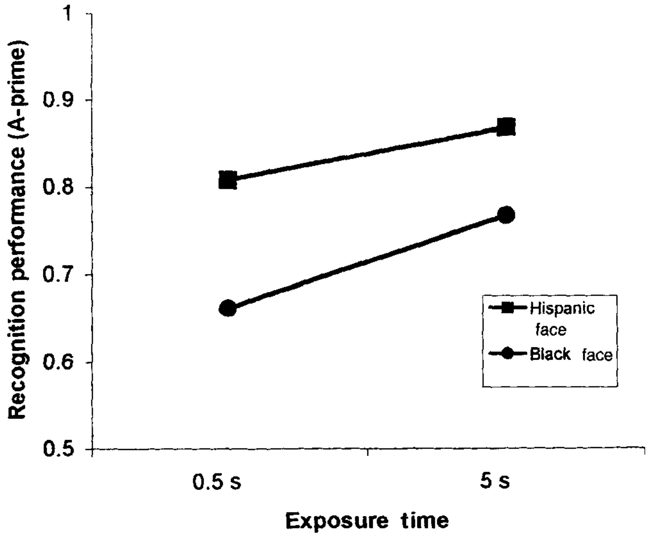

Figure 1. Recognition performance in A' as a function of exposure, delay, and race of facial image.

for the 0.5 s exposure and 5 s exposure (F = .991), indicating a systematic shift in the recognition performance for other-race faces.

Increasing the delay from immediate to 30 min had no effect on recognition performance (F = 1.90). This finding is consistent with those found in earlier studies in which delay was manipulated from 4 min to 6 weeks in six weeks in six increments (see Chance & Goldstein, 1987; Fessler, Lenorovitz, & Yoblick, 1974), and they, too, found no effect of delay on recognition performance. Contrary to these findings, other research has found a significant decrease in

Table 2
Recognition Performance for Hispanic Faces and Black Faces: Experiment 1

	Hits		FA		A'	
Race of face	*M*	*SD*	*M*	*SD*	*M*	*SD*
Black						
5 s/0 min	6.81	1.45	2.37	1.45	.810	.10
5 s/30 min	6.75	1.14	3.25	1.98	.761	.20
0.5 s/0 min	6.00	1.54	3.75	2.23	.672	.17
0.5 s/30 min	6.12	1.54	4.31	2.27	.650	.19
Hispanic						
5 s/0 min	6.62	2.21	1.25	1.43	.873	.08
5 s/30 min	6.68	1.81	1.87	1.14	.833	.09
0.5 s/0 min	6.87	1.45	2.12	1.89	.834	.10
0.5 s/30 min	5.81	1.64	4.31	2.27	.778	.09

Note. Hits = correct identifications; FA = false alarm (mistaken identifications).

recognition performance when delay is increased (Barkowitz & Brigham, 1982; Krouse, 1981; McKelvie, 1988; Podd, 1990).

Experiment 2

Experiment 2 examined the effects of arousal, attention, delay, and race by presenting face images paired with images from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1995). The IAPS is a database of images with known statistical values on such indexes as positive and negative emotional arousal that is often used in research in which these factors are of interest. The IAPS images have been demonstrated to attract attention (Lang, 1995) and to increase participants' overall level of arousal (Ito, Cacioppo, & Lang, 1988; Lang, 1995; Patrick & Lavoro, 1997). Results from psychophysiological studies (in which data such as heart rate and skin conductance levels were collected) demonstrated that these pictures elicit *actual* feelings of arousal rather than merely eliciting cognitive evaluations, such as likes or dislikes, toward the pictures (Ito et al., 1998; Lang, 1995). Images in IAPS are standardized for both low and high arousal, and the IAPS images are also standardized for positive, neutral, or negative valence. In other words, images of high arousal can be categorized as either negative (e.g., a snake about to strike) or positive (e.g., a picture of a roller coaster). An example of an image with neutral valence would be a picture of a napkin.

When past researchers studying weapon focus addressed arousal, a negative valence was assumed, although some research has shown that positive arousal (induced with erotic pictures) also degraded memory performance (Christianson, 1986). Whether aroused states must be negative or are solely or always negative for eyewitnesses to experience weapon focus is unknown. However, operating under the presumption that for most witnesses weapon-present situations will be perceived as negative, images used in this study were selected on the basis of their negative valence.

Same- and other-race faces were presented with IAPS pictures known to elicit various states of arousal. In both attention conditions, faces were presented simultaneously and sequentially. We predicted that when the IAPS images were presented simultaneously in the high arousal condition, they would compete for attention with the facial images. In the low arousal condition, presentation mode (simultaneous or sequential) should have a minimal effect on recognition performance. Additionally, a condition consisting of either an immediate test or a delay of 30 min prior to testing was included. In summary, there were eight conditions. For each of the two delay conditions (no delay and 30 min delay), there were the following experimental groups: (a) low-arousal–simultaneous, (b) high-arousal–simultaneous, (c) low-arousal–sequential, and (4) high-arousal–sequential.

Method

Design. This experiment used a 2 (Arousal: high and low) × 2 (Delay: immediate or 30 min) × 2 (Presentation: simultaneous or sequential) × 2 (Race of face: Hispanic or Black) mixed factorial analysis design with race of face as a within-participants variable.

Participants. A sample of 128 Hispanic students from the UTEP psychology department participated in Experiment 2 for extra credit. All participants were treated in conformity with the ethical standards and the code of ethics outlined by the American Psychological Association (1992).

Stimuli and apparatus. The stimuli and apparatus were the same as used in Experiment 1, with the following exceptions. Sixty IAPS pictures were selected for high negative valence (high arousal), and 60 IAPS images were selected for neutral valence (low arousal). All IAPS images were sized to 217 pixels high by 201 pixels wide with a resolution of 72 dpi. Images were displayed side by side in the simultaneous condition, with the facial image located to the left of the IAPS image. Past studies have shown that the position of picture pairs has no effect on affective ratings (U. Schimmack, personal communication, March 15, 2000). Pictures were shown either simultaneously or sequentially. Regardless of presentation mode, the left and right positions were maintained throughout all presentation conditions. Therefore, when the presentation was sequential, the face appeared on the left location, with nothing to the right; when the IAPS image was on the screen, it was presented in the right location, with nothing on the left.

Procedure. Participants were randomly assigned to one of the eight conditions. Participants received the same instructions as were provided in Experiment 1, with the addition of the instruction to make affect ratings after the presentation of each picture pair. The procedure was identical to that of Experiment 1, with the following exception: In Experiment 2, the training phase was parsed into three time intervals to accommodate the sequential mode of presentation.

In the sequential mode, the time intervals were as follows: Time 1, a face was displayed for 5 s; Time 2, the face image was removed, and an IAPS image appeared to the right of where the face image had been and remained on the monitor for 5 s; and Time 3, the IAPS image was replaced with two 9-point scales for rating pleasantness and unpleasantness, which remained on the screen until the participants had rated their affect.

The two rating scales were presented in a random sequence, one at a time. It has been demonstrated that pleasantness and unpleasantness are not polar opposites and can occur simultaneously (Schimmack & Colcombe, 2000), making it necessary to collect ratings for both scales. Above the rating scale the phrase "During the presentation I felt . . . " appeared on the screen, followed by the adjective "pleasant" or "unpleasant" (Schimmack & Colcombe, 2000). The scales were labeled 0 to 8 with the anchors of *not at all* to *maximum intensity*. The value *0* was included to represent an absence of either pleasantness or unpleasantness. Once the participants had responded to both rating questions, the sequence repeated by displaying a new face.

In the simultaneous condition, the following procedure was was used. During Time 1, the screen remained blank. This allowed the training phase to last an equivalent duration for both presentation modes. During Time 2, both the face and the IAPS image were presented, with the face image on the left and the IAPS image on the right. During Time 3, the pictures were replaced with two 9-point scales for rating pleasantness and unpleasantness, which remained on the screen until the participants had rated their affect.

The testing phase in Experiment 2 was the same as that used in Experiment 1.

Results and Discussion

Pleasure and displeasure. Pleasantness and unpleasantness ratings were averaged for Hispanic faces and Black faces across each participant. An interaction occurred for affect type and level of arousal, $F(1, 126) = 49.65$, $p < .001$. As shown in Figure 2, participants in the high-arousal conditions rated the picture pairs higher for unpleasantness ($M = 4.34$) than did participants in the low-arousal conditions ($M = 2.58$), $t(126) = 6.61$, $p < .001$, whereas there was no difference in the pleasantness values across levels of arousal ($t = 1.68$; see Table 3). Furthermore, there were no significant differences in pleasantness or unpleasantness for presentation mode ($F = .22$) or delay ($F = 1.21$). As

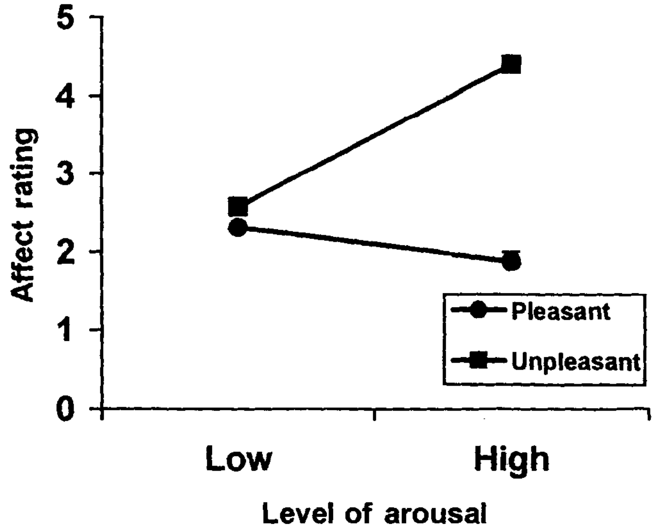

Figure 2. Pleasantness and unpleasantness ratings across levels of arousal.

intended, the arousal manipulation was effective: When picture pairs contained stimuli known to elicit high levels of arousal and negative valence, participants rated the pairs higher in unpleasantness, regardless of simultaneous or sequential presentation.

The finding that pleasantness was unaffected by the arousal manipulation, whereas the unpleasantness ratings were affected, supports the research of Schimmack and Colcombe (2000), who demonstrated that pleasantness and unpleasantness are not complements and should be rated with separate scales. If these two scales were measuring the same affect, as unpleasantness increased, pleasantness would decrease, which did not occur.

Recognition performance. Recognition scores were calculated for each participant (see Table 4) and converted to A' (Rae, 1976). A' scores were computed across participants for each race of face. There was a significant main effect for race, $F(1, 120) = 56.44$, $p < .001$, and a significant main effect for arousal, $F(1, 120) = 29.27$, $p < .001$. Paired comparisons indicated that A' was higher for Hispanic faces presented sequentially ($M = .84$) than for Hispanic faces presented simultaneously ($M = .75$), $t(62) = 2.84$, $p < .01$.

Table 3
Pleasantness and Unpleasantness Ratings by Arousal and Race of Face: Experiment 2

	Pleasant		Unpleasant	
Level of arousal	*M*	*SD*	*M*	*SD*
Low				
Simultaneous	1.84	1.28	2.09	1.34
Sequential	2.55	1.69	2.79	1.79
High				
Simultaneous	2.45	1.96	4.81	1.18
Sequential	1.69	1.13	4.48	1.68

Table 4
Recognition Performance Across Arousal and Race of Face: Experiment 2

	Hits		FA		A'	
Race of face	*M*	*SD*	*M*	*SD*	*M*	*SD*
Black						
No delay						
Low sim	7.06	1.76	2.82	1.51	.81	.10
Low seq	6.33	1.41	2.59	1.54	.78	.10
High sim	6.25	1.57	4.13	1.89	.69	.17
High seq	6.94	1.92	4.56	2.57	.72	.16
30 min delay						
Low sim	7.13	1.30	3.14	1.92	.80	.10
Low seq	7.07	1.73	3.64	1.34	.76	.13
High sim	5.60	1.99	3.67	1.45	.65	.17
High seq	6.46	1.45	3.60	2.44	.73	.14
Hispanic						
No delay						
Low sim	7.31	1.35	1.19	1.16	.88	.07
Low seq	6.88	2.26	1.34	1.92	.86	.11
High sim	5.18	1.37	1.57	1.36	.82	.08
High seq	7.28	1.67	2.11	1.28	.86	.09
30 min delay						
Low sim	7.40	1.50	1.20	1.26	.89	.05
Low seq	7.14	2.17	1.14	0.95	.89	.08
High sim	5.13	2.61	2.34	1.39	.66	.19
High seq	6.60	1.35	1.80	1.82	.83	.10

Note. FA = false alarm (mistaken identification); A' = nonparametric statistic for unbiased response; low = low arousal; high = high arousal; seq = sequential presentation; sim = simultaneous presentation.

However, no difference was found between presentation mode for Black faces (M = .71 and .67 for sequential and simultaneous presentations, respectively), $t(62) = 1.0$.

As can be seen in Figure 3, higher A' values indicate that Hispanic faces were better recognized than Black faces. The finding of a cross-race effect for Hispanic participants is consistent with that of an earlier research finding that Hispanic store clerks identified a suspect in a lineup more often when the suspect was Hispanic than when the suspect was Black (Platz & Hosch, 1988). This finding of a cross-race effect with Hispanics and Blacks is also consistent with the literature on the cross-race effect in general (Anthony, Cooper, & Mullen, 1992; Bothwell, Brigham, & Malpass, 1985; Meissner & Brigham, 2001).

Participants in the high arousal condition reported a higher level of unpleasantness when presented with IAPS images rated for high arousal, regardless of whether the stimuli were presented simultaneously or sequentially. Additionally, the participants in the high arousal condition performed worse on the recognition task, as shown by A' values for both Hispanic faces and Black faces. Both the self-report and recognition performance were consistent with other research that has manipulated arousal to examine same-race recognition (Peters, 1988; Read et al., 1991; Tooley et al., 1987), indicating that even laboratory-induced arousal can have a significant effect on recognition performance. These findings do not, however, support the theory that the object causing the arousal must

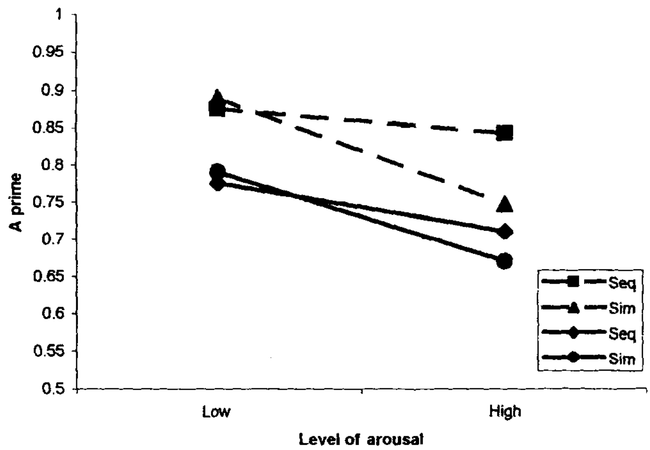

Figure 3. Recognition performance as measured by A' by level of arousal and presentation mode. Broken lines indicate performance for Hispanic faces. Sim = simultaneous presentation; Seq = sequential presentation.

be present in order to interfere with memory performance (Christianson & Mjorndal, 1985).

General Discussion

Similar to Experiment 1, the arousal manipulation affected the recognition performance for the Hispanic faces and the Black faces by systematically shifting the performance indicators, in this case downward. A similar shift was found when the effect of orienting strategies was examined for other-race faces (Devine & Malpass, 1985). This systematic shift is not evident for presentation mode in the high arousal condition as recognition performance is better for Hispanic faces presented sequentially than for Hispanic faces presented simultaneously. This, however, is not the case for Black faces, for which no significant difference between sequential and simultaneous presentation was found. When examining factors involved in weapon focus, a decrease in performance was found for White same-race faces, whereas correct identifications increased with Black faces in the gun-present condition (Tooley et al., 1987).

The difference for race of face across presentation mode is important because when faces were presented simultaneously with other images, there was the opportunity for the nonfacial images to complete for attention. When arousal was high, the images competed for attention with the Hispanic faces, as demonstrated by lower A' values. This is not to say that there was an absence of competition with the Black faces; however, the competition for attention in the simultaneous mode for Black faces did not interfere with the encoding of facial information, suggesting that the encoding strategies used by the cognitive system of these Hispanic participants differed, depending on whether they were looking at Black or Hispanic faces.

Previous research has examined whether own-race and other-race faces are processed differently (Fallshore & Schooler, 1995; Rhodes, Brake, Taylor, & Tan, 1989). It has been proposed that faces are processed in two modes: featurally and configurally (Diamond & Carey, 1986). That is to say that faces can be processed solely on the basis of their individual features or on the basis of the unique configuration of those features. Configural encoding is thought to be a more efficient encoding process than featural encoding. There is evidence that other-race faces are encoded using the less-efficient featural encoding strategy, which in turn results in poorer recognition (Fallshore & Schooler, 1993; Rhodes, Brake, Taylor, & Tan, 1989; see MacLin & Malpass, 2001, for data on how the feature hair can act as a racial marker and influence face recognition).

Encoding individual facial features may be an easier task than configural encoding, although both are automatic processes. According to the cue utilization model, arousal will have a greater effect when complex processes are involved, because resources are reallocated, in this case toward the object acting as the source of arousal. It should be emphasized that when the object causing the arousal is present (i.e., is competing for attention), recognition performance is reduced for same-race faces.

Conclusion

The research reported here is important for several reasons. First, it is one of a small number of experiments confirming the susceptibility of Hispanics to the other-race effect. The majority of studies to date have examined the other-race effect among Whites and Blacks. In a field study—one of the few studies to examine the other-race effect with Hispanic participants—the ability of Hispanic participants to recognize Black faces was worse than their ability to recognize Hispanic faces (Platz & Hosch, 1988). Other researchers found that Hispanic participants recognized identical composite faces better when they had stereotypical Hispanic hair rather than when the identical faces had stereotypical African-American hair (MacLin et al., 2001). Recognition performance of Hispanic participants for White faces and Black faces was equivalent to that of the White participants' recognition performance for White faces and Black faces in another lab study (Teitelbaum & Geiselman, 1997).

Second, although decreased duration of exposure during study time and increased delays between study and testing phases (for a review, see Shapiro & Penrod, 1986), as well as attention and arousal (for a review, see Steblay, 1992), have been shown to reduce recognition performance, some of these factors have a differential effect on same- and other-race faces. This is an important finding because although it is generally understood that recognition performance is worse for other-race faces (Kassin, Ellsworth, & Smith, 1989), a lay person can only assume that factors affecting same-race faces will have an equivalent and systematic effect for other-race faces. And, indeed, for some factors this assumption is correct, as in the case of reduced viewing time, as demonstrated in Experiment 1. Thus, the assumption of equivalent effects for same- and other-race faces is a good heuristic in the absence of empirical evidence to the contrary. However, the problem exists when factors affect recognition performance for faces of the same race differently from recognition performance for other-race faces. As demonstrated in Experiment 2, Black faces are not affected by a competition for attention (as are Hispanic faces) when viewed by Hispanic participants. To assume that Black faces would be affected equivalently would have been an error. In fact, some research has demonstrated better recognition for previously seen images of Black people with a gun (Tooley et al., 1987). It is not sufficient to know how nonoptimal viewing conditions affect face recognition in general. Additional research on how these factors affect memory for other-race faces is required to determine whether it is differently affected.

There are a few possible explanations as to why differential recognition performance was found for Black faces in Experiment 2. First, the Yerkes-Dodson law may account for the differential performance. The Yerkes-Dodson law predicts that different levels of arousal produce better or worse performance. Although the level of arousal is equal for the Black faces and the Hispanic faces, participants may exert less effort in encoding the Black faces. If other-race faces are encoded in a less efficient featural mode, reducing task demand, it is possible that different outcomes may be derived at equal levels of arousal. Although incentive does not reduce the other-race effect (Barkowitz & Brigham, 1982), the cognitive processing used to encode other-race faces may require fewer resources than are used for same-race faces.

Another explanation for the difference in performance in the high arousal condition is that when viewing the Black faces, participants do not attend to the face as carefully as they are prone to do when viewing Hispanic faces, but instead they attend to the peripheral environmental or to internal information (i.e., they may be thinking about a homework assignment). During high arousal states, their attention is directed toward the task at hand. Cue utilization predicts that a reallocation of resources occurs during an aroused state, resulting in a reduced number of cues being used to the exclusion of peripheral information. The configural information regarding the same-race faces may be more susceptible to reallocation, causing a disruption in the configural process, causing same-race faces to be processed featurally. Other-race faces may already be processed featurally. The increased attention paid to the individual features of the same-race faces is less efficient and results in a differential recognition performance.

Contrary to the theory stating that the object that causes the arousal must be present in order to interfere with memory performance (Christianson & Mjorndal, 1985), we found that recognition performance for the participants in the high arousal condition decreased regardless of whether the arousal-inducing image was presented simultaneously. With the Hispanic faces, having the object present during the presentation of the face increased the effect for arousal, although having the object present during the presentation of Black faces did not affect recognition of the Black faces.

Another important contribution of this study is that a method to examine the factors moderating weapon focus (attention and arousal) was devised. Previously, weapon focus was examined in experimental laboratories using aversive stimuli such as an injection from a hypodermic syringe (Peters, 1988), a threat of injection (Maass & Koehnken, 1989), or white noise and the threat of shock to induce a state of arousal and a visual orienting task to direct attention (Brigham, Maass, Martinez, & Whittenberger, 1983; Tooley et al., 1987). Other studies have manipulated arousal by injecting adrenaline (Christianson & Mjorndal, 1985), having participants complete either pleasant or unpleasant passages before the training phase of a recognition task (Teitelbaum & Geiselman, 1997), or by displaying pictures that elicit arousal (Christianson & Nilsson, 1984; Lang, 1995).

Experiment 2 demonstrates that the role of attention and arousal can be isolated and examined in a less elaborate way by displaying the arousing images in either sequential or simultaneous presentation.

Although it can be argued that the level of arousal derived from a pointed gun or a threatening knife is not the same as the level of arousal induced in a laboratory setting, it is unlikely that participants are using cognitive systems in the laboratory that are separate from what they use during an actual crime event. Thus, studying these factors in a laboratory setting can and does provide empirical evidence that can lend insight into how these factors affect a witness to a crime. For ethical reasons, participants in research experiments cannot be subjected to levels of arousal as extreme as those present when a person is in a life-threatening situation. Recall that the Yerkes-Dodson law predicts that different levels of arousal produce better or worse performance. The impact of extreme levels of arousal on performances is difficult to assess in a laboratory situation. However, not all witnesses of crimes are the victims, and all crimes are not violent. Although the research findings may not generalize to a victim of a violent crime, because of the extreme level of arousal, there is little reason not to generalize these findings to the performance of bystanders who serve as eyewitnesses, as the levels of arousal may be more comparable.

Knowing more about how memory for other-race and same-race faces is processed and how factors such as arousal, attention, exposure, and delay affect recognition performance will allow lawyers, courts, and juries to use this information to determine the potential accuracy of eyewitness identifications when the suspect and the witness are of different races. Although conditions in the research laboratory and those in an actual crime event may seem removed from one another, it is difficult to argue that the cross-race effect found in the laboratory is not the same cross-race effect responsible for placing many innocent people, who have since been exonerated, in prison and on death row.

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