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Race-Specific Perceptual Discrimination Improvement Following Short Individuation Training With Faces

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Abstract

This study explores the effect of individuation training on the acquisition of race-specific expertise. First, we investigated whether practice individuating other-race faces yields improvement in perceptual discrimination for novel faces of that race. Second, we asked whether there was similar improvement for novel faces of a different race for which participants received equal practice, but in an orthogonal task that *did not* require individuation. Caucasian participants were trained to individuate faces of one race (African American or Hispanic) and to make difficult eye-luminance judgments on faces of the other race. By equating these tasks we are able to rule out raw experience, visual attention, or performance/success-induced positivity as the critical factors that produce race-specific improvements. These results indicate that individuation practice is one mechanism through which cognitive, perceptual, and/or social processes promote growth of the own-race face recognition advantage.

Keywords: Face recognition; Own-race advantage; Perceptual expertise

1. Introduction

Perceptual expertise with objects from a visually similar category, such as cars, birds, or faces, can result in rapid recognition of these objects at the individual level. But how is perceptual expertise acquired? The learning experiences of real-world experts are complex

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and varied, making it difficult to tease apart the separate components associated with the acquisition of expertise. For instance, it is possible that simply being repeatedly exposed to objects of a given category is sufficient to acquire perceptual expertise in that domain. Alternatively, it may be that the critical factor in attaining perceptual expertise is practice recognizing objects at a more specific categorical level than what has been termed the ‘‘basic level’’ of categorization (e.g., bird, chair, car; see Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976). We refer to this particular type of experience as ‘‘individuation training.’’ In accordance with the hypothesis that such experience is central to the acquisition of expertise, our tendency to individuate faces of our own race but to categorize faces of other races has been proposed as an explanation for the own-race-advantage (‘‘ORA’’; Lebrecht, Pierce, Tarr, & Tanaka, 2009; Levin, 1996, 2000; Tanaka & Pierce, 2009). The ORA encompasses a collection of phenomena whereby we tend to recognize faces from our own race better than those of less familiar races (Allport, 1954; Anthony, Copper, & Mullen, 1992; Bar-Haim, Ziv, Lamy, & Hodes, 2006; Bothwell, Brigham, & Malpass, 1989; Malpass & Kravitz, 1969; Meissner & Brigham, 2001). Developmental work underscores the role of environment in shaping this bias (e.g., Bar-Haim et al., 2006; Sangrigoli, Pallier, Argenti, Ventureyra, & de Schonen, 2005). Here, we test whether individuation training with faces from a less familiar race can result in race-specific improvement in face discrimination performance.

Practice individuating members of a category is critical to the acquisition of a type of perceptual expertise that allows for rapid discrimination of objects that share parts in a common configuration. The most studied example of such expertise is found in face recognition. Human faces share with one another a similar spatial arrangement of features, such that the simple presence of a nose or the presence of the eyes above the nose is not helpful to individuate a face. This shared general configuration, together with the fact that each part is relatively visually homogeneous across faces (i.e., few eyes, noses, or mouths alone are unique enough to support individual recognition), is thought to encourage the use of configural information, or the relationships between features, as well as the adoption of a holistic processing strategy when we perceive faces (Farah, Wilson, Drain, & Tanaka, 1998; Richler, Tanaka, Brown, & Gauthier, 2008; Young, Hellawell, & Hay, 1987). Certain hallmarks of face-like expertise—including a speed advantage in learning new exemplars and a sensitivity to small configural changes—have also been obtained following individuation training with novel objects (Gauthier & Tarr, 1997; Gauthier, Williams, Tarr, & Tanaka, 1998; Wong, Palmeri, & Gauthier, 2009). However, even in most controlled training conditions in the laboratory, practice individuating objects is inherently confounded with exposure to objects, so the root causes of training-related changes remain unclear.

To address this question, Tanaka, Curran, and Sheinberg (2005) trained participants for 5 days in the classification of wading birds or owls at either the subordinate level of species or the basic level of family, while equating visual exposure between the two training conditions. With perceptual exposure held constant, individuation training relative to basic-level training led to better transfer to untrained exemplars. Consistent with this work, Nishimura and Maurer (2008)—using novel objects (blobs) and a single-session training paradigm—found that training participants to recognize blobs at the individual level led to an improved sensitivity to second-order relations of the trained objects; similar effects were absent with basic-level training. These studies (see also Scott, Tanaka, Sheinberg, & Curran, 2006, 2008) rule out the possibility that mere exposure is sufficient for expertise to develop. However, such experimental designs cannot demonstrate unequivocally that it is individuation per se that produced expertise effects, since the individuation training task was fundamentally more difficult in terms of perceptual discrimination than the control categorization training task.

A recent study, however, speaks to this question. As in the work just discussed, two separate training regimens were compared for the same objects (Wong et al., 2009). One group of participants was trained to individuate novel objects, while another group of participants learned to categorize the same objects in a procedure similar to that administered in prior studies comparing categorization and individuation (e.g., Tanaka et al., 2005). Critically, a considerable portion of the categorization training was spent on a demanding visual search task modeled after letter perception. Participants in the individuation group exhibited hallmarks of face-like processing (i.e., configural processing) and participants in the categorization group were actually faster than those in the individuation group in performing posttest categorization at the basic level for sequences of the new instances of the stimuli. Thus, despite a new training regimen that was more difficult than those of previous studies, this letter-like training did not improve individuation performance to an equal extent relative to individuation training.

We follow up on this question here, asking whether differential practice individuating faces of multiple races contributes to the ''ORA,'' and if so, whether it is possible to reduce this advantage via individuation training. Critically, we also use a comparison task that has been equated in difficulty with individuation. The ORA refers to the significant advantage in recognition performance for faces of the observer's race relative to faces of different races (Allport, 1954; Bothwell et al., 1989; Malpass & Kravitz, 1969; O'Toole, Deffenbacher, Valentin, & Abdi, 1994; Walker & Tanaka, 2003). Real-world exposure to other-race faces in multiracial neighborhoods (Chiroro & Valentine, 1995; Meissner & Brigham, 2001; Ng & Lindsay, 1994; Sangrigoli et al., 2005) or sports television (MacLin, Van Sickler, MacLin, & Li, 2004) has been shown to reduce differences in the processing of own- and other-race faces. Nevertheless, a meta-analysis of ORA research articles concluded that self-report assessments of other-race contact explain less than 3% of the total variance in the ORA (Meissner & Brigham, 2001), suggesting that components beyond mere exposure to unfamiliar or other-race faces may influence the magnitude of the ORA. Under some conditions, the ORA can be reduced by instructions to focus on individuating features of other-race faces (Hugenberg, Miller, & Claypool, 2007). Another study reduced the ORA by induction of a positive mood that is thought to increase holistic processing (Johnson & Frederickson, 2005). It appears that various types of experience may influence the ORA, perhaps through common mechanisms having to do with expert individuation, which depends on holistic processing mechanisms. Here, we specifically put to test the idea that learning to individuate faces, and not some associated attentional requirement, can improve discrimination of faces from a less familiar race.

Recent work provides evidence for dissociable effects of individuation training with faces of another race relative to practice categorizing the same faces. Caucasian individuals were trained to categorize Hispanic (HS) or African American (AA) faces at either the subordinate level of the individual (e.g., Bob, Joe, Fred) or the basic level of race (HS, AA; Tanaka & Pierce, 2009). While individuation training facilitated the recognition of novel faces of the individuated race, categorization training did *not* improve subsequent recognition of new faces from the categorized race. Similar to the effects observed in object-training studies (Scott et al., 2006, 2008), faces from the individuated race evoked a larger face-selective electro-physiological brain component (the N250) relative to faces from the categorized race, and the N250 generalized from trained faces to novel within-category faces following individuation but not categorization training (Tanaka & Pierce, 2009). In addition, this training paradigm led to a reduction in implicit racial biases following individuation but not categorization-level training (Lebrecht et al., 2009).

Together with what is known about the ORA, this body of experimental results suggests that practice individuating faces may improve perceptual expertise with faces from a specific race. However, our understanding of generalization in non-face domains of expertise may not be sufficient to support this conclusion. On the one hand, Wong et al.'s study with novel objects compared two different but difficult training regimens with the same objects, but did so across two separate groups of participants. Therefore, those results do not speak to transfer that might occur in a situation where the same participants practice two different tasks for different objects that are nonetheless perceptually related (such as faces from two different races). Indeed, there is evidence that individuation training generalizes to other objects within the same domain. For example, participants trained to discriminate Spotted and Barred owls were able to transfer their skills to the discrimination of Great Grey owls, for which they received no training (Tanaka et al., 2005). Thus, it is an empirical question as to whether faces of two different races are sufficiently distinct that practice individuating faces from one race would not indirectly benefit individuation of faces from the other race that participants have practiced with, but not individuated. Although such transfer was not observed in situations where the faces from the nonindividuated race did not require an equated degree of visual attention (Lebrecht et al., 2009; Tanaka & Pierce, 2009), in these studies, the categorization judgment was easy relative to the individuation judgment. Thus, it is unclear whether individuation training effects generalize to faces of trained but non-individuated race given the latter are processed with the same level of visual attention. To address this question directly, we trained participants to individuate faces from one race while they received an equal amount of exposure to faces from another race and, critically, this exposure occurred in a training task that equated to be at least as difficult as individuation but did not require individuation.

While it is challenging to perfectly equate the difficulty of two training protocols—which would require an exact matching of the difficulty of each task at the start, and then matching the learning rate associated with each task—we developed a novel task for which extensive pilot work suggested a difficulty level and learning rate reasonably similar to that observed with individuation training. More specifically, we compared individuation training with subordinate-level naming to a training with an eye-luminance judgment task in which identity is entirely irrelevant. Of particular importance, attention is not removed from the salient eye region of the faces, which is generally attended during identification (Caldara et al., 2005; Itier, Alain, Sedore, & McIntosh, 2007; Sekuler, Gaspar, Gold & Bennett, 2004). Participants learned to judge which eye was of a brighter luminance, while the brightest eye was never predictable based on face identity. In other words, identity and brightest eye were orthogonal.

In this study, we measure face perception and face recognition for faces of two races (AA and HS), both before and following a short training protocol. We used a within-subject design in which Caucasian participants practiced individuating faces of one race and practiced making eye-luminance judgments for faces of the other race. By the end of the training protocol, the race of the face will be the only cue as to which task should be performed, so participants have learned distinct task associations for each race.

2. Methods

2.1. Participants

Thirty-nine of forty-three Caucasian individuals who volunteered for this study completed all three sessions. The training data and the results from the two-alternative forced choice (2-AFC) perceptual pre–posttest represent these 39 participants (16 male, mean age 22 years). Because one individual failed to complete the memory part of the posttest, results from a recognition memory test represent 38 participants. All participants had normal or corrected-to-normal visual acuity. All received a small payment ($12 an hour) or course credit and provided written informed consent. The study was approved by the Institutional Review Board at Vanderbilt University.

2.2. Stimuli

Eighty AA and HS face images each were used, as in Tanaka and Pierce (2009). This subset of 160 faces was selected from 600 original photographs of AA and HS faces obtained from the Department of Corrections' face databases from the states of Florida, Arkansas, Georgia, and Kansas. Adobe Photoshop was used to create 440 grayscale images with these faces. All the faces displayed neutral expressions and were males of either AA or HS ethnicity between the ages of 20–35 years. Internal face features were digitally placed in a standard face template with identical hairstyle, face contour, and clothing (see Fig. 1). External cues (e.g., hairstyle, clothing) were minimized and kept constant in order to promote recognition strategies based on facial features, rather than non-face strategies based on incidental cues (Bonner, Burton, & Bruce, 2003; O'Donnell & Bruce, 2001). General image luminance was controlled within each racial group, but not between racial groups (AA = 121 mean luminance, HS = 151 mean luminance).

We generated several variations based on each face: no difference between the luminance values of the irises of the two eyes, brighter right eye (easy, average, and difficult luminance

Left-Normal
“<”

Right-
Easy
“>”

Left-Difficult
“<”

No
Difference
“space bar”

Fig. 1. Seven variations of each AA identity and five variations of each Hispanic identity were used in training (see text for details). Top labels specify the degree of eye-luminance manipulation between the left and right eyes and the correct key response. Eyes were manipulated on both races for all participants regardless of training task, and the eye-luminance value was not correlated with identity.

discrepancies), and brighter left eye (easy, average, and difficult). Because pilot data suggested superior discrimination of iris luminance changes in average HS faces relative to average AA faces, ‘‘easy’’ versions of HS identities were removed from the training set. In exemplars where the luminance of the irises varied between the eyes, Adobe Photoshop CS2 version 9.0 was used to adjust one eye (i.e., the iris) by 12%, 20%, or 28% of its original brightness intensity for difficult, normal, and easy versions of discrepancy, respectively. All image variations were used in both identification and luminance-judgment tasks, and identity and eye-brightness were never mutually predictive. All images were 225 × 311 pixel bitmaps presented on a 21-inch CRT monitor (1,024 × 768 pixel screen resolution, refresh rate 75 Hz, 87 cm from the participant) with a Macintosh G3 computer using MATLAB (Mathworks, Natick, MA, USA) and Psychophysics Toolbox extensions (Brainard, 1997; Pelli, 1997). The visual angle subtended by the stimuli varied across tasks: perceptual discrimination pre–post task (approximately 2.9° and 4.0° in the vertical and horizontal dimensions, respectively), recognition memory pre–post task (3.2° × 4.4°), and training tasks (3.9° and 5.4°). For each participant, 36 of the 80 available faces for each race were selected for training. Twelve of these faces were randomly selected as the ''learned'' faces, to which twelve names were randomly assigned. The other faces were used in posttests.

From the 160 faces differing in identity, 80 were selected for pretraining tests and training, while the remaining 80 were reserved for posttraining tests. In the pretraining, 40 new faces were used in the perceptual discrimination task. These 40 faces served as ''old'' exemplars in the recognition memory test, with the addition of 40 ''new'' faces previously unseen. For each individual, training involved 36 faces randomly selected from the 80 used in pretests. Finally, all face images displayed in the posttraining tests had never been seen. The images employed across all tests and tasks were randomized across participants.

2.3. Procedure

2.3.1. Perceptual discrimination pretest

Participants performed a 2-AFC perceptual discrimination task on Day 1 prior to training. Each trial began with a fixation cross for 850 ms, followed by the target image for 125 ms, then a visual mask for 500 ms. The mask was created by randomly selecting a face image not employed in the current trial, parsing the image into 16 squares of equal size, then rearranging the squares and resizing the final scrambled construction to match the size the target image (233 × 168 pixels). Immediately following the mask a test screen appeared with two faces: a probe face identical to the test face and a novel distractor face. The two faces were separated by 311 horizontal pixels, and the probe image randomly occurred at either the left or right location on the screen. Participants indicated which of the two faces (''left'' or ''right,'' as labeled on the keyboard) previously occurred as the target image, indicating the correct response with the dominant hand. They were asked to respond as quickly as possible within a 2,000 ms allotted window. Participants performed 4 blocks of 20 trials, 2 blocks per race. The blocks always alternated by race, but the race of the first block was randomly selected. In total, participants had 40 trials with AA faces and 40 trials with HS faces.

2.3.2. Recognition memory pretest

Before the 2-AFC perceptual discrimination pretest participants were warned that at the end of each race block, their memory for the 20 *target* faces would be tested. Indeed, immediately following each block of 20 perceptual discrimination trials, participants were given 20 recognition memory trials. Before each block, instructions reminded the participant of the changing task from perceptual discrimination to memory. Each memory trial began with a fixation dot for 250 ms, followed by a test screen displayed until either the participant made a response or 4,000 ms elapsed. The test screen consisted of an ''old'' image that previously occurred as a target in the discrimination test, and a ''new'' image of the same race but yet unseen. The two images were slightly enlarged (256 × 185 pixels) relative to the perceptual discrimination trials (233 × 168 pixels) and separated by a question mark sign, reminding the subjects of their present task (old—new as opposed to same—different). When the two images appeared, participants indicated which face they had previously seen in the perceptual discrimination test, using their left and right index finger to code the left or right face, respectively. Non-target faces from the memory test and perceptual discrimination test were never repeated.

Recognition memory trials were separated by an intertrial interval of 250 ms. As each block of 20 memory trials immediately followed the block of 20 discrimination trials, the order of blocks (i.e., race) was identical. In total, participants completed 40 recognition trials with AA faces and 40 recognition trials with HS faces. Before and after the completion of each discrimination and recognition block, participants were offered a break and warned that they would be switching tasks.[1]

2.3.3. Training

Training consisted of three sessions on different days but completed within a 7-day window. The first, second, and third training sessions lasted approximately 30, 60, and 30 min, respectively. Participants were randomly assigned to either the AA individuation/HS eye-luminance judgment, or the HS individuation/AA eye-luminance judgment conditions, and the order of blocks were determined by latin-square for the combination of race assignment and training task. No faces used in training were used in the posttraining tests (Table 1).

2.3.4. Day 1

Immediately following the pretests, participants began their first 30-min training session in which they completed five blocks of train-followed-by-test (‘‘train-test’’) trials for the first task/race, followed by five blocks for the second task/race. After these ten blocks new faces were added and another ten blocks of train-test were completed.

In the first set of training trials, participants were exposed to three faces with labels (names for the individuation race and left/right or no difference for the eye-luminance judgment race) each presented twice. Training trials were immediately followed by testing trials, where these three faces were presented three times, intermixed with five unpreviewed faces

Table 1
Training protocol. The initial task—individuation or luminance-judgment—was randomized across participants. Participants always completed five blocks (each block consisting of training trials—image + label—immediately followed by test trials—image only) with one task/race before advancing to the second task/race. See text for details

	Pretest	Posttest
a. Accuracy (% correct) ± *SEM*		
Individuation	0.721 ± 0.01	0.729 ± 0.02
Luminance judgment	0.700 ± 0.01	0.704 ± 0.01
b. Response times (ms) for correct trials only ± *SEM*		
Individuation	1579 ± 34	1500 ± 34
Luminance judgment	1639 ± 38	1476 ± 38

shown twice. After participants completed five such train-test blocks with each task ⁄ race, they were introduced to three new faces. Subsequent training trials consisted of the three faces previously learned with the addition of three new faces. Old and new faces were intermixed, presented twice, and always shown with a label. As before, each set of training trials was immediately followed by a set of testing trials, in which these six pre-viewed faces were presented three times, intermixed with twelve unlearned faces. After five such train-test blocks per task ⁄ race, participants ended Day 1 training with 288 trials (with a break offered every 36 trials) where no instructions were given and, based on the race of the face on the screen, participants made either an individuation or eye-luminance judgment. The goal of the randomized trials was to force participants to internalize the associations between race and task.

All trials began with a fixation cross for 250 ms, followed by a face presented for 500 ms. During training trials, a label appeared below the face specifying the correct answer, either the face name (''Chris,'' ''Drew,'' ''Greg,'' ''Ryan,'' ''Mark,'' ''Paul,'' ''Scott,'' ''Brad,'' ''Jeff,'' ''Adam,'' ''Zach,'' or ''Tom'') for the individuation race or the brightest eye (''Left Eye'' or ''Right Eye'') for the eye-luminance judgment race. In the individuation task, names were randomly assigned to unique faces separately across individuals. In the luminance-judgment task, training trials were not intended for learning, but rather to equate exemplar exposure across tasks. During test trials, the face appeared without the label. In individuation test trials the participants responded with the first letter of the name learned in the training, or with a ''no name'' response (''n'') if the face was not previously learned in association with a name. In eye-luminance judgment test trials participants responded with the appropriate key specifying right eye (''>''), left eye (''<''), or no difference between eyes (''space bar''). The number of ''no name'' trials in individuation blocks corresponded with the number of ''no difference'' trials in luminance-judgment blocks. After the participants' response, feedback was presented for 250 ms: The participants were told if they were correct or incorrect and, if incorrect, what the correct response should have been. There was a 100 ms intertrial interval.

By the end of Day 1, participants had completed 1,078 trials (790 blocked and 288 randomized). They learned the names of six faces of one race (with eye-luminance variations being task-irrelevant) and learned to make eye-luminance judgments on the same number of faces from the other race (with identity being task-irrelevant). Importantly, the frequency with which same-identity faces occurred for luminance-judgment trials was equal to the frequency of occurrence in the individuation blocks, and the identity of the face in luminance-judgment trials was never predictive of the eye-luminance value. In other words, a given face could occur on different trials with either the right or left eye brighter, and these luminance variations only influenced the correct response for the race trained on the eye-luminance judgment.

2.3.5. Day 2

The structure of Day 2 was similar to that of Day 1, but it began with a review block of train-test trials for the six faces learned on Day 1. After two review blocks (one per task ⁄ race), nine faces (six previously learned, three new) were presented twice with labels.

These training trials were followed by test trials in which the nine previewed faces were presented three times, intermixed with eighteen novel faces presented twice. After five train-test blocks with one task/race, participants performed five train-test blocks with the other task/race. Next, participants were introduced (or reintroduced) to 12 faces (9 old, 3 new) presented twice with labels. The test trials followed immediately, consisting of the 12 previewed faces presented three times randomly intermixed with 24 unpreviewed faces presented twice. After ten train-test blocks with 9 faces, followed by ten train-test blocks with 12 faces, participants performed 216 randomized trials without instructions (with a break every 36 trials) where they automatically responded with the face name or brighter eye as trained. In sum, Day 2 consisted of 2,214 trials (1,998 blocked, followed by 216 randomized).

2.3.6. Day 3

Day 3 of training consisted of 1,080 randomized trials, with a break every 36 trials.

2.3.7. Posttests

The posttests paralleled the pretests, including both the perceptual discrimination and the recognition memory tasks, but used novel faces exclusively.

3. Results

3.1. Training

Fig. 2 shows performance during training for each task in bins of 200 training trials over the 3 days of training. It is difficult to compare changes in performance over time because new faces are added at different points during training. However, because faces are added in the same manner for both tasks, we can compare tasks within each bin, for the same number of stimuli, and the pattern reveals that we succeeded in making the control task at least as difficult as individuation (unlike prior studies where control trainings were considerably easier). Interestingly, when the training tasks switched from blocked to randomized (bins 4 and 13), the individuation task suffered more than the luminance-judgment task in accuracy (paired *t*-tests, $p = .05$ and $p = .03$, respectively; Fig. 2a). However, performance remained higher than in the luminance task. The inclusion of the more difficult eye judgment trials on bin 14 slowed individuation judgments ($p < .0001$; Fig. 2b), even though this change had no implication for the difficulty of individuation judgments. This suggests that under these training conditions performance in the two tasks was not fully independent.

The pattern of response time data for individuation and eye-luminance training tasks remained relatively consistent over the course of training, despite overall faster responses for eye-luminance judgments ($p < .0001$) (Fig. 2b). By the end of the training, however, there was no difference in response time between tasks.

Although this was not manipulated here, we speculate that randomized training conditions facilitate stronger associations between each race and its associated task.

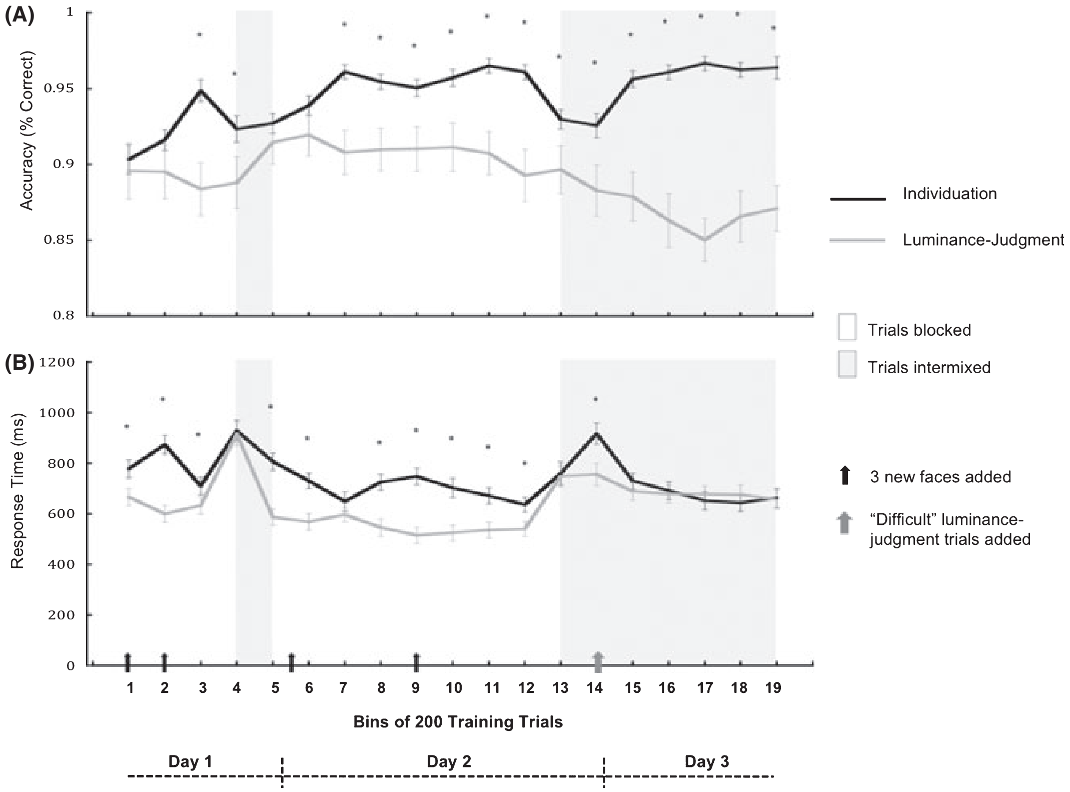

Fig. 2. Training data plotted for all subjects over bins of 200 trials over the course of the 3-day training paradigm for (a) average accuracy and (b) average response time of correct trials only. Performance on the individuation-trained race is plotted in black, while performance on the luminance-trained race is shown in gray. The shaded regions represent periods of trials with races randomly intermixed. Black arrows signify the training of three new faces, and the gray arrow signifies the introduction of more difficult eye-luminance trials on 30% of the randomized trials. Asterisks represent significant results from paired *t*-tests comparing performance across individuation and luminance-detection trials for all participants at each bin. Error bars represent the standard error of the mean for all participants at each data point.

It is difficult to know what would happen over the course of a longer training regimen under these training conditions. One possibility is that participants would gradually learn to associate the required task with each race more efficiently, such that eventually the dependencies that we observed across tasks would disappear. For our present purposes, however, such dependencies can only make it more difficult to find our predicted pattern of results, namely that individuation training selectively benefits the individuated race.

3.2. Perceptual discrimination test

To evaluate the effects of training, we conducted a 2 × 2 × 2 ANOVA on performance in the 2-AFC perceptual discrimination pre/posttest, with two within-subjects factors—

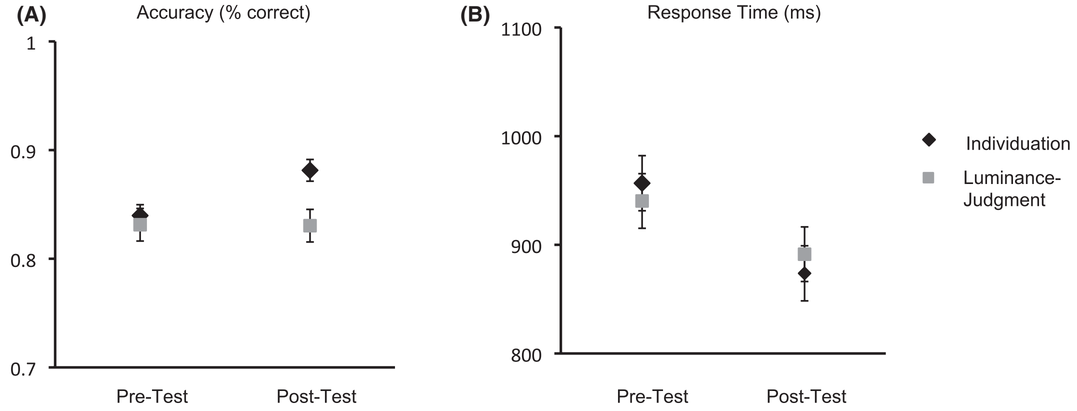

Fig. 3. Results from the two-alternative forced choice perceptual discrimination pre- and posttest. (A) Perceptual discrimination of novel faces was improved after individuation training but not luminance-detection training, despite equated difficulty and exposure in the two tasks. (B) Response time data show a significant improvement in speed following training with no difference between training tasks. Error bars represent the standard error of the mean.

training task (individuation vs. luminance judgment) and test time (pretraining vs. posttraining)—and assignment of race to the training conditions as a between-subjects factor (AA-individuation/HS-luminance or AA-luminance/HS individuation). As expected, performance was better at posttest relative to pretest ($F_{1,37} = 4.256$, $MSE = 0.0156$, $p = .046$, $\eta_p^2 = .10$). We also observed a significant main effect of task, with greater performance for the individuated race ($F_{1,37} = 9.379$, $MSE = 0.0413$, $p = .004$, $\eta_p^2 = .20$) (Fig. 3a).

Critically, there was a significant task-by-test time interaction ($F_{1,37} = 5.414$, $MSE = 0.0183$, $p = .026$, $\eta_p^2 = .13$), and all planned comparisons revealed effects that were consistent with the expected pattern of results, with no difference between training tasks at pretest and a significant improvement only for the individuation training ($p = .002$, $\eta_p^2 = .23$). In addition, race assignment interacted with the training task ($F_{1,37} = 12.81$, $MSE = 0.0564$, $p = .001$, $\eta_p^2 = .31$) and post-hoc tests (Scheffé, $p < .05$) revealed that this was due to the eye luminance being harder for AA than HS faces, with no difference between races for the individuation task. Race assignment to the task did not interact with the training effect ($F_{1,37} < 1$).

A homologous 2 × 2 × 2 ANOVA was conducted on response time data for correct trials. The only significant effect was a main effect of test time with faster overall response time (RT) at posttest ($F_{1,37} = 11.137$, $MSE = 204539$, $p = .002$, $\eta_p^2 = .23$). Several factors approached significance but none complicate our interpretation of the results. There was a trend for a test time × training task interaction ($F_{1,37} = 2.885$, $MSE = 8432.85$, $p = .098$, $\eta_p^2 = .07$) due to a relatively larger improvement for individuation than for the luminance training. There was a trend for a test time x race assignment interaction ($F_{1,37} = 3.489$, $MSE = 64076.8$, $p = .07$, $\eta_p^2 = .09$) as pretest RTs were longer for the group who had AA faces assigned for training with the luminance task, but this difference vanished at posttest.

Finally, there was a trend for a task × race assignment interaction ($F_{1,37} = 3.71$, $MSE = 24409$, $p = .062$, $\eta_p^2 = .09$), whereby race assignment made a difference for the luminance training (harder for AA faces) but not for individuation training. In sum, the analysis of response time reveals that no tradeoff with speed that influences our interpretation of the training effect on accuracy. In addition, while there were some differences driven by the two groups of faces we used, likely due to mean differences in luminance, the advantage of individuation for perceptual discrimination was obtained for both races.

3.3. Recognition memory test

We also computed a 2 × 2 × 2 ANOVA on accuracy and response time data from the recognition memory test, with two within-subjects factors (training task and test time) and one between-subjects factor (race assignment to the task) (Table 2). Although individuals did not show a general training-induced improvement in accuracy ($F < 1$, n.s.), their response times for correct responses significantly decreased following training ($F_{1,37} = 8.299$, $MSE = 0.628019$, $p = .001$, $\eta_p^2 = .18$). As with the perceptual discrimination test, we found a significant main effect of task on accuracy rates, with better memory for the individuated race ($F_{1,37} = 5.112$, $MSE = 0.0206$, $p = .030$, $\eta_p^2 = .12$) but, unlike for perceptual task, there was no interaction between training task and test time ($F < 1$, n.s.).

Our recognition memory test failed to replicate previous results obtained in longer training paradigms (e.g., Lebrecht et al., 2009; Scott et al., 2006, 2008; Tanaka & Pierce, 2009; Tanaka et al., 2005). Our recognition test differed from these studies, in that we tested memory for faces briefly presented during the discrimination judgments. Still, recognition memory was neither at floor nor ceiling in this study and thus, our results may suggest that perceptual effects precede those of recognition memory. However, it would be unwarranted

Table 2
Accuracy (% correct) (a) and response time (ms, correct trials only) (b) from the recognition memory test plus/minus the standard error of the mean ($n = 39$). Statistical results did not reveal a significant effect of training

Training Task	Race Assignment	Pretest	Posttest
a. Accuracy (% correct] ± *SEM*			
Individuation	*AA individuation/HS luminance judgment*	0.720 ± 0.022	0.728 ± 0.02
	HS individuation/AA luminance judgment	0.728 ± 0.03	0.71 ± 0.01
Luminance judgment	*AA individuation/HS luminance judgment*	0.715 ± 0.02	0.727 ± 0.03
	HS individuation/AA luminance judgment	0.680 ± 0.03	0.673 ± 0.01
b. Response times (ms) for correct trials only ± *SEM*			
Individuation	*AA individuation/HS luminance judgment*	1530 ± 45	1528 ± 55
	HS individuation/AA luminance judgment	1624 ± 58	1457 ± 70
Luminance judgment	*AA individuation/HS luminance judgment*	1575 ± 58	1446 ± 57
	HS individuation/AA luminance judgment	1702 ± 77	1492 ± 83

Note. AA, African American; HS, Hispanic.

to use this null result as evidence against recognition memory effects of individuation training because our training procedure was much shorter (45 min of training per race) than in studies where recognition memory effects were obtained.

4. Discussion

Our study adds to a growing body of work suggesting that individuation specifically results in the acquisition of category-specific expert skills at the subordinate level (Gauthier & Tarr, 1997, 2002; Gauthier, Tarr, Anderson, & Gore, 1999; Gauthier et al., 1998; Rossion, Kung, & Tarr, 2004; Scott et al., 2006, 2008; Tanaka & Pierce, 2009; Tanaka et al., 2005; Wong et al., 2009). Our results are consistent with recent findings with novel objects suggesting that not only is exposure *not* sufficient for the acquisition of this sort of expertise, but that even practice in a difficult task that requires significant visual attention does not produce the same effects as obtained with individuation practice (Wong et al., 2009). In the case of faces, generally associated with individuation, it was not clear that increased attention, especially to the eye region, would not automatically improve discrimination. The perceptual skills acquired during individuation training generalize to novel exemplars within that subcategory (i.e., faces of a given race). At the same time, these skills do not extend to the faces of another race for which equivalent practice was provided in a difficult eye-luminance task. Because of its equally high attentional demands relative to individuation, our eye-luminance judgment task may be useful in other situations where behavioral or neural differences for different race faces could be attributed to attentional differences (e.g., Golby, Gabrieli, Chao, & Eberhardt, 2001).

Notably, our work finds effects of training that generalize to novel exemplars of the individuated category using a much shorter procedure (90 min of training, half of which was devoted to individuation) than in any of the other studies in this literature (225–360 min over the course of 5 or 6 days; Lebrecht et al., 2009; Scott et al., 2006, 2008; Tanaka & Pierce, 209; Tanaka et al., 2005). This suggests that the acquisition of expertise is a gradual process and that even a small amount of practice individuating faces facilitates performance.

At the same time, we have several caveats to these conclusions. First, while discrimination was not improved by the eye-luminance training, we suspect that some perceptual learning nonetheless occurred for the eye-judgments. Because we did not include an eye-luminance testing task, we cannot tell whether eye-luminance judgments on new exemplars of the trained race would have been facilitated (as would seem likely), and if they were, whether this improvement would be race-specific or would generalize to faces of any race. To better assess the different kinds of learning acquired in these contrasting tasks, it would be necessary to include testing tasks that allow for both types of learning to be expressed (Wong et al., 2009). Second, while we find that eye-luminance judgment training was insufficient to improve perceptual discrimination at the subordinate level, it is also possible that performance of this task inhibited the transfer of individuation skills from the individuated race to the race used in the eye-luminance task. This could be tested by using faces of another race, one not shown during training. At the least, our work finds, under differential training conditions for two races, important difference between training tasks with generalization of individuation training within race and no evidence for cross-race generalization.

More globally, our work has implications for how we understand the ORA. By ruling out a primary role for visual attention, our results are consistent with an expertise account of the ORA, whereby the ORA could arise as a consequence of a difference in one's perceptual expertise between faces of different races (Lebrecht et al., 2009; Meissner & Brigham, 2001; Tanaka & Pierce, 2009). Our work also differs from these studies by showing an effect in perceptual discrimination.

Note, however, that there are competing accounts for the possible causes of the ORA. One alternative is the feature-selection account (Levin, 1996, 2000), which has been interpreted by some authors as being inconsistent with an expertise account (Hugenberg, Miller, & Claypool, 2007). According to this interpretation, the ORA may not be a consequence of a lack of perceptual expertise with other-race faces, but rather arising from the fact that people tend to socially and perceptually process individuals from other races at the category level, failing to engage available subordinate-level processing strategies. Evidence in support of a default difference in processing strategies includes the fact that the recognition memory effect can be reduced simply by warning observers about the ORA and asking them to individuate other-race faces (Hugenberg, Miller, & Claypool, 2007). Although there is no question that such instructions do lead to a reduction in the ORA, it is unclear whether this manipulation would be equally effective with face stimuli that are more homogeneous (such as those used in our present study).

In light of our present results, we suggest that these two models should not be considered as mutually exclusive. Even assuming that the ORA is primarily driven by the manner in which observers categorize other-race faces as opposed to differential experience individuating them, our present study suggests that perceptual effects are likely to arise as a consequence of any attitude that reduces practice with the task of individuating faces. It is easy to imagine how the ensuing differences in perceptual ability might further encourage a differential attitude towards faces of another race, thereby contributing to a recurrent pattern of reinforcing the ORA. It is also interesting to consider the potential of expertise training as a behavioral intervention that might ameliorate the ORA (applicable, for instance, to jobs where good facial recognition regardless of race may be valued; Lebrecht et al., 2009). High levels of expertise can result in increased automaticity; for instance, face experts process faces holistically even when it is not optimal for the current task (Young et al., 1987). By way of contrast, such holistic processing may be reduced for other-race faces (Tanaka, Kiefer, & Bukach, 2004). Thus, instructions to individuate may not be sufficient to overcome long-term, default processing strategies outside of laboratory contexts. In contrast, acquired perceptual expertise has been demonstrated to produce better perceptual skills (this work), better recognition memory performance (Tanaka & Pierce, 2009), and can even reduce social bias (Lebrecht et al., 2009). In sum, while a theoretical goal may be to compare the expertise and the feature-selection accounts of the ORA, in practice these two accounts may work hand in hand, and the best approaches to increasing performance with other-race faces may include them both.

Note

1. A third task followed the final set of recognition trials. This task was designed to assess implicit racial biases (Lebrecht et al., 2009). Details are not reported here due to data loss related to script error.

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