Differences of Affective Learning with Own-Race and Other-Race Faces: An Eye-Tracking Study

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Abstract. Minimal affective learning is a phenomenon wherein people can learn about the affective meaning of other people with brief behavioral descriptions. Prior research mainly focused on affective learning with own-race faces. Own-race bias is a robust phenomenon describing that people can recognize own-race faces more efficiently than other-race faces. In the current study, we investigated whether own-race bias would influence minimal affective learning. Chinese participants learned Chinese and Caucasian faces paired with behaviors of different valence. After learning, they were asked to evaluate the learned faces and novel faces. Their eye movements and pupil diameters were continuously monitored during the experiment. We analyzed the change in pupil dilation to assess how much cognitive effort was required for affective learning. The results showed that participants only learned positive information with faces. Learning performance for other-race faces was similar with own-race faces. In addition, change of pupil dilation was larger when learning other-race than own-race faces, suggesting a greater cognitive effort for affective learning with other-race faces. Taken together, the results demonstrated that affective learning for other-race faces was more difficult than own-race faces. This research provided more support for the notion that different cognitive strategies were employed by faces of different race.

Keywords: Affective learning · Own-race bias · Eye movements · Pupil dilation

1 Introduction

When we make an impression of a person, we compare the person to previous memory. Psychological research revealed that our impressions of a person are easily changed by previous affective information [1, 2]. This phenomenon is called minimal affective learning. In a typical affective learning research, participants see neutral faces presented with sentences describing positive, neutral or negative behavior, later made judgments about the faces. Faces paired with negative behaviors were evaluated more negatively than those paired with neutral, positive behaviors. In turn, faces paired with neutral

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behaviors were evaluated more negatively than those with positive behaviors [1, 3]. Affective learning effect is robust and reliable within Western culture [1–4]. One recent study with Chinese participants found similar results [5]. However, since these studies have only examined minimal affective learning with faces of participants' own race, it remains unclear whether race will affect the learning effect with faces.

We argue that learning affective associations with faces may be impacted by race. The "own-race bias" (ORB; also called the cross-race effect or other-race effect, and outgroup homogeneity effect) is a robust phenomenon in face learning and recognition, wherein people are better able to recognize own-race faces compared to other-race faces [6]. This effect is reliable across cultural and racial groups [7]. According to [8], the context in which faces appear may strongly impact face perception. There are four types of context: within-face features, within sender features, external features from the environment surrounding the face, and within-perceiver features. Affective learning processes and own-race bias are within-perceiver features, both can impact face perception.

Prior research has rarely examined whether affective learning can be modulated by own-race bias, except for [9]. Reference [9] demonstrated an overlap between own-race bias and fear conditioning. In this research, two black and two white neutral faces were shown to both white and black Americans. During the learning phase, one face from each race was paired with an electric shock. Then, in the extinction phase, there were no shocks. Skin conductance responses were measured to assess the conditioned fear response. The results indicated that participants showed a conditioned response to both black and white faces during acquisition, while they only showed a significant conditioned response to other race faces in extinction. Thus, other-race faces are more likely associated with negative information. However, this research [9] did not experimentally investigate why people associated other-race faces more easily with aversive stimulus. They speculated that human might have evolved to take persons who were from another race or outgroup as a threat. In addition, stimuli in fear conditioning were always strongly aversive, such as an electric shock, whereas stimuli in minimal affective learning are mildly affective in nature [1]. It is unknown whether the own-race bias would influence this type of learning.

Our goal in the present study was to test whether minimal affective learning with own-race faces is different with other-race faces. In the main experiment, Chinese participants learned to associate own-race and other-race faces with negative, neutral or positive behavior. Then, they rated these faces plus novel faces. We compared learning effect of own-race faces with other-race faces. If other-race faces were threat stimuli, participants should only learn negative information with them. In addition, a recent study found that healthy participants recalled the behavior paired with faces and recognized the faces after affective learning [10]. It is possible that affective learning is partially impacted by memory of the face-behavior pairings. Since other-race faces are more difficult to remember, affective learning for other-race faces may be more difficult than own-race faces.

Furthermore, recent studies used eye-tracking to investigate the face-processing strategies of different race [11–15]. For example, participants' pupils were more dilated when encoding other-race faces [12, 13]. The pupil dilation indicated that other-race face encoding required more cognitive load or mental effort, leading to lower efficiency in processing other-race than own-race faces. In the present study, we also used

eye-tracking and pupillometry to measure the cognitive effort invested when encoding the face and behavioral sentences, in order to explain the differences in affective learning. We predicted that our participants would show larger changes in pupil dilation when learning Caucasian faces than Chinese faces.

To sum up, we aimed to answer two questions: (1) Is affective learning effect of other-race faces different with own-race faces? (2) Does affective learning of other-race faces require more mental effort than own-race faces?

2 Method

2.1 Participants

Thirty-four Chinese undergraduate students (15 male, 19 female, M age = 22.65,SD age = 2.42) voluntarily took part in the experiment for payments. Participants all had normal or corrected-to-normal vision.

2.2 Materials

Digitized grayscale pictures of 40 faces displaying neutral expressions (20 Caucasian, 20 Chinese) were used in the study. The Chinese faces were taken from a Chinese facial expression database [16], and the Caucasian faces were taken from the faceset used by [17]. The original images were cropped around the face to exclude hair and ears using Adobe Photoshop CS, and were adjusted to equal mean luminance. The faces were randomly divided into four sets, with 5 Caucasian faces and 5 Chinese faces in each set. One set of faces were paired with negative behaviors, one set of faces with neutral behaviors, one set of faces with positive behaviors, and one set of faces were presented without behaviors. Thirty behavioral sentences were selected from [1], and were translated into Chinese. The pairing of faces and behaviors was counterbalanced across participants.

The stimuli were displayed on a 17-in LCD monitor at approximately 70 cm away from participants' eyes. The images covered 12 of visual angle horizontally and 17 of visual angle vertically. The face images and sentences were incorporated on a 1280 × 1024 pixel white background. The stimuli were presented and responses were recorded using E-Prime Version 2.

Eye movements were recorded at a sampling rate of 250 Hz with an infrared camera on an iView X RED 500 system (SensoMotoric Instruments, Germany). Chin and forehead rests were used to minimize the participant's head movements. Only the left eye of each participant was tracked continuously throughout the experiment. Prior to the experiment, calibration of eye fixations was conducted using a nine-point fixation procedure.

2.3 Procedure

Participants were seated in a room with dim light. We adopted the minimal affective learning task [1]. The main experiment was comprised of two phases: learning phase

and test phase. During the learning phase, the participants were presented with 30 face-sentence pairs, and were instructed to remember each pair by imaging each person performing the behavior described in the corresponding sentence. In the beginning of each trial, a fixation cross was presented in the center of the screen for 500 ms. Then, one face-sentence pair was shown for 5 s. The intertrial interval was 1 s, after which the next trial started. Each face-sentence pair was presented four times in random order.

During the test phase, participants evaluated the 30 learned faces, plus 10 novel faces, as negative, neutral, or positive. Each trial started with a 500-ms fixation cross. Then, a face was presented in the center of the screen. Participants were instructed to make "quick snap" judgments about each face. The face was displayed until the participant pressed labeled keys. The intertrial interval was 1 s, after which the next trial started. The faces were shown in random order. The response options were coded as negative = 1, neutral = 2, and positive = 3 [17]. The participants' pupil diameters were continuously monitored during the experiment. The change in pupil dilation was analyzed to assess how much cognitive effort was required for affective learning.

3 Results

Analyses were performed in two parts: rating data in the test phase, pupil dilation during the learning phase. The eye-tracking data was analyzed with BeGaze software (Senso-Motoric Instruments, Germany). For analysis, we rejected trials in which there were no fixations within the borders of the face area. 3.4 % of all trials were rejected as invalid.

3.1 Behavioral Data

The rating scores were submitted to 4 (Behavior: negative vs. neutral vs. positive vs. no behavior) × 2 (race: Caucasian vs. Chinese) repeated-measures ANOVA. Descriptive statistics are presented in Table 1. The main effect of behavior was significant, $F(3, 99) = 14.71$, $p < .001$, $\eta 2 = .31$. Pairwised comparisons (Bonferroni) showed that people evaluated faces presented with negative behaviors more negatively than those presented with neutral ($p = .012$) or positive behaviors ($p < .001$), and those with neural behaviors more negatively than those with positive behaviors, p = .021. Novel faces were rated as more negatively than those with positive behaviors ($p < .001$), suggesting that positive learning occurred. However, ratings of novel faces were not different with faces presented with negative behaviors ($p > .84$), or those presented with neutral behaviors ($p > .14$), suggesting that negative learning did not occur. We did not found significant effect of race, $F(1, 33) = .007$, $p > .93$, $\eta 2 < .001$, or

Table 1. Mean (and standard deviation) affective ratings of faces as a function of valence of behavior and race of stimulus.

	Positive behavior	Neutral behavior	Negative behavior	No behavior
Chinese faces	2.19 (0.47)	1.95 (0.33)	1.79 (0.37)	1.88 (0.36)
Caucasian faces	2.14 (0.34)	1.99 (0.33)	1.76 (0.32)	1.83 (0.36)

interaction between behavior and race, $F(3, 99) = .38$, $p > .77$, $\eta 2 = .01$. The results indicated that race of face did not influence affective learning.

3.2 Pupil Dilation

We used horizontal pupil diameter to extract changes in pupil dilation toward Caucasian faces and Chinese faces in the learning phase. We used a transformation procedure to calculate a ratio percentage in pupil dilation for each trial [18]. According to [18], the ratio percentage score represents the range of change in pupil dilation, which indicated cognitive effort when viewing a face. Ratio percentage score is calculated as follows: ([minimum overall pupil diameter–current pupil diameter]/[maximum overall pupil diameter–minimum overall pupil diameter]).

A 2 (race: Caucasian, Chinese) × 3(valence of paired behavior: positive, negative, neutral) repeated-measures ANOVA was conducted on pupil ratio percentages. A main effect of race emerged, $F(1,33) = 6.14$, $p = 0.019$, $\eta 2 = .16$, suggesting that the range of change in pupil dilation was larger when participants fixed on Caucasian faces, comparing to Chinese faces (see Fig. 1.). The main effect of valence was not significant, $F(2,66) = 2.46$, $p > 0.09$, $\eta 2 = .07$. Finally, we did not observe a significant race × valence interaction, $F(2,66) = .75$, $p > 0.47$, $\eta 2 = .02$. Thus, these results support the prediction that learning other race faces required more cognitive effort as compared with own race faces.

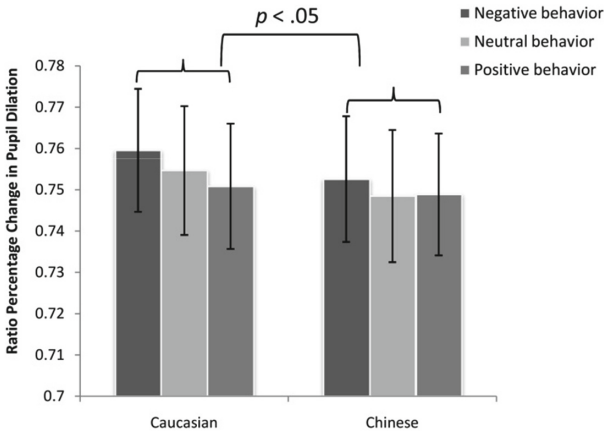

Fig. 1. Change in pupil dilation as a function of face race while encoding face-sentence pairs. Error bars reflect standard error.

4 Discussion and Conclusion

In the present study, Chinese participants learned positive information with faces in minimal condition of affective learning. However, there is no negative learning. This is not consistent with previous research in which both positive learning and negative

learning occurred [1, 5]. It should be noted that reference [17] used the same paradigm with reference [1], but they only observed negative learning. The reason for the mixed findings of these studies may be individual differences in affective learning. Verosky and Todorov [3] observed that some participants did not rate faces associated with positive behaviors more positively than faces associated with negative behaviors. In their study, only 35 of the 57 participants' judgments showed strict ranking of the associations: positive > neutral > negative. In our study, the pattern should be positive > neutral > novel > negative. It was hard to use this strict criterion to exclude participants because there were only 34 participants. If we excluded half of participants, the data would be lack of statistic power. Nonetheless, it reminds us that minimal affective learning is hard to form since the affective stimulus is mild, which may result in mixed results. Future studies should test our findings by recruiting a larger sample of participants.

Affective learning effect of other race faces is similar with own race faces. This is not consistent with research of fear conditioning in which other-race faces were more easily associated with aversive information [9]. The reason may be that the present study involved different learning processes with fear conditioning. Fear conditioning is based on associative learning, while minimal affective learning in the present study is based on rule-based learning [1].

Moreover, participants demonstrated a greater change in pupil dilation when associating other-race faces with behaviors as compared to own-race faces. These results are completely consistent with [12, 13]. This may reflected enhanced cognitive exertion while learning other-race faces. This also provide support for the in-group/out-group theory of own-race bias [19]: processing of in-group faces is efficient and automatic, while processing of out-group faces is less efficient and non-automatic. In order to get equal performance of learning with the own race faces, participants had to make greater cognitive effort with other race faces.

In conclusion, the results of current study demonstrated that own-race bias influenced affective learning. In line with the idea that different cognitive strategies were employed by faces of different race, we found evidence that affective learning is also modulated by race. The findings expended our understanding of both affective learning and own-race bias. This point is helpful in the research areas of human computer interaction, such as affective computing and design of emotional machine. Furthermore, since culture influences multiple cognitive and affective processes [20], it would be interesting to compare affective learning effect across cultures. Furthermore, in the present study, we only tested Chinese faces and Caucasian faces, it is not clear whether affective learning effect for other race face, such as black faces, would be differenct with own race faces. Future studies should also test affective learning effect for faces from different out groups.

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