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The Cross-race Effect on Face Recognition and Judgments of Learning*

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***Abstract*—More and more studies show that perceptual cues affect individual memory and metamemory. Judgments of Learning (JOLs) are important form of metamemory monitoring. Assessment of the racial attribute effect on face recognition and JOLs through JOLs procedure showed that the JOLs level of the participants was significantly lower than actual memory, and the metamnemonic judgement accuracy for faces of their own race was the highest; the JOLs and recognition of racial ambiguous faces were lower than their own-race faces, and was of little difference from that of other-race faces. The results indicate a Cross-race Effect (CRE) on the judgement accuracy of faces recognition and metamemory.**

Keywords—face race; judgments of learning; face recognition

I. Introduction

Growing number of studies in recent years have shown that perceptual cues, such as context, music, material brightness, etc., can impact the memory processing of individual (Tinghu Kang & Xuejun Bai, 2013; Lulu Wang, 2018). As a more socially meaningful learning material, the properties of faces also affect individual memory. Researcher had examined face attractiveness effect on memory and found that individual achieved better memory performance for higher-attractive faces (Wiese, Altmann, & Schweinberger, 2014). In addition, racial attribute, as an important factor of face feature, also have effect on individual memory performance. Humans have been shown to be better at remembering faces from their own race than faces from other races, that is, the memory of faces has the Cross-Race Effect (CRE; also known as the Other-Race Effect or Own-Race Bias) (Young, Hugenberg, Bernstein, & Sacco, 2012), and a large number of studies have proved that the CRE is universal and stable (Meissner & Brigham, 2001).

Studies in recent years found that perceptual cues could even affect the higher-level individual cognition of metamemory (Alban & Kelley, 2013; Rhodes & Castel, 2009). Nelson and Narens (1990) divided the individual memory process into object memory and metamemory. Object memory refers to the process that individual codes, stores and extracts information of objects. While metamemory refers to how individuals recognize and evaluate the content and function of memory, as well as monitor the entire memory process. Monitoring and control are generally used as two important indexes of metamemory assessment and the judgments of learning (JOLs) is an important way in the study of metamemory monitoring. JOLs refer to the predicted judgement of individual memory performance in subsequent test of learned items (Arbuckle & Cuddy, 1969). Researchers have often used joint word pair or chapter reading as the learning material of metamemory study. While face as a more social information material, whether there is metamemory monitoring in the process of learning a face can also be studied through the test method of JOLs. Hourihan and other researchers (2012) examined the accuracy of the metamemory monitoring in own-race and other-race face recognitions. The findings indicated that participants had higher relative metamemory accuracy on own-race, and implied that there was CRE on metamemory monitoring accuracy.

Previous studies mainly adopted faces of distinctive racial attribute as the material. While in the diversified society, there are growing communication and integration of various ethnic groups. As with the interracial combination between blacks and whites, blacks and Asians, Whites and Asians, there are a great amount of mixed-race people. So far, studies on mixed-race faces are relatively limited. The mixed-race face has facial features of both parents, so it is often more difficult to identify by its facial features (Chen & Hamilton, 2012), and the ambiguity of mixed-race face also add to the burden of individual memory on this kind of face (Pauker, Kristin, et al., 2009).

Therefore, exploration on individual behavior performance in the context of faces of ambiguous racial attributes has gradually become a trend of research. But for that, current studies on face racial attributes have not yet covered much on the level of individual metamemory monitoring on faces of different racial attributes. At the same time, while metamemory monitoring studies much on abstract word pair and chapter, the more social and authentic face effect on JOLs still needs further exploration. Therefore, our research adopted a standard JOLs paradigm to examine the accuracy of memory and metamemory monitoring for faces of different racial attributes.

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II. Method

A. Pilot Study

Stimuli were created with FaceGen Modeller 3.4, which enables racial morphing along parameters of skin color, texture and also allows creation of faces given specific parameters, such as racial group, age and facial symmetry. We first settled the face age to be between 20 and 30 years old and generated 50 prototypical Asian faces (25 male, 25 female) and 50 prototypical Caucasian (25 male, 25 female) faces. Next, we morphed the two sets of Asian and Caucasian prototypical faces together by gender using FaceGen. We created five morphs clustered around 50% of each 50 prototypical face (e.g., 42:58, 46:54, 50:50, 54:46, 58:42). This amounted to a set of 250 racially ambiguous faces with neutral facial expressions (Pauker et al., 2009) (As shown in "Fig. 1"). All pictures were edited using Adobe Photoshop and adjusted to uniform size and resolution (255×350 pixels).

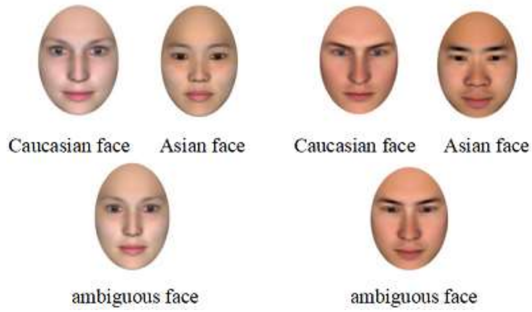

Fig. 1. Examples of stimuli.

To select only the most ambiguous faces of the original 250, we conducted a test with a convenience sample of 10 participants (6 women, 4 men) to complete a forced-choice racial categorization task on the ambiguous faces. Of the 250 rated pictures, the 20 (10 male, 10 female) faces perceived as the most ambiguous were used in the final stimulus set. These 20 Asian and 20 Caucasian faces, combined with the 20 racially ambiguous faces, comprised the final set available for use in study. At last, 10 Asian participants (5 women, 5 men) rated each face on prototypicality using Likert-type scales (ranging, for example, from 1 = must be Asian to 7 = must be Caucasian). The result showed that the Asian faces (M=1.43, SD=0.12) and Caucasian faces (M =5.92, SD=0.45) were both seen as more prototypical than the ambiguous faces (M=3.76, SD=0.51; (F (1, 9)=323.33, p<0.001, $\eta 2$=0.96)).

B. Participants and Design

Thirty Asian students (19 women, 11 men) participated in this experiment that they all had been living in China for a long time and never been abroad.

Judgment of learning paradigm was used in this one-factor design. The independent variable is the face image type (Asian, Caucasian, ambiguous), and the dependent variable is the recognition result.

C. Procedure

60 photos were used which made from the pilot study. Each subject completed the experiment individually in a small room on the white background computer. Prior to study, participants were informed that they would be studying a series of faces, one at a time, for a later recognition memory test. They were instructed that they would be making a recognition prediction for each face after they had studied it.

Each study trial began with presentation of a faces on a white background at the center of the screen for 3000 ms. Following a 1000 ms blank screen, the JOL screen appeared. Subjects were instructed to "Please judge how likely you are to recognize the newly learned face in a subsequent test." The numbers 1 through 9 were displayed at the bottom of the screen (for example, from 1 = I am sure that I will NOT remember this face to 9 = I am sure that I WILL remember this face). During the learning phase, participants were asked to memorize 30 photos (half male, with an average of the three races), and the photos were presented in a random order.

Following completion of the test phase, the instructions for the recognition test appeared on the screen. Subjects were told to identify whether the photos had been seen in the learning phase. They were instructed to press the "1" key if they recognized the presented face as one they had studied and to press the "3" key if they believed the face was new. The maximum rendering time of the photo was 5000ms and after pressing the button, the photo would disappear immediately. There was an interference phase between the learning phase and the test phase. The participant was told to do 20 simple addition and subtraction calculation questions, then took a break and pressed the "w" key to enter the test phase. After completing all the experimental tasks, the participants filled out the demographic information.

III. Results

A. Recognition Performance

Accuracy, mean hits, false alarms, *d'* and β were calculated. All data were subjected to a single factor (faces: Asian, Caucasian, ambiguous) repeated measurement analysis. For the accuracy, the effect of face type was not significant [F (2, 28) = 0.09, p>0.05, η^2 = .06]. For the data of mean hits, the effect of face type was significant [F (2, 28) = 10.25, p < 0.001, η^2 = .42], with the Caucasian faces (0.72 ± 0.15) showing higher mean hits compared with Asian (0.54±0.25) and ambiguous faces (0.51±0.20). Moreover, there was also a significant main effect of face type for false alarms data [F (2, 28) = 11.19, p < 0.001, η^2 = .44], revealing that false alarms for Caucasian faces (0.53 ± 0.20) being higher than for Asian (0.32 ± 0.20) and ambiguous faces (0.35±0.16). The effect of face was not significant ford' [F (2, 28) = 1.80, p > 0.05, η^2 = .11]. For the β the effect of face was also significant [F (2, 28) = 4.60, p < 0.05, η^2 = .25], with the β for Caucasian faces (0.88 ± 0.25) was lower compared with Black (1.12 ± 0.48) and ambiguous faces (1.11±0.36).

B. Metamemory

JOLs. The JOL scores were analyzed in a single factor (faces: Asian, Caucasian, ambiguous) repeated ANOVA, with the result showing that main effect of face was significant [F (2, 28) = 18.08, $p < 0.001$, $\eta^2 = .56$], indicating that the JOL for Asian faces (0.56±0.14) was significantly higher than for Caucasian faces (0.47±0.12) and ambiguous faces (0.46±0.12).

1) Absolute accuracy: The absolute accuracy was subjected to a face (3 levels: Asian, Caucasian, ambiguous) ×measurements (2 levels: JOLs, hits) repeated ANOVA. The analysis revealed a significant effect of face × measurements [F (2, 28) =13.73, p<0.001, η^2=0.49], with the mean hits for Caucasian faces was higher compared with JOL scores for that ("Fig. 2").

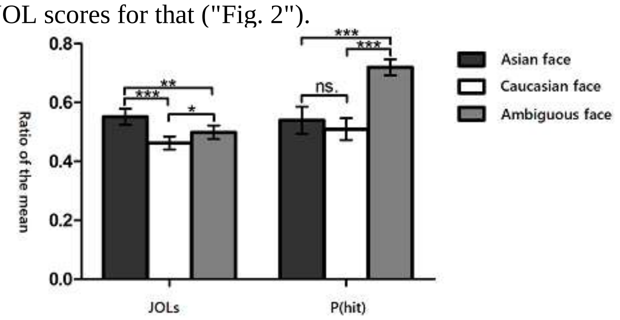

Fig. 2. Interaction analysis of JOL values and hit rates for faces of different races.

2) Relative accuracy: The relative accuracy of JOLs was calculated by Gamma coefficient, then the correlation between the learning judgment value of faces with different racial attributes and the recognition score was calculated, a single sample t test was performed between Gamma values and zero. No significant difference was found (all p>0.05).

IV. Discussion

A. The Cross-race Effect effect in Face Recognition

The study examined the effect of race on face recognition. There was no significant difference in the discrimination of faces of different races. At the same time, the hits and false alarms on Caucasian faces were significantly higher than those of Asian faces.

Different from previous studies (Qiandong Wang, Chao Hu, Genyue Wang, 2013), under JoL test mode, there was no CRE on the discrimination of their own-race faces. This might be due to the difference of JOLs from traditional learning recognition paradigm that JOLs procedure required subjects to judge the possibility of recognition each time an item was learnt, which prolonged the study time. However, there was a study that adopted JOLs and the CRE on recognition performance appeared (Hourihan K L et al, 2012). But our research specifically added in mixed-race faces with ambiguous racial feature that could reduce the distinctiveness of faces and take up much cognitive resources of participants. They reduced relative differentiation on faces of distinctive racial features in memory and affected the recognition scores.

In terms of the hit rate, unlike previous studies, participants in this study had lower hit rates on own-race faces than other-race faces. It indicated that the participants were stricter in judging own-race faces but more relaxed in judging other-race faces, for own-race faces they tended to choose "not seen" when they were not sure whether they had seen them or not (Meissner & Brigham, 2001). The test results also showed that the participants had a lower degree of memory for ambiguous faces. According to the internal and external group theory, people tend to classify own-race faces as internal group, and other-race faces as external group, while which group mixed-race faces should belong to is hard to determine, thus causes memory bias. According to previous studies, Black-White faces were harder to remember than single-race faces (Pauker & Kristin, 2009). Previous studies mainly used Black-White faces as learning materials (Freeman, Pauker, & Sanchez, 2016). But this study, based on studying the memory of Asian participants on Asian-Caucasian mixed faces, also discovered the same findings. It indicates that there is interracial consistency in the memory of ambiguous faces.

B. The Cross-race Effect Effects in JOLs

The results also showed that the racial attribute of face affected the performance of JOLs. In this study, participants had significantly higher JOLs of their own-race faces than other- and mixed-race faces. The JOLs was remarkably lower than the hit rates of different faces, that is, the JOLs level of participants was significantly lower than the level of actual memory, and the JOLs level of mixed-race faces was the lowest.

Our results supported the cue-utilization theory, in which participants used different racial attributes as a cue to predict their memory performance. Since relative differentiation of the internal perceptual cues affected the prediction of the score (Sommer et al, 1995), participants made corresponding predictions on the learning levels according to different face categories. Consistent with previous study, the recognition predictions for own-race faces was significantly higher than that for other-race faces that is, there was a CRE in the JoL level of face recognition (Hourihan K L et al, 2012). While participants have little motivation to remember ambiguous faces, it was predicted at the first stage that their recognition score would be worse than memory performance of own-race faces. Different from previous study (Chu Xu, Jian Li, Houcan Zhang, 2017), findings of this study indicated that participants tend to underestimate their memory score at the prediction phase, and are clearly "lacking confidence". Koriat and Bjorkhas (2005) had proposed a concept of predictive bias, which mainly referred to the overestimation of absolute accuracy, and believed that predictive bias is an important reason of learner's monitoring bias. However, in this study, there was no overestimation on recognition predictions of other- and mixed-race faces, but only slight overestimation on that of own-race faces, which could be attributed to the influence of inner attributes of the learning materials on participants. Since face materials are more socially meaningful than words and chapters, they are more effective perceptual cue in learning. At the same time, there was distinctiveness between own-and other-race faces, participants were more confident in remembering faces of their own race, and correspondingly "lacking confidence" in memorizing other- and mixed-race faces. This was also reflected in the absolute accuracy index of the test results that metamemory monitoring for own-race faces achieved highest accuracy and participants are better at predicting memory performance of own-race faces.

In terms of the relative accuracy index of face JOLs, there were some interesting phenomena that were different from previous findings: in this study, there was almost not effective on metamemory monitoring, and accuracy of metamemory monitoring for faces of different races showed no difference. Some studies indicated that the metacognitive accuracy of predictions of recognition was higher for own-race faces than other-race faces. But in these studies, there were no significant differences in predictions of recognition between Asian and Caucasian faces among Asian participants (Hourihan K L et al, 2012), which was consistent with our test findings. One possible explanation is, as with the wide broadcast of American TV programs and China's growing internationalization, participants are getting familiar with foreign faces, thus showed no metamemory monitoring bias between own- and other- race faces. Another possible reason is adding in mixed-race faces reduced the relative distinctiveness of face cues in the study, thus the metamemory monitoring accuracy showed no difference. Moreover, in a study on the peer effect of face learning judgment, there was no difference in the relative accuracy of JOL in different age groups (Xiping Liu, Le Tang, Weihai Tang, 2012).

There are also some limitations in our study. For example, it only examined the influence of Asian participants on the learning judgment and recognition of faces, but not discussed that on European participants, who could be studied in future, researches. Also, despite that the computer-generated faces offset much of the influence of different-race effect, there was still limited difference between fake faces and real faces that could impact the experiment results. And as was indicated in previous studies, it was more difficult for participants to remember computer-generated faces than real faces (Balas & Pacella, 2015). Thus, faces of real Asian, Caucasian, and mixed-race peoples can be further explored in future studies. In addition to racial attributes, effect of other face features on face recognition metamemory monitoring can also be further discussed.

V. Conclusion

The present findings are basically consistent with several views on the origin of the CRE. However, there were some inconsistencies with the previous studies after including the ambiguous faces, that is, the JOLs level of the participants was significantly lower than actual memory. This suggests that the number and discrimination of faces may affect the accuracy of metamemory monitoring of faces. While the precise mechanisms are still unclear, it is clear that both memory and metamemory are superior for own-race faces.

References

[1] Tinghu Kang, Xuejun Bai. (2013). Effects of target stimulus transformation and situational information attribute on real situation recognition. Psychological science (3), 558-565.

[2] Lulu Wang. (2018). Effects of animated film music on children's cognitive ability. Contemporary film (09), 139-142.

[3] Xiping Liu, Le Tang, Weihai Tang. (2012). Peer effect in face recognition and learning judgment. Psychological development and education, 28(3), 271-275.

[4] Qiandong Wang, Chao Hu, & Genyue Fu. (2013). Eye movement study on heterogeneous effect of infant face processing. Acta psychologica sinica, 45(2), 169-178.

[5] Chu Xu, Jian Li, Houcan Zhang. (2017). Research on the accuracy of metacognition monitoring based on new tasks of face memory.

[6] Alban, M. W., Kelley, C. M. (2013). Embodiment meets metamemory: weight as a cue for metacognitive judgments. J Exp Psychol Learn Mem Cogn, 39(5), 1628-1634.

[7] Arbuckle, T. Y., Cuddy, L. L. (1969). Discrimination of item strength at time of presentation. Journal of Experimental Psychology, 81(1), 126-131.

[8] Balas, B., Pacella, J. (2015). Artificial faces are harder to remember. Computers in Human Behavior, 52, 331-337.

[9] Chen, J. M., Hamilton, D. L. (2012). Natural ambiguities: racial categorization of multiracial individuals. Journal of Experimental Social Psychology, 48(1), 152-164.

[10] Freeman, J. B., Pauker, K., Sanchez, D. T. (2016). A perceptual pathway to bias: interracial exposure reduces abrupt shifts in real-time race perception that predict mixed-race bias. Psychological Science, 27(4), 502.

[11] Hourihan, K. L., Benjamin, A. S., Liu, X. (2012). A cross-race effect in metamemory: predictions of face recognition are more accurate for members of our own race. Journal of Applied Research in Memory & Cognition, 1(3), 158-162.

[12] Koriat, A., Bjork, R. A. (2005). Illusions of competence in monitoring one's knowledge during study. J Exp Psychol Learn Mem Cogn, 31(2), 187-194.

[13] Meissner, C. A., Brigham, J. C. (2001). Thirty years of investigating the own-race bias in memory for faces: a meta-analytic review. Psychology Public Policy & Law, 7(1), 3-35.

[14] Nelson, T. O. (1990). Metamemory: a theoretical framework and new findings. Psychology of Learning & Motivation, 26, 125-173.

[15] Pauker, K., Weisbuch, M., Ambady, N., Sommers, S. R., Adams, R. B., Ivcevic, Z. (2009). Not so black and white: memory for ambiguous group members. Journal of Personality & Social Psychology, 96(4), 795.

[16] Sommer, W., Heinz, A., Leuthold, H., Matt, J., Schweinberger, S. R. (1995). Metamemory, distinctiveness, and event-related potentials in recognition memory for faces. Memory & Cognition, 23(1), 1-11.

[17] Rhodes, M. G., Castel, A. D. (2009). Metacognitive illusions for auditory information: effects on monitoring and control. Psychonomic Bulletin & Review, 16(3), 550-554.

[18] Wiese, H., Altmann, C. S., Schweinberger, S. R. (2014). Effects of attractiveness on face memory separated from distinctiveness: evidence from event-related brain potentials. Neuropsychologia, 56(1), 26-36.

[19] Young, S. G., Hugenberg, K., Bernstein, M. J., Sacco, D. F. (2012). Perception and motivation in face recognition: a critical review of theories of the cross-race effect. Personality & Social Psychology Review An Official Journal of the Society for Personality & Social Psychology Inc, 16(2), 116.