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Research paper

Neural Processing of Other-Race Faces as a Function of Racial Familiarity: A P300 Study

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Abstract

Background: The other-race categorisation advantage (ORCA) is a well-established phenomenon, whereby other-race faces are categorised faster than own race faces. **Objectives:** This study investigated whether extraverts would demonstrate an ORCA-like effect toward unfamiliar other-race faces and familiar other-race faces in a modified oddball and choice reaction paradigm. **Methods:** This event-related potential (ERP) study employed a repeated measures experimental design with one independent variable (racial familiarity) and three levels (familiar other-race/Malay faces, unfamiliar other-race/African faces, control group/furniture photos). In the oddball task, African faces and Malay faces were the target stimuli and furniture photos were the standard stimuli. Electroencephalography data (EEG) was collected during the oddball task, from which ERP components were derived. **Results:** The reaction time (RT) for African and Malay faces were not significantly different. Significant effect of racial familiarity on P300 latencies at all electrode sites was not observed. However, there was a significant effect of racial familiarity on P300 amplitudes at midline electrodes (Cz). It was also observed that the P300 amplitude was larger for African faces than Malay faces at midline electrodes (Cz). **Conclusion:** An ORCA-like effect was not found in categorisation tasks involving faces from a familiar and an unfamiliar other-race, but a larger P300 amplitude was evoked by African faces. This dissociation between RT and P300 amplitude provided important theoretical implications with regard to models associated with ORCA. Specifically, the current findings lent support to the social cognition model and the Categorisation-Individuation Model (CIM).

Keywords: *P300, ORE, ORCA, Neural Processing, Odd-ball paradigm*

1. Introduction

Studies on people's reactions toward cross-race faces have garnered much attention throughout the decades. The other-race effect (ORE) refers to when individuals perform better in recognizing own-race faces in comparison to other-race faces [1, 2]. On a related note, face-processing studies also showed that participants were quicker to categorise other-race faces in comparison to own-race faces [3 – 6], a phenomenon known as the other-race classification advantage (ORCA). These phenomena, whilst seemingly antagonistic, share the same underlying face processing mechanism involving the fusiform face area (FFA) and the occipital face area (OFA), thus explaining why faster recognition occurs at the expense of categorisation speed [7, 8]. The relationship between ORE and ORCA allows both phenomena to be explained as a single phenomenon.

1.1 Theories underlying the ORE and ORCA

Two of the more prevailing theories of ORE (and ORCA) are the perceptual learning model and the social cognitive model of ORE. The perceptual learning model proposes that we are experts at recognizing own-race faces due to greater experience differentiating individuals from our own race [2, 9, 10]. Processing of own- and other-race faces are, by default, different, as more experience in own-race differentiation leads to automatic attendance to the configural information in own-race faces. A lack of experience with other-race faces leads to processing other-race faces in a less efficient, piecemeal manner [10 – 12]. This suggests that the ORE can be attenuated through increased exposure to other races. Indeed, in [10]'s study, Asian Americans recognized Asian and Caucasian faces equally well. Being in a predominantly Caucasian environment provided the participants plenty of opportunity to differentiate Caucasian faces, thus making them an expert in individuating Caucasian faces (see also [9, 13, 14]).

Alternatively, the social cognitive model proposes that we are equally capable at individuating other-race faces, but are disinclined to do so due to their outgroup membership [14]. We are less motivated to attend to outgroup faces as much as we attend to ingroup faces because outgroup faces are less socially relevant [15]. Therefore, categorizing other-race faces as outgroup members leads to shallower encoding of other-race faces [2]. In studies that manipulate ingroup/outgroup membership, ORE was overcome by making non-salient social categories salient. For instance, [16] manipulated university affiliation for Caucasian and African faces, and found that ORE disappeared in the subsequent old/new recognition task for other-race faces that shared the same university affiliation with the participants (see also [17, 18]).

The categorisation-individuation model (CIM) is an integration of the two aforementioned models [14]. CIM emphasized that the choice to focus on category-diagnostic or identity-diagnostic facial characteristics is dependent on a few co-acting cues. Faces are first categorised spontaneously through activation of a social category [14, 19]. Selective attention will then be directed at the facial characteristics that are either category-diagnostic or identity diagnostic, depending on factors such as social importance of the face and situational cues. Faces belonging to socially important categories, such as racial ingroup, celebrities, or one's employers, will direct attention toward individuating facial characteristics. Likewise, situational cues that enhance the social importance of a social category also produce the same effect. Lastly, prior experience at individuating faces of a specific race enhances one's ability to process and remember faces at the individual level. These factors add up to explain both the ORE and ORCA [14].

1.2 P300, Own-, and Other-Race Faces

The study of race-based face-processing also extends to the realm of neurocognition, specifically in relation to the P300 component. In electroencephalography (EEG) studies, The P300 amplitude is a positive going event-related potential (ERP) that occurs around 300ms after stimulus onset [20, 21]. It is most prominent in response to low-probability stimulus that commands more attention [21 – 24].

P300 amplitude has been reliably shown to be larger for faces from other-race groups compared to faces from own-race group [5, 6, 25, 26]. This was due to the more attention-grabbing distinctiveness of other-race faces in comparison to own-race faces [27]. It thus shows that behavioural and neurocognitive responses toward own- and other-race faces are markedly different. Nevertheless, at the time of writing, past studies focused exclusively on comparisons between own- and other-races, but neglected to investigate how participants would respond toward different types of other-races, namely familiar and unfamiliar other-races.

1.3 The Current Study

The current study was inspired by the fact that in oddball paradigms, the P300 component evoked signals processing and categorisation of different stimuli. The P300 amplitude peaks when the mental schema, initially established by a series of similar stimuli, is updated upon perceiving a rarer stimulus that does not fit into the mental schema [24]. This is only possible when the brain is engaged in categorical processing of different stimuli.

While studies comparing own- and other-race faces showed consistent results, to the author's knowledge, thus far no research has investigated whether familiarity with the faces of an other-race group will produce ORCA-like effects when compared with faces of an unfamiliar other-race group. It remained to be seen whether past findings could be extrapolated to the current sample consisting of Chinese Malaysians, as they evaluated and categorised the familiar Malay face and the unfamiliar African face [28, 29].

Malaysia may be a Southeast Asian country but it is heavily influenced by Western culture through the media. This is evidenced by the overwhelming representation of Western movies screened in Malaysian cinemas (86%) in comparison to local movies (13.7%) [30]. While Western films are typically more ethnically diverse, [31] have found that between the year 2007 and 2015 (excluding year 2011), representation of Caucasian actors in top-grossing films hovered between 71.2% and 77.6%, whereas representation of actors of African descent hovered between 10.3% to 14.7%. Therefore, the current study's choice of the unfamiliar other-race was informed by the possibility that Malaysians might be more familiar with the Caucasian face than the African face. Based on the last population survey conducted by the Department of Statistics in Malaysia [32], Malays make up 95.7% of the Kelantanese population, therefore making them a familiar other-race to the Chinese population here.

Based on previous literature, it was hypothesized that an ORCA-like effect would occur, wherein the reaction time (RT) toward faces from a familiar other-race and faces from and unfamiliar other-race would differ significantly. A significant difference in P300 amplitudes evoked by both types of faces was also hypothesized.

As mentioned, the issue of racial familiarity among different other-races has not been conclusively investigated in literature concerning the ORE or ORCA. The current study could serve as a springboard for future investigations into the topic of other-race familiarity.

2. Methodology

2.1 Design

The current study employed a repeated measures experimental design with one-independent variable (IV) and three levels. The IV was racial familiarity, and the three levels were namely: familiar other-race, unfamiliar other-race, and control group. Racial familiarity was operationally defined as prolonged exposure to and experience in individuating members of a different race. Familiar other-race was represented by photos of Malay faces, unfamiliar other-race was represented by photos of African faces, and the control group was represented by non-face photos, i.e. photos of furniture.

2.2 Ethical Clearance

The current study received ethical clearance from the Human Ethical Committee of Universiti Sains Malaysia Health Campus (Ref: USM/JePeM/15040127). There is no conflict of interest regarding the publication of this paper.

2.3 Participants

Based on an a priori statistical power analysis by G*Power 3.1.9.2 [33], 30 Chinese Malaysians from Chinese households (both parents cannot be of mixed heritage) were recruited to achieve a medium effect size of partial eta-squared (**Error! Reference source not found.**) = 0.06. The participants were recruited from the student population in a publicly-funded university in Kelantan, Malaysia. All participants were right-handed, had normal or corrected to normal vision, and were free from a history of psychiatric disorders, consumption of psychiatric medication, major head injuries leading to loss of consciousness, seizures, and major neurological, hepatic, or cardiovascular disorders.

2.4 Procedures

After providing written informed consent, participants shampooed their hair thoroughly with baby shampoo and avoided using any hair products before the study. the participants were led into the recording room for electroencephalograph (EEG) net outfitting, after which they completed the EEG recording session while completing the modified oddball and choice reaction task. After that, the participants were asked whether they knew any of the faces in person to ascertain that none of the participants were personally familiar with the faces. This was because personal familiarity overrides racial cues and also modulates P300 amplitude [14, 34, 35]. Upon study completion, the participants were compensated for their time and dismissed.

2.4.1 Modified Oddball and Choice Reaction Paradigm

The participants were seated 80cm away from the computer LCD screen during the oddball task. The modified oddball and choice reaction paradigm was adapted from [34] and designed using the E-Prime® 2.0 software. This oddball paradigm was used to investigate whether the physiognomic differences in the target Malay faces and African faces would evoke different P300 amplitudes among the participants.

A total of 100 trials were shown with a stimuli presentation ratio of 3 (furniture photos):1 (African faces): 1 (Malay faces). All photos were coloured and reconfigured automatically by E-

Prime® 2.0 to a resolution of 640 pixels x 480 pixels, positioned at the centre of the screen against a black background, and presented in a random sequence. Each trial began with a 500ms presentation of a white fixation cross against a black background, followed by a blank screen for 800ms, and the stimulus photo for 2000ms (Figure 1)

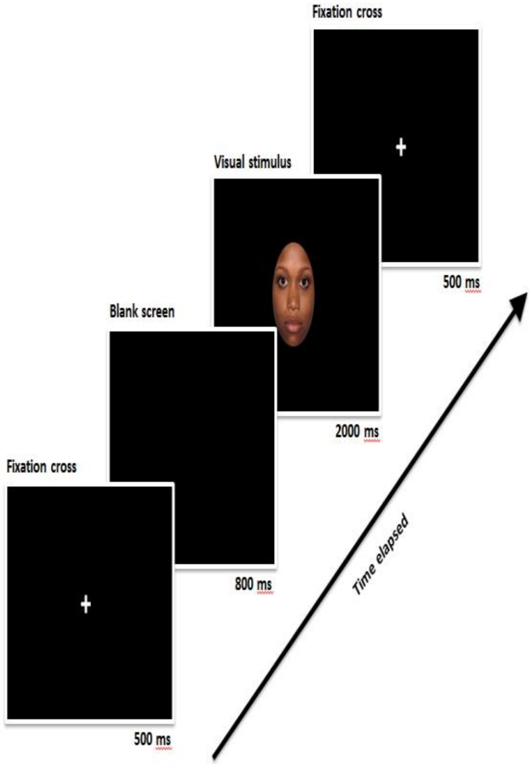

Fig 1: Visual representation of the modified visual oddball and choice reaction paradigm

Participants pressed '1' when they saw an African face, and '2' when they saw a Malay face. No response was required for furniture photos. They were required to response as quickly and as accurately as possible using their index and middle fingers of their right hand. Participants were allowed to familiarize themselves with the task until they felt ready to commence the actual study.

Visual stimuli. Photos of African faces were selected from the NimStim set of facial expression [36]. Photos of Malay faces were researcher-generated. Any facial scars or moles were digitally removed from the photos. Four photos from each race category were used as the target stimuli. All photos of faces were cropped to show only the face, thus occluding the model's hair, neck, and body. Only female faces with a closed-mouth, neutral expression were used as past research has shown that different facial expressions elicited by familiar and unfamiliar faces were processed differently at the neurophysiological level [37].

Fifteen photos of furniture with neutral valence and low arousability were selected from the Geneva Affective Picture Database (GAPED) [38], and were used as the standard stimuli.

2.4.2 EEG recording and pre-processing

Continuous EEG recordings were obtained throughout the oddball task, from which the ERP waveforms were derived. EEG data was recorded with a 128 HydroCel GSN connected to a high-input impedance NetAmps 300 amplifier. The EEG data were recorded from midline electrode sites (Fz, Cz, Pz) and digitized at 250 Hz.

Processing of EEG data was completed using the EGI Net Station 5.3 software. Raw EEG recordings were subjected to 0.30-50.00Hz bandpass filter, and a 50Hz Notch filter was applied. Segmentation was locked to 100ms pre-stimulus onset and 1000ms post-stimulus onset, with a 17ms offset. Ocular artefacts (eye blinks and eye movements) and other movement artefacts were removed and bad channel replacement was performed through interpolation from nearby electrodes. The data were then averaged separately, converted into the 10-20 EEG montage, and subjected to baseline correction. After all individual EEG data files were processed as mentioned, they were combined and averaged together.

3. Results

The current study recruited a total of 30 Chinese Malaysian participants with equal gender distribution. The mean ages for male and female participants were 21.33 years (*SD* = 1.72) and 21.87 years (*SD* = 1.88), respectively. None of the participants indicated that they knew any of the faces shown in the oddball paradigm personally, thus ruling out any effects from pre-experimental familiarity with the faces.

Response accuracy was reasonably high, with a mean of 0.91 (*SD* = 0.08) for African faces and a mean of 0.97 (*SD* = 0.06) for Malay faces. Independent t-tests revealed no significant differences between male and female participants in RTs for African [t (21.49) = -0.60, $p > .05$] and Malay faces, [t (21.88) = .351, $p > .05$]. As such, RT scores were collapsed across gender and analysed together. A paired-samples t-test revealed no significant difference between RT for African faces [mean = 663.16, *SD* = 111.36, 95% CI (621.58, 704.74)] and RT for Malay faces [mean = 645.36, *SD* = 126.72, 95% CI (598.04, 692.68)], t (29) = 1.67, $p > .05$, indicating that an ORCA-like effect failed to manifest behaviourally in this study.

Several criteria of normality were assessed for P300 amplitudes for all three conditions (African faces, Malay faces, and furniture photos). Log 10 transformation was applied for data at Cz and Pz electrodes prior to further analyses to improve normality.

Independent t-tests revealed no significant effect of gender on P300 amplitudes at all three electrode sites (Fz, Cz, and Pz) across all conditions, all *p*s > .05. Thus the data was collapsed across gender for subsequent analyses. At Fz, assumption of sphericity was met at Fz, $\chi 2$ (2) = .54, $p > .05$. A repeated measures one-way ANOVA showed a significant effect of racial familiarity on P300 amplitude, F (2, 58) = 10.40, $p < .001$, **Error! Reference source not found.** = 0.264.

At Cz, assumption of sphericity was not met, $\chi 2$ (2) = .80, $p = .047$. After Greenhouse-Geisser correction, there was a significant effect of racial familiarity on P300 amplitudes at site Cz, F (1.67, 48.51) = 29.01, $p < .001$, **Error! Reference source not found.** = .500. Pairwise comparisons revealed that P300 amplitude was significantly greater in the African faces condition as compared to the Malay faces condition, $p = .001$. P300 amplitude was also significant greater in the African faces condition ($p < .001$) and the Malay faces condition ($p = .017$), as compared to the furniture photos condition.

At Pz, sphericity was not assumed, $\chi 2$ (2) = 8.09, $p = .017$. Repeated measures one-way ANOVA revealed a significant effect of racial familiarity on P300 amplitude at Pz after Greenhouse-Geisser correction, F (1.60, 46.36) = 31.64, $p < .001$, **Error! Reference source not found.** = 0.522. Pairwise comparisons revealed that P300 amplitude was significantly greater in the African faces condition as compared to the Malay faces condition, $p < .001$. While participants also produced greater P300 amplitude in the African faces condition as compared to the furniture photos condition ($p < .001$), there was no significant difference between the Malay faces condition and the furniture photos condition, $p > .05$.

4. Discussion

The first hypothesis was not supported as the mean RTs for African and Malay faces did not differ significantly, thus signifying that an ORCA-like effect did not manifest behaviourally for the relatively unfamiliar African faces. However, the second hypothesis was supported, as racial familiarity was shown to exert a significant effect on P300 amplitudes at all central electrode sites (Fz, Cz, and Pz) with large effect sizes. At site Fz, participants produced larger P300 amplitudes for Malay faces than for African faces, whereas at sites Cz and Pz, participants produced larger P300 amplitudes for African faces than Malay faces.

Past studies on ORCA focused exclusively on classification or recognition performance between own-race and other-race faces. Uniquely, the current study investigated an ORCA-like effect when different types of other-race faces were presented, namely a familiar other-race (which the current study proposed would have effects mimicking that of one's own-race) and an unfamiliar other-race. While the ORCA effect did not manifest behaviourally, in that RTs toward African faces and Malay faces did not differ significantly, the significant differences in P300 amplitudes evoked by both faces indicated that a familiar other-race face was processed differently from an unfamiliar other-race face.

4.1 RT and Racial Familiarity

At least among Chinese Malaysians, familiarity with Malay faces did not result in quicker classification of the more unfamiliar African face. Previous studies on the ORCA have reliably demonstrated that individuals categorised other-race faces faster than own-race faces [3, 5, 6], and the effect extended even to own-race and other-race eyes shown in isolation of other facial features [12]. Researchers found that recognition speed occurred at the expense of categorisation speed, mainly because both ORCA and ORE have been demonstrated to share the same underlying face processing mechanisms [7, 8]. As such theories explaining ORE could be used to explain ORCA as well.

In the present study, an ORCA-like effect was not found despite the predictions made by the perceptual learning model, on which the initial hypothesis was built. Participants in the current sample have a high level of exposure to Malay individuals. This should, in theory, lead to experience and expertise in individuating Malay faces to a level comparable to own-race faces [5]. The resulting default tendency to process Malay faces at the individual level should hamper categorisation speed relative to African faces [7, 8]. [10]'s found that Asian Americans were able to recognize both Asian and Caucasian faces equally well, which suggested that the Asian Americans' RTs toward Asian and Caucasian faces should not differ (see also [13]). In contrast, the current study found that exposure to a familiar other-race alone was insufficient to elicit an ORCA-like effect for the more familiar Malay face, relative to the less familiar African face. It seemed that at least in the context of racial familiarity between two other-race groups, familiarity with an other-race group did not automatically engage individuating processes in the presence of another unfamiliar other-race group [5].

Another prevailing model of ORE applicable to the ORCA phenomenon is the social cognitive model. Given that recognition speed occurs at the expense of categorisation speed [7, 8], the similar RTs toward African and Malay faces in the current study suggested that the participants failed to make an ingroup-outgroup distinction between African and Malay faces on the basis of racial familiarity. The participants in the current study might have displayed a category formation strategy similar to perceptual narrowing behaviour, in that both African and Malay faces were lumped together as the "other-race outgroup", regardless of relative racial familiarity [39]. This is in stark contrast with studies that required participants to make race-based categorisation of own- and other-race faces, where familiarity and constant exposure to same-race faces prompted ingroup classification of own-race faces [2, 6, 40]. Taken together, the current findings hinted at a qualitative difference between familiarity with one own's race and familiarity with an other-race.

Indeed, for most individuals, their primary experience with own-race individuals is with their parents and other family members who played the role of a provider and protector in their early years. This early priming is typically reinforced throughout their formative years and perhaps even well into adulthood, such that members from one's own-race are looked on more favourably. Therefore, a familiar other-race might not be considered as the ingroup based on the race dimension alone, as a familiar other-race is incapable of evoking similar associations.

Another possible explanation for this qualitative difference could stem from the influence of unintentional activation of racial attitudes during categorisation. [41] found that racial stereotypes were triggered automatically following categorisation of African and Caucasian faces on the racial dimension. However, they did not find activation of racial stereotypes when their participants were required to categorise African and Caucasian faces by age, thus suggesting that race-related stereotype activation could be attenuated by drawing attention to non-racial characteristics. The automaticity of racial stereotypes activation was also demonstrated in an earlier study by [42]. Importantly, *knowledge* of racial stereotypes was not necessarily related to personal beliefs in the racial stereotypes, as high- and low-prejudiced individuals in [42]'s study were equally cognizant of the cultural stereotypes regarding a particular racial group. In the current study, the participants were required to quickly and accurately categorise African and Malay faces on the racial dimension. Under these task constraints, they lacked the time and cognitive resources to inhibit racial stereotypes that might have been activated automatically [42]. The automatic activation of race stereotypes might have prevented the current sample to consider highly familiar Malay faces as part of the "ingroup" despite it being contrasted with less familiar African faces. This shows that barring other contextual cues, when two other-races were presented together, racial familiarity alone was not a motivating factor for ingroup formation. Unlike one's own race, individuals from any other races were considered dissimilar from the participants, and were not considered socially important enough to individuate [14]. The need to individuate ingroup faces could perhaps be evoked by other more contextually meaningful shared ingroup membership such as shared university affiliation [17], religious affiliation [18], and nationality.

4.2 The P300 Component and Racial Familiarity

Although behavioural measures failed to show a manifestation of ORCA-like effect in the current study, Malay and African faces evoked different patterns of P300 elicitation at the midline electrodes. At both Cz and Pz electrodes, P300 amplitude was significantly larger for African faces than Malay faces. The Fz electrode however showed an opposite trend, in that P300 amplitudes were found to be larger for Malay faces than African faces. This mismatch with the Cz and Pz electrodes was unexpected and has never been seen in relevant literature, thus making it difficult to interpret. Replication studies need to be carried out to rule out the possibility that the mismatch was not an anomalous finding. Nevertheless, as P300 amplitude is most prominent at the centro-parietal midline [43, 44], meaningful conclusions could be drawn from the Cz and Pz electrodes.

The finding at Cz and Pz electrodes is reminiscent of researches that found that P300 amplitude was larger for other-race faces as compared to own-race faces [5, 6, 25]. As expected, the current findings suggest that neurophysiologically, the processing of familiar and unfamiliar other-race faces is analogous to the processing of own- and other-race faces. Malay faces were processed in a manner similar to own-race faces, as evidenced by the smaller P300 amplitude in comparison to African faces at Cz and Pz electrode sites [5, 6, 25]. As African individuals are not prevalent in Malaysian media and community [28, 29], the larger amplitude could be attributed to the relative distinctiveness of African faces (in comparison to Malay faces), which in turn attracted more attention [3, 4, 6].

This finding is important because it demonstrated that while racial familiarity was qualitatively different for own-race and other-races, it remained a factor on which neuropsychological processing of other-races faces was differentiated. While past studies have shown that a difference in P300 amplitude between stimuli was typically accompanied by a difference in RTs [5, 6, 25], the atypical findings in the current study pointed, for the first time, toward a dissociation between implicit social categorisation as evidenced by different P300 amplitudes along the lines of relative racial familiarity, and explicit social categorisation as evidenced by similar RTs.

Importantly, the finding lends support for [14]'s categorisation-individuation model (CIM), which integrated the perceptual learning and social cognitive models of ORE (and ORCA). In line with the predictions of CIM, Malay faces and African faces were first spontaneously categorised according to race [14, 19]. This first categorisation registered the influenced of racial familiarity [5, 6, 25], evidenced by the less familiar African faces evoking larger P300 amplitudes than Malay faces. However, familiarity with an other-race group did not turn out to be socially important, so the participants were not motivated to consider the more familiar Malay faces as part of the "ingroup" based on racial familiarity alone. Thus this relegated Malay faces and African faces to a larger "outgroup" category. As both groups were assigned to the "outgroup" category, attention was drawn instead to category-diagnostic facial characteristics [14]. As a result, the participants were not burdened by the need to inhibit their tendency to individuate ingroup members [5, 12, 45, 46]. This explained why the RTs for both African and Malay faces were similar in the race categorisation task despite the fact that the current participants were very experienced in individuating faces from the familiar Malay race, which should, in theory, slow down categorisation speed [5].

4.3 Limitations and Future Recommendations

Nevertheless, it is unclear whether the effects of a familiar other-race face and own-race face on P300 amplitude is actually comparable in the current study, given that the current study did not include own-race faces in the investigation. Thus, it is suggested that future studies should include comparisons between own-race faces, familiar other-race faces, and unfamiliar-race faces to see whether the current findings can be replicated in a larger sample. In addition to that, including own-race faces will allow future studies to confirm the explanations provided for the current findings.

Despite the limitations, the current findings contributed significantly to the understanding of the processing of other-race faces as a function of racial familiarity. Through behavioural measures alone, it was clear that an ORCA-like effect did not occur for the African faces, which might prompt the conclusion that other-race faces were processed similarly regardless of racial familiarity. However, the P300 amplitudes obtained through the oddball task showed that the participants did in fact process African and Malay faces differently. Thus, through comparing two other-races, the current study made the following theoretical contributions:

(1) Familiarity with an other-race does *not* automatically prompt attendance to identity-diagnostic facial features, as purported by the perceptual learning model. A qualitative difference exists between familiarity with one own's race and familiarity with an other-race, such that exposure and experience in individuating among faces of a familiar other-race alone (relative to an unfamiliar other-race) were unable to mimic the ORCA-effects found in own- and other-race comparisons.

(2) Between faces from a familiar other-race and an unfamiliar other-race, difference in P300 amplitudes may *not* hint at a difference in race-categorisation RT, unlike in studies that presented own- and other-race faces.

(3) The aforementioned dissociation strengthened [14]'s CIM. Racial familiarity only encourages one to confer ingroup membership to own-race individuals. It does not have the same effect on a familiar other-race group, as despite familiarity, other-races are not considered socially important enough to individuate.

5. Conclusion

An important take-home message afforded by the current findings is that in a multi-ethnic country such as Malaysia, familiarity with other-races alone might not be enough to foster a sense of ingroup belongingness. Instead, more meaningful social categories that are not dependent on the racial dimension should be emphasized. More importantly, further effort should be devoted to finding out how individuals from different racial backgrounds can form stable a ingroup identity after activities that promote an ingroup recategorization process.

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