

Why the other-race effect matters: Poor recognition of other-race faces impacts everyday social interactions.

Short title: The ORE impacts social interactions

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ABSTRACT

What happens to everyday social interactions when other-race recognition fails? Here, we provide the first formal investigation of this question. We gave East Asian international students (N=89) a questionnaire concerning their experiences of the other-race effect (ORE) in Australia, and a laboratory test of their objective other-race face recognition deficit using the Cambridge Face Memory Test (CFMT). As a 'perpetrator' of the ORE, participants reported that their problems telling apart Caucasian people contributed significantly to difficulties socialising with them. Moreover, the severity of this problem correlated with their ORE on the CFMT. As a 'victim' of the ORE, participants reported that Caucasians' problems telling them apart also contributed to difficulties socialising. Further, 81% of participants had been confused with other Asians by a Caucasian authority figure (e.g., university tutor, workplace boss), resulting in varying levels of upset/difficulty. When compared to previously-established contributors to international students' high rates of social isolation, ORE-related problems were perceived as equally important as the language barrier and only moderately less important than cultural differences. We conclude that the real-world impact of the ORE extends beyond previously identified specialised settings (eyewitness testimony, security), to common everyday situations experienced by all humans.

The other-race effect — poorer ability to recognise other-race than own-race faces — is well established in laboratory experiments. Hundreds of published experimental studies over 50+ years have established many basic facts about the ORE, including that the ORE affects both face memory and face perception, can result in both false negatives (failing to recognise a previously-seen other-race person) and false positives (falsely 'recognising' an unknown other-race person as familiar), can impair the process of making new faces familiar, and occurs across the world for multiple race combinations (e.g., Dawel et al, 2019; Hayward et al, 2017; Meissner & Brigham, 2001; Michel et al, 2006; Tanaka et al, 2004; Tullis et al, 2014; Zhang et al, 2011; Zhou et al, 2018).

The ORE's impacts in the real world have, to date, received less investigation. Studies of real-world impact have focussed primarily on failures of eyewitness testimony (e.g. Wells & Olson, 2001), and the subsequent severe consequences of false convictions and long prison sentences for innocent people incorrectly identified by an eyewitness of a different race (e.g., in the US Innocence Project or the infamous Ronald Cotton case; Scheck et al, 2003; Thompson, 2000). Additionally, there has been some investigation of the effects of the ORE in security settings, such as failures of face matching by police or in passport control (e.g., Bate et al, 2019).

An equally important question, however, is whether and how the ORE might impact everyday social interactions between people. Surprisingly, there appears to have been no previous formal investigation of this topic. Here, we begin that investigation.

Why and how the ORE might impact everyday social interactions

There are several broad reasons to predict that poor ability to tell apart other-race individuals is likely to be associated with difficulties in everyday social interactions.

The first reason concerns the general importance — regardless of face race — of person-identity information to ordinary social interactions. Logically, the ability to form and maintain friendships, and to interact successfully in the workplace with colleagues, clients or students, all require an awareness of *who* one is speaking to, including whether that person is a stranger or a person known to yourself, and, if familiar, exactly who that person is. Appropriate social behaviour depends critically on this identity information. For example, walking past a person on a busy street and ignoring them is socially appropriate if that person is a stranger, but is not appropriate and likely to cause offence if that person is a friend or a work colleague. Similarly, it is not socially appropriate for a teacher to confuse one student in their class with another, or for a business owner to confuse one important client with another. Critically, person-identity recognition is driven primarily by *face* recognition ability: other clues to identity, such as hairstyle, clothing, body shape and gait, frequently fail in the real world (e.g., Duchaine et al, 2007; Lane et al, 2018a; Yardley et al, 2008).

Correspondingly, negative impacts on social interactions have been identified where face recognition fails for reasons other than the ORE. For instance, face recognition fails even for own-race faces in *prosopagnosia*, a clinical difficulty in telling apart individual faces following brain injury or atypical development (Duchaine & Nakayama, 2006), and in people with *impaired vision*, such as older adults with age-related macular degeneration who lose fine vision and thus have difficulty perceiving the details necessary to distinguish individual faces (Lane et al, 2018b). Both these groups describe recurrent and sometimes

traumatic social interaction difficulties caused by recognition problems, including failing to recognise work colleagues, close friends and family members, and also falsely 'recognising' strangers and wrongly treating them as familiar (Dalrymple et al, 2014; Lane et al, 2018a; Murray et al, 2018; Yardley et al, 2008). This commonly results in fear of making errors and offending others. A minority of people (10-20% of participants in these small-sample studies), report dealing with this situation by behaving in a more socially outgoing manner (e.g., smiling at everyone in case they might know them; air-kissing everyone at a party and calling them 'darling' to hide the fact they don't know who they are). However, the majority report experiencing embarrassment, guilt or frustration, anxiety in social settings (e.g., due to not knowing who is present around the table at a workplace meeting, or worrying they will be perceived as deliberately ignoring a colleague or acquaintance), and feelings of missing out socially (Lane et al, 2018a; Yardley et al, 2008). Long-term consequences can include social withdrawal, a restricted social circle, more limited employment opportunities (e.g., due to others perceiving you as socially difficult), dependence on others to tell you who people are, misattributions of why other people respond negatively to you (e.g., 'I must be boring or have an unpleasant personality', rather than realising you ignored the person the day before), lowered quality of life, and loss of self-confidence in social settings (Dalrymple et al, 2014; Lane et al, 2018a; Murray et al, 2018; Susilo et al, 2010; Yardley et al, 2008).

Turning specifically to the other-race situation, we would then predict similar types of social interaction problems, but specifically restricted to interactions with other-race people, rather than with all people. Social difficulties are likely to be worst for people who have a *severe* inability to recognise other-race faces: there is substantial individual variability in the size of the ORE (Wan et al, 2017) and, while some people show no ORE at all, others are so poor at recognising other-race faces that, were their own-race recognition this poor, they would qualify as prosopagnosic (8.1% of a cohort of N=550 in Wan et al, 2017). At the same time, failures in recognising other people do not have to be complete to induce real-world social difficulties. In macular degeneration, patients with only mild vision loss, whose face recognition failures are only intermittent, report, qualitatively, exactly the same social interaction difficulties and anxiety as patients with severe vision loss who can barely see faces at all (Lane et al, 2018a). Indeed, even for normal-vision healthy young adults, who are within the normal range of own-race face recognition abilities, individuals who are relatively poorer at recognising own-race faces report higher social anxiety than those with better face recognition abilities (Avery et al, 2016; Davis et al, 2011). Together, these observations predict that, while real world social interaction difficulties between different-race people are likely to be most severe where one or both of the individuals interacting have a severe objective face recognition deficit for the other race (e.g., as assessed by validated laboratory tests), even milder OREs that result in less frequent face recognition errors are likely to lead to some degree of real-world social interaction difficulty.

Finally, anecdotal reports suggest that the ORE can indeed impact social interactions. These reports suggest potential difficulties for both a person who has failed to be recognised by an other-race person — whom we will label the '*victim*' of the ORE — and a person who has failed to recognise an other-race person, who we will label the '*perpetrator*' of the ORE. An Australian national radio podcast (Dias, 2018) described experiences of 4 minority-race (e.g., Asian-Australian) and 2 majority-race (Caucasian) individuals. As *victims* of the ORE,

the minority-race Australians reported incidents such as: their Caucasian bosses at work confusing them with another East Asian colleague in the office, resulting in embarrassment and social difficulty deciding whether to inform the boss of their mistake or just ignore it; or their Caucasian primary school teacher confusing them with the other South Asian student in their class, resulting in getting in trouble for something the other child did. *Perpetrators* also reported social embarrassment and concern for others, in incidents that included, for example, a Caucasian teacher who was aware of, and worried by, her inability to tell apart the Asian students in her class. Importantly, anecdotal cases also suggest that social consequences of the ORE are not limited to the situation of a majority-race or higher-status perpetrator with a minority-race or lower-status victim. Perpetrators and victims can be of equal status, such as the man who reported failing to recognise his other-race wife in public, resulting in scathing comments from his (now ex-) wife (Glover, 2015). Perpetrators can be lower status than victims, such as the first author's experience, when a junior postdoc, of being incapable of recognising her other-race senior professor boss by anything other than his coat. And perpetrators can be minority-race individuals, such as the Asian PhD student in Australia unable to recognise the Caucasian parents of her daughter's friends from childcare (Wan, 2017).

Present Study: The ORE experiences of East Asian international students in Australia

The above examples suggest that there are many social settings — both informal (e.g., recognising people at a party) and formal (e.g., workplace, educational) — in which the ORE might impair the success of real-world social interactions. Here, to begin the investigation of this topic, we focus on the social interaction experiences of Asian international students (from East/South-East Asia) who moved to Australia as adults to study at university.

As a group, international students in Australia have a number of relevant attributes. First, they are known to suffer greater social isolation, and associated depression and anxiety, than the local student population (Redfern, 2016). Socialising and friendships are important to mental health in general (e.g., as emphasised by impacts of social disruption on mental health during the Covid-19 pandemic, Dawel et al, 2020), and are likely to be of particular importance in international students who, as young adults, commonly do not yet have a stable home life of their own, and have also recently arrived in a new location as strangers knowing few or no other people. Previous studies of international students in Western countries have established two important factors that contribute to their social isolation and negative mental health outcomes, namely the language barrier (i.e., English is a second language for many Asian international students in Australia, although not all) and cultural differences (e.g., Redfern, 2016; Sherry et al, 2010; Wu et al, 2015). These previous studies, however, have not considered the possibility that *face recognition difficulty* — having trouble recognising Caucasian people, or Caucasian people having trouble recognising them — could be another important contributor to social isolation.

Second, the international student group allows us to study both perpetrator and victim experiences of the ORE in the same participants. Previous research (Wan et al, 2015) has established that, on average, Asian international students in Australia show a significant other-race effect for recognising Caucasian faces in the laboratory (mean accuracy 8.8% worse for Caucasian faces than Asian faces); this argues they are potential real-world

perpetrators of the ORE, i.e., they will likely have trouble telling apart Caucasians in everyday life. Equally, Caucasian Australians show a symmetrical other-race effect for Asian faces (7.3% worse for Asian faces than Caucasian faces); this makes Asians in Australia potential real-world *victims* of the ORE from Caucasians, the local majority race.

Third, it has been shown that, for the Asian/Caucasian cultural setting in Australia, these laboratory-measured OREs represent a fundamental perceptual failure with faces of the other race that cannot be improved simply by trying harder. The ORE in some other settings (e.g., US Whites looking at African-American faces) has been attributed to cognitive disregard and/or lack of effort in attending to individual-identity-level rather than race-level information (Levin, 2000; Sporer, 2001; Young et al, 2012). However, in the Asian/Caucasian setting in Australia, participants of both races spontaneously apply *more* effort to distinguishing other-race than own-race faces (Wan et al, 2015; Crookes & Rhodes, 2017; also see Tullis et al, 2014) and, correspondingly, their ORE is not improved at all by the Hugenberg et al (2007) motivation-to-individuate instructions (Wan et al, 2015; also see replication in Thorup, 2020). This is relevant because most real-world social interactions *require* attending to peoples' individual-level identity (rather than merely their social category or group membership). Thus, studying a cultural setting in which the ORE has a perceptual rather than motivational origin increases the chances that real-world consequences of the ORE will be observed.

Fourth, the ORE in Asian international students is related to their lack of *early life* exposure to Caucasian faces — specifically during a 'critical period' prior to approximately 12 years of age — and their ORE does not improve with real world contact with Caucasians obtained as an adult even with up to 5 years' exposure in the West, and regardless of the quality of that contact (McKone et al, 2019). This implies that a real-world ORE should still be measurable in participants who have been in the West long enough to have experienced a range of social situations, rather than having, say, disappeared within their first few weeks in the country.

Finally, we suggest Asian international students are likely to be aware of, and thus be able to explicitly report on in a questionnaire, their everyday difficulties with Caucasian faces. People's conscious insight into their objective face recognition ability is poor for *own-race* faces (Palermo et al, 2017), reflecting a general pattern that people are often unaware of perceptual problems where they have had no direct opportunity to compare their abilities to what is 'normal' (e.g., individuals who grow up unaware of their colour blindness). Importantly, however, Asian international students have a clear comparison situation against which to compare their face recognition and social interaction experiences with Caucasians, namely their many years of living in Asia surrounded by own-race faces.

Study design and research questions

Figure 1 shows the questionnaire we developed for Asian international students in Australia. Given that this was a first study, our questionnaire aimed simply to demonstrate whether there *are* identifiable effects of the ORE on everyday social interactions, rather than to fully explore the details of these. The questionnaire items were chosen to assess two broad types of social interactions of practical importance to international students: socialising with local White students (note the questionnaire used 'White' instead of 'Caucasian' because our

experience is White is the term commonly used by our international student cohort); and interactions with White people in a position of power over the participant (e.g., their teachers, or bosses at work).

Questions 1 and 2 investigated the ability to socialise successfully with local Whites (e.g., other students in their classes), as relevant to forming friendships and avoiding social isolation. For the first time, we asked international students about the extent to which they attributed difficulties socialising with White people to other-race face recognition problems, as a perpetrator of the ORE (i.e., due to their problems telling apart White people, or linking White people's faces to their names), and as a victim of the ORE (i.e., due to White students confusing them with other Asians). Here, our research questions were: whether international students reported *any* contribution of the ORE to difficulties socialising (as opposed to no contribution), given that previous studies have never asked about face recognition; and how *important* students perceived ORE contributions to be. To evaluate importance, we compared average ratings for the ORE factors to ratings for the two factors previously considered to be the primary contributors to international students' difficulty socialising, namely language barrier and cultural differences (Redfern, 2016; Sherry et al, 2010; Wu et al, 2015). *A priori*, we thought it unlikely the ORE would be perceived by students as equal in importance to these factors. However, given that both factors have been treated by universities to be of sufficient real-world importance to justify providing significant and costly interventions (e.g., language training, training on cultural differences, opportunities for cultural integration), a perceived importance of ORE factors even half that of these established factors would be enough to indicate the ORE should also be taken seriously. Finally, we tested, in multiple regression, whether there were independent ORE contributions to individuals' total difficulties socialising (Q1), separate from the contribution of language barrier and cultural differences.

<u>Item types</u>	<u>Full questions and response scales</u>	<u>Short names used in Results</u>
	Q1. How hard have you found it to socialise with local White people while you have been in Australia? 1 = <i>Very Easy</i> to 7 = <i>Very Hard</i>	Total difficulty socialising
	Q2. To what extent have these different factors made it hard to socialise with White people? For each factor: 1 = <i>Not at all</i> to 7 = <i>Very much</i>	
<u>Non-ORE-related factors</u> previously established to affect social life of international students in Australia	2a. Language barrier (i.e., you don't speak English very well or find Australians use unfamiliar words).	Language barrier
	2b. Cultural factors (e.g., you need to spend more time on study and don't have time to socialise; or Australian students tend to be independent, coming, going and studying on their own, and not wanting to socialise; or Australian students talk about things you are unfamiliar with; or Australians want to do things you aren't interested in, like drinking a lot of alcohol or talking about unfamiliar sports).	Culture differences
	2f. You don't meet many White people (e.g., because there aren't enough in your classes or college).	Don't meet many Whites
<u>ORE-related</u> as a 'perpetrator' of the ORE	2c. You have trouble recognising White people, i.e., they tend to all look the same , and you have trouble telling them apart, e.g., so you aren't sure if a person you see now is the same person you've spoken to earlier.	I can't tell them apart
	2d. You find it hard to remember White Australians' names & match names to their faces	I can't link names to their faces
<u>ORE-related</u> as a 'victim' of the ORE	2e. You find White students confuse you with other Asians.	They can't tell us apart
	Q3. Have you had authority figures (e.g., tutors, bosses at work) who are White? <i>Yes/No. [If choose yes, then 3a appears]</i>	
	3a. In general, how much do you find these people confuse you with other Asians (e.g., with other Asian students in the class, or with other Asian employees at work)? <i>1 = Not at all to 7 = Very much. [If choose >1, then 3b appears]</i>	Been authority victim
	3b. How much has this confusion upset you or made things difficult for you? <i>1-7 Not at all to Very much.</i>	How upset/difficult

Figure 1. Our 'Real World Experience of the Other-Race Effect' questionnaire designed for Asian international students in Australia (English version; for Mandarin translation see Supplementary Information). The figure shows how items group into ORE-related and non-ORE-related items, and also lists the short names for each variable used in Results figures and tables. For Q2, the order in which participants saw the items was 2a-2f (i.e., 2f was the last item in Q2).

We also included laboratory tests of each participant's *objective* face recognition ability for own- and other-race faces. To do so, we used Asian-face and Caucasian-face variants of the standardised Cambridge Face Memory Test (Duchaine & Nakayama, 2006), chosen due to the high reliability and validity of this test format (see Method). This allowed us to test the prediction that individuals' objective other-race recognition deficit should correlate with the extent to which they subjectively attributed real-world difficulties socialising with White students to other-race recognition problems, specifically as a *perpetrator* of the ORE, but not as a victim of it.

Question 3 then asked students about their experiences, as an ORE victim, in situations with a power differential involving an authority figure (e.g., involving the student's

tutors at university, or boss at work). Our first question was what proportion of students had experienced being a victim of the ORE from a White authority figure. Our second question of interest was the students' *response* to this situation, specifically the degree to which they found it upsetting or difficult. Perhaps surprisingly, anecdotal reports suggest no serious distress at being confused with other people of the same race. In the national radio podcast described above (Dias, 2018), the four minority-race victims of the ORE tended to describe the effects as annoying rather than distressing, with their response being usually to just ignore it or 'call it out'. These people, however, were all regular media presenters, confident in speaking in public, and likely to have high general social confidence. It is possible that other people might find being a victim of the ORE much more distressing, for example, if they have low social confidence in general, or have experienced the ORE in a setting with a particularly negative practical outcome. We were thus interested in the *range* of distress, specifically whether it might be that some participants completely shrug off being a victim of the ORE (rate upset/difficulty at 1 = Not at all), while others find it much more problematic (rate close to 7 = Very Much).

METHOD

Participants

The final data analysis used N=89 participants (61 female, 28 male; ages 18-32 yrs, M=23.1, SD=3.1) who completed the ORE experience questionnaire and met inclusion criteria; we set a minimum of N=80 to provide N=20 per predictor for our most power-demanding statistical analysis (a 4-predictor regression, see Results), and then recruited participants in batches until we had exceeded that minimum. Of the final N=89, N=85 had valid CFMT scores. For the 1 hr study, participants were paid AUD\$18 where tested in person, or an equivalent amount (USD\$12.50) where participating online via the Testable platform (Rezlescu et al, 2020). For recruitment, we advertised in both English and Chinese via university Facebook pages, WeChat, fliers around campus, and word of mouth. The majority of participants were from the Australian National University, but others were from other universities in Canberra, Melbourne and Sydney.

Inclusion criteria were as follows: either current or recent international students; of East/South-East Asian origin; living in Australia; reported their race as fully Asian (both parents East/South East Asian; mixed-race individuals were excluded, as was South Asian heritage such as India or Pakistan); born and raised in East/South-East Asia; and came to Australia as adults aged 18+ years. Most participants (94%) reported at least half Chinese heritage regardless of origin country (which included China, Korea, Singapore, Malaysia, Thailand, Indonesia). All participants provided informed consent and the study was approved by the Human Research Ethics Committee of the Australian National University.

Prior to determining the final N=89 data set, we excluded anyone with evidence of prosopagnosia (1 participant with own-race CFMT-Chinese score <40/72, McKone et al, 2017) or obviously non-effortful or internally contradictory responses (2 participants; e.g., contact scores with different races that added up to far more than the expected total of 100%). Finally, we excluded CFMT data (but retained ORE experience questionnaire data) for

anyone who were interrupted or had equipment/internet failure, or reported seeing the CFMT faces before in previous studies (n=4).

Task order

Participants completed tasks in the order: Cambridge Face Memory Test Caucasian face version; Cambridge Face Memory Test Asian face version; real-world ORE experience questionnaire; demographics questionnaire. Finally, we included questionnaires concerning participants' lifetime history of contact with people of various races.

Real-world ORE experience questionnaire: English and Mandarin versions

Participants selected their first language from three options. Participants who chose 'English' or 'Other' were given the ORE-experience questionnaire in English (n=58), using the wording shown in Figure 1. Participants who chose 'Chinese (Mandarin)' were given a Mandarin translation (Supplementary Information) (n=31).

Objective face recognition ability: Cambridge Face Memory Tests

We assessed objective face recognition ability for own-race Asian faces using the Cambridge Face Memory Test - Chinese (CFMT-Chinese, McKone et al, 2012) and for other-race Caucasian faces using the Cambridge Face Memory Test - Original (henceforth referred to as CFMT-Caucasian; Duchaine & Nakayama, 2006). The CFMT format is widely used (740+ citations), due to its many advantages: it assesses *face* not merely photograph recognition by showing each face in multiple images (different viewpoints and/or lighting conditions); it provides a valid predictor of real-world face recognition ability (e.g., accurate diagnosis of prosopagnosia); and it produces reliable scores for individual participants (see Wan et al, 2015, for details).

CFMT tasks use a three-phase procedure where the participant learns 6 people's faces in three viewpoints and, across a total of 72 test trials, has to recognise: studied images (Stage 1, learning, 18 trials); novel images (Stage 2, 30 trials); and novel images degraded by visual noise (Stage 3, 24 trials). On each trial, one of the 6 learned people is presented, together with 2 distractors, for three-alternative-forced-choice. Full details of face stimuli and test procedure are in Duchaine and Nakayama (2006) and McKone et al (2012).

Scoring and reliability. For each participant, we computed percentage correct trials (out of 72), for each of the CFMT-Chinese and CFMT-Caucasian. Objective ORE score was calculated as CFMT-Chinese *minus* CFMT-Caucasian; this difference score gives the participant's relative deficit for White faces compared to their baseline own-race recognition ability. Note the two tests are equal in difficulty for own-race observers (Wan et al, 2015), so a difference score of 0 validly indicates the participant has no ORE (within measurement error).

Internal reliability of the CFMT-Chinese was Cronbach's alpha = .874, and of the CFMT-Caucasian alpha = .853. This gives reliability of ORE difference scores = .662, using Reliability of difference scores = $\{[(r_{xx} + r_{yy})/2] - r_{xy}\} / (1 - r_{xy})$, where r_{xx} = reliability of condition x; r_{yy} = reliability of condition y; r_{xy} = correlation between condition x and condition y (e.g., DeGutis et al, 2013).

Lifetime Contact with Caucasians questionnaires

Participants completed childhood (ages 0-12 yrs) and adult variants of the standard Hancock and Rhodes (2008) contact questionnaire, assessing history of contact with Asians and Caucasians. They also reported the percentage of their friends, classmates, and people in the neighbourhood who were Asian, Caucasian and Other, at three life stages easily separable in memory: primary school (ages 5-12 yrs), high school (ages 12-18), and now as an adult. For wording of questions, see McKone et al's (2019) supplementary materials; also note present data replicated that article's findings of a childhood critical period for other-race faces (Supplementary Information).

Contact questionnaires were included primarily to allow a description of the participant sample. As expected, our sample reported very low early-life contact with Caucasians (Table 1): participants' origin countries all have <3.5% Caucasian population, including countries where English is learned as a first language (e.g., Singapore).

In-laboratory versus online testing: Minor procedural variations due to Covid-19.

Supplementary Information describes minor procedural variations for participants tested in person (before the Covid-19 pandemic) and online (during Covid-19).

Table 1. Participants' childhood contact with Caucasians, showing self-reported percentage of school classmates, friends, and people in the neighbourhood who were Caucasian, during Primary School (ages 5-12 years) and Secondary School (ages 12-18 years), plus ratings from the Hancock and Rhodes (2008) contact questionnaire for childhood exposure (ages 0-12 years).

	Child 0-12 yrs H&R ¹	Primary School (5-12 yrs)			Secondary School (12-18 yrs)		
		Friends	Classmates	Neighbours	Friends	Classmates	Neighbours
Median	1.1	0%	0%	0%	0%	0%	0%
Mean	1.4	0.8%	1.3%	0.9%	2.9%	4.5%	3.4%
N>20% ²	–	1/89	3/89	0/89	4/89	7/89	4/89

Notes: 1. Hancock & Rhodes (2008) contact questionnaire, scale 1 = minimum to 7 = maximum contact, as adapted to refer specifically to childhood contact (McKone et al, 2019).

2. Number of participants (out of total N=89) who reported that more than 20% of their friends, classmates or neighbours were Caucasian.

RESULTS

Data presentation and statistical analysis

Figure 2 shows the ORE Experience Questionnaire results, specifically the mean ratings, SEMs, and all individual scores (grey dots). For comparing means across items, we used standard t-tests (nonparametric alternatives gave equivalent results, Supplementary Information).

We also conducted statistical analysis (Table 2) addressing whether there was simply *any*, rather than *no*, experience reported on questionnaire items that used a hard scale endpoint of "Not At All" (Figure 1). Here, a rating of 1 (Not at All) indicates '*none*'; for

example, the participant felt a specified factor *did not contribute at all* to their difficulties socialising in Q2, or the participant had *never* experienced being a victim of the ORE from a White authority figure in Q3. Any rating higher than 1 (i.e., anything in the 2-7 range) indicates 'some'; for example, the participant felt there was *some* contribution of the specified factor to their difficulties socialising.

We used Spearman's correlational analysis and ordinal regression, given nonnormality of many distributions (grey dots Figure 2; Supplementary Information).

Replications and confirmation of expected results

Before turning to our research questions, we first confirmed our data replicated all expected findings. In the socialising domain, we confirmed that Asian international students experienced difficulty socialising and forming friendships with local White people (replicating Wu et al, 2015; Sherry et al, 2010; Redfern, 2016): mean rating for *Total difficulty socialising* on Q1 fell close to the midpoint of the Very Easy to Very Hard scale (Figure 2A), and a greater degree of difficulty socialising with Whites was associated with reporting that a lower percentage of their current friends in Australia were White ($\rho = -.644, p < .001$, Figure 2B). We also replicated significant contributions of cultural differences and language barrier to difficulty socialising (Wu et al, 2015; Sherry et al, 2010; Redfern, 2016): Table 2 shows perceived contribution was significantly greater than *none* for cultural differences ($p < .001$), and also for the language barrier where participants had English as a second language (ESL, $p < .001$). As would be expected, where participants had English as a first language, the language barrier contribution was much smaller: non-significant on *none* vs *some* comparison (EFL $p = .591$ Table 2), and significantly lower on mean rating than for ESL (Figure 2A, $t(77.41) = 5.661, p < .001$, Cohen's $d = 1.197$). Finally, on the Cambridge Face Memory Tests, we confirmed there was a significant objective ORE, with CFMT-Chinese $M = 80.3\%$, CFMT-Caucasian $M = 69.7\%$, $t(84) = 9.016, p < .001, d = 0.978$; these results closely replicate Wan et al's (2015) previous findings in Asian international students in Australia. Overall, these replications give us confidence in questionnaire item wording and the CFMT task implementation.

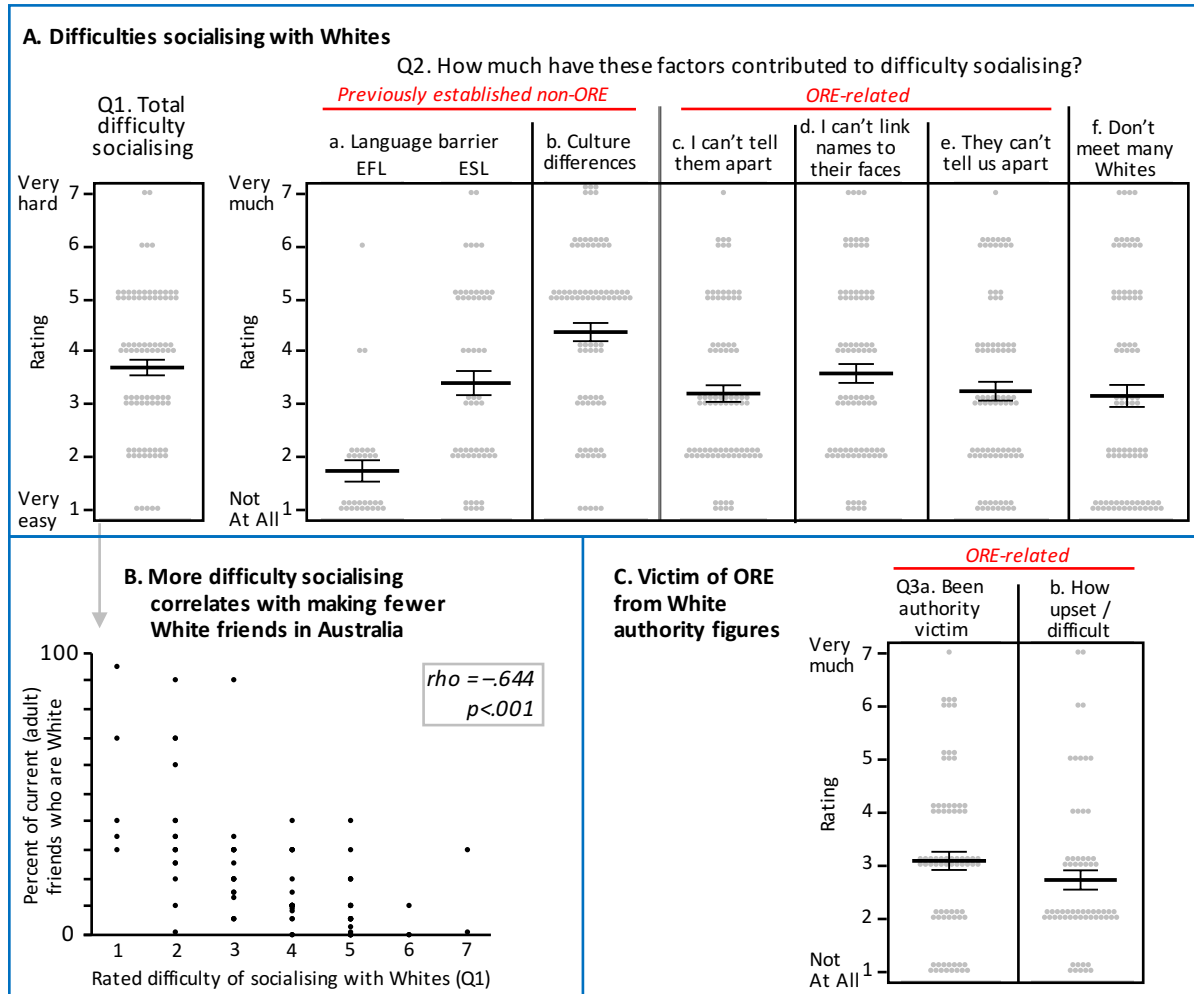


Figure 2. Results of our ‘Real World Experience of the Other-Race Effect’ questionnaire from Asian international students in Australia. **A & C.** Mean, error bars showing \pm SEM, and all individual participant scores for each questionnaire item. See Figure 1 for full questions. Where >5 participants gave the same score, we display half of the participants as their true score +.1 (to fit all results for socialising with Whites into a single row). EFL = participants with English as their first language. ESL = participants with English as a second language. **B.** Scatterplot showing relationship between ratings for degree of difficulty socialising with Whites (Q1) and participants’ report of the percentage of their current friends in Australia who are White (from our adult contact questionnaire).

Table 2. *Some vs none* statistical tests for all items with an absolute lower scale endpoint of 1 = "Not At All", testing whether participants were significantly more likely to respond 2-7 (indicating *some*) than 1 (indicating *none*).

Scale item	N choosing <i>none</i>	N choosing <i>some</i>	Coef.	SE	Odds ratio	Wald χ^2	<i>p</i>
Q2: Contribution to difficulty socialising of:							
- Language barrier - EFL	17	14	-.19	0.36	.82	0.29	.591
- ESL	8	50	1.83	0.38	6.25	23.16	<.001
- Culture differences	5	84	2.82	0.46	16.79	37.57	<.001
- I can't tell Whites apart	8	81	2.32	0.37	10.12	39.02	<.001
- I can't link names to White faces	8	81	2.32	0.37	10.12	39.02	<.001
- Whites can't tell us apart	15	74	1.60	0.28	4.93	31.77	<.001
- Don't meet many Whites	27	62	0.83	0.23	2.30	13.00	<.001
Q3a. How much ORE victim from authority figure	15	64	1.45	0.29	4.27	25.58	<.001
Q3b. How much upset/difficulty resulted	9	55	1.81	0.36	6.11	25.34	<.001

Note: For this analysis, ratings were coded as: 0 if the rating was 1 = "not at all" (i.e., *none*, meaning *no* contribution of factor to difficulty socialising, *never* been an ORE victim from a White authority figure, experienced *no* distress in response); or 1 if rating was 2-7 (i.e., *some* contribution or experience). Logistic regression was run on each dichotomised variable with "not at all" being treated as the base group. A positive intercept coefficient indicates participants were more likely to choose *some* than *none*; negative coefficients indicate greater likelihood of choosing *none* than *some*. The effect sizes were represented by the odds ratio (exponential of the coefficient), which indicate the ratio between the likelihood of choosing *some* and the likelihood of choosing *none*.

Does the ORE contribute to real-world experiences of difficulties socialising with White people?

Turning to real-world experiences of the other-race effect, we first consider the socialising domain, as relevant to forming friendships and avoiding social isolation.

Previous studies have failed to consider the possibility that face recognition problems might play any role in international students' difficulties socialising. Thus, our first research question was whether participants perceived ORE-related face recognition factors as having *any* contribution to causing difficulties socialising. Results from Q2 indicate all three factors associated with face recognition — *I can't tell Whites apart*, *I can't link names to White faces*, and *Whites can't tell us apart* — were perceived as non-zero contributors to difficulties socialising; that is, ratings were significantly more likely to be 2-7 (*some* contribution) than 1 ('Not At All', i.e., *no* contribution), all $ps < .001$ in Table 2. The percentage of participants reporting *some* ORE contribution was 91%, 91% and 83% for the three factors respectively.

We next examined mean ratings, to assess the *importance* of ORE contributions by comparing mean ORE-factor ratings to the established factors of cultural differences and the language barrier. As shown in Figure 2A, on average participants viewed ORE-related contributions to their difficulties socialising as *equally as important as the language barrier when they had English as a second language* and only moderately less important contributors

than cultural differences. Statistically, a mean-ORE-factors contribution to difficulties socialising (average of Q2c-e for each participant) was significantly less than culture differences, $t(88)=6.104$, $p<.001$, Cohen's $d = 0.647$, and did not differ from the language barrier, $t(57)=0.320$, $p>.7$, $d = 0.042$ (for the $n=58$ participants with English as second language).

We next examined the relative importance of perpetrator vs victim experiences. Interestingly, Figure 2A shows that, on average, participants rated perpetrator contributions to difficulty socialising (*I can't tell them apart* and *I can't tell link names to their faces*) as just as important as victim contributions (*They can't tell us apart*).

The next key finding was that there was considerable *individual variation* in how much participants perceived their problems telling apart White faces as contributing to their social interaction difficulties (grey dots in Figure 2A for Q2c and d). Importantly, this individual variation correlated with participants' objective difficulty recognising White people on the CFMT. That is, larger ORE scores (CFMT-Chinese minus CFMT-Caucasian) correlated significantly with larger real-world contribution to difficulties socialising for both factors: *I can't tell them apart*, $\rho=.33$, $n=85$, $p<.002$; and *I can't link names to their faces*, $\rho=.25$, $n=85$, $p=.022$. When interpreting the size of these correlations, note the upper bound is not 1, which would imply no measurement error, but is at most .66 (i.e., the reliability of the ORE scores; $r_{\text{upper bound}} = \text{square root of the product of the internal reliabilities of the two variables being correlated}$, Nunnally & Bernstein, 1967). Similar findings were obtained if simple CFMT-Caucasian ability was used as the predictor, rather than the ORE (Supplementary Information). In contrast to these ORE *perpetrator* correlations, we also confirmed the expected *lack* of correlation between Asian participants' objective ORE and the contribution of ORE *victim* experiences (*They can't tell us apart*, $\rho=.02$, $p>.8$); no correlation is predicted because an Asian participant's experience of a White person confusing them with other Asians should be related instead to the *White* person's objective ORE (which of course we could not measure).

Finally, still looking at individual differences, we examined correlational associations of *Total Difficulty Socialising* (Q1) with the ORE-related contributors (Q2c, d, e). Table 3 shows significant bivariate associations with both the ORE victim factor *They can't tell us apart* and the ORE perpetrator factor *I can't tell them apart*. To then determine whether any ORE factors explained *unique* variance in Total Difficulty Socialising, independent of the established factors of cultural differences and language barrier, we performed an ordinal regression with all four variables predicting Total Difficulty Socialising (all predictor variables entered simultaneously). Table 3 shows that the ORE victim factor *They can't tell us apart* still significantly predicted Total Difficulty Socialising when the two established factors were controlled for, indicating a unique contribution. There was no unique contribution of the ORE perpetrator factor *I can't tell them apart* did not. Table 4 shows that this appears to be because *I can't tell them apart* explains overlapping variance with *culture differences* (i.e., these factors correlate).

In sum, these results show international students viewed ORE-related factors — both as a perpetrator (Asians' problems recognising White people) and as a victim (White people's problems recognising them) — as highly relevant factors to understanding their real-world difficulties socialising with White people. Indeed, the average rated importance of face

recognition difficulties was equal to that of the language barrier, and only moderately smaller than that of cultural differences. Experiences as an ORE victim explained independent variability in participants' total difficulty socialising; experiences as an ORE perpetrator did not, which can be attributed to a correlation with culture differences. (We consider why this correlation might exist in the Discussion). Finally, the severity of perceived ORE-perpetrator contributions to real-world social interactions were related to the person's objective difficulty recognising White faces on the CFMT.

Table 3. Role of factors contributing to difficulties socialising with Whites (Q2a-f) in explaining variability in Total Difficulty Socialising (Q1), showing bivariate correlation with Q1, and then results for multiple ordinal regression assessing independent contributions of each of the four most theoretically relevant factors ¹.

Predictor	Bivariate		Multiple ordinal regression ²			
	Rho	Sig.	B	SE	Type III likelihood Ratio χ^2	Sig.
Non-ORE factors						
- Language barrier	.538	p<.001	.495	.138	12.787	.000
- Culture differences	.613	p<.001	.889	.180	24.971	.000
- Don't meet many Whites	.422	p<.001	–	–	–	–
ORE as a perpetrator						
- I can't tell them apart	.214	p=.044	-.177	.157	1.267	.260
- I can't link names to their faces ³	.202	p=.058	–	–	–	–
ORE as a victim						
- They can't tell us apart	.328	p=.002	.376	.125	8.649	.003

Notes:

1. Using 4 factors ensures >20 participants per predictor. Conclusions were the same if all 6 factors were included in the model (see Supplementary Information).
2. The multiple ordinal regression model is similar to a standard multiple regression entering all predictor variables simultaneously (but for ordinal rather than continuous data). The likelihood ratio χ^2 test compares a full model with all predictors in the model and a model with the specific predictor excluded, and indicates the unique contribution of the specific predictor to model fit. The degrees of freedom of all the likelihood ratio χ^2 are 1. Note the overall ordinal model was significant at $\chi^2(4)=70.561$, p<.001.
3. *I can't link names to their faces* had significant bivariate association with another measure of socialising, namely the percentage of the participants' friends in Australia who are White (rho=-.275, p=.009).

Table 4. Bivariate Spearman's correlations (*rho*) between factors in the socialising domain.

	I can't link names to their faces	They can't tell us apart	Language barrier	Culture differences	Don't meet many
I can't tell them apart	.548**	.223**	.125**	.426**	.161**
I can't link names to their faces		.319**	.202**	.301**	.253**
They can't tell us apart			.056**	.179**	.099**
Language barrier				.350**	.445**
Culture differences					.457**

** = $p < .01$, * = $p < .05$

Experiences as an ORE victim of an authority figure

Our final questionnaire item (Q3) asked students about their experiences as an ORE victim in situations with a power differential involving an authority figure, such as a tutor or workplace boss. Here, our interest was in how often international students experienced being an ORE victim from a White authority figure and, when this occurred, to what extent they found it upsetting or difficult. This analysis was limited to the 89% of the participants (79/89) who indicated they had *had* White authority figures.

Results in Figure 2C indicate that it was common rather than rare for participants to have experienced being a victim of the ORE from a White authority figure. When asked '*how much do you find these people confuse you with other Asians*', 81% of participants (64/79) reported having had such experiences (i.e., gave a rating of 2-7, with *some* experience significantly more likely than *none*, $p < .001$, Table 2). Individual ratings ranged up to the top of the scale (7 = Very Much), and 16% of participants (13/79) indicated confusion with other Asians occurred frequently (ratings in the 5-7 range).

We then examined level of distress in response to this situation, limiting analysis to the $n=64$ participants who had experienced being an ORE victim from a White authority figure. When asked '*How much has this confusion upset you or made things difficult for you*', across the whole group of participants distress was significantly greater than none (*none* vs *some* comparison, $p < .001$, Table 2). Perhaps more importantly, Figure 2C shows striking individual differences. Many participants largely shrugged off being an ORE victim, with 59% of participants (38/64) experiencing no or little upset/difficulty (distress ratings of 1 or 2). However, some other participants experienced high levels of upset/difficulty, with 14% of the sample (9/64) giving ratings in the 5-7 range. The present study did not aim to explore the reasons *why* some participants experience more distress than others, but we note there was a positive correlation of distress (Q3c) with how often they reported being a victim (Q3b), $\rho = .40$, $p = .001$.

In sum, results showed that international students in Australia experience being a victim of the ORE from a White authority figure quite commonly. Levels of distress in response to this are highly variable. One contributing factor may be simply how often it happens, with more frequent experiences of being confused with other Asians adding up to more upset/difficulty.

DISCUSSION

Our study provides the first formal investigation of effects of poor other-race face recognition on real-world social interactions. We examined participants in an age group and contextual setting where socialising and establishing friendships are particularly important, namely international university students. We also asked about experiences as an ORE victim of authority figures relevant to this particular group.

Our findings demonstrate important real-world effects of the ORE. These occurred in both socialising and authority-figure domains, and both as a perpetrator and a victim of the ORE. As a perpetrator, Asian international students reported that their difficulties telling apart Caucasian faces, and their difficulties linking names to those faces, contributed significantly to difficulties socialising with Caucasian people; moreover, as predicted, the severity of reported real-world difficulties correlated with participants' objective deficit in Caucasian-face recognition ability on laboratory face tests (CFMT). As a victim, international students reported that Caucasian Australians' difficulty telling apart Asians also contributed significantly to the Asians' difficulties socialising. As a victim from an authority figure (e.g., university tutor, or workplace boss) the experience of being confused with other Asians was common rather than rare, being reported by 81% of participants. Such experiences resulted in variable degrees of distress: many participants shrugged it off but others were very upset, with greater distress correlated with more frequent experiences.

In the socialising domain, we also examined the relative importance of different factors to Asian international students' difficulties socialising with local Caucasians. Previous research has established that two key contributors to international students' high rates of social isolation are the language barrier and culture differences (Wu et al, 2015; Sherry et al, 2010; Redfern, 2016), but have not addressed the possibility that contributions could also arise partly from the inability to recognise other-race faces and thus to know who other people are. Our present results show that, on average, ORE-related factors — both as a perpetrator and as a victim — were viewed by international students as only moderately less important than cultural differences and *equally important as the language barrier* in students with English as a second language (i.e., where the language barrier is greatest). Experiences as an ORE victim also explained independent variability in total difficulty socialising, over and above cultural differences and language barrier.

We now discuss the broader implications of our findings, limitations on the scope of this first study, and directions for future research.

The ORE matters

Our study findings confirm that the ORE really does matter. Previously, important consequences of the ORE have been demonstrated in two specialised areas of real life: eyewitness testimony and security settings. Here, we have shown that the ORE also causes real-world problems in *common everyday situations experienced by all humans*. These situations include socialising with others, and interactions with educational and workplace

authority figures. This argues that real-world ORE impacts are much more widespread than previous research has formally identified.

Additionally, we have shown that the ORE matters as a *perpetrator* of the ORE — i.e., as the person who has trouble telling apart other-race individuals — not just as its *victim*. Previous investigations of real-world impacts have tended to focus on ORE impacts on the victim. This is unsurprising in the case of eyewitness testimony, where it is the person who has been misidentified who can face years in jail for a crime they did not commit. There have been previous anecdotal reports that being an ORE perpetrator can cause distress to the perpetrator: for example, to the Caucasian teacher who knows she confuses her Asian students (Dias, 2018); or to the Caucasian woman who confidently identified the African-American man Ronald Cotton as her rapist, but later discovered from DNA analysis that she was wrong, after the innocent Cotton had spent 11 years in jail (Thompson, 2000). Our present formal study joins and strengthens these anecdotal reports, showing that, in the domain of socialising and forming friendships, international students view their perpetrator ORE (*I can't tell them apart*) as, on average, equally as problematic as being an ORE victim (*They can't tell us apart*).

We have also shown that the real-world impacts of the perpetrator ORE tend to be most severe in those individuals who have the largest objective deficit in their ability to recognise faces of the other-race. This implies that, while the ORE matters in everyday settings, it will *matter by different amounts in different people*. Indeed, our results imply that the success of a real-world social interaction between two people of different races will depend on the severity of the ORE of *both* of those individuals. Where both individuals have good ability to recognise other-race faces, no ORE impacts would be predicted. But, where either of the individuals have significant other-race face recognition problems, much poorer outcomes would be likely.

In total, this all adds up to a picture of the ORE being a phenomenon of strong practical relevance wherever a societal setting contains people of more than one race.

Face identity recognition problems contribute to social interaction difficulties

Traditionally, psychological studies of social interaction difficulties and social isolation have focused on clinical conditions (e.g., depression, Social Anxiety Disorder, Autism Spectrum Disorder) or barriers to social engagement (e.g., physical isolation, loosening of societal bonds, stigma). To the extent that face perception has been considered at all, the focus has been on problems with perceiving others' facial *emotions* (e.g., in ASD, Joseph & Tanaka, 2002).

In contrast, psychology has been late to appreciate the role of face *identity* recognition problems in social interaction difficulties. In the context of social anxiety, the relationship between individuals' face recognition ability and social anxiety was first reported only in 2011 (Davis et al, 2011). In the context of vision loss, the first detailed study of the effects of face recognition problems was published only in 2018 (Lane et al, 2018a). In prosopagnosia, the mere existence of developmental prosopagnosia was not consistently recognised until the early 2000s, and investigations of the social-interaction difficulties arising from it have been published only since 2008 in adults (Yardley et al, 2008), and 2014 in children (Dalrymple et

al, 2014). And, prior to the present study, we could locate no formal studies of the social interaction difficulties that arise from poor recognition of other-race faces.

Across all of the domains in which face identity has now been examined, the consistent evidence is that *failure to be able to tell who other people are* is, in fact, an important contributor to social interaction difficulties and social isolation. This implies that identity-related problems are also likely to be revealed in other settings yet to be examined. These might include, for example, nursing (in Western countries, nurses are often immigrants of races unfamiliar to patients) and aged-care homes (where a combination of dementia, vision loss, and race differences between staff and residents suggest potentially frequent face recognition problems).

Limitations and future research

As a first study, our questionnaire about the real-world experiences of the ORE aimed simply to demonstrate whether there *are* identifiable effects of the ORE on everyday social interactions, rather than to fully explore the details of these. This means there are many limitations on the scope of the present work, all of which open up possibilities for future research.

One question deserving follow-up is why only ORE-victim experiences explained independent variability in total difficulty socialising (over and above language barrier and cultural differences), while ORE-perpetrator experiences did not, instead explaining overlapping variability with cultural differences. At present this remains a mystery. One obvious hypothesis is that Asians' failures of Caucasian face recognition and cultural differences from Caucasians could be driven by a common factor of how much exposure they had to Caucasians during their childhood, either in person or via visual media (television, films, Facebook, etc). Here, the argument would be that higher childhood exposure would result in better face recognition ability for Caucasian faces (McKone et al, 2019), and simultaneously in greater knowledge of Western culture. However, our present data and sample attributes do not support this hypothesis. Almost all of our sample had almost no in-person exposure to Caucasians in everyday life as a child (Table 1), leaving only exposure via media as a possible explanatory factor. We did measure childhood media exposure, but analysis showed no association with the rated importance of the ORE factors (Supplementary Information).

A limitation of the present research is that it was conducted in one particular cultural setting, with one particular primary cause of the ORE. As a minority group in Australia, Asians have equal socioeconomic status (SES) to the majority race Caucasians. In this particular setting, the ORE is entirely perceptual (rather than motivational) in origin, and is driven by a lack of childhood exposure to the other race (Wan et al, 2015; Wan et al, 2017; McKone et al, 2019). Under these circumstances, one might expect real-world ORE impacts on social interactions to be maximal. This is because the ORE in everyday life cannot be overcome just by trying harder, nor by the natural 'task' requirement of most social settings to attend to people at the individual identity level not at merely the category level (e.g., at a university staff meeting, it is socially essential to interact with a person using the knowledge that they are "Kate, the social psychology professor", as opposed to a generic Caucasian). It remains to be explored whether the real-world impacts of the ORE are different in other types

of cultural settings, for example where childhood exposure to the other-race group is high but there are large inter-race status differences.

It would also be of interest to know whether the real-world impacts of the ORE contribute to the higher rates of anxiety and depression present in international students as compared to local students (Redfern, 2016). We have demonstrated here that the ORE has negative impacts on socialising, and previous studies show social isolation is a contributing factor to depression and anxiety (Dawel et al, 2020, Hawkley & Capitano, 2015), suggesting there is likely to be some effects of the ORE on mental health *via* social isolation. It is also possible that the ORE could lead to anxiety or depression via other routes. For example, impacts on mental health might occur in ORE perpetrators if they see their inability to tell apart other race people as a personal failing. And, as a victim, mental health impacts could be associated with the *attribution* that an ORE victim applies to that experience: for example, if an Asian interprets Caucasians confusing them with other Asians as deliberate racial bias against their group, then this might contribute to greater depression/anxiety (Schmitt et al, 2014).

More broadly, this indicates a need to examine the range of interpretations that people place on the ORE in the real world. Anecdotal evidence suggests that one 'folk science' understanding of the ORE by its victims is that the perpetrator simply needs to spend more time with people of their race, on the presumption that greater exposure (even as an adult) will necessarily improve face recognition ability (e.g., Dias, 2018). Other ORE victims may believe that the perpetrator could fix the problem simply by trying harder. Or, ORE victims may assume that the perpetrator is being deliberately racist (i.e., holds negative attitudes to their group), or implicitly racist (e.g., fails to attend properly to members of their group). In each case, it is important to determine how widespread are these various 'folk science' interpretations, given that all of them have been shown in scientific studies to be inaccurate in at least some cultural settings (e.g., McKone et al, 2019; Wan et al, 2015; Crookes & Rhodes, 2017).

A related question is why our international students showed such wide range in how upsetting/difficult they have found it to be an ORE victim from an authority figure. In this first study, our aim was simply to determine whether there *was* such a range, rather than to investigate its origins should it occur. We did identify one potentially relevant factor: distress increases with increasing frequency of having been an ORE victim. Other factors to investigate include the victim's particular 'folk science' understanding of the cause of the ORE (e.g., attributing it to deliberate racism might lead to higher distress than attributing it to poor perceptual ability), and also the victim's interpersonal skills (e.g., extraverts with high social confidence might find it easier to quickly repair the social situation after an ORE event), and the severity of the practical outcomes (e.g., particularly high distress might arise after being fired, or given an unfairly low class contribution mark, by a Caucasian boss/tutor who confused you with another Asian employee/student).

Our results also raise the possibility the ORE might contribute to self-segregation between groups. When people cannot recognise other-race faces, then they may choose to socialise preferentially with own-race people, who they *can* reliably tell apart. This could lead to Asian international students withdrawing from social or workplace situations involving Caucasians (and vice versa), limiting racial integration and perpetuating unintended

segregation. Misattributions of the cause of the ORE could also contribute a wish to segregate, such as thinking that, when an other-race person you know ignores you on the street, this is because they hold racist attitudes towards you, or otherwise do not like you, rather than because they have a perceptual deficit that means they were unable to recognise you.

Finally, our findings open up potential for real-world evaluation of interventions designed to improve other-race face recognition (e.g., training, Matthews & Mondloch, 2018; motivational instructions, Hugenberg et al, 2007). Evaluating interventions outside the lab is often impractical, particularly in eyewitness testimony (e.g., evaluation would require knowledge of the true number of incorrect other-race identifications in real-world criminal trials, which is unknown and unknowable). However, ORE-related social interaction difficulties can easily be evaluated via questionnaire in a setting of interest, such as a particular workplace type, and repeating the questionnaire pre- and post- intervention can evaluate if there has been a real-world benefit.

Conclusion

Our study has confirmed the real-world importance of the ORE, demonstrating for the first time its detrimental effects on everyday social interactions. Our findings also strengthen the recently-emerging evidence that failures of face identity recognition can play a surprisingly important role in social interaction difficulties and social isolation.

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