Searching for Happiness Across Cultures

Ljubica Damjanovic

University of Bangor, UK

Debi Roberson

University of Essex, UK

Panos Athanasopoulos

University of Bangor, UK

Chise Kasai

University of Gifu, Japan

Matthew Dyson

University of Essex, UK

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Abstract

Using the face-in-the-crowd paradigm, the detection of happy and angry facial expressions was investigated across cultures in English and Japanese participants. Visual search displays used photographs of real Caucasian and Japanese faces with the targets and distractors differing in identity (Experiment 1). Under such realistic search conditions, participants in both cultural groups were faster to detect a happy target, irrespective of the ethnicity of the faces in the visual search display. Experiment 2 attempted to induce a search advantage for angry faces by using target and distractor photographs of the same individual, posing different expressions. The speeded search advantage for happy targets was maintained in our English sample, but was absent in our Japanese sample. Experiment 3 reinstated the search advantage for happy faces in our Japanese sample by using culturally relevant instructions. This detection advantage for happy targets was strongest when the faces in the display differed in ethnicity from the participant.

The Face-in-the-Crowd-Effect Across Cultures: A Search Advantage for Happy Faces

In a crowd of unfamiliar faces, which one do we notice first; the face with the smile or the one with the frown? An initial investigation of this question by Hansen and Hansen (1988) found that participants' attention was rapidly drawn to a frowning or angry face. This search advantage has been termed the threat-superiority effect, and has been observed with perceptually matched schematic faces (Eastwood, Smilek & Merikle, 2001; Fox et al., 2000; Öhman, Lundqvist & Esteves, 2001a; Tipples, Young & Atkinson, 2002) and with photographic images faces (Fox & Damjanovic, 2006). In Fox and Damjanovic's (2006) studies, presentation of the eye region of angry faces alone was sufficient to drive this processing advantage, thus replicating the saliency of this facial region previously found with schematic faces (Tipples et al., 2002, but see Hortsmann & Bauland, 2006). In visual search tasks, other negatively-valenced faces such as sad faces do not draw attention as effectively as angry ones (Öhman et al., 2001a), so it appears to be the threat relevant status of angry faces that prompts its efficient detection, rather than its overall negative valence.

The facial expression of anger, characterized by intensely staring eyes, a deep furrowed brow and a down-turned mouth (Ekman & Freisen, 1975) is considered a potent warning signal to the observer, conveying immediate danger and attack. Some researchers have suggested that the threat-superiority effect is automatic and engages dedicated processing systems in the brain relating to fear and arousal and involving the amygdala (Öhman & Mineka, 2001). Studies combining backward masking techniques with neuroimmaging procedures have shown that the amygdala is activated by threatening facial expressions such as anger and fear, even when conscious awareness of such stimuli is prevented (Morris, Öhman & Dolan, 1998; Whalen, et al., 1998). Moreover, in a clinical framework, the threat-superiority effect is larger in participants with sub-clinical anxiety (Byrne & Eysenck, 1995; Gilboa-Schechtman, Foa & Amir, 1999) and in phobic individuals (Öhman, Flykt & Esteves, 2001b). Indeed, one of the key characteristics of anxiety disorders may be an increased vigilance towards threat (however, see Fox, Russo, Bowles & Dutton, 2001 for an alternative explanation).

Alongside the evolutionary need to cope rapidly with threat stimuli, humans may also have an evolutionary drive to sustain social bonds that would favor attention to happy faces (Oatley & Jenkins, 1996; Chance, 1988; de Waal, 1988; Gilbert, 2001). Evidence from categorization tasks show that happy faces are easier to recognize than angry faces, perhaps because expressions of happiness are encountered more often than negative emotions such as anger and fear (Bond & Siddle, 1996). Yet, while happy faces are more easily categorized than angry faces, angry faces are detected more easily in visual search tasks. One reason for this difference may be that visual search relies on attention allocation, or attentional shift, while categorization tasks measure decision-making for targets to which attention is already fully allocated.

Attentional paradigms such as the visual search and disengagement tasks test the attention-grabbing power of positive and negative emotions (Öhman et al., 2001a) and the efficiency with which attention can shift away from a location previously occupied by a positive or negative expression (Fox et al., 2001). Categorization tasks do not require the deployment or reallocation of attention, because they generally measure accuracy and response time for a single target expression that appears at fixation (Hugenberg, 2005). When attention is fixed, happy faces are easier to categorize than negative faces, to both real (Juth, Lundqvist, Karlsson & Öhman, 2005; Leppanen & Hietanen, 2003) and schematic (Kirita & Endo, 1995) stimuli. Only when attentional resources need to be distributed, or disengaged, do negative faces produce a search advantage.

The visual search task has been widely used across a variety of populations to measure the allocation of attention to emotional facial expressions. However, many studies have used schematic faces, which might exaggerate those features of an angry face most likely to trigger rapid deployment of attention. Juth et al. (2005) failed to replicate the finding used more ecologically valid photographic stimuli, especially when the set of faces includes different identities – a realistic ‘crowd’ scene. In this condition Juth et al’s (2005) study found a search advantage for happy rather than angry targets. Juth et al.’s ‘happy advantage’ has recently been replicated by Calvo and Nummenmaa (in pressa). Combining visual search performance with online eye-tracking measures, Calvo and Nummenmaa (in pressb) demonstrated that happy faces gain their processing advantage by generating greater first-fixations to its location, thus facilitating the overt orienting component of attention, which in turn makes the discrimination between the happy face target and its neutral distractor faces more efficient. Furthermore, Williams, Moss, Bradshaw and Mattingley (2005) observed search time equivalence for angry and happy targets in their face in the crowd experiment with neutral distractors. A detection advantage for angry faces only emerged in Williams et al’s study when participants were specifically instructed to search for an angry target and under larger display sizes. This evidence of top-down influences on the processing of emotional targets, combined with the heightened threat-superiority found for clinically anxious participants, raises the possibility that the effect may relate more to individual search strategies than automatic attentional mechanisms.

Juth et al argued that threat-superiority in visual search tasks is directly related to the heterogeneity of the target and distractors in the visual display. Studies in which the threat superiority has been found used target and distractor images of the same individual. In a display where identity does not differ, the facial features indicative of threat, such as frowning eyebrows may be rapidly and reliably detected without the need for a face-by-face search of the display. If the effect arises through fast, prepotent responses to threat associated with the 'quick and dirty' processing mode of amygdala-driven threat-detection systems (LeDoux, 1996, p. 164), then it might only be observed in very rapid responses. Using a more realistic crowd of different distractor faces should increase the perceptual load of the task and elicit a more controlled item-by-item search of the display that might eliminate the effect. Indeed, when schematic clones were used in their search displays, Juth et al. did observe the predicted search advantage for angry targets.

An alternative explanation comes from Adolphs (2002), who suggested that happy faces are classified as happy faster than faces displaying negative emotions because happy faces may be categorized effectively from a single feature: the presence of a smiling mouth. Negative expressions, in contrast, share many characteristic facial properties with each other. For example, an open mouth is a component facial feature of both fear and surprise. Such a view would predict slower categorization of angry than of happy faces, due to the more effortful and extensive analysis needed to select the correct negative emotion (including eye, nose and mouth regions). Faster categorization times for happy over negative faces would reflect differences in the amount of perceptual information needed to identify the emotion correctly (Adolphs, 2002; Leppänen & Hietanen, 2007). Such an account would also predict that angry expressions should also be detected more slowly than happy targets in visual search tasks where a variety of expressions need to be distinguished.

The experiments reported here directly manipulate the allocation of attention to positive (happy) and negative (angry) faces by creating visual search displays likely to generate a search advantage for happy targets in one context, but a threat-superiority effect in another. Juth et al. proposed that real ‘crowds’ would favour the detection of happy targets, whereas ‘cloned’ displays using different expressions posed by the same model, would favor a threat-superiority effect. This manipulation of the relationship between targets and distractors also allowed us to investigate the role of cultural variables in the detection angry and happy facial expressions.

Testing participants from different cultures with search displays that are either congruent or incongruent with the observer’s ethnicity enabled us to directly address the extent to which facial expressions of emotion are produced and recognized universally across cultures (Ekman, 1994; Ekman, Sorenson & Friesen, 1969) and the extent to which the intensity with which an emotion is expressed is modulated by cultural factors (Elfenbein & Ambady, 2002; Marsh, Elfenbein & Ambady, 2003; Matsumoto, 1989; Russell, 1994).

The visual search task provided a sensitive measure of the contribution of cultural factors and bypassed some of the problems associated with explicit emotion labelling tasks (see Russell, 1994; Wierzbicka, 1999, for discussion). It has recently been used to study cultural effects on the processing of color categories in English and Korean participants (Roberson, Pak & Hanley, 2008). The studies reported here used detection latencies and error rates in processing happy and angry targets as an index of emotion recognition in native Japanese and English speakers. Experiment 1 aimed to replicate Juth et al’s (2005) finding using photographic images of different faces to produce more realistic ‘crowd’ displays. Both an attentional allocation account and a featural vs. wholistic account would predict a search advantage for happy targets in this condition.

Experiment 2 used displays of photographic images of faces belong to the same individual, to extend the findings of Juth et al (2005) who used cloned schematic faces. This experiment assessed whether displays of identical real faces, in which only emotion differed, would favor rapid detection of an angry stimulus, thus eliciting the threat-superiority effect (Fox & Damjanovic, 2006). Evolutionary accounts of threat-superiority (e.g. Öhman & Mineka, 2001) would predict that the effect should be shown by both groups of participants for both types of displays in Experiment 2. Alternatively, some models might predict faster and better detection of own-race angry faces due to the accessibility of memory templates for own-race relative to other-race faces (e.g. Valentine, 1991). Social models of emotion suggest that there is a greater readiness to perceive anger in other-race faces than in own-race faces (Ackerman et al., 2006; Hugenberg, 2005; Hugenberg & Bodenhausen, 2003), which in turn may be derived from a fear of outgroups (Brewer & Brown, 1988; Buss, 2001) and would thus predict a larger threat-superiority effect for other-race faces. Experiment 3 used the same stimuli as Experiment 2, but modified the instructions so that participants were not specifically alerted to search for a discrepant expression of emotion.

Cultural congruency of the displays was manipulated by presenting native Japanese and Caucasian (English) participants with displays consisting of faces taken from the Caucasian and Japanese set of facial expression stimuli (Matsumoto & Ekman, 1988). English participants were tested in the UK and Japanese participants were tested in Japan. Both cultural groups have been shown to recognize facial expressions of emotion with relative ease for both the Caucasian and Japanese sets of facial expressions (Matsumoto, 1992; Shiori, Someya, Helmeste & Tang, 1999) and the Japanese and Caucasian faces in the database developed by Matsumoto and Ekman (1988) have been matched for equivalence of the intensity of the emotion expressed, so recognition accuracy should not have been affected by the ethnicity of the faces within the displays.

Despite this stimulus equivalence, some researchers have proposed that the rigorous emotion elicitation system produced through the facial action coding system (FACS) in Matusmoto and Ekman's database may remove subtle differences in muscle innervations and intensities that may be intrinsically related to the emotional expression within a given cultural group (Elfenbein & Ambady, 2002). Additionally, some cross-cultural evidence shows that individuals from Western societies show higher recognition rates of negative emotions, specifically anger, than East Asian individuals (Matusmoto, 1992; Russell, Suzuki & Ishida, 1993; Shioiri et al., 1999). Western display rules favour the outward display of emotions, whereas Japanese display rules tend to inhibit the display of emotions, especially emotions that threaten social harmony (Biehl, Matsumoto, Ekman & Hearn, 1997; De Sonneville et al., 2002; Matsumoto, 1992; Yuki, Maddux & Masuda, 2007). These cultural display rules might affect the detection of negative emotions by Japanese participants, but such an effect should be equivalent across all three experiments.

Finally, differences in the ethnicity of targets may influence the speed of detecting the target emotion in the current experiments, either because participants detect any emotion faster in faces belonging to their own race (because the memory template for the facial features of their own race is more accessible than for other-race faces, Valentine, 1991) or because expressions of anger in other-race faces are perceived as more threatening (Ackerman et al., 2006; Hugenberg, 2005; Hugenberg & Bodenhausen, 2003). Categorization tasks have shown that negative (e.g., sad and angry) expressions in other-race faces are categorized faster than happy facial expressions, reversing the trend for own-race happy faces to be categorized more quickly (Hugenberg, 2005).

The experiments reported in this study systematically evaluate the extent to which the deployment of attention is modulated by cultural factors in high (mixed identity) and low (same identity) attentional load conditions. If the threat-superiority effect can be accounted for by evolutionary predispositions to vigilance, then the effect should occur in both our cultural groups, irrespective of the ethnicity of the expressor. Any cross-cultural differences in the effect would indicate that it is modulated by cultural and attentional factors.

Experiment 1

Method

Participants.

Eighteen native English-speaking Caucasian participants were recruited from the University of Essex in the U.K (6 males and 12 females, with a mean age of 20.6 years). Eighteen native Japanese participants were recruited from the University of Gifu in Japan (10 males and 8 females, with a mean age of 20.4 years). All participants received payment for their participation. Caucasian participants were instructed in English by a Caucasian experimenter, and Japanese participants were instructed in Japanese by a native Japanese experimenter. Participants in all three experiments completed a detailed demographic questionnaire that ensured that all English participants were of Caucasian origin, with no links to Japan or Japanese contacts. Likewise, Japanese participants in all three experiments were of Japanese origin with no links to the UK or English contacts.

Apparatus.

Stimuli were presented using Mac G4 OSX laptop running an experimental programme written in SuperLab.

Stimuli.

Stimuli were taken from the Matsumoto and Ekman JACFEE and JACNeuF (1988) database of facial affect. Sixteen Caucasian and 16 Japanese individuals were selected from the database. Within each race, eight faces displayed emotional expressions (four angry and four happy) and eight faces displayed a neutral expression. Each colour image was converted to greyscale and cropped to an oval template (125 pixels wide by 168 pixels high) to remove external features (e.g. hair, ears, neckline) using Adobe Photoshop. Within each race, mean luminance and contrast were matched for all faces across all experiments. The four faces in each visual search trial differed in identity and always consisted of two males and two females. Each visual search trial consisted of a central fixation cross with four faces arranged in an imaginary circle around it. The four photographs could appear in one of four locations relative to fixation (North, East, South or West). Each face subtended a visual angle of 3.1° horizontally by 4.1° vertically at a viewing distance of 60cm. The centre of each face was 6.2° of visual angle from fixation (see Figure 1).

(Figure 1 about here)

Procedure.

The experiment was divided into two blocks (one with Caucasian faces and one with Japanese faces), each consisted of 7 practice trials and 224 experimental trials, and the order of blocks was counterbalanced across participants. On *same* trials the faces of four different individuals displaying the same emotional expression were displayed (angry, happy, neutral). The *discrepant* displays consisted of three individuals expressing the same emotion (e.g., happy) and one different individual expressing a different emotion (e.g., angry). The four discrepant-display types were as follows: one angry, three neutral; one angry, three happy; one happy, three neutral; and one happy, three angry (see Figure 1). Thus, there were two types of target (angry and happy) and two types of distractor (neutral or emotional [angry and happy] faces). In each block there were 96 same-display trials (32 angry expressions, 32 happy expressions, 32 neutral expressions). There were 128 discrepant-display trials in each block (32 in each of the four conditions). Each target appeared equally often in each of the four possible locations, and the trials were presented in a different random order to each participant. The *same* and *discrepant* trials were randomized within each block.

On each trial a fixation cross was displayed in the centre of the screen for 500 ms followed by a display of four faces surrounding the central fixation point for 800 ms. There was an interval of 2000 ms between each trial. As all the faces differed in identity, participants were provided with the following instructions in their native language: “Your task is to decide whether all of these pictures show the SAME emotion or whether one shows a DIFFERENT emotion”. Response was by key press. Response mapping was reversed for half the participants. Feedback, in the form of a 1,000 ms beep was given on incorrect trials.

Results

Mean correct reaction times (RTs) for correct responses for each group were calculated for each cell of the design, excluding RTs less than 100 ms or greater than 2,000 ms as per Fox and Damjanovic (2006). Data were analysed separately for each group to avoid artefactual effects generated by group differences in response criteria. Figure 2 displays the RTs and error rates for both English and Japanese participants in Experiment 1.

(Figure 2 about here)

Discrepant display analyses for English participants.

RTs for correct 'different' responses by English participants were entered into a 2 (display: Caucasian or Japanese) x 2 (target emotion: angry or happy) x 2 (distractor type: emotional or neutral) repeated measures ANOVA. There was a main effect of display, F (1, 17) = 7.30, MSE = 27025.24, $p < 0.01$, $\eta_p^2 = 0.30$, with faster reaction times to Japanese than Caucasian displays. There was also a main effect of target emotion, F (1, 17) = 22.07, MSE = 5832.21, $p < 0.001$, $\eta_p^2 = .56$, such that happy targets were detected significantly faster than angry targets. The main effect of distractor type was also significant, F (1, 17) = 25.15, MSE = 5186.47, $p < 0.001$, $\eta_p^2 =.60$, reflecting faster reaction times to displays with emotional than with neutral distractors. There was a significant interaction between emotion and distractor type, F (1, 17) = 19.11, MSE = 6168.44, $p < 0.001$, $\eta_p^2 = 0.53$ Simple main effects analyses showed that angry faces were responded to significantly faster when surrounded by emotional than neutral faces, F (1, 17) = 47.85, MSE = 5186.47, $p < 0.0001$, $\eta_p^2 = 0.71$. The detection of happy faces was unaffected by distractor type ($F < 1$). The search advantage for happy over angry targets occurred only with neutral distractors, F (1, 17) = 42.62, MSE = 5832.21, $p < 0.0001$, $\eta_p^2 = 0.74$. No other interactions were significant.

A 2 (display: Caucasian or Japanese) x 2 (target emotion: angry or happy) x 2 (distractor type: emotional or neutral) repeated measures ANOVA was also applied to the error data. There was a main effect of display, F (1, 17) = 21.21, MSE = 149.21, $p < 0.001$, η_p^2 = 0.56, with fewer errors to the Japanese than the Caucasian displays. There was also a main effect of target emotion, F (1, 17) = 103.71, MSE = 131.25, $p < 0.0001$, η_p^2 = 0.86, with better accuracy to happy than to angry targets. There was also a significant main effect of distractor type, F (1, 17) = 51.30, MSE = 105.13, $p < 0.001$, η_p^2 = 0.75, with fewer errors to displays with emotional than with neutral distractors. There was a significant target emotion x distractor type interaction, F (1, 17) = 35.61, MSE = 173.71, $p < 0.001$, η_p^2 = 0.68. Simple main effects analyses showed that angry faces produced significantly fewer errors when surrounded by emotional than neutral faces, F (1, 17) = 110.00, MSE = 105.13, $p < 0.001$, η_p^2 = 0.87. The detection of happy faces was unaffected by distractor type ($F < 1$). Happy targets generated fewer errors than angry targets when surrounded by emotional, F (1, 17) = 5.51, MSE = 131.25, $p < 0.05$, η_p^2 = 0.24 and neutral distractors, F (1, 17) = 145.33, MSE = 131.25, $p < 0.0001$, η_p^2 = 0.90, respectively. No other interactions were significant. Happy faces were detected fast and accurately from both emotional and neutral distractors, but angry faces were detected more slowly from neutral than from happy distractors.

Discrepant display analyses for Japanese participants.

Data from Japanese participants were analysed in the same way as those from English participants. RTs and error rates for Japanese participants are shown in Figure 2.

There was a main effect of display, F (1, 17) = 6.87, MSE = 49714.16, $p < 0.05$, η_p^2 = 0.29, with faster RTs to Japanese than Caucasian faces. There was a main effect of target emotion, F (1, 17)

= 14.72, *MSE* = 8024.33, $p < 0.001$, $\eta_p^2 = 0.46$ with faster RTs to happy than angry targets. There was also a main effect of distractor type, F (1, 17) = 21.18, *MSE* = 9452.73, $p < 0.001$, $\eta_p^2 = 0.55$ with faster RTs to displays with emotional than with neutral distractors. The target x distactror interaction was significant, F (1, 17) = 16.55, *MSE* = 9951.50, $p < 0.001$, $\eta_p^2 = 0.49$. Simple main effects analyses showed that angry targets were responded to significantly faster when surrounded by emotional than neutral distractors, F (1, 17) = 38.50, *MSE* = 9452.73, $p < 0.0001$, $\eta_p^2 = 0.69$. The detection of happy faces was unaffected by distarctor type ($F < 1$). The search advantage for happy over angry faces was significant with neutral, F (1, 17) = 35.00, *MSE* = 8024.33, $p < 0.0001$, $\eta_p^2 = 0.67$, but not with emotional distarctors ($F < 1$). No other interactions were significant.

Analyses of the error rate data showed that the main effect of display failed to reach significance ($p = 0.054$). The main effect for target emotion was significant, F (1, 17) = 19.60, *MSE* = 244.81, $p < 0.001$, $\eta_p^2 = 0.54$, with fewer errors to happy than to angry targets. There was also a main effect of distractor type, F (1, 17) = 15.58, *MSE* = 203.07, $p < 0.001$, $\eta_p^2 = 0.48$, with fewer errors to displays with emotional than with neutral distractors. The target x distractor interaction was also significant, F (1, 17) = 16.16, *MSE* = 237.65, $p < 0.001$, $\eta_p^2 = 0.49$. Simple main effects analyses showed that angry faces produced significantly fewer errors when surrounded by emotional than neutral faces, F (1, 17) = 34.42, *MSE* = 203.07, $p < 0.0001$, $\eta_p^2 = 0.67$. The detection of happy faces was unaffected by distarctor type ($F < 1$). Fewer errors were made to happy than angry targets in displays with neutral distractors , F (1, 17) = 35.18, *MSE* = 244.81, $p < 0.0001$, $\eta_p^2 = 0.67$. No other interactions were significant. As with English participants, happy faces were detected fast and accurately with both types of distractor, but angry faces were detected more slowly and less accurately with neutral than with happy distractors.

Same display analyses for English participants.

RTs and error rates for both groups of participants for same display trials are shown in figure 3.

(Figure 3 about here)

Analyses for correct 'same' responses by English participants were analyzed by a 2 (display: Caucasian or Japanese) x 3 (emotion: angry, happy, or neutral) repeated measures ANOVA. For RTs, the main effect of display was not significant, F (1, 17) = 4.23, MSE = 21722.60, $p = 0.06$. The main effect of emotion was significant, F (2, 34) = 22.32, MSE = 9266.37, $p < 0.0001$, $\eta_p^2 = 0.57$, as was the display x emotion interaction, F (2, 34) = 5.75, MSE = 2878.22, $p < 0.01$, $\eta_p^2 = 0.25$. Post hoc tests showed that for both displays, happy faces were responded to significantly faster than both angry ($p < 0.01$) and neutral faces ($p < 0.001$), which did not differ significantly from each other (see Figure 3).

Analyses of the error rate data revealed no significant effect of display (F <1). However, the main effect of emotion was significant, F (2,34) = 18.61, MSE = 279.55, $p < 0.0001$, $\eta_p^2 = 0.52$. Post hoc tests showed that there were significantly fewer errors made to happy faces than both angry and neutral faces (both $p < 0.001$), which did not differ significantly from each other. The race of display x emotion interaction was not significant (F < 1). For 'same' judgements, English participants were faster and more accurate to respond to happy displays.

Same display analyses for Japanese participants.

Analysis of the Japanese participants' RT data revealed a main effect of display, F (1, 17) = 4.52, MSE = 28696.03, p = 0.04, η_p^2 = 0.21, with faster 'same' responses to Japanese than Caucasian faces. The main effect of emotion was significant, F (2, 34) = 20.06, MSE = 10638.61, p < 0.0001, η_p^2 = 0.54 and there was also a significant display x emotion interaction, F (2, 34) = 13.82, MSE = 3013.91, p < 0.0001, η_p^2 = 0.45. Simple main effects analyses showed that for happy faces, participants were significantly faster to respond to Japanese than Caucasian displays, F (1, 17) = 5.72, MSE = 28696.03, p < 0.05, η_p^2 = 0.25. The effects of display were not significant for angry and neutral faces.

Post hoc tests of the main effect of emotion revealed a significant difference between happy and angry faces for Caucasian displays (p < 0.01), with significantly faster RTs to happy than angry displays. For the Japanese displays, RTs were significantly faster to happy than either angry or neutral displays (both p < 0.001), which did not differ significantly from each other.

Analyses of error rate performance for the Japanese participants revealed only a significant effect for type of emotion, F (2, 34) = 8.65, MSE = 233.10, p < 0.001, η_p^2 = 0.34. Post hoc tests showed that fewer errors were made with happy than angry or neutral displays (p < 0.05, p < 0.01 respectively). Angry and neutral displays did not differ. Japanese participants also showed faster and more accurate responses to happy displays, particularly those of their own ethnicity.

Discussion

The results of Experiment 1 support the 'happy face' advantage reported by Juth et al. (2005), for the discrepant display trials. Both groups of participants were faster to detect the happy over the angry target. However, although detection of happy faces was faster than detection of angry faces overall, for discrepant displays this was due to angry faces being detected significantly less accurately and more slowly in neutral than in emotional displays, by both groups and regardless of display type. Amongst emotional distractors happy faces were not detected faster than angry faces, although English participants discriminated them more accurately. This appears to be not so much a ‘happiness superiority’ effect as a large disadvantage for angry faces when presented with neutral distractors, with both groups making twice as many errors (failing to identify that the target differs from distractors) when angry targets were surrounded by neutral faces. This result is consistent with Adolphs’ (2002) view that happy faces consist of a unique feature, the smile, and that this single facial feature of happy faces may be sufficient to differentiate the target happy face from both angry and neutral distracter faces (Calvo & Nummenmaa, in press). Thus, the type of distractor should not affect the detection of the physically salient happy targets. Similarly, when a target angry face appeared among happy, distractors the happy distractors might allow the target to ‘pop out’ because it did *not* share this crucial feature with the distractor faces (Duncan & Humphreys, 1989; Treisman & Gelade, 1980). In neutral displays, both angry targets and distractors would need to be processed configurally before the target could be identified, leading to longer reaction times and more errors. This might be a particularly error-prone process when both the identity and gender (and thus the configuration) of the faces in a display differs. In summary, happy faces were detected overall faster and with greater accuracy than angry faces. There was no evidence, with mixed-identity distractors of a threat superiority effect, nor was there any consistent bias related to own- rather than other-race displays although, for discrepant displays, both Japanese and English participants were significantly faster to detect both happy and angry targets in the Japanese displays.

Experiment 2 used a similar paradigm, but with same-identity face displays. In line with previous results from English participants using schematic faces (Eastwood et al., 2001; Fox et al., 2000; Öhman et al., 2001a; Tipples et al., 2002) and photographic images (Fox and Damjanovic, 2006; Gilboa-Schechtman et al., 1999), these displays were predicted to provide a fast detection context that would favour threat detection. In this context participants were predicted to be faster and more accurate to detect angry targets than happy ones. If superior discrimination of angry faces in visual search arises from an evolutionary bias towards threat vigilance (Öhman & Mineka, 2001), then it should be equally strong in both populations. However, if it is modulated by social factors, such as differences in the extent to which it is acceptable to display emotion openly within a particular culture (Matsumoto, 1992; Yuki et al., 2007), then it might be stronger in English than Japanese participants. Finally, if there is a general recognition advantage for own- than for other-race faces, because they fit a 'template' in mental representation, then each group might display the effect more strongly for own- than for other-race faces (Valentine, 1991).

Experiment 2

Method

Participants.

Eighteen native English-speaking Caucasian participants were recruited from the University of Essex in the U.K (12 males and 6 females, with a mean age of 19.8 years). Eighteen native Japanese participants were recruited from the University of Gifu in Japan (10 males and 8 females, with a mean age of 19.2 years). All participants received payment for their participation. Caucasian participants were instructed in English by a Caucasian experimenter, and Japanese participants were instructed in Japanese by a native Japanese experimenter. None of the participants had taken part in Experiment 1.

Apparatus.

The apparatus used was identical to that in Experiment 1.

Stimuli.

Stimuli were taken from the same databases as for Experiment 1. Sixteen Caucasian and 16 Japanese individuals were selected. Within each race, eight faces displayed emotional expressions (four angry and four happy) and eight faces displayed a neutral expression. Each colour image was converted to greyscale, and equated for mean luminance and brightness and cropped as in Experiment 1. The four faces on each visual search trial belonged to the same individual. The layout of stimuli in each trial was identical to that in Experiment 1, except that target and distractor facial expressions belonged to the same individual (see Figure 4).

(Figure 4 about here)

Procedure.

The experimental trials were divided into two blocks (one with Caucasian faces and one with Japanese faces), each consisted of 5 practice trials and 112 experimental trials, and the order of blocks was counterbalanced across participants. The three *same* trials consisted of the four faces belonging to the same individual displaying the same emotional expression (angry, happy, neutral). The two *discrepant* display types were as follows: one angry, three neutral and one happy, three neutral. (see Figure 4 for examples). Thus, participants were required to detect two types of target (angry and happy) against neutral distractors[1]. In each block there were 48 same-display trials (16 angry expressions, 16 happy expressions, 16 neutral expressions). There were 64 discrepant-display trials in each block (32 in each of the two conditions). Thus, the ratio between same and discrepant displays was identical to Experiment 1. Each target appeared equally often in each of the four possible locations, and the trials were presented in a different random order to each participant. The *same* and *discrepant* trials were randomized within each block.

Trial procedure was identical to that in Experiment 1. Once again, participants' task was to respond, as quickly as possible, whether all 4 faces displayed the same emotion, or whether one of the four faces displayed a different emotion from the other three.

Results

As in Experiment 1, RTs less than 100 ms or greater than 2,000 ms were excluded and data from the two participant groups were analysed separately. Figure 5 shows the mean RTs and error rates for English and Japanese participants in Experiment 2.

(Figure 5 about here)

Discrepant display analyses for English participants.

RTs for correct 'different' responses from English participants were entered into a 2 (display: Caucasian or. Japanese) x 2 (target emotion: angry or happy) repeated measures ANOVA. This revealed a main effect of display, F (1, 17) = 17.04, MSE = 8092.13, $p < 0.001$, η_p^2 = 0.50, with faster responses to Japanese than Caucasian displays. There was also a significant main effect of target emotion, with faster reaction times to happy than angry targets, F (1, 17) = 39.41, MSE = 5903.49, $p < 0.0001$, η_p^2 = 0.70. The display x target emotion was also significant, F (1, 17) = 8.19, MSE = 3332.58, $p < 0.01$, $\eta_p^2 = 0.33$. Simple main effects analyses showed that RTs were faster to happy targets when expressed by Japanese that Caucasian faces, F (1, 17) = 17.79, MSE = 8092.13, $p < 0.001$, $\eta_p^2 = 0.51$. For Caucasian displays, RTs were faster for happy than angry targets, F (1, 17) = 8.52, MSE = 5903.49, $p < 0.01$, $\eta_p^2 = 0.33$. This was also true for the Japanese displays, F (1, 17) = 35.51, MSE = 5903.49, $p < 0.0001$, $\eta_p^2 = 0.68$.

For error rates, the only significant effect that emerged was for target emotion, F (1, 17) = 7.44, MSE = 131.78, $p < 0.01$, $\eta_p^2 = 0.30$, with lower error rates in response to happy than angry targets.

Discrepant display analyses for Japanese participants.

A 2 (display: Caucasian or. Japanese) x 2 (target emotion: angry or happy) repeated measures ANOVA for RTs by Japanese participants revealed a significant effect of display, F (1, 17) = 8.51, MSE = 15144.13, $p < 0.01$, $\eta_p^2 = 0.33$, with faster RTs to Japanese than Caucasian displays, there was no significant effect of emotion ($F < 1$) and no significant ethnicity of display x emotion interaction ($F < 1$).

However, inspection of their error rate performance revealed significantly fewer errors for happy than for angry targets, F (1, 17) = 7.39, MSE = 25.13, $p < 0.01$, $\eta_p^2 = 0.30$. No other effects were significant. Japanese participants, made fewer errors for happy than for angry targets, but showed no difference in response times.

Same display analyses for English participants.

RT and error rates for both participant groups are shown in Figure 6.

(Figure 6 about here)

RTs for 'same' responses for English participants were analysed in a 2 (display: Caucasian or Japanese) x 3 (emotion: angry, happy or neutral) ANOVA which showed no significant main effect of display ($F < 1$), but a significant main effect of emotion, F (2, 34) = 19.74, MSE = 6757.96, $p < 0.0001$, $\eta_p^2 = 0.54$, along with a significant display x emotion interaction, F (1, 17) = 7.98, MSE = 4604.79, $p < 0.001$, $\eta_p^2 = 0.32$. Post hoc tests showed that for Caucasian displays, angry and happy displays were responded to significantly faster than neutral displays ($p < 0.05$ and $p < 0.01$ respectively). Angry and happy displays did not differ from each other. For Japanese faces happy displays were detected significantly faster than angry and neutral targets (both $p < 0.001$),which did not differ from each other.

Analyses of the English participants' error rates for the same displays showed that whilst the main effect of display failed to reach significance, ($p = 0.07$), the main effect of emotion was significant, F (2, 34) = 15.00, MSE = 109.66, $p < 0.0001$, $\eta_p^2 = 0.47$. The race of display x target emotion was not significant ($F < 1$). Post hoc tests showed that angry and happy displays did not differ from each other, but both had lower error rates than neutral displays (both $p < 0.001$). When identity was held constant English participants made 'same' responses faster and more accurately to both types of emotion for their own race, but were faster to respond to happy Japanese displays.

Same display analyses for Japanese participants.

Reaction time analyses from our Japanese sample produced a significant main effect of display, F (1, 17) = 4.54, MSE = 28665.46, $p < 0.05$, $\eta_p^2 = 0.21$, with faster RTs to Japanese than Caucasian faces. The main effect of emotion was also significant, F (2, 34) = 9.67, MSE = 3889.93, $p < 0.001$, $\eta_p^2 = 0.36$ and there was a significant race of display x emotion interaction,

F (2, 34) = 4.00, MSE = 2001.01, $p < 0.05$, $\eta_p^2 = 0.19$. Post hoc tests showed that for Caucasian displays, RTs were faster for angry compared to neutral faces ($p < 0.01$). For Japanese faces both angry and happy faces were responded to significantly faster than neutral faces (both $p < 0.01$). Rts for angry and happy faces did not differ.

For error rates for Japanese participants there was a significant main effect of emotion, F (1, 17) = 39.87, MSE = 46.77, $p < 0.0001$, $\eta_p^2 = 0.70$. Post hoc tests showed that both angry and happy faces had significantly fewer errors than neutral faces (both $p < 0.001$). However, reaction times between angry and happy faces did not differ significantly from each other. See Figure 6.

Discussion

Experiment 2 had been predicted to elicit a speed and accuracy advantage for angry faces based on previous research that has demonstrated this effect for displays consisting of faces of the same individual (Eastwood et al., 2001; Fox & Damjanovic, 2006; Fox et al., 2000; Öhman et al., 2001a; Tipples et al., 2002). However, although responses in Experiment 2 were generally faster than in Experiment 1, the result was consistently in the opposite direction to that predicted. This effect was most strongly pronounced for English participants, who demonstrated faster reaction times and lower error rates to happy than angry targets in the discrepant condition. Japanese participants were more accurate in responding to happy than to angry targets, but their reaction times did not differ across emotions. Again, Japanese participants were faster to detect both types of targets in the Japanese displays, while English participants detected happy, but not angry targets faster in the Japanese displays. For ‘same’ displays however, for both groups of participants, with both sets of targets, the large advantage in accuracy for happy faces seen in Experiment 1 was no longer present. Instead, both types of emotional expression elicited faster and more accurate responding than neutral expressions. Overall, while no threat-superiority was observed, the disadvantage for angry faces observed in Experiment 1 was greatly reduced in displays representing the same individual.

Nevertheless, the current findings present a marked contrast to other recent findings using photographic stimuli (e.g. Fox & Damjanovic, 2006) or cloned schematic faces (Juth et al., 2005). One reason for this might lie in the specificity of instructions used here. In Experiments 1 and 2, participants were asked to decide whether the four faces displayed the same emotion or not. Whilst not directing their attention specifically to threat (as in Williams et al., 2005), this instruction may have favoured the use of a verbal labelling strategy. Such a strategy might result in slower responding, which would not be expected to promote threat-superiority. Moreover, recent evidence has shown that verbal labelling can reduce the perceptual saliency of the emotion portrayed in a face (Lindquist, Barrett, Bliss-Moreau & Russell, 2006). Even the presence of a to-be-ignored emotional label also affects the recognition of facial expressions of emotion (Roberson, Damjanovic & Pilling, 2007). Moreover, in Experiment 2 Japanese participants displayed a somewhat different pattern of performance to English participants, suggesting that Japanese participants may have adopted a different strategy, although error rates and reaction times were comparable across the two groups.

Cultural differences in display rules might selectively affect the recognition of negative emotions by Japanese participants (e.g. Matsumoto, 1992; Shioiri, et al., 1999). Moreover, Russell et al. (1993) found more variation in the way basic category emotions, such as anger and happiness were labelled by Japanese speakers, compared to English speakers. In Russell et al.'s study, when instructed to provide an emotional label for facial expressions, Japanese speakers often referred to complex internal cognitive states, such as 'thinking' and 'remembering'. In contrast, English speakers appear to map emotion terms directly onto facial expressions. So there may be less direct one-to-one correspondence between emotional terms (e.g., ‘happy’ and ‘sad’) and facial expressions for Japanese than for speakers. In Experiments 1 and 2 the instruction to report whether all faces displayed the same ‘emotion’ may have confused Japanese speakers. Experiment 3 attempted to overcome any such cultural difference by modifying experimental instructions to remove the term ‘emotion’ from the instructions. This modification not only brought the experimental instructions in line with those used by Fox and Damjanovic (2006) but also made it less likely that participants would strategically label all expressions in order to carry out the task. In Experiment 3 participants were simply asked to respond whether the displays were ‘same or different’. It had not been possible to use such instructions in Experiment 1 because each display contained faces that differed in identity.

Experiment 3 thus aimed to minimise the use of a verbal labelling strategy in detecting discrepant displays by instructing participants just to report whether displays were ‘same’ or ‘different’ without drawing attention to the expression of emotion.

Experiment 3

Method

Participants.

Twenty-four native English-speaking English participants were recruited from the University of Essex in the U.K (14 males and 10 females, with a mean age of 21.2 years). Twenty-four native Japanese participants were recruited from the University of Gifu in Japan (12 males and 12 females, with a mean age of 19.4 years). All participants received payment for their participation. English participants were instructed in English by a Caucasian experimenter, and

Japanese participants were instructed in Japanese by a native Japanese experimenter. The participants in Experiment 3 had not taken part in previous experiments.

Apparatus and stimuli

The apparatus, stimuli and arrangement used were identical to that in Experiments 2.

Procedure.

The experimental procedure was identical to Experiment 2 with the exception that participants were instructed in their native language to: "Press the red button if all the faces are the SAME, and the green button if one face is DIFFERENT from the remaining three faces".

Results

RTs less than 100 ms or greater than 2,000 ms were excluded. Mean RTs and error rates for both groups are shown in figure 7.

(Figure 7 about here)

Discrepant display analyses for English participants.

A 2 (display: Caucasian or Japanese) x 2 (target emotion: angry or happy) repeated measures ANOVA for English participants revealed a main effect of display, F (1, 23) = 14.08, MSE = 13608.45, $p < 0.001$, $\eta_p^2 = 0.38$, with faster RTs to Japanese than Caucasian displays. There was also a main effect of target emotion, with RTs to happy targets faster than to angry targets, F (1, 23) = 37.69, MSE = 3321.11, $p < 0.0001$, $\eta_p^2 = 0.62$. There was also a significant display x target emotion interaction, F (1, 23) = 7.41, MSE = 1286.51, $p < 0.01$, $\eta_p^2 = 0.24$. Simple main effects analyses showed that happy targets displayed by a Japanese face were detected faster than happy targets displayed by a Caucasian face, F (1, 23) = 10.53, MSE =

13608.45, $p < 0.01$, $\eta_p^2 = 0.31$. Happy targets were responded to significantly faster than angry targets for both Caucasian, F (1, 23) = 9.88, MSE = 3321.11, $p < 0.01$, $\eta_p^2 = 0.30$ and Japanese displays, F (1, 23) = 30.68, MSE = 3321.06, $p < 0.0001$, $\eta_p^2 = 0.57$.

Error rates analyses revealed a main effect of display, F(1, 23) = 9.34, MSE = 136.65, $p <$ 0.01, $\eta_p^2 = 0.29$, with fewer errors to Japanese than Caucasian displays. Happy targets also produced fewer errors than angry targets, F (1, 23) = 19.76, MSE = 76.62, $p < 0.001$, $\eta_p^2 = 0.46$. The display x target emotion interaction was not significant ($F < 1$). Discrepant happy faces were detected faster and more accurately in both displays, but discrepant Japanese displays were detected faster and more accurately than Caucasian ones and this effect was particularly marked for happy faces.

Discrepant display analyses for Japanese participants.

Japanese participants' RT analysis showed a main effect of display with faster reaction times to Japanese than Caucasian faces, F (1, 23) = 9.83, MSE = 10557.65, $p < 0.01$, $\eta_p^2 = 0.30$. The main effect of target emotion failed to reach significance ($p = 0.067$). However, there was a significant display x target emotion interaction, F (1, 23) = 9.35, MSE = 1071.39, $p < 0.01$, $\eta_p^2 =$ 0.29. Simple main effects analyses showed that RTs were faster to Japanese angry faces than Caucasian angry faces F (1, 23) = 8.44, MSE = 10557.65, $p < 0.01$, $\eta_p^2 = 0.78$. Happy faces were detected faster than angry faces in the Caucasian displays, F (1, 23) = 6.84, MSE = 3168.13, $p <$ 0.01, $\eta_p^2 = 0.23$.

Analyses of error rates showed that participants produced fewer errors to Japanese displays than to Caucasian displays, F (1, 23) = 5.87, MSE = 62.42, $p < 0.05$, $\eta_p^2 = 0.20$ and produced fewer errors to happy than angry targets, F (1, 23) = 4.47, MSE = 76.62, $p < 0.05$, $\eta_p^2 =$

0.16. The display x target emotion interaction was not significant ($F < 1$). For Japanese participants, although discrepant Japanese displays were detected faster and more accurately than Caucasian displays, there was a difference in speed of detection of the two emotions only for Caucasian faces. In this condition, Japanese participants showed faster detection of own- than of other-race angry faces.

Same display analyses for English participants.

RTs and error rates for both groups for correct 'same' responses are shown in figure 8.

(Figure 8 about here)

Analyses of RT data for the Caucasian group revealed a main effect of display, F (1, 23) = 9.86, MSE = 17836.55, $p < 0.01$, $\eta_p^2 = 0.30$, with Japanese displays eliciting faster RTs than Caucasian displays. There was also a main effect of emotion, F (2, 46) = 16.58, MSE = 4508.32, $p < 0.0001$, $\eta_p^2 = 0.42$. The display x emotion interaction was significant, F (2, 46) = 3.38, MSE = 2133.26, $p < 0.05$, $\eta_p^2 = 0.13$. Post hoc tests showed that for Caucasian displays, angry and happy displays were responded to significantly faster than neutral faces ($p < 0.01$), but did not differ significantly from each other. For Japanese displays, happy faces were responded to faster than both angry ($p < 0.05$) and neutral faces ($p < 0.001$). The difference between angry and neutral faces was not significant.

Error rate analyses revealed only a main effect of emotion, F (2, 46) = 40.59, MSE = 71.16, $p < 0.0001$, $\eta_p^2 = 0.64$. Post hoc tests showed that both angry and happy faces were responded to more accurately than neutral displays ($p < 0.001$). Angry and happy displays did not differ significantly from each other.

Same display analyses for Japanese participants.

Japanese RT analyses showed no effect of display (p = 0.07). However, the main effect of emotion was significant, F (2, 46) = 8.26, MSE = 3936.02, p < 0.001, η_p^2 = 0.25, moderated by a significant display x emotion interaction, F (2, 46) = 3.71, MSE = 3566.59, p < 0.05, η_p^2 = 0.14. Simple main effect analyses revealed that the emotional displays differed significantly only for the Japanese faces, F (2, 46) = 9.88, MSE = 3936.02, p < 0.001, η_p^2 = 0.30. Post hoc tests showed that happy faces were responded to faster than angry and neutral faces (p < 0.01). Angry faces did not differ significantly from neutral faces.

Error rates analyses revealed only a main effect of emotion, F (2, 46) = 31.94, MSE = 62.10, p < 0.0001, η_p^2 = 0.58. Post hoc tests showed that both angry and happy displays produced fewer error rates than neutral faces (p < 0.001). Angry and happy displays did not differ from each other. See Figure 8.

Discussion

For both populations and with both Japanese and Caucasian displays the results of Experiment 3 largely replicate the findings of Experiment 2. For discrepant displays there is consistently faster and more accurate detection of happy than of angry faces, even though the distractor images are of the same individual as the target, unlike the findings of Juth et al. (2005). Removing the term ‘emotion’ from our instructions did not change the pattern of responding for English participants, who continued to show superior discrimination of happy faces and of Japanese over English displays. Overall, responses by Japanese participants were faster in Experiment 3 than those in Experiment 2, so the term ‘emotion’ in the instructions for Experiments 1 and 2 may have distracted Japanese participants if they lacked the direct mapping of emotion labels to facial expressions available to English speakers.

Japanese participants in Experiment 3 also showed faster detection of own- than of other-race angry faces, and faster detection of discrepant happy targets only for other-race faces. Critically, this manipulation still fails to promote superior detection of angry faces, so there is no hint of threat-superiority, despite the faster responding by Japanese participants.

One possible explanation for the discrepancy between our results and those of Fox and Damjanovic (2006) is a difference in reaction times. If threat-superiority is only present when responses are extremely fast, participants in the present experiment might have simply responded too slowly to show the effect, despite being instructed to respond as quickly as they could. Indeed, the detection of angry targets by our English sample with the Caucasian display was considerably slower (984.03ms) compared with 845.8ms observed by Fox and Damjanovic (2006). We therefore examined the data just for the 16 English participants with RTs <926.15ms for the Caucasian displays (faster than the mean target detection RTs for the neutral distractors condition reported in Fox and Damjanovic's Experiment 1 with upright faces). Of these 16 participants, 12 showed faster recognition of happy faces, while 4 showed faster recognition of angry faces. Thirteen of these fast responders also made fewer errors to happy targets, while two made fewer errors to threatening targets and one made equal numbers of errors to both types of target. Furthermore, this observation was made on an overall sample size that was substantially larger than reported in Fox and Damjanovic (2006).

In Fox and Damjanovic's upright face condition, the whole face was presented in the visual search display, whilst the faces in our display, following from Williams et al., (2005), were cropped with an oval template. Results from our 'same' trials show approximately equal performance for angry and happy targets, it is therefore unlikely that our lack of a threat superiority effect in Experiment is due to the removal of the external facial features, such as hair, neck and ears. Furthermore, in Juth et al.'s (2005) crowd displays, the detection advantage favouring happy faces was observed with complete faces.

General Discussion

The studies reported in this paper examined the generality of the threat-superiority effect by manipulating the heterogeneity of target and distractors and by testing participants from two different ethnic groups with two different types of display. Extending previous visual search tasks that have used displays where the targets and distractors belonged to the same individual, either in schematic displays (Eastwood et al., 2001; Fox et al., 2000; Öhman et al., 2001a; Tipples et al., 2002) or displays with photographic images (Fox & Damjanovic, 2006), the present set of experiments used both mixed 'crowds' (Experiment 1) and cloned, same-identity 'crowds' (Experiments 2 and 3). In Experiments 1 and 2 participants were instructed to look for a discrepant expression of emotion, while in Experiment 3 participants were just asked to judge whether any of the faces differed from the others.

Despite using a paradigm based very closely on that of Fox and Damjanovic (2006), no advantage for angry faces was found, either with more ecologically valid sets using target and distractors belonging to different individuals (Experiment 1), or with sets containing images of the same individual (Experiments 2 and 3). Indeed, in Experiment 1, angry faces were detected more slowly and less accurately if the distractors had neutral, rather than happy expressions. Other experiments have reported a search advantage for happy over angry faces (Juth et al., 2005) or equivalence of discrimination for the two expressions (Williams et al., 2005), but only with displays where identity varied (but see Cavlo & Nummenmaa, in pressa; in pressb). No other experiments have examined the effect with own- vs. other-race faces.

The main difference between English and Japanese participants in the present experiments is for discrepant displays, where English participants displayed a consistently larger 'happiness-superiority' effect than Japanese participants for both Caucasian and Japanese displays across all three experiments. At least for English participants, the present results strongly support a perceptually based explanation (Adolphs, 2002). Adolphs (2002) suggests that happy faces can be swiftly discriminated from all other expressions by a single feature – the smiling mouth (see also Leppanen & Hietanen, 2007) . However, since a range of negative emotions, including anger, share a variety of features (downturned mouth, frowning eyebrows), more holistic processing would be needed to isolate a particular negative emotion. Our results support this view because when identity was kept constant in Experiments 2 and 3, so that there was a high degree of conformity of facial features within trials, English participants were consistently faster and more accurate at distinguishing discrepant happy faces, regardless of the ethnicity of the display. In Experiment 1, where identity varied, angry faces were identified as quickly as happy faces, among emotional distractors. This explanation is further supported by the results for 'same' displays across the three experiments. In Experiment 1, where identity and gender varied within the display, happy displays evoked faster and more accurate responses than either angry or neutral displays for both groups of participants, indicating that these displays might have been matched on a single feature. In Experiments 2 and 3, where identity was held constant, so the 4 faces in any display shared much of their configuration, both happy and angry 'same' displays were identified faster and more accurately than neutral faces.

For Japanese participants on discrepant trials, while the results of Experiment 1 were very similar to those for English participants, they made fewer errors overall and showed a reduced advantage for happy, over angry faces, especially with neutral distractors. In Experiment 2 fewer errors were made in response to happy than to angry targets, but there was no difference in reaction time and in Experiment 3 there was no difference in reaction time for Japanese displays. Although the difference between detection rates for the two emotions was smaller for Japanese than English speakers, it was in the same direction and neither population showed evidence of a threat-superiority effect under any condition.

Across the three experiments there was no consistent evidence of either facilitation or inhibition of expression detection for own- or other-race faces. For both participant groups, for discrepant displays, responses were faster and more accurate to Japanese than to Caucasian displays, although this was not the case for 'same' displays, so it is unlikely to relate to some perceptual property of the stimulus sets. One possibility is a difference in familiarity of the two sets of facial characteristics for the two groups, so that, for English participants, the Japanese faces might have had greater novelty value (since participants were selected on the basis that they had never visited Japan and had minimal prior contact with Japanese people). The reverse might not have been true for Japanese participants, who might be more familiar with Caucasian facial features through media exposure.

By reverting to the traditional 'cloned' displays in Experiment 2, we expected to obtain a detection advantage for angry faces in discrepant displays. It has been suggested that these kinds of displays promote rapid allocation of attention to threat in the environment. Despite the difference in attentional demands between Experiment 1 and Experiments 2 and 3 (because the stimuli in Experiment 1 contained inter-individual noise, Juth et al., 2005) the direction of the result did not change although the advantage for happy, over angry targets was greatly reduced.

For Japanese participants, the failure to find a threat-superiority effect in Experiments 1 and 2 might have related to the instruction to report whether one face differed in emotion from the others. Russell et al's study (1993) found that Japanese participants generated much more varied labels relating to a broad range of internal states such as 'perplexed',' thinking', 'patience' and 'remembering'. Japanese participants did not show the direct one-to-one semantic correspondence between the emotional expression and its emotional label that English speakers did. Western and Japanese cultures also differ in their expression of emotions, with Western cultures favouring overt display of emotions, compared to a more subdued display exhibited by the Japanese. Yuki et al. (2007) demonstrated that Western participants are more sensitive to changes within the mouth region as an emotional cue, whereas Japanese participants rely more heavily on the slight muscular innervations surrounding the eye region. Instructions to search for a discrepant 'emotion' might have been less straightforward for Japanese than English participants.

In Experiment 1, RTs were slower across all discrepant conditions for Japanese participants, perhaps because, with a less direct mapping of facial expressions to categorical labels of emotions than Westerners, the task of searching for a discrepant emotion was particularly difficult when identity and gender also differed. This does not appear to account for a lack of threat-superiority however, since the pattern of results for Japanese participants is very similar in Experiments 2 and 3 even though, in Experiment 3, the instruction to compare emotions was removed. In Experiment 3 Japanese participants responded faster overall than English participants, while in Experiment 2 reaction times were comparable across groups, so any difficulty was not associated with the visual search task per-se.

The failure to find a threat-superiority effect in these experiments is contrary to the findings of Fox and Damjanovic (2006). Even when the analysis of the RT data was taken into consideration, the search advantage for happy targets was maintained. A lack of a threat superiority effect has been attributed to differences in database selection and the exemplars within them (Calvo & Nummenmaa, in pressa). However, we would like to consider two key methodological differences between Experiment 3 and the visual search task used by Fox and Damjanovic (2006) that could account for the discrepancy in results. These differences relate to the kinds of distractors used and the male to female ratio in the visual search displays. In relation to the first point, in contrast to Fox and Damjanovic, Experiment 3 did not include angry distractors in the search display. As to the second point, the ratio of male to female models in Fox and Damjanovic (2006) was 2: 1.Experiment 3 used equal sets of male and female displays. In a visual search task, angry facial expressions portrayed by male posers elicit greater attentional capture (Williams & Mattingley, 2006). A direct consequence of this would result in greater priming of the threat detecting capacities of the amygdala which would build up across the displays sets in Fox and Damjanovic's study. The combined effects of angry male target and distractor faces would lead to an accumulation of threat relevant signals. Such a display would increase the likelihood of a threat superiority effect.

In Experiment 1, where attentional load was high, both groups of participants displayed the same pattern of performance and, in both cases, angry targets elicited particularly slow and inaccurate detection when distractors had neutral expressions. In Experiment 2, with less attentional load, both groups still made more errors in detecting angry targets, although only English participants were also slower. The change of instructions in Experiment 3, did not change the pattern of performance for English participants, for whom there may be a direct categorical mapping of facial expressions to emotions. Changing the instructions did induce slower detection of discrepant angry faces, but only for other-race displays.

Addressing our initial aim of testing the threat-superiority effect, our results do not support this attentional bias at all, at least when the visual search task is considered. As argued previously by Tipples, Young, Quinlan, Broks and Ellis (2002), it may be the case that the bias towards threat has a greater impact on other components of attention (Posner & Petersen, 1990) such as the ability to shift attention away from a threatening stimulus (Fox et al, 2001). Whilst supporting Juth et al's initial observation of the happiness advantage, our findings do not support their proposal that the threat superiority effect is determined by the relationship between target and distractors, but rather support a perceptual processing account (Adolphs, 2002).

A body of empirical research has demonstrated that face recognition is based on configural processing (Sergent, 1984; Diamond & Carey, 1986; Rhodes, Brake & Atkinson, 1993) and other race faces may be particularly likely to engage a feature-by-feature face encoding process (Rhodes, Tan, Brake & Taylor, 1989; Sangrioli & de Schonen, 2004). Thus, whilst a smiling mouth may provide a key salient feature (Leppanen & Hietanen, 2007) to drive the detection advantage for happy faces (Cavlo & Nummenmaa, in press), its saliency is modulated by contextual factors. In the case of the experiments reported here, the additional contextual information is within the other race face, which may further enhance the detection of this unique feature in happy faces.

The present study demonstrates that happy faces, not angry faces, are powerful magnets for attentional capture, even when the faces are matched for emotional equivalence as afforded by the FACS system. Further research is needed to explore the time course of this advantage, as well as the effects of exposure to other race faces in order to measure the attentioanl demands of processing identity and emotion based information simultaneously, a process that is more representative of our everyday encounters with others, outside the laboratory. The present findings demonstrate that, when searching in crowds, we go for the face with the smile.

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Correspondence concerning this article should be addressed to Dr Ljubica Damjanovic, School of Psychology, Bangor University, Bangor, Gwynedd, LL57 2AS, United Kingdom. E-mail: l.damjanovic@bangor.ac.uk

Footnotes

[1]Unlike the Ekman and Freisen (1976) database, in which every poser provided an expression for each emotional category, the Matsumoto and Ekman (1988) database consists of posers that have contributed one emotional and one neutral expression. Therefore, developing emotional distractors that matched the identity of the target was not possible in Experiment 2.

Figure Captions

Figure 1. Two examples of the Caucasian displays (left) and the Japanese displays (right) that were used in Experiment 1 for the 'crowds' displays. Race of display was presented in blocks, counterbalanced across participants. Both examples show a happy target (top pictures) surrounded by neutral distractors. The displays do not represent the actual size of the stimuli used in the experiments.

Figure 2. Results for the discrepant displays for Experiment 1 with crowds. The upper panels show reaction time and the lower panels show error rates for detecting an angry or a happy target surrounded by neutral and emotional distractors for Caucasian and Japanese displays. The right panels show the data for the Japanese participants and the left panels show the data from the English participants. Error bars correspond to the standard errors of the mean of each condition individually.

Figure 3. Results for the same displays for Experiment 1 with crowds. The upper panels show reaction time and the lower panels show error rates for making a 'same' response to all angry, all happy and all neutral displays for Caucasian and Japanese displays. The right panels show the data for the Japanese participants and the left panels show the data from the English participants. Error bars correspond to the standard errors of the mean of each condition individually.

Figure 4. Two examples of the Caucasian displays (left) and the Japanese displays (right) that were used in Experiment 2 for the 'clones' displays. Race of display was presented in blocks,

counterbalanced across participants. Both examples show an angry target (bottom pictures) surrounded by neutral distractors. The displays do not represent the actual size of the stimuli used in the experiments.

Figure 5. Results for the discrepant displays for Experiment 2 with clones. The upper panels show reaction time and the lower panels show error rates for detecting target an angry or a happy target surrounded by neutral distractors for Caucasian and Japanese displays. The right panels show the data for the Japanese participants and the left panels show the data from the English participants. Error bars correspond to the standard errors of the mean of each condition individually.

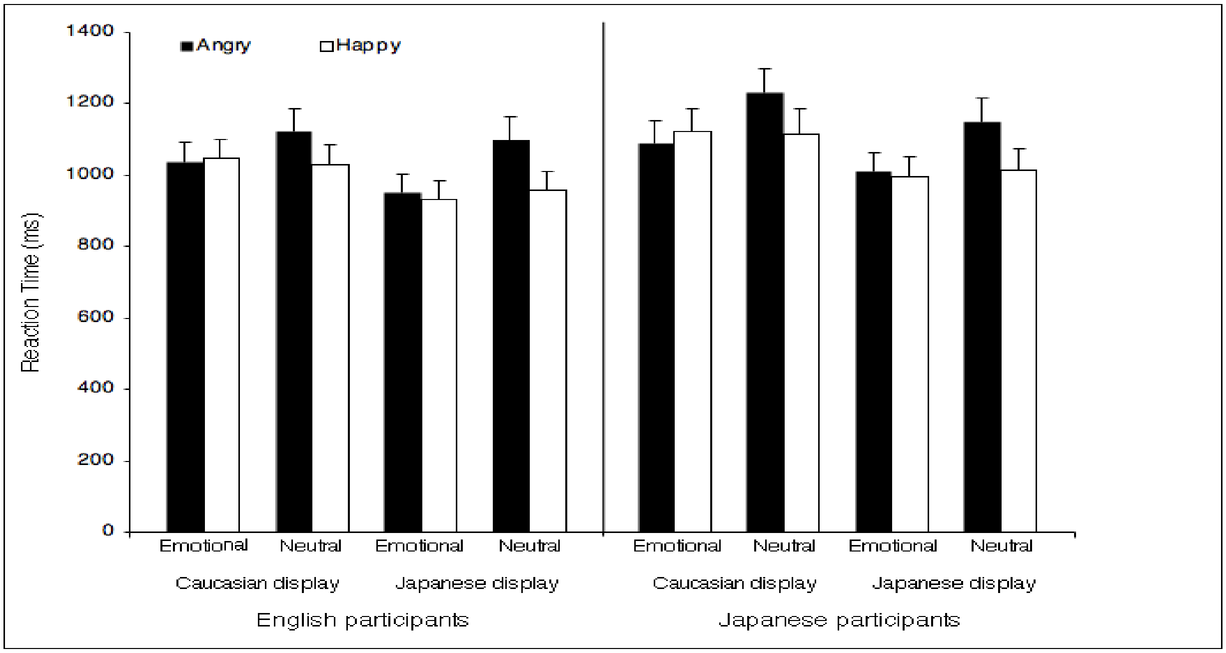
Figure 6. Results for the same displays for Experiment 2 with clones. The upper panels show reaction time and the lower panels show error rates for making a ‘same’ response to all angry, all happy and all neutral displays for Caucasian and Japanese displays. The right panels show the data for the Japanese participants and the left panels show the data from the English participants. Error bars correspond to the standard errors of the mean of each condition individually.

Figure 7. Results for the discrepant displays for Experiment 3 with clones and the modified instructions. The upper panels show reaction time and the lower panels show error rates for detecting target an angry or a happy target surrounded by neutral distractors for Caucasian and Japanese displays. The right panels show the data for the Japanese participants and the left panels

show the data from the English participants. Error bars correspond to the standard errors of the mean of each condition individually.

Figure 8. Results for the same displays for Experiment 3 with clones and the modified the instructions. The upper panels show reaction time and the lower panels show error rates for making a ‘same’ response to all angry, all happy and all neutral displays for Caucasian and Japanese displays. The right panels show the data for the Japanese participants and the left panels show the data from the English participants. Error bars correspond to the standard errors of the mean of each condition individually.

Figure 1.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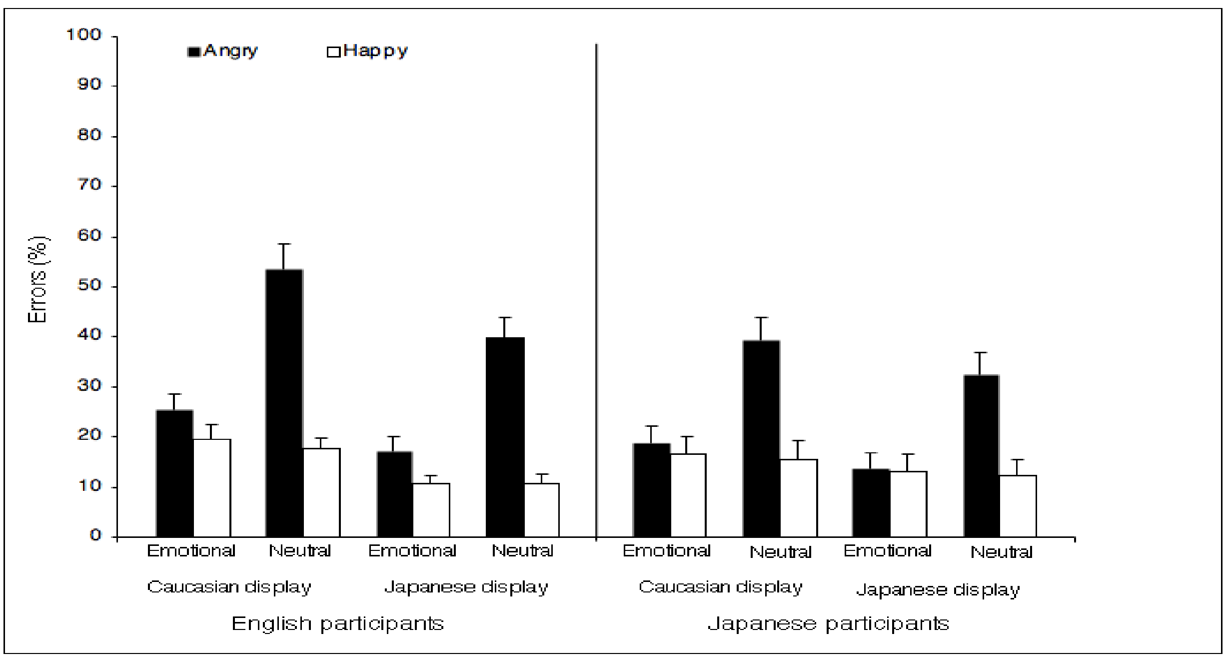
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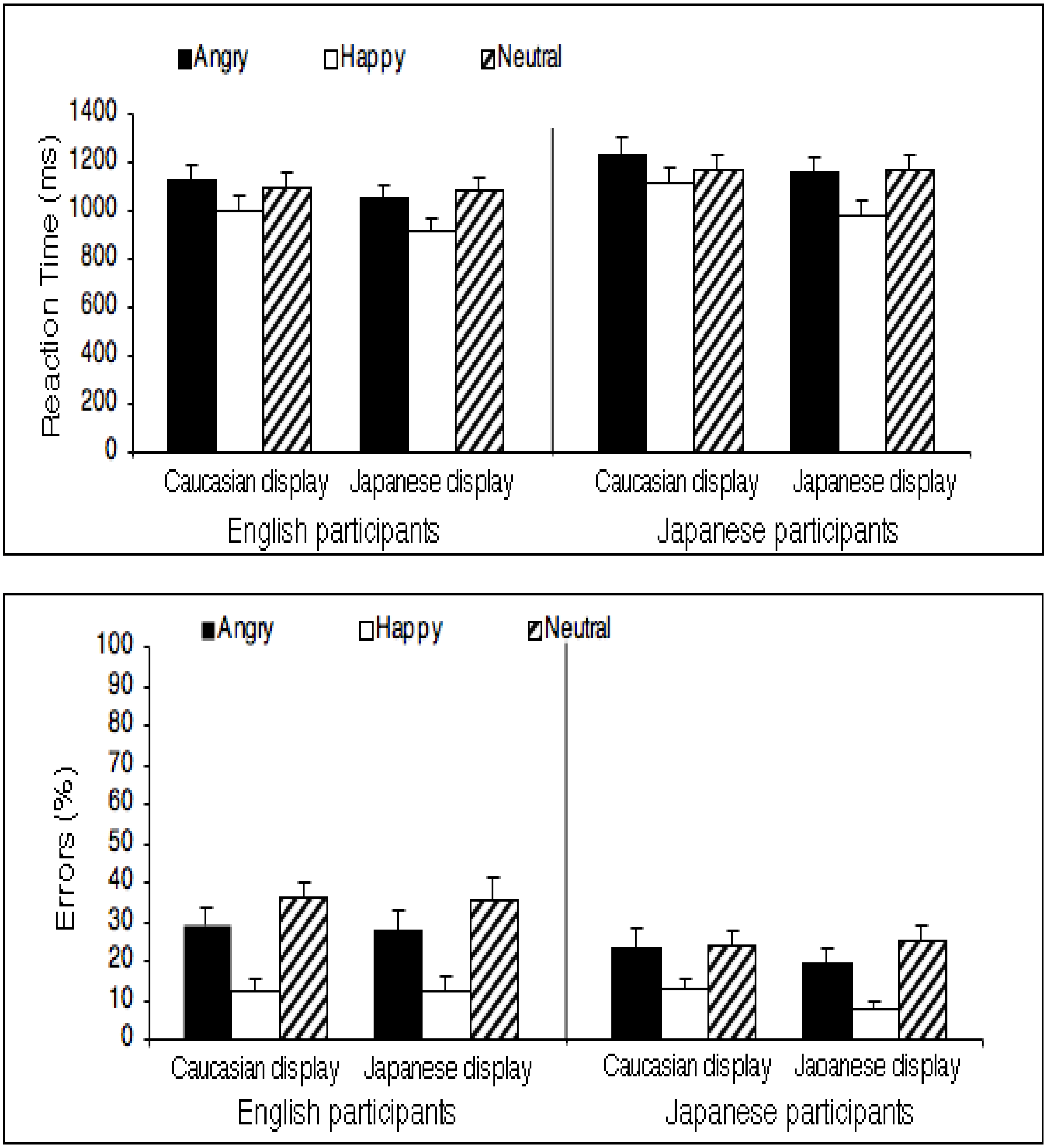
English participants
Japanese participants

Figure 2.



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Angry
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Errors (%)
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Figure 3.

Figure 4.

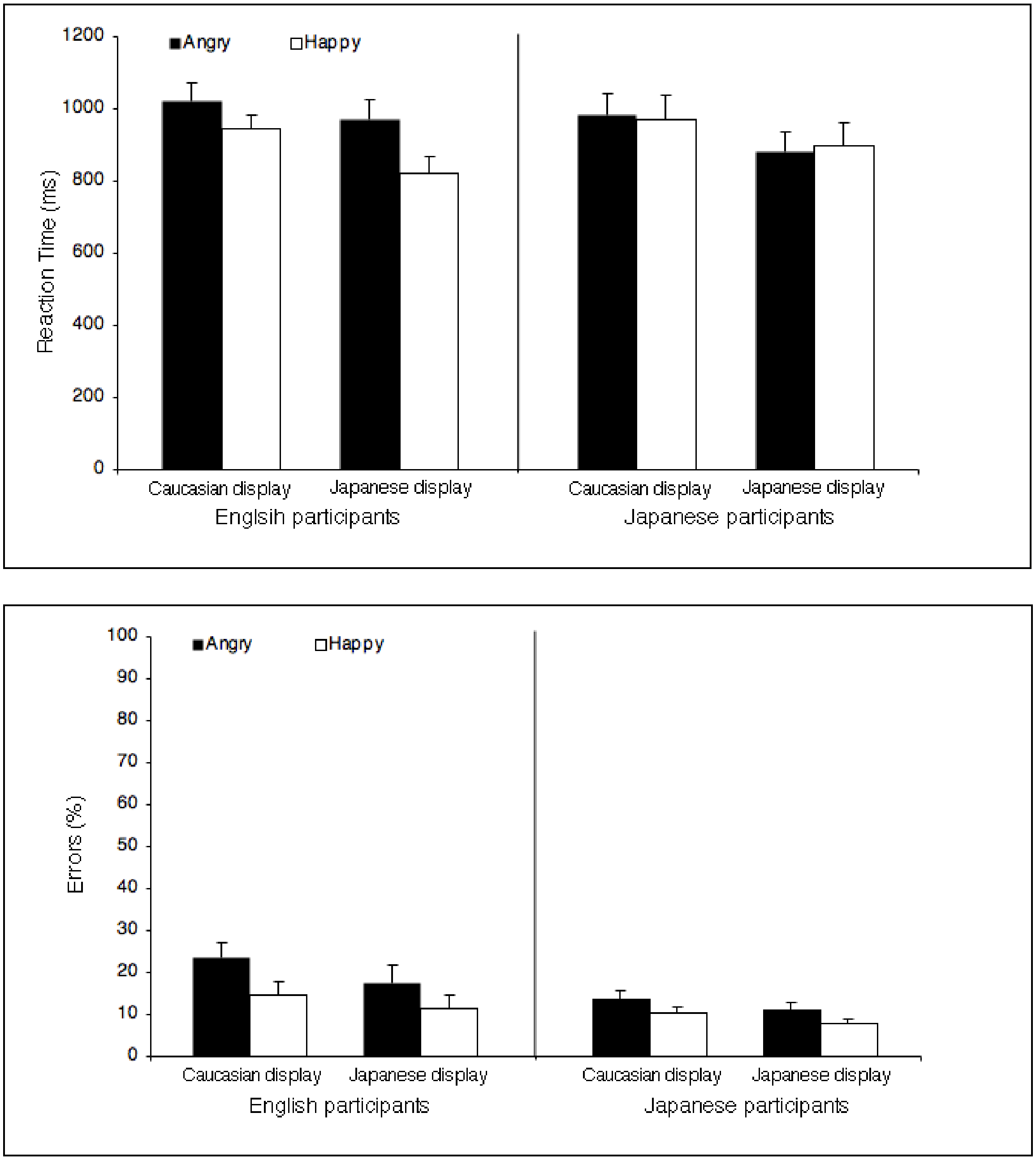
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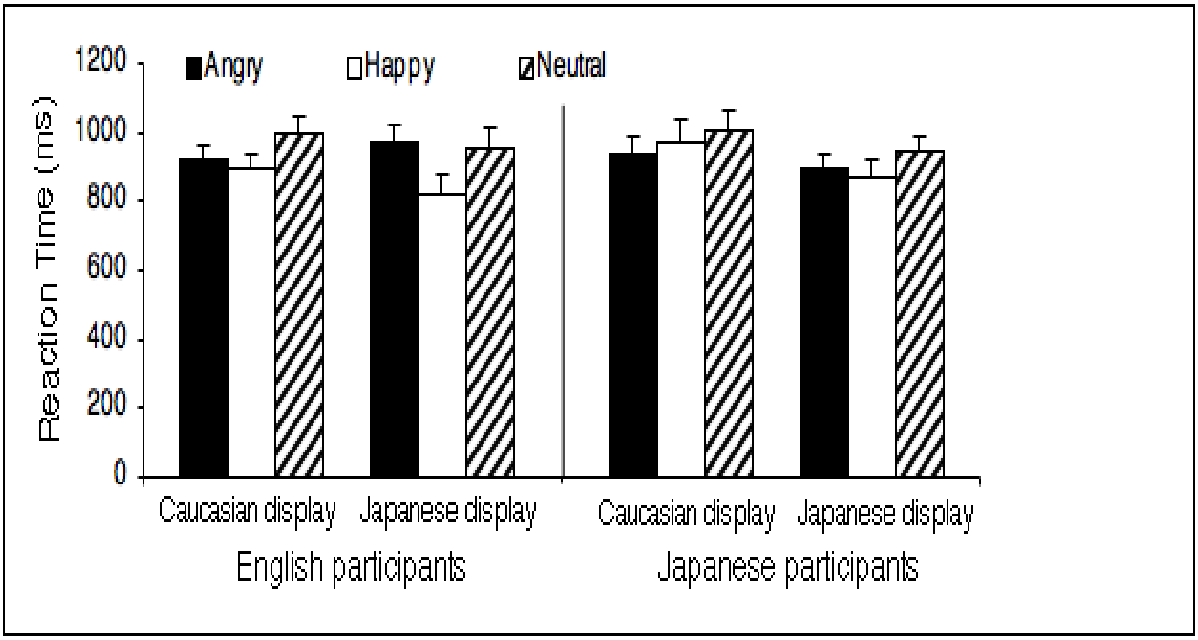
Figure 5.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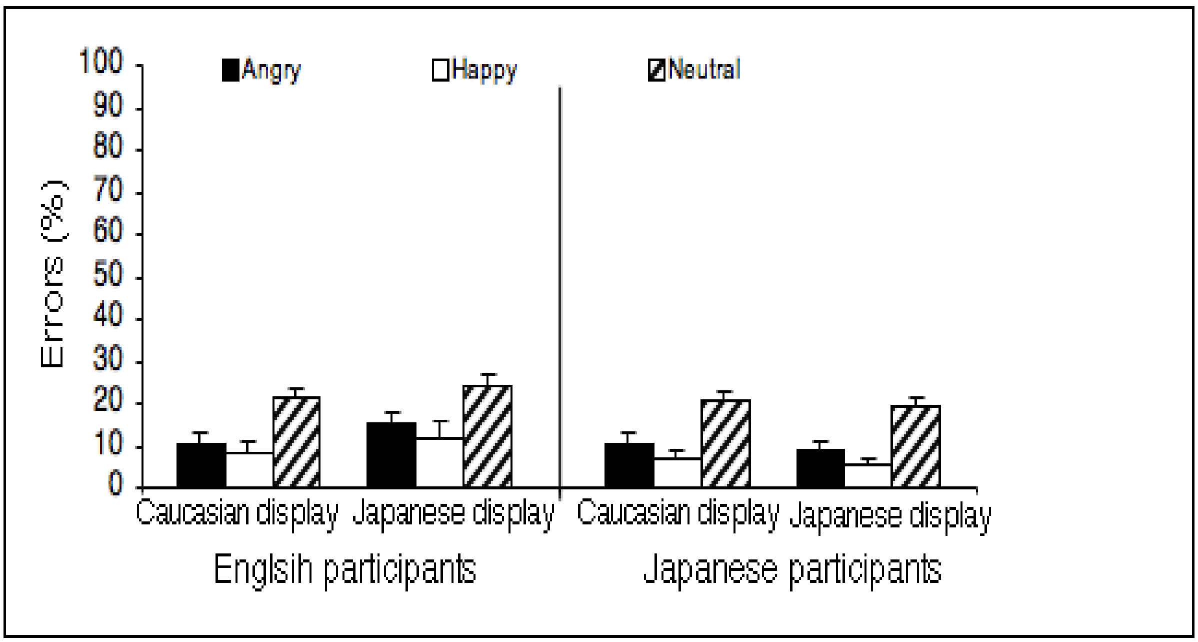
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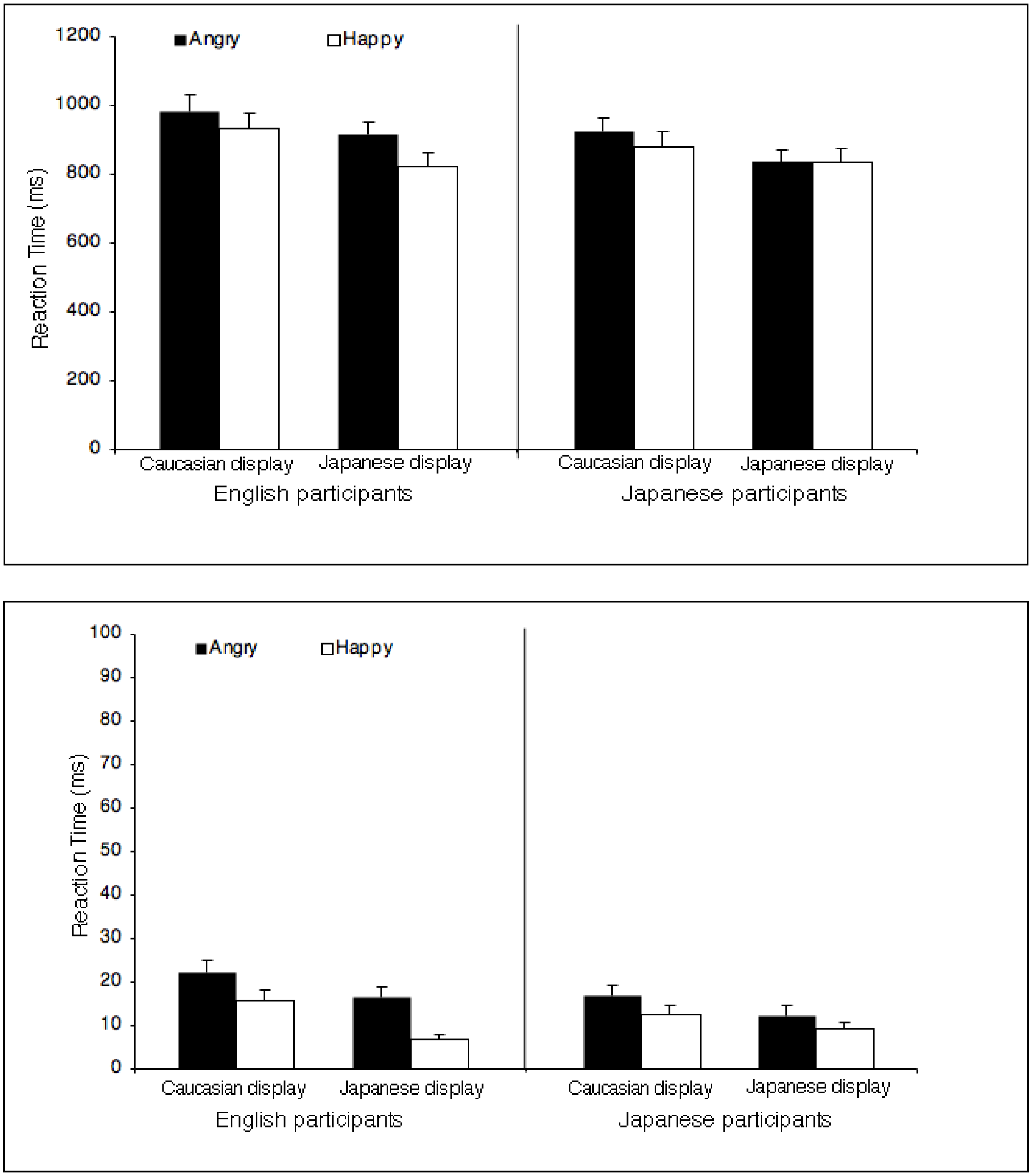
Figure 6.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Caucasian display
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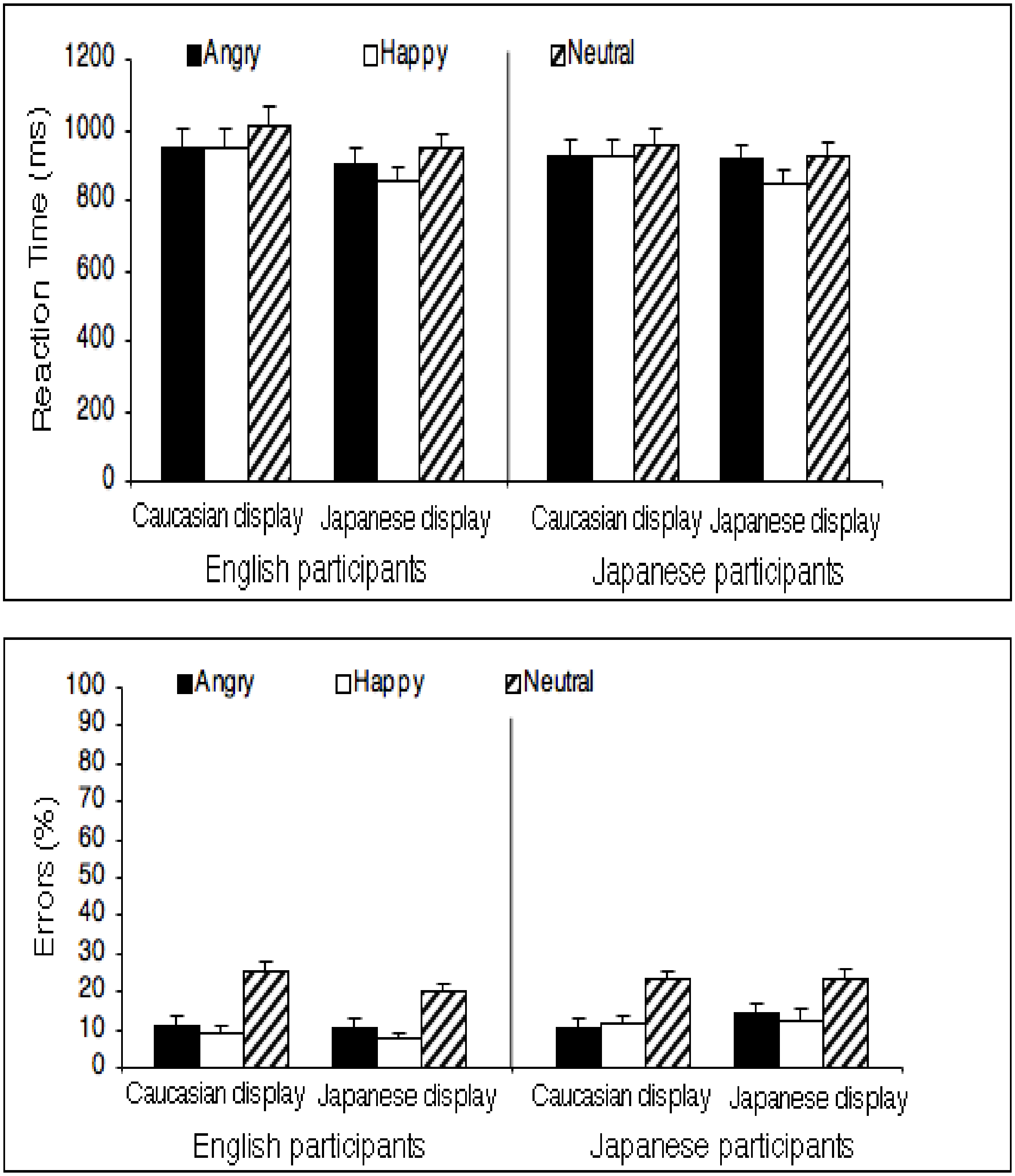
Japanese participants

Figure 7.



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Caucasian display
Japanese display
English participants
Japanese participants

Figure 8.