ETHNICITY AND PAIN RECOGNITION: UNRAVELLING CONFUSION PATTERNS IN FACIAL EXPRESSIONS

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INTRODUCTION

- Ethnic minorities expressing pain are often under-diagnosed and under-treated[1]. According to current theories of social perception, one potential reason for this is that their facial expressions are misinterpreted due to ethnic stereotype knowledge[2] biasing perception towards similar-looking facial expressions, such as anger or disgust (*See Fig. 1* action units (AUs) overlaps) [3,4,5].
- **In two independent/complementary experiments we examined whether and how facial expressions of pain and other negative emotions are interpreted differently according to the ethnicity of the expresser.**

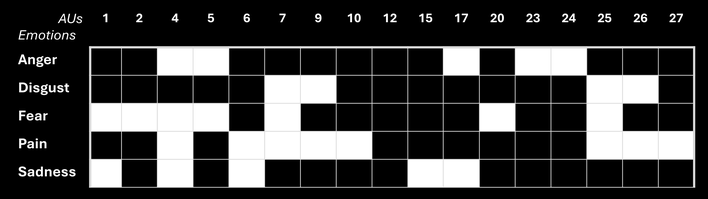
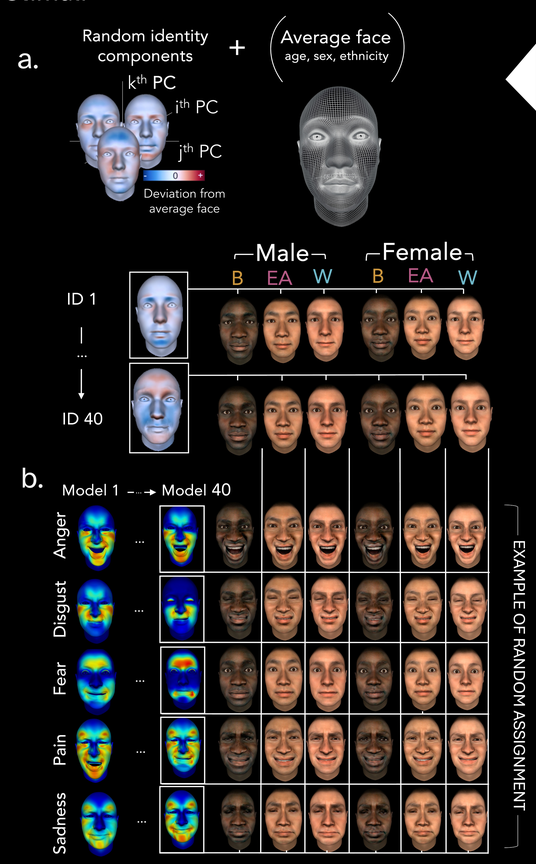


Figure 1. Action units (AUs) activated for basic emotions [6] and pain [4].

METHOD

Stimuli



- Using a generative model of the human face[9,10], we generated 40 face identities varying in ethnicity (**Black**, **East Asian**, **White**) and sex (*Fig. 2a*).
- We then displayed a set of dynamic facial expressions of the 5 expressive categories (i.e., anger, disgust, fear, pain sadness; n = 40 each) on those identities (*Fig. 2b*).
- The 40 facial expression models of pain or a negative emotion were selected from previous studies [7,8].
- We created a total of **1200 stimuli**.

Figure 2. a) Generative model of 3D face identity (GMF)[9] enables the creation of 40 random identities and their 6 variations. PC = principal component **b) 4D Generative Face Grammar (GFG)**[10] enables the creation of dynamic stimuli using 40 facial expression models in each of the 5 expressive categories.

Procedure

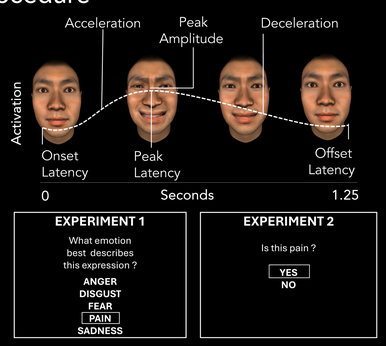


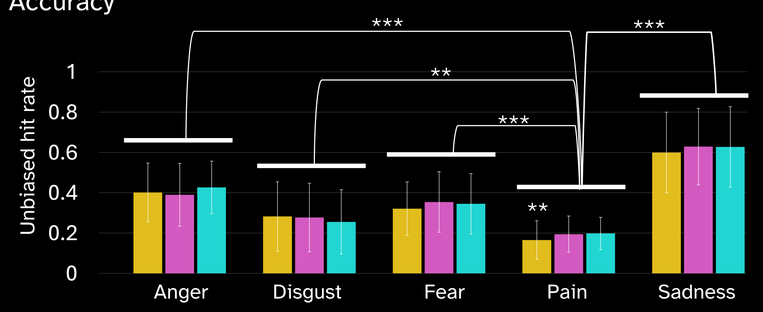
Figure 3. Task procedure: on each trial, the participant is presented with a dynamic stimulus and asked to perform one of two tasks.

Sixty participants (White Western; sex-balanced; 18-35 years) completed either:

- **Task 1 – 5AFC**: Classify the facial expressions of emotion as anger, disgust, fear, pain or sadness.
  - **1200** trials.
- **Task 2 – Yes/No**: Detect the presence of target emotions.
  - **1920** trials.
- **Complementary tasks**
  - Implicit association tests[11].
  - Contact questionnaire[12].

5AFC RESULTS

Accuracy



Black faces
East Asian faces
White faces

Figure 4. Average categorization accuracy across emotions and ethnicity. Error bars represent standard deviation of the mean value

* $p < .05$
** $p < .01$
*** $p < .001$

- Analyses on accuracy for pain expressions suggest that pain tends to be identified less accurately than other negative emotions.
- This drop in performance is even greater when the pain expression is displayed on a **Black** face compared to **East Asian** or a **White** face.

Confusion matrices

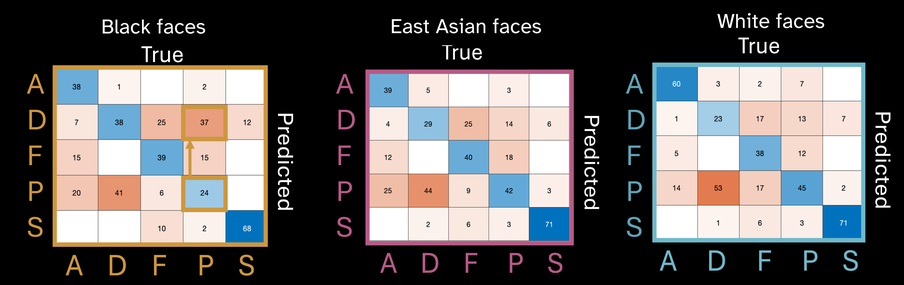


Figure 5. For each participant three confusion matrices were computed, one for each ethnicity. The figure shows an example of a participant consistently mistaking pain (P) for disgust (D) when displayed on **Black** faces, but not when displayed on **East Asian** or **White** faces.

Within-subject bootstrap

Figure 6. The sum of the purple cells in the matrix represents the total number of missed trials in the pain condition.

- For each matrix, the chance level (c) of confusion between pain and other emotions was measured.

$$\text{Chance level} = \frac{\text{total n of misses}}{\text{total n of instances of other emotions}}$$

- We then conducted a within-subject permutation analysis on the confusion matrix. On each of the 10,000 permutations, we resampled the participant data to generate new confusion matrices.
- We then identified participants for whom pain was systematically misclassified with another emotion (i.e. the 99% confidence interval goes beyond the chance level of confusion).

Confusion systematicity

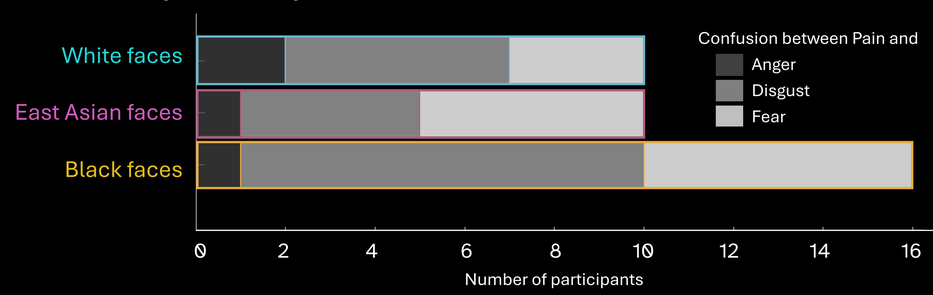


Figure 7. Number of participants presenting an individual effect (i.e., confusion between pain and **anger**, **disgust** or **fear**. No systematic confusion between pain and **sadness**.

- For **Black** faces the number of participants showing a significant effect of confusion between **pain** and **disgust** exceeds the population prevalence threshold (n = 8 > 7), which was not the case for **East Asian** and **White** faces.
- Systematic confusion between **pain** and **disgust** could not be predicted by:
  - Level of ethnic bias [$b = 3.40$, *Wald* $\chi^2(1) = 2.96$, $p = .09$].
  - Global interethnic social contact [$b = .16$, *Wald* $\chi^2(1) = .13$, $p = .21$] .
  - Childhood interethnic social contact [$b = -.08$, *Wald* $\chi^2(1) = .49$, $p = .48$].

- A combination of within-subject bootstrap analysis (10,000 resamples) with the Bayesian estimate of population prevalence[13] shows that pain generate more systematic confusion with other facial expressions especially with disgust when displayed on **Black** faces in comparison with **White** faces.
- However, this confusion could not be predicted by participants' levels of ethnic prejudice or history of interethnic social contact.

CONCLUSION

- The overall findings indicate that facial expressions of pain are generally less accurately categorized compared to other negative emotions and that this shortcoming is even worse when expression are displayed on a **Black** face in comparison to an **East Asian** or a **White** face.
- A detailed analysis of confusion patterns reveals a notable difference: pain expressions are more consistently confused with **disgust** when displayed on **Black** faces (other race) than when displayed on **White** faces (same race).
- To delve deeper into these confusions, we plan to conduct a complementary discrimination task where participants will detect the presence of target emotions (measured using d-prime, n = 30).
- By investigating the role of face ethnicity in interpreting facial expressions of pain, our study aims to shed light on how and why disparities in pain perception arise and provide potential insights into mitigating these effects.

References

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