Discrimination of pain facial expression intensity is modulated by the observer's culture

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Context

The ability to identify and interpret another's pain is an essential trait for survival. Facial expression is one of the most efficient way to communicate pain to others[1]. Research has revealed that the ability to recognize basic facial emotions (i.e. anger, fear, disgust, sadness, happiness, surprise) is reduced when they are expressed by individuals of another ethnic group, compared to the own ethnic group[2]. Culture also modulates the visual strategies underlying the recognition of these basic facial expressions[3-5]. In spite of these findings, the impact of culture on the ability to recognize and decode facial expressions of pain is still underexplored in the scientific litterature. The goal of the present study is to evaluate the impact of culture on the visual representation (Experiment 1) and on the decoding (Experiment 2) of facial expressions of pain.

Experiment 1

Participants : 30 Canadians and 30 Chinese subjects were recruited.
Stimuli : The background face used in the experimental stimuli consisted of a morph between avatars of a Caucasian and an Asian face. The avatar was created using FACEGen and FACSGen. A random patch of sinusoidal white noise was added on top of the background face.
Task : Participants completed a 2 forced-choices *reverse correlation* task[6]. They were shown two experimental stimuli at once, and had to identify the face that they rated as experiencing most intense pain.

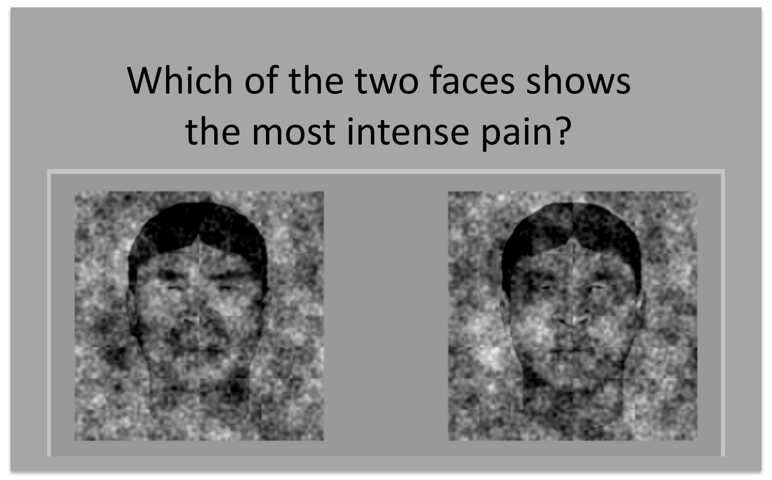

Figure 1 – Example of an experimental trial

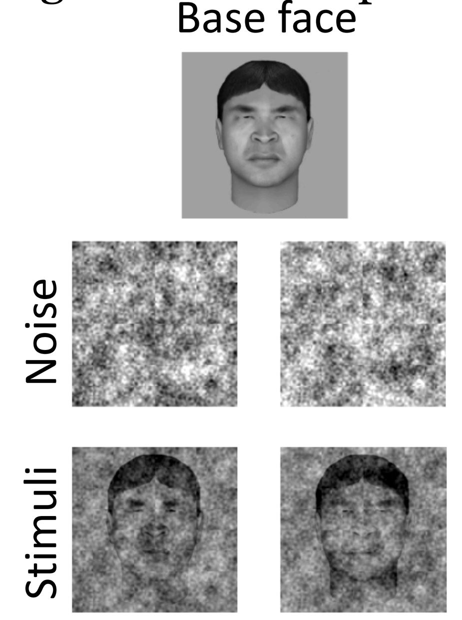

Figure 2 – Creation of experimental stimuli

Results – Experiment 1

For each participant, resulting classification images were computed, then compared on their luminance values using a Cluster Test (Stat4Ci[7]). This reveals a significant difference in the upper lip region. This region is darker for Chinese participants. Independent observers have unanimously agreed that the Chinese CI seems to feel more pain compared to the Canadian CI.

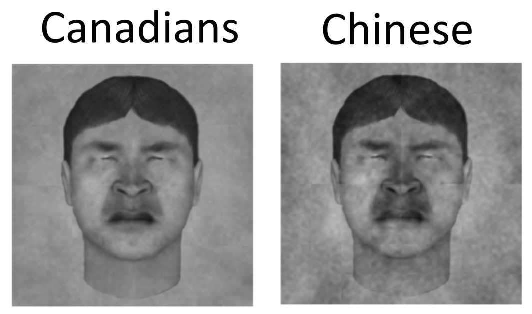

Figure 3 – Classification images for Canadian (left) and Chinese (right) participants

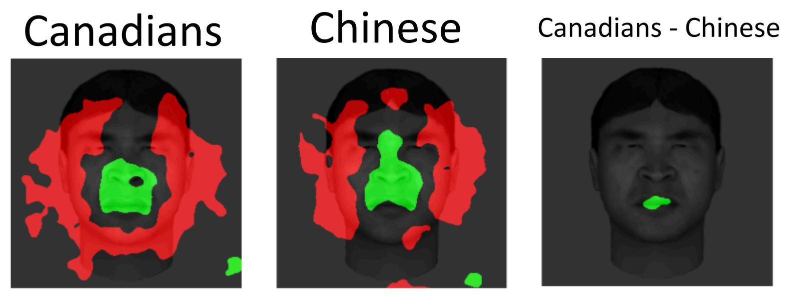

Figure 4 – Results of the Cluster Test. From left to right; Test on the Canadian CI; Test on the Chinese CI; Difference between the Canadian and Chinese CI.

Experiment 2

Participants : 28 Canadians (13 males), 21 years old on average and 30 Chineses (15 males), 21 years old on average.
Stimuli : 16 face avatars (2 identities [male and female] x 2 ethnicities [Caucasian and Asian] x 4 levels of intensity) created with FACEGen and FACSGen.
Task : Participants were asked to decide which of two face avatars expressed the most pain. The two faces differed in terms of expression intensity (33%, 66% or 100%). On a given trial, both faces were of same ethnicity, but the ethnicity varied randomly across trials. The faces were sampled through space and spatial frequencies using the Bubbles method[8]. Each participant completed 3024 trials (1512 per ethnicity). The number of bubbles was adjusted separately for the three intensity conditions using QUEST[9] in order to maintain an average performance of 75% per intensity condition.

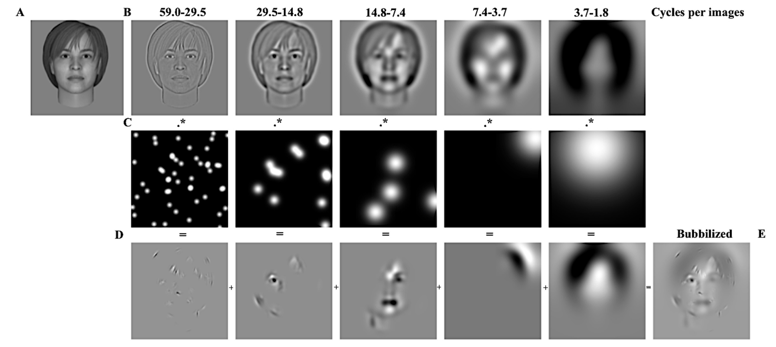

Figure 5. Procedure to create a stimulus with the Bubbles method.

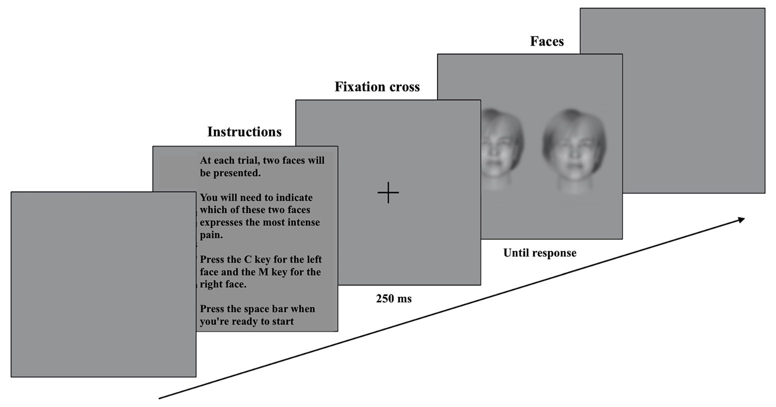

Figure 6. Sequence of events on each trial.

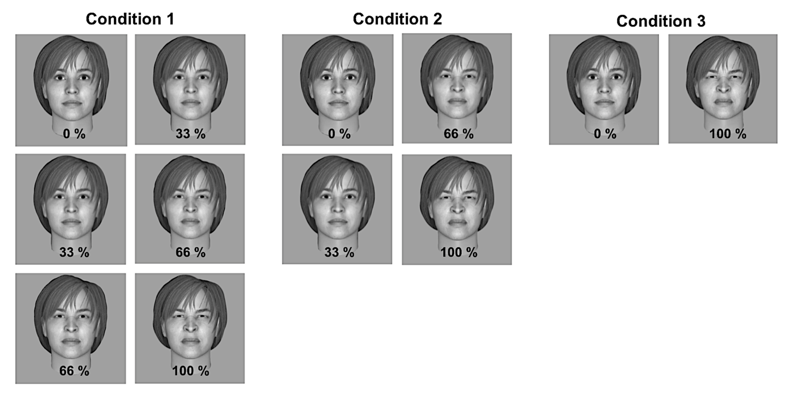

Figure 7. Representations of the three possible levels of difficulty.

Results – Experiment 2

A mixed ANOVA 2 (cultures) x 3 (levels of difficulty) on the number of bubbles revealed significant main effects of the level of difficulty [$F(1,56)$ 239.888, $p < 0.001$] and of culture [$F(1,56) = 20.618$, $p < 0.001$]. The interaction between culture and level of difficulty was also significant [$F(1,56) = 15.807$, $p < 0.001$]. Paired t-tests on the levels of difficulty were conducted separately for each culture, showing significant differences in all conditions ($p<0.001$). Independent t-tests also reveal a cultural difference across all conditions ($p<.001$).

Classification images. The visual information used to judge facial expressions of pain was determined by computing classification images (CIs) for each condition and face ethnicity. CIs consist of weighted sums of the bubble masks presented during the experiment, using the accuracy transformed into z-scores as weights. The CIs were then transformed into z-scores using a permutation method to estimate the mean and SD of the null hypothesis, and a Cluster test (Stat4CI) was applied to determine the statistically significant regions ($Z_{crit}= 3.0$; $k = 667$; $p < 0.05$).

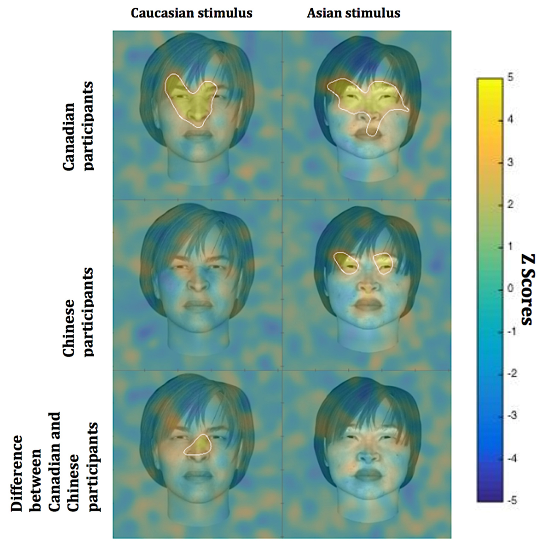

Figure 8. Visual information used by Canadian and Chinese participants to correctly discriminate among two intensities of pain. Significant regions are delimited by a white contour.

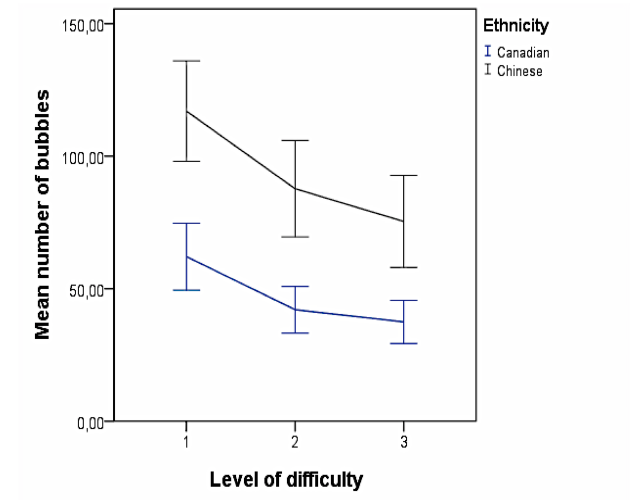

Figure 9. Mean number of bubbles for each level of difficulty for both ethnicity. The error bars represent confidence intervals at 95%.

Discussion

Our results indicate that Canadians and Chinese have different visual representations of pain, and that it is harder for Chinese to discriminate between two intensities of pain. These results also suggest that culture impacts on the visual decoding of pain expressions; namely, Canadians rely more on the nasolabial folds and nose wrinkles than Chinese to discriminate pain intensities.

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