The link between the mental representation of pain facial expressions and the estimation of pain in others.

Caroline Blais, Alexandra Lévesque-Lacasse, Carine Charbonneau, Marie-Claude Desjardins, Daniel Fiset & Stéphanie Cormier.
Department of Psychology, University of Québec in Outaouais.

Context.

Evaluating the pain experienced by someone else is a skill of high social and biological importance. Interestingly, an underestimation bias in pain judgments is often observed. The present study aims at investigating if the sensitivity to pain expressions and the tendency to underestimate pain is associated with the way an observer has encoded the appearance of facial expressions of pain in visual memory.

Method

73 White-Westerner participants (36 women; 37 men, from 19 to 36 years) were tested in two tasks: task 1 aimed at revealing their mental representation of pain facial expressions and task 2 aimed at measuring their sensitivity to varying level of pain and the magnitude of their pain estimation bias.

Task 1: Revealing the mental representations

- The Reverse Correlation technique was used[1]. Sinusoidal noise[2] varying randomly across trials was added over a base face expressing a low level of pain. See Figure 1 for the procedure to create a stimulus.
- The task consisted in judging to what degree a face embedded in visual noise corresponded to their representation of pain expressions (500 trials; see Figure 2)

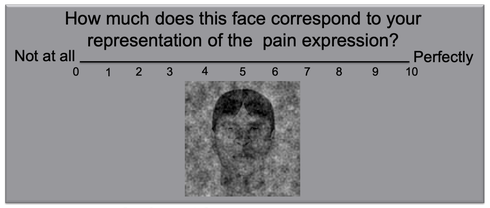

Figure 2. Example of one trial.

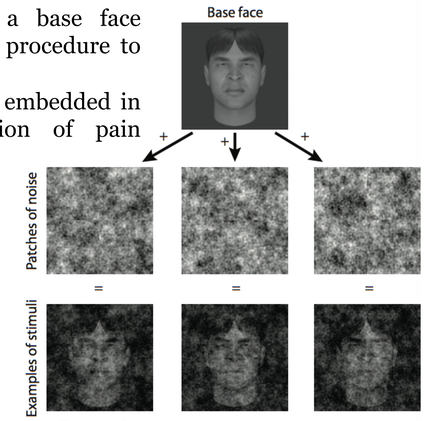

Figure 1. Procedure to create a stimulus.

Task 2: Measuring the sensitivity and the magnitude of the estimation bias at estimating pain

- 30 videos of individuals experiencing pain were selected from the UNBC-McMaster Shoulder Pain Expression Archive Database[3].
- Videos of 10 individuals, with 3 levels of pain per individual.
- Videos were presented in a random order. Participants had to estimate the level of pain experienced by the individual using a 0«none» to 10 « worst possible pain» scale.

References

1. Eckstein, M. P., & Ahumada, A. J. (2002). Classification images: A tool to analyze visual strategies. *Journal of vision*, *2*(1), i-i.
2. Mangini, M. C., & Biederman, I. (2004). Making the ineffable explicit: Estimating the information employed for face classifications. *Cognitive Science, 28(2),* 209-226.
3. Lucey, P., Cohn, J. F., Prkachin, K. M., Solomon, P. E., & Matthews, I. (2011, March). Painful data: The UNBC-McMaster shoulder pain expression archive database. In Face and Gesture 2011 (pp. 57-64). IEEE.
4. Chauvin, A., Worsley, K. J., Schyns, P. G., Arguin, M., & Gosselin, F. (2005). Accurate statistical tests for smooth classification images. Journal of Vision, 5, 659-667.

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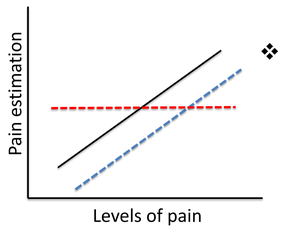
Analyses and results

- A classification image (CI) was created for each participant by calculating the weighted sum of all of the noise patches presented during task 1, using the pain ratings as weights. See Figure 3.

Figure 3. Examples of CIs obtained with three participants.



❖ The sensitivity and estimation bias were not correlated, r=0.13, p=0.27.

Figure 4. Hypothetic pattern of results to illustrate the pain estimation measures. Black line represent the estimations provided by the sufferer; Blue and red lines the ones provided by two different observers. In this scenario, the "blue" observer has an underestimation bias, but is sensitive to changes in pain intensities. The "red" observer has no estimation bias but is not sensitive to changes in pain intensities.

- Based on the ratings of each video in Task 2, two pain estimation measures were calculated. 1) <u>Sensitivity to varying levels of pain:</u> average absolute difference between the slope of estimations provided by the individuals experiencing pain (e.g. black line on Figure 4) and the slope of estimations provided by the participant viewing the videos (e.g. blue and red dotted line on Figure 4). 2) <u>Magnitude of estimation bias:</u> difference between the average pain estimations provided by the individuals experiencing pain and the ones provided by the participant viewing the video.

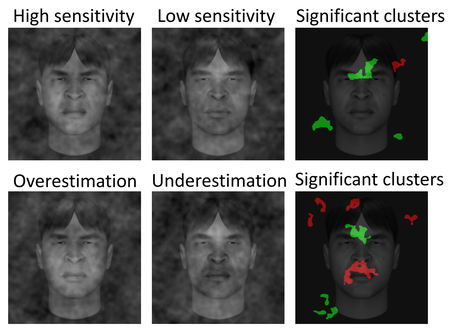


Figure 5. Top row shows the association between sensitivity to varying pain levels and mental representation. Green clusters: the higher the sensitivity, the darker this region was in mental representations. ***Bottom row*** shows the association between pain estimation biases and the mental representation of pain. Green clusters: the higher the estimation bias value, the darker this region was in mental representations. Red clusters: the higher the estimation bias value, the lighter this region was in mental representations.

- To verify the presence of an association between the mental representation of pain and 1) the sensitivity or 2) the estimation bias, pixel-by-pixel correlations were calculated. The Stat4CI Cluster test[4] was used to calculate a statistical threshold, taking into account multiple tests (t_{crit}=2.3, k=130 ,p<0.025). See Figure 5 for the correlation CIs. In Figure 5, the left and middle panels are mathematical inverse, highlighting either how the mental representations of highly sensitive or overestimators looked like (left panels), or how the mental representations of low sensitive or underestimators looked like.

Discussion

- The results suggest that the ability to perceive differences in pain intensities is not correlated with the estimation bias, suggesting that a sensitive individual could either overestimate, underestimate, or have no bias.
- The more sensitive an individual is, the more salient the brow lowering feature is in their mental representation.
- A stronger tendency to underestimate pain is associated with a mental representation in which the upper lip raising feature is salient but the brow lowering feature is almost inexistent.
- Together, these results suggest that an individual accuracy at estimating the pain experienced by another is in part determined by the facial features they are expecting to see in the sufferer's face.

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