



Gender-specific distinctions in encoding and decoding pain through facial expressions

Arianne Richer¹, Camille Saumure², Daniel Fiset¹, Zoé Glardon² & Caroline Blais¹

1. Department of Psychoeducation and Psychology, University of Quebec in Outaouais, Canada
2. Department of Psychology, University of Fribourg, Switzerland

Context

Facial expressions play a crucial role in assessing others' affective states. However, pain facial expressions (PFE) encounter challenges in recognition, often being confused with other negative affective states¹ and being less easily perceived in women's faces². Studies have identified various configurations of PFE³, but it remains unclear whether some of these configurations are more easily recognizable, potentially explaining disparities in perceived pain based on face gender. **This study investigates potential gender and sex differences in the configurations of PFE (encoding) as well as their perception by external observers (decoding).**

Method

We used 189 pictures (77 women) of White women and men posing PFE from the Delaware Pain Database (DPD)⁴.

Decoding: To verify if PFE are decoded differently as a function of face gender, we used averaged ratings (~44 observer's ratings / picture) previously collected and openly available within the DPD.

Task : 7-point Likert-type sliders (e.g., "How much does this face look like it is in physical pain?", 1 = not at all; 7 = extremely).

Affective states we analyzed:

- Pain
- Anger
- Sadness
- Fear
- Joy
- Surprise
- Sadness



Figure 1. Examples of faces from the DPD

Encoding : To investigate potential differences in PFE encoding between women and men, we used OpenFace⁵ to measure the activation levels of 17 action units (AUs) in the 189 pictures extracted from the DPD.

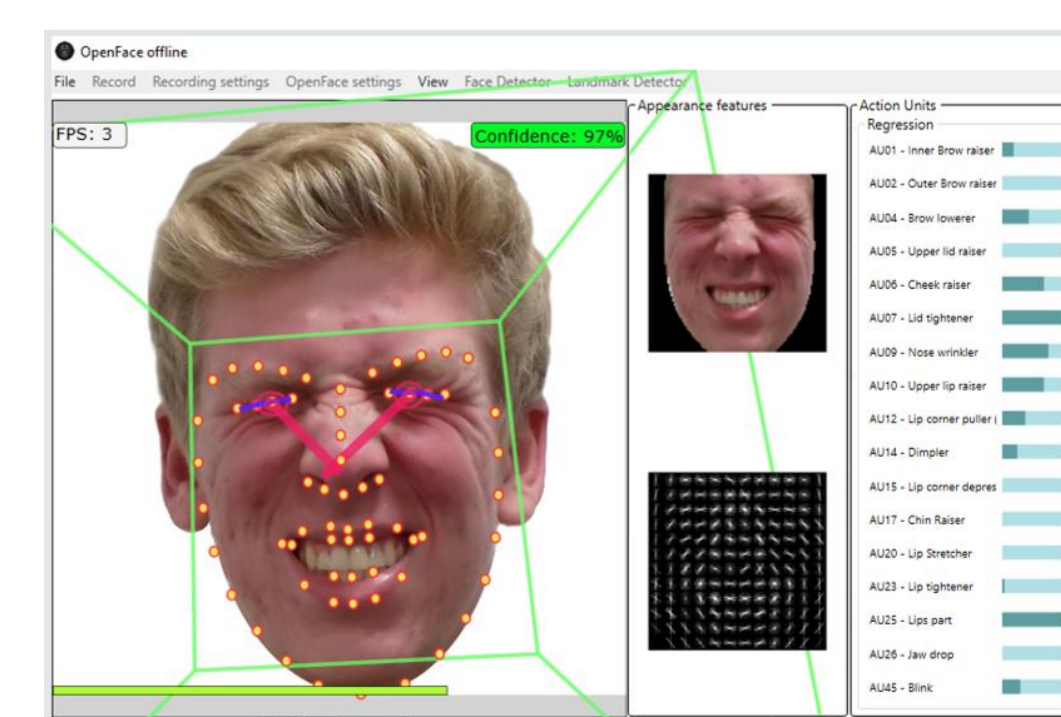


Figure 2. OpenFace pipeline including facial landmark disposition and action units' recognition.

References

1. Kappesser, J., & De Williams, A. C. (2002). Pain and negative emotions in the face: Judgements by health care professionals. *Pain*, 99(1), 197–206. [https://doi.org/10.1016/S0304-3959\(02\)00101-X](https://doi.org/10.1016/S0304-3959(02)00101-X)
2. Riva, P., Sacchi, S., Montali, L., & Frigerio, A. (2011). Gender effects in pain detection: Speed and accuracy in decoding female and male pain expressions. *European Journal of Pain*, 15(9). <https://doi.org/10.1016/j.ejpain.2011.02.006>
3. Kunz, M., & Lautenbacher, S. (2014). The faces of pain: A cluster analysis of individual differences in facial activity patterns of pain: Clustering facial expressions of pain. *European Journal of Pain*, 18(6), 813–823. <https://doi.org/10.1002/j.1532-2149.2013.00421.x>
4. Mende-Siedlecki, P., Qu-Lee, J., Lin, J., Drain, A., & Goharzaad, A. (2020). The Delaware pain database: A set of painful expressions and corresponding norming data. *Pain reports*, 5(6), e853. <http://dx.doi.org/10.1097/PR9.0000000000000853>
5. Baltrušaitis, T., Robinson, P., & Morency, L. P. (2016, March). Openface: an open source facial behavior analysis toolkit. In 2016 IEEE winter conference on applications of computer vision (WACV) (pp. 1-10). IEEE.

Results

Decoding

A 2 (genders) x 7 (affective states) mixed ANOVA:

Affective states [$F(3.8, 710.66)=55.08, p<.001, \eta^2_p=.23$]

Genders [$F(1, 187)=11.92, p<.001, \eta^2_p=.06$]

Interaction [$F(3.8, 710.66)=7.42, p<.001, \eta^2_p=.04$]

T-tests confirmed significantly higher perception of fear, sadness and surprise in PFE of women than men, while pain is significantly more perceived in PFE of men.

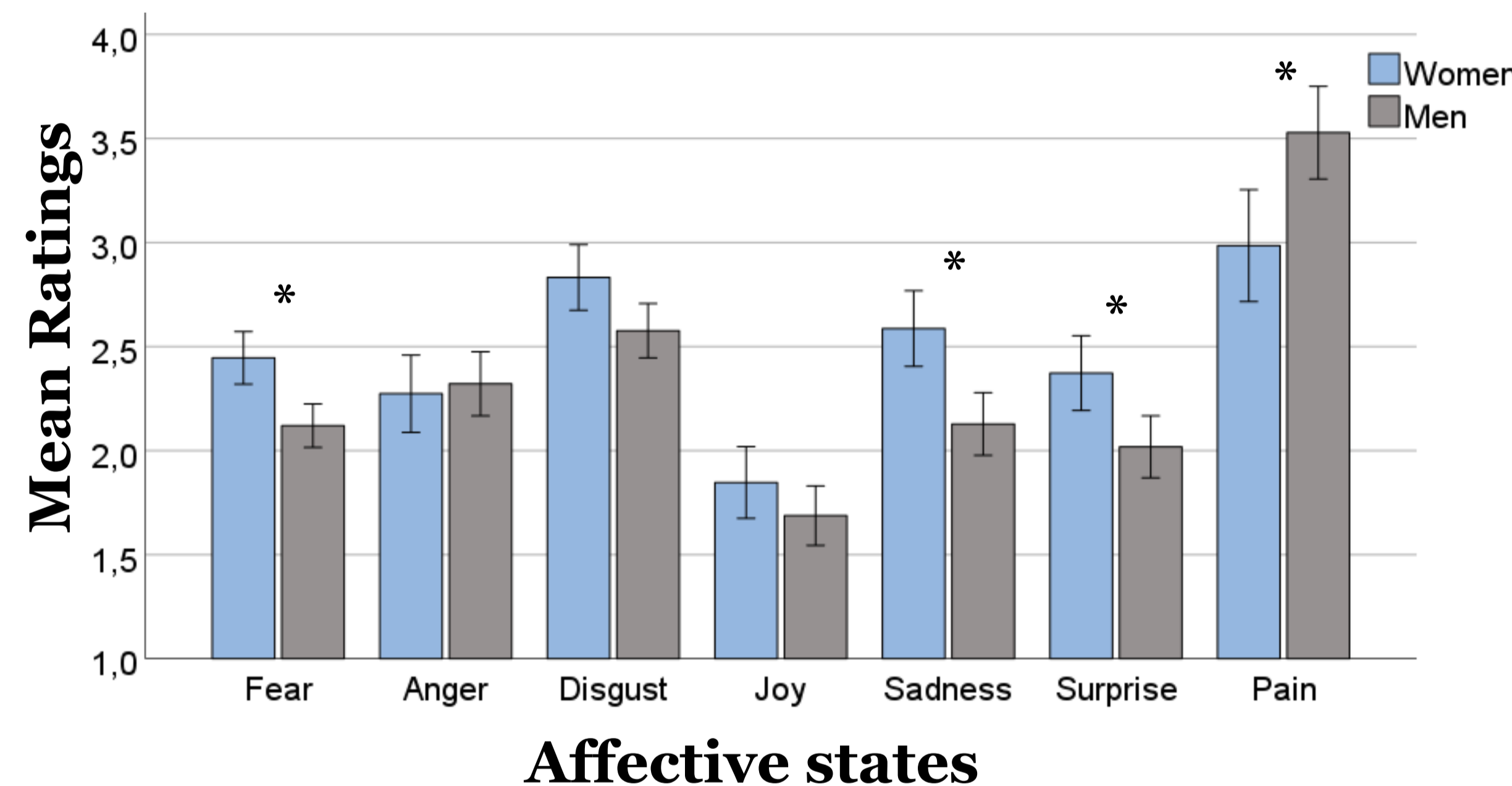


Figure 3. Bar graph representing the degree to which each affective states were perceived in PFE of women and men. Error bars represent the 95% confidence intervals.

Linear regression models

We conducted four linear regression models, one for each affective state with significant decoding differences. We examined whether AUs components and gender predict the decoding of affective states in PFE.

Summary of the four linear regression models results conducted on significant affective states

Affective States	Components					Gender
	1	2	3	4	5	
Fear		.17 (.02)				.31 ($<.001$)
Sadness					.29 ($<.001$)	.30 ($<.001$)
Surprise		.65 ($<.001$)	.13 (.02)	.14 (.01)		.17 (.003)
Pain	.53 ($<.001$)	.27 ($<.001$)		.29 ($<.001$)		

Figure 5. Table showing significant results of linear regression models conducted on the four affective states where significant differences were found. P value is presented in parentheses under the coefficients β .

Encoding

A Principal Component Analysis (PCA) revealed five components of AUs with correlated activations. *T*-tests showed that the first component was significantly more present in men's faces, with no significant differences in other components. Notably, the first component gathers AUs typically associated with PFE.

Summary of PCA results for AUs extracted from OpenFace

Action Units	Components				
	1	2	3	4	5
AU1	-.238	.661	.002	.202	.074
AU2	-.180	.807	-.033	.015	-.058
AU4	.352	-.325	.122	.539	-.028
AU5	-.174	.833	.004	-.103	-.080
AU6	.927	-.185	-.072	-.064	.077
AU7	.782	-.274	.085	.125	-.193
AU9	.757	-.278	.042	.185	-.276
AU10	.880	-.137	-.125	.106	.025
AU12	.756	.019	-.303	-.297	.322
AU14	.704	-.173	.182	-.071	.378
AU15	-.081	.067	.589	.267	.088
AU17	-.085	-.062	.881	.052	.046
AU20	.030	-.029	.083	.049	.881
AU23	.258	.017	.740	-.107	.034
AU25	.362	.163	-.669	.402	.100
AU26	-.089	.290	-.042	.673	-.012
AU45	.003	-.375	.044	.457	.357

Figure 4. Table showing loadings for the 17 AUs on the five components extracted from the PCA. Factor loadings over .40 appear in bold.

Discussion

- Our results revealed that observers tend to perceive more fear, sadness and surprise in PFE of women, while they perceive more pain in men's PFE.
- We also found that AUs typically associated with PFE tend to be more present in men's PFE.
- Finally, we found that activation of certain AUs drive the observer's perception of affective states in PFE, but beyond that, the gender of the face itself exacerbate perception of fear, sadness and surprise in women's PFE.
- These results highlight the need to raise awareness of disparities in pain perception as they might lead to lack of care in the medical field.