Gender differences in the encoding and decoding of pain facial expressions

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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 states[1] and being less easily perceived in women's faces[2]. Studies have identified various configurations of PFE[3], 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 OpenFace[5] to measure the activation levels of 17 action units (AUs) in the 189 pictures extracted from the DPD.

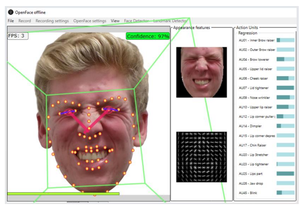

Figure 2. OpenFace pipeline including facial landmark disposition and action units' recognition.

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.

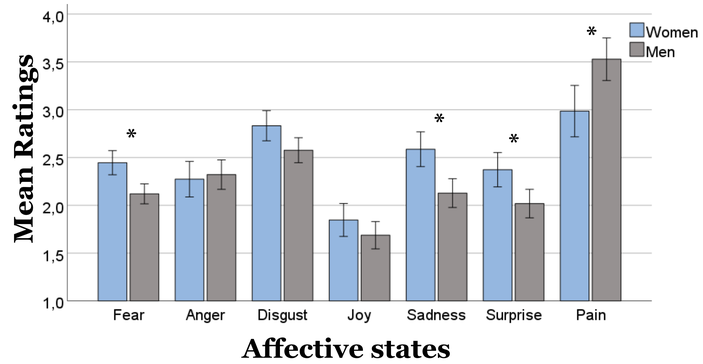

Figure 3. Bar graph representing the degree to which each affective states were perceived in PFE of women and men. Error bars represent the 95% confidence intervals.

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		.16 (.02)				.31 (<.001)
Sadness					.28 (<.001)	.30 (<.001)
Surprise		.66 (<.001)	.12 (.02)			.17 (.003)
Pain	.51 (<.001)	.27 (<.001)		.34 (<.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.

A) Summary of PCA results for AUs extracted from OpenFace

Action Units	Components				
	1	2	3	4	5
AU1	-,226	**,673**	-,022	,126	,072
AU2	-,183	**,816**	-,031	-,066	-,081
AU4	,300	-,285	,108	**,599**	-,077
AU5	-,158	**,820**	,006	-,186	-,046
AU6	**,927**	-,207	-,101	-,020	,032
AU7	**,761**	-,283	,074	,175	-,246
AU9	**,729**	-,252	,029	,265	-,340
AU10	**,880**	-,128	-,133	,148	-,048
AU12	**,791**	-,004	-,287	-,281	,295
AU14	**,736**	-,171	,158	-,027	,333
AU15	-,106	,076	**,612**	,304	,045
AU17	-,111	-,038	**,888**	,090	,020
AU20	,009	-,046	,102	,119	**,893**
AU23	,280	,001	**,754**	-,154	,097
AU25	,377	,193	**-,666**	,357	,050
AU26	-,047	,396	-,031	**,632**	,028
AU45	,002	-,337	-,012	**,543**	,248

B)

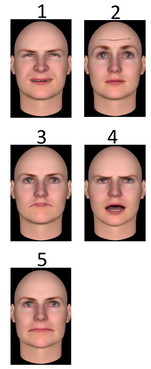

Figure 4. A) Table showing loadings for the 17 AUs on the five components extracted from the PCA. Factor loadings over .40 appear in bold. **B)** Visual representation of the expression configurations when activating the AUs reaching a loading greater than .40 in each of the five components revealed by the PCA. A White androgynous avatar face produced with FaceGen was used.

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.

References

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