Investigating Sex-Based Differences in Encoding the Facial Expression of Pain

Arianne Richer[1*], Daniel Fiset[1], Roberto Caldara[2], Camille Saumure[2] & Caroline Blais[1]

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

* rica30@uqo.ca

Introduction

Facial expressions of affective states are crucial for assessing others' affective states. However, the facial expression of pain (FEP) is poorly recognized, often confused with other negative affective states[1] and less easily perceived in women's faces[2]. Studies have revealed various action units (AUs) configurations of FEP[3]. Yet, it is unclear whether some of these configurations occur more frequently in one sex than the other; such differences may, in part, explain the disparities in perceived pain as a function of face gender. **This study explored potential biological sex differences in the AUs configurations during the production of the FEP (pain encoding) in *posed* and *genuine* stimuli.**

Method

We used videos of posed and genuine FEP of White men and women from the Denver Pain Authenticity Stimulus Set (D-PASS)[4] and the Pain E-motion Faces Database (PEMF)[5].

D-PASS:

Posed F1 (unrehearsed) FEP: 56 videos (26 women).
Genuine FEP: 56 videos (same identities).
Posed F2 (rehearsed) FEP: 56 videos (same identities).

PEMF:

Posed FEP: 55 videos (38 women).
Genuine FEP: 55 videos (same identities).

Encoding :

To investigate potential differences in FEP encoding between men and women, we used OpenFace[6] to define the activation levels of 17 AUs in the 278 videos extracted from the D-PASS and PEMF.

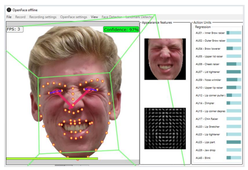

Figure 1. OpenFace pipeline including facial landmark disposition and action units' recognition.

Results

D-PASS

All 2D Principal Component Analyses (PCAs) revealed 6 components of AUs with correlated activations.

Posed F1: *T*-tests showed that the 1st component was significantly more present in men's FEP compared to women's, while the 2nd was significantly more present in women's FEP compared to men's.

Genuine: *T*-test showed that the 3rd component was significantly more present in women's FEP compared to men's while the 5th one was significantly more present in men's compared to women's.

Posed F2: *T*-tests showed that the 4th component was significantly more present in women's FEP compared to men's.

Action Units	Components																	
	1			2			3			4			5			6		
	F1	G	F2	F1	G	F2	F1	G	F2	F1	G	F2	F1	G	F2	F1	G	F2
AU1	-0,02	0,01	-0,01	0,00	-0,02	0,03	0,09	0,10	0,10	-0,02	-0,03	-0,01	-0,05	0,01	0,08	0,02	0,03	0,06
AU2	0,00	0,00	-0,01	0,00	0,00	0,01	0,02	0,03	0,01	-0,01	0,01	0,00	0,01	0,00	0,02	0,02	0,03	0,03
AU4	-0,25	0,12	-0,18	-0,07	**0,41**	-0,38	0,14	**0,40**	0,38	**0,90**	**0,47**	**0,66**	-0,10	**-0,40**	-0,25	0,17	-0,22	0,25
AU5	0,00	0,00	0,01	0,01	-0,01	0,01	-0,01	-0,01	-0,01	-0,01	0,00	0,00	-0,02	0,00	0,00	0,00	0,02	0,01
AU6	**-0,50**	**0,50**	**-0,49**	0,06	-0,03	0,07	-0,07	-0,07	-0,08	-0,05	-0,07	0,02	0,12	0,05	0,07	-0,08	-0,23	-0,08
AU7	**-0,59**	**0,55**	**-0,64**	**-0,65**	**0,63**	**-0,54**	0,21	-0,07	-0,01	-0,23	-0,16	**-0,40**	-0,08	0,27	0,02	0,10	0,21	-0,09
AU9	-0,05	0,05	-0,05	-0,02	0,02	-0,01	0,07	0,03	0,01	0,01	-0,09	0,01	0,01	-0,03	0,02	-0,04	0,03	0,01
AU10	-0,32	0,37	-0,32	0,18	-0,13	0,19	-0,05	0,04	-0,04	0,00	0,13	0,35	0,24	-0,16	-0,01	**-0,77**	-0,23	0,04
AU12	-0,32	**0,43**	-0,34	0,36	**-0,46**	0,37	-0,15	-0,20	-0,14	-0,28	-0,23	0,00	0,09	0,00	0,27	**0,57**	-0,16	-0,08
AU14	-0,36	0,30	-0,31	**0,54**	**-0,44**	**0,57**	-0,16	0,27	0,10	0,11	**0,52**	0,16	-0,18	0,00	-0,25	0,03	0,29	-0,04
AU15	0,00	0,01	0,00	0,00	0,00	0,02	-0,01	0,03	0,01	-0,01	0,01	-0,04	-0,10	0,05	-0,06	-0,03	0,06	0,07
AU17	-0,05	0,05	-0,07	0,02	-0,07	0,17	-0,05	0,17	0,17	-0,12	0,12	**-0,45**	**-0,77**	0,35	**-0,58**	-0,16	**0,54**	0,38
AU20	-0,01	0,01	-0,01	0,03	-0,01	0,04	0,01	0,05	0,08	-0,01	-0,01	-0,06	-0,16	0,02	-0,06	-0,02	0,05	0,01
AU23	-0,01	0,02	-0,02	0,01	0,01	0,04	0,01	0,04	0,02	-0,04	0,02	-0,07	-0,33	0,16	-0,14	-0,05	0,19	0,06
AU25	-0,05	0,11	-0,06	0,00	0,00	0,03	0,06	-0,12	-0,04	-0,05	-0,29	0,00	0,23	**-0,73**	**0,57**	0,00	**0,40**	**0,67**
AU26	-0,01	0,05	-0,02	0,06	0,01	0,07	0,02	0,00	0,11	-0,06	-0,08	-0,13	-0,30	-0,23	0,00	-0,09	**0,44**	**0,49**
AU45	0,01	0,01	0,01	0,32	-0,09	0,13	**0,93**	**0,81**	**0,87**	-0,12	**-0,55**	-0,18	0,00	0,04	0,33	0,00	-0,09	-0,24

Figure 2. Table showing loadings for the 17 AUs on the six components for F1, G (genuine) and F2 FEPs extracted from the 2D PCAs in the D-PASS. Factor loadings over .40 appear in bold dark blue.

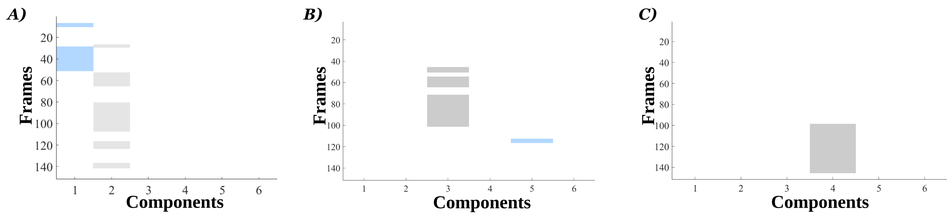

Figure 3. Graphs representing clusters of significant components across 150 frames for **A)** F1, **B)** genuine and **C)** F2 FEPs for the D-PASS. Gray clusters indicate components significantly more present in women's FEP, while blue clusters indicate those more present in men's FEP.

PEMF

All 2D PCAs revealed 6 components of AUs with correlated activations.

Genuine: *T*-test showed that the 6th component was significantly more present in women's FEP compared to men's.

Posed: *T*-test showed that the 5th and 6th components were significantly more present in women's FEP compared to men.

Action Units	Components											
	1		2		3		4		5		6	
	Genuine	Posed	Genuine	Posed	Genuine	Posed	Genuine	Posed	Genuine	Posed	Genuine	Posed
AU1	0,01	0,03	-0,01	0,04	0,03	0,02	0,00	0,03	-0,04	-0,01	0,30	0,15
AU2	0,01	0,01	0,00	0,01	0,01	0,01	0,01	0,02	-0,01	0,01	0,15	0,08
AU4	-0,26	-0,19	**-0,84**	**-0,94**	0,16	0,07	0,35	0,00	0,25	0,17	-0,03	0,19
AU5	0,01	0,01	0,00	0,01	0,00	0,01	0,00	0,02	-0,01	-0,01	0,03	0,05
AU6	**-0,45**	**-0,48**	0,15	0,14	-0,09	-0,03	-0,15	-0,04	0,14	0,16	0,02	0,19
AU7	**-0,66**	**-0,61**	-0,10	0,02	-0,11	**-0,62**	**-0,43**	0,17	-0,37	-0,32	0,00	-0,09
AU9	-0,01	-0,01	-0,01	0,00	-0,04	-0,01	0,03	-0,06	-0,02	-0,03	-0,01	-0,03
AU10	**-0,40**	**-0,44**	0,10	0,06	0,02	0,24	0,03	-0,20	0,23	0,37	0,07	**-0,50**
AU12	-0,26	-0,33	**0,42**	0,28	0,12	0,35	0,26	-0,06	**0,59**	0,26	0,21	**0,59**
AU14	-0,24	-0,24	0,25	-0,06	**0,40**	**0,65**	**0,61**	0,23	**-0,54**	**-0,65**	-0,20	-0,19
AU15	0,01	0,01	-0,01	0,03	0,04	0,01	-0,02	0,04	-0,04	-0,05	0,09	0,07
AU17	0,03	0,00	-0,05	0,01	0,12	-0,03	0,06	0,09	-0,21	-0,25	**0,57**	**0,45**
AU20	0,00	0,00	0,00	0,01	0,01	0,01	0,00	-0,01	-0,02	-0,01	0,01	0,01
AU23	0,00	-0,01	-0,02	0,00	0,04	0,00	-0,01	0,04	-0,01	-0,02	0,06	0,02
AU25	-0,08	-0,04	0,04	-0,04	**-0,81**	-0,03	**0,45**	**-0,86**	-0,04	-0,29	-0,13	0,04
AU26	0,00	0,01	-0,06	-0,01	-0,32	-0,05	0,12	-0,32	-0,20	-0,26	**0,49**	0,14
AU45	0,01	0,02	-0,01	0,00	0,06	0,09	0,10	-0,13	-0,02	0,09	**0,45**	-0,16

Figure 4. Table showing loadings for the 17 AUs on the six components for genuine and posed FEPs extracted from the 2D PCAs in the PEMF. Factor loadings over .40 appear in bold dark blue.

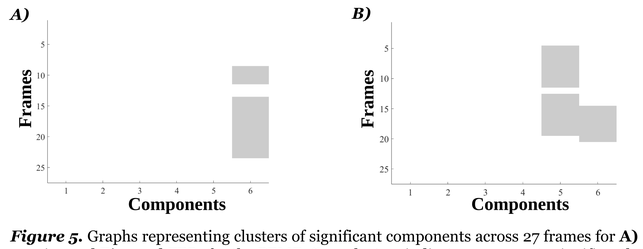

Figure 5. Graphs representing clusters of significant components across 27 frames for **A)** genuine and **B)** posed FEPs for the PEMF. Gray clusters indicate components significantly more present in women's FEP.

Discussion

- Our data show that all components include **AUs typically associated with the FEP**[7]. However, **components differ between posed and genuine FEP,** indicating that individuals use distinct AUs when posing versus genuinely expressing pain.
- Some components were significantly more present in **men's and women's FEP in the D-PASS**, while differences emerged only in **women's FEP in the PEMF**. In the D-PASS we found that the components that were significantly more present in **men's FEP predominantly involve AUs around the mouth region,** whereas components significantly more present in **women's FEP primarily include AUs around the eye region**. In the PEMF, however, components occurring significantly more in **women's FEP mainly involve AUs around the mouth region**.
- It is important to consider methodological differences between the creation of the two databases. Notably, the D-PASS includes longer clip durations showing facial expressions before and after FEP, whereas the PEMF contains short clips showing only **the most potent FEP**. As a result, the methodology used in the D-PASS may have introduced noise, potentially contributing to the differences observed between the databases.
- These findings highlight the importance of considering the **participant's sex**, the **context of the pain expression** (posed or genuine), and the **database** used when interpreting FEP in scientific research.

References

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