ELECTROCORTICAL RESPONSES TO EMOTIONAL FACIAL EXPRESSIONS

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BACKGROUND

Given its high temporal resolution, brain potentials related to events (ERP) potentially allow the evaluation of the time-course of facial expression processing states (Itier & Neath-Tavares, 2017), but still, the neural signatures for facial expressions remain under debate. Several components of the ERPs might be sensitive to the emotional content of the faces:

- The P1 (~80–120ms post-stimulus onset at occipital sites), and its negative counterpart N1, reflect early selective attention and low-level stimulus properties (i.e. color, luminance – Johannes et al., 1995). Evidence about emotional modulation of the P1 during face viewing is mixed, with some studies reporting enhanced P1 for fearful compared to neutral and happy faces (e.g., Batty & Taylor, 2003) and others do not (Vuilleumeier & Pourtois, 2007).

- The N170 (~130–200 ms post-stimulus onset at occipito-temporal sites) and its positive counterpart VPP, are the earliest indicator of face processing (Rossion, 2014; Rossion & Jacques, 2012 for a review), though its sensitivity to emotion in faces is still under debate (Hinojosa, Mercado & Carretié, 2015). Thus, enhanced N170 for fearful compared to neutral and happy expressions have been found in some studies (e.g., Blau et al., 2007) —sometimes related to a right-hemisphere advantage (cf. Wronka & Walentowska, 2011) —but not in others (e.g., Eimer et al. 2003; Rellecke et al., 2013).

- The LPP (beginning ~300 ms post-stimulus onset at central-parietal sites) is associated with sustained attention to motivationally-salient stimuli –whether pictures, words or faces (Cuthbert el al., 2000; Hajcak, Weinbwerg, MacNamara & Foti, 2012).

AIM

To investigate with dense-array ERP recordings the time-course of emotional facial expression processing using three electrophysiological indices: P1, N170 and LPP.
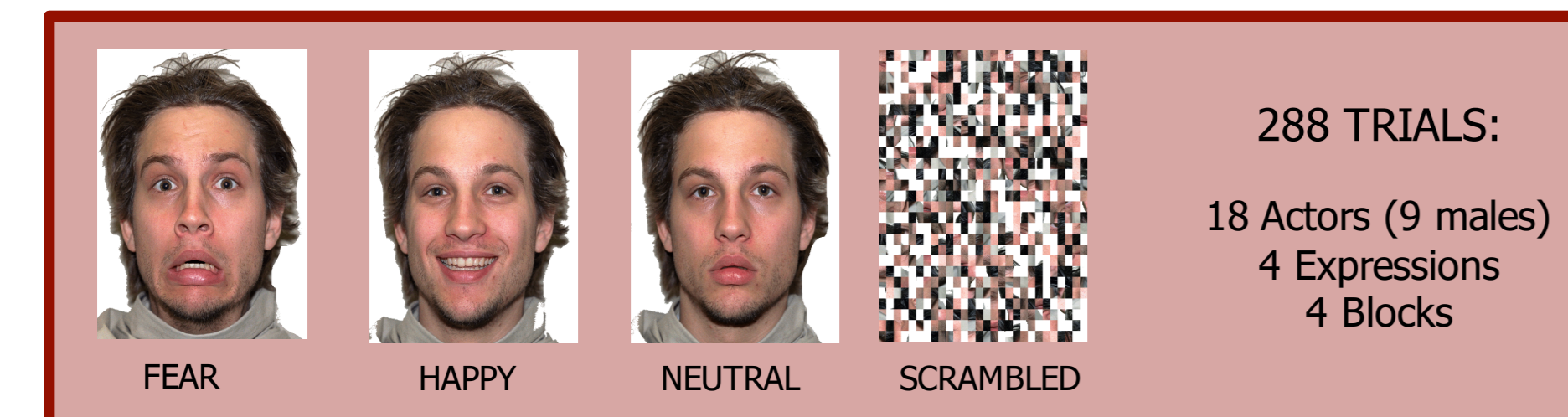
METHOD

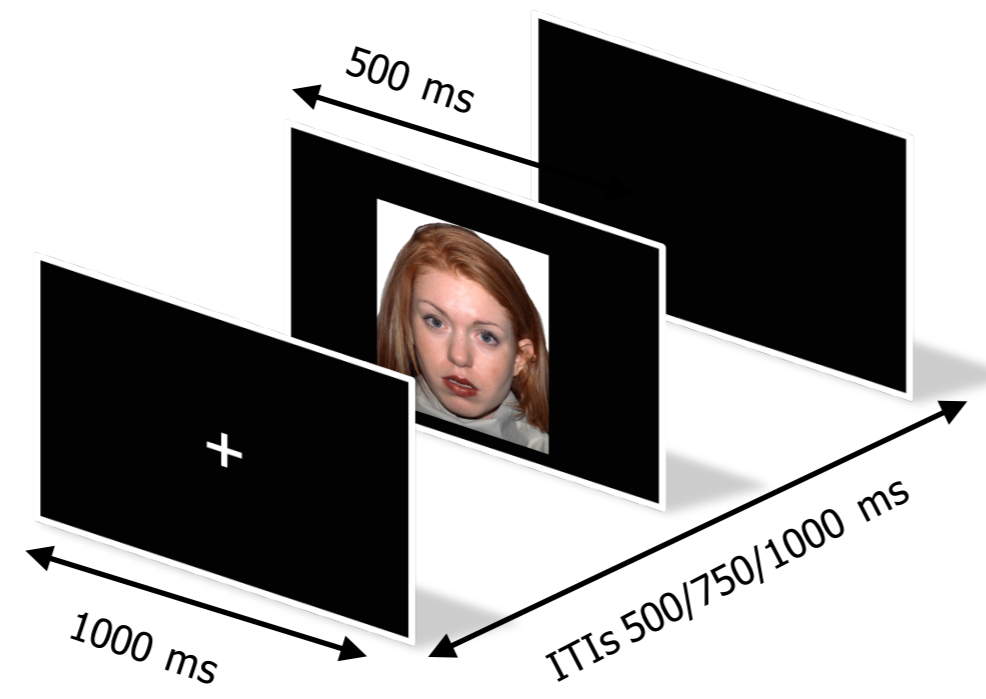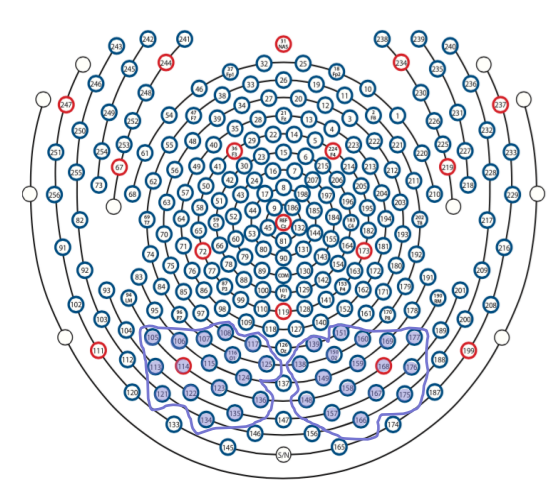### Design

Participants:

127 undergraduates (95 females)

Pseudorandom order
Restriction:
No more than two consecutive presentation of the same actor and/or emotional expression

Stimuli: Faces of NimStim (Tottenham et al., 2009)

FEAR   HAPPY   NEUTRAL   SCRAMBLED

288 TRIALS:
18 Actors (9 males)
4 Expressions
4 Blocks

500 ms / 1000 ms / ITIs 500/750/1000 ms

Data acquisition and analyses

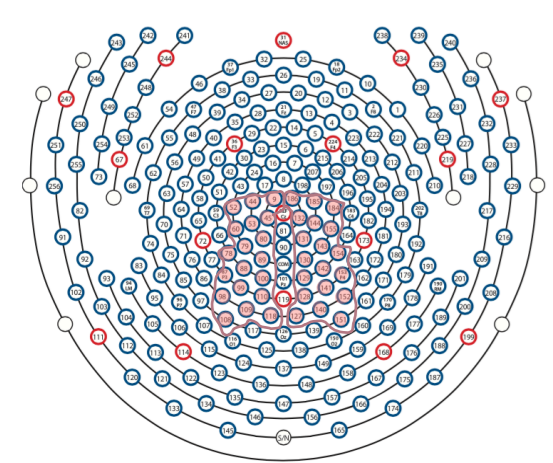> Analog filters: 0.1 - 100 Hz bandpass; digitized at 250 Hz with a 24-bits A/D converter

> Epochs: -500 to 1000 ms

> Baseline correction: -500 to 0 ms
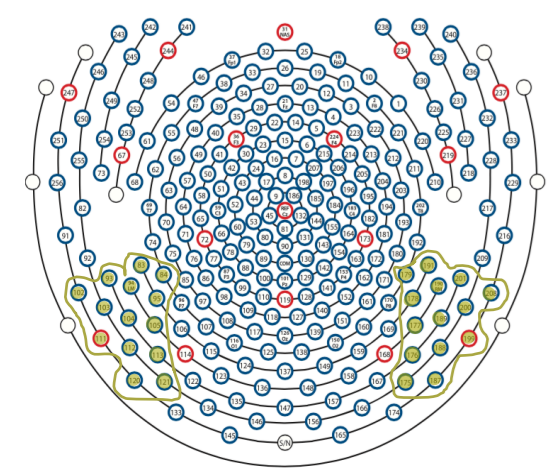
> Dependent variables (DVs):

- P1: 90 - 110 ms peak amplitude at POz clusters (left and right)
- N170: 130 - 150 ms peak amplitude at TOz (left and right)
- LPP: 600 - 1000 ms mean amplitude at CPz (left and right)

256–Channel HCGSN

Statistical analyses

- A 4 (**Emotion:** Fear, Happy, Neutral, Scrambled) x 2 (**Laterality:** Left, Right) repeated measures ANOVA on each DV
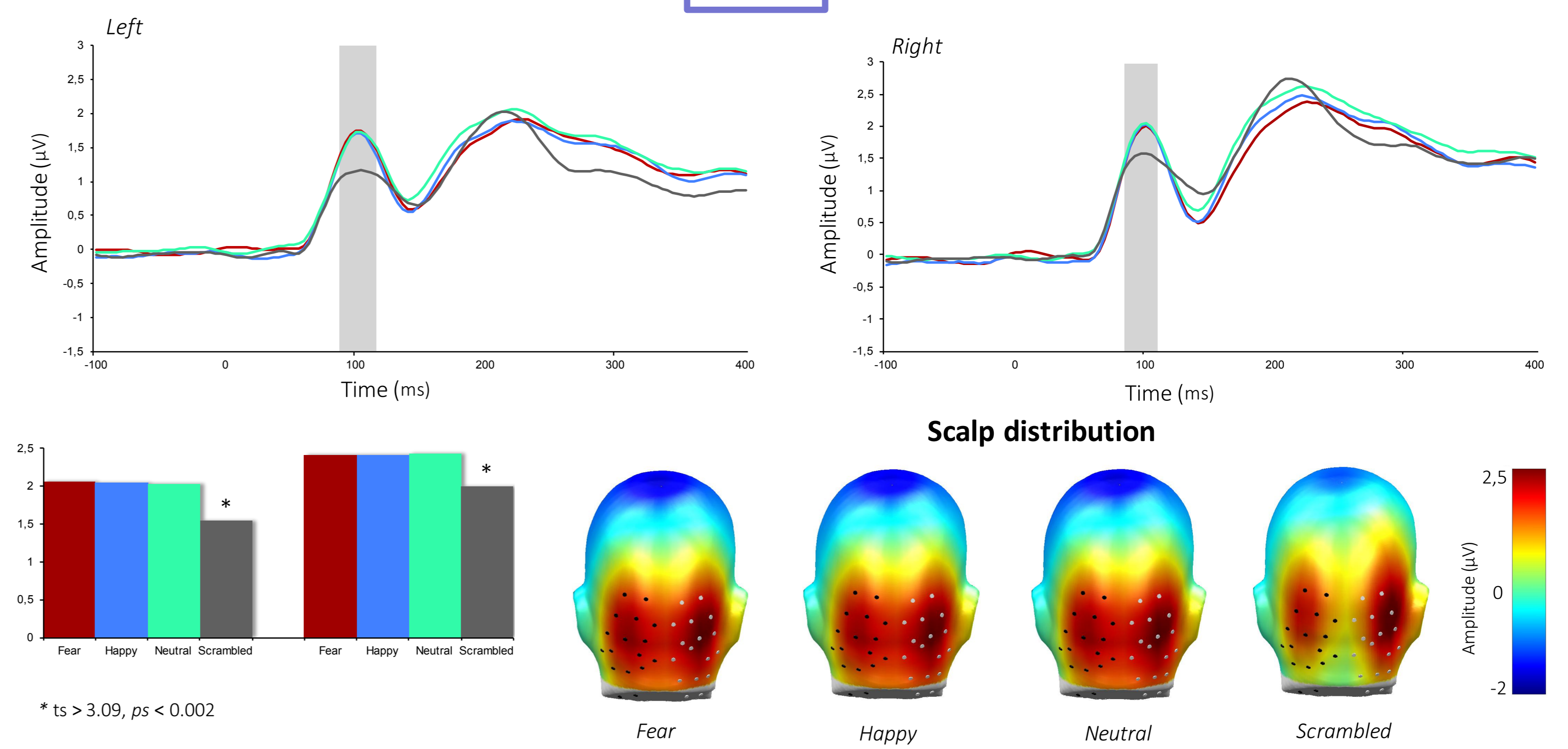
CONCLUSIONS

The three ERP components studied are sensitive to different aspects of perceptual processing of emotional faces:

- The P1 amplitude is greater for the **faces** than the scrambled stimuli and this effect is greater over the **right hemisphere**, confirming that P1 is a sensitive component, specifically, to the low-level structural properties of the stimuli (Johannes et al., 1995).

- The N170 face-specific ERP amplitude is greater for **faces** compared to scrambled stimuli and, importantly, larger for **fear** compared to the other facial expressions, being these effects greater over the **right hemisphere**. These results suggest that threat detection seems to be prioritised quickly in neural systems supporting emotion recognition (Calvo & Nummenmaa, 2016), also indicating a right-hemisphere advantage in perception and interpretation of emotional expressions (Adolphs et al., 1996).

- The LPP amplitude continues to show priority processing for **fear** over the other emotional expressions, suggesting that the facilitated motivated attention for fearful faces is maintained over time.
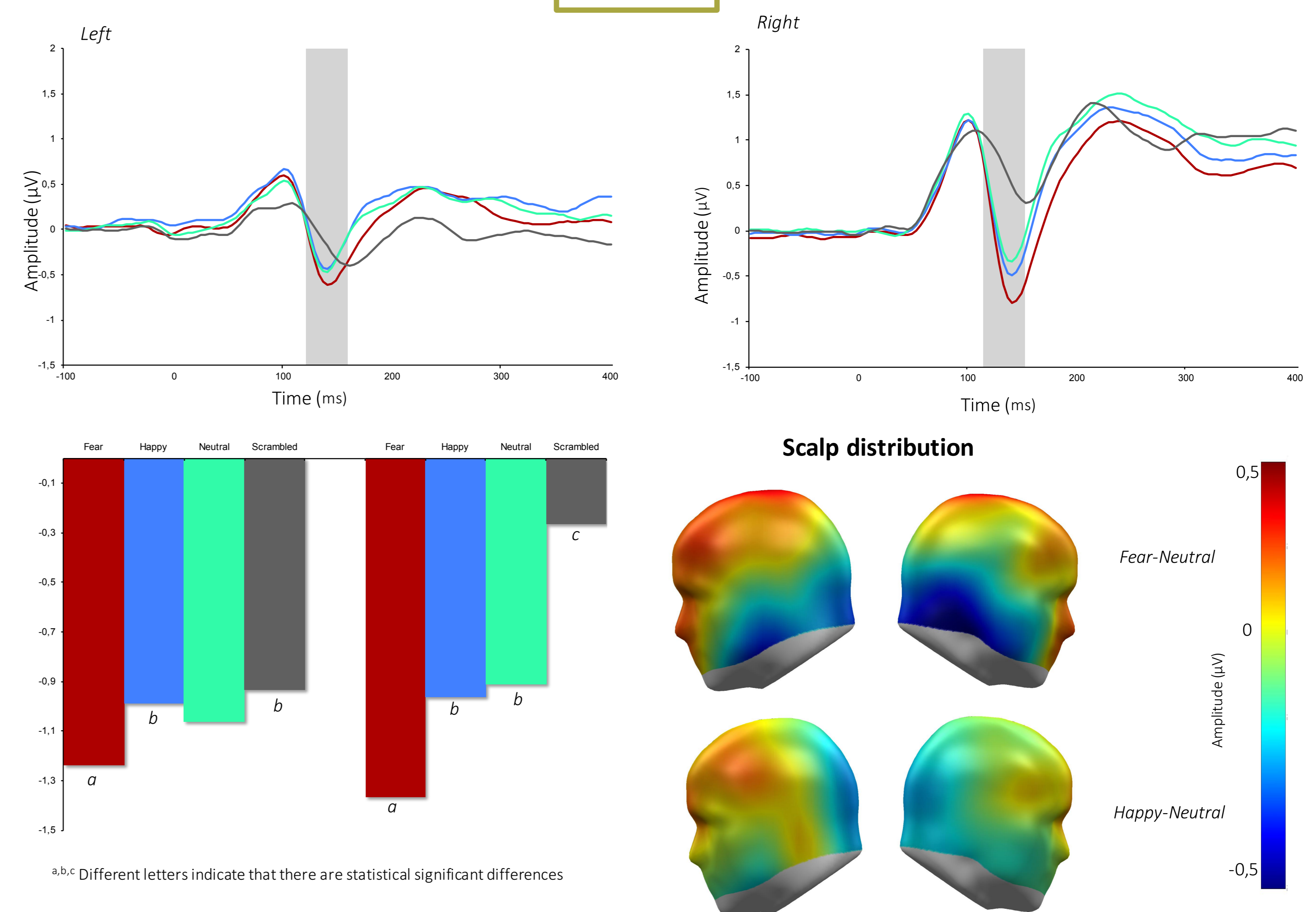
RESULTS

Fear / Happy / Neutral / Scrambled

P1

Left / Right

Scalp distribution

Fear   Happy   Neutral   Scrambled
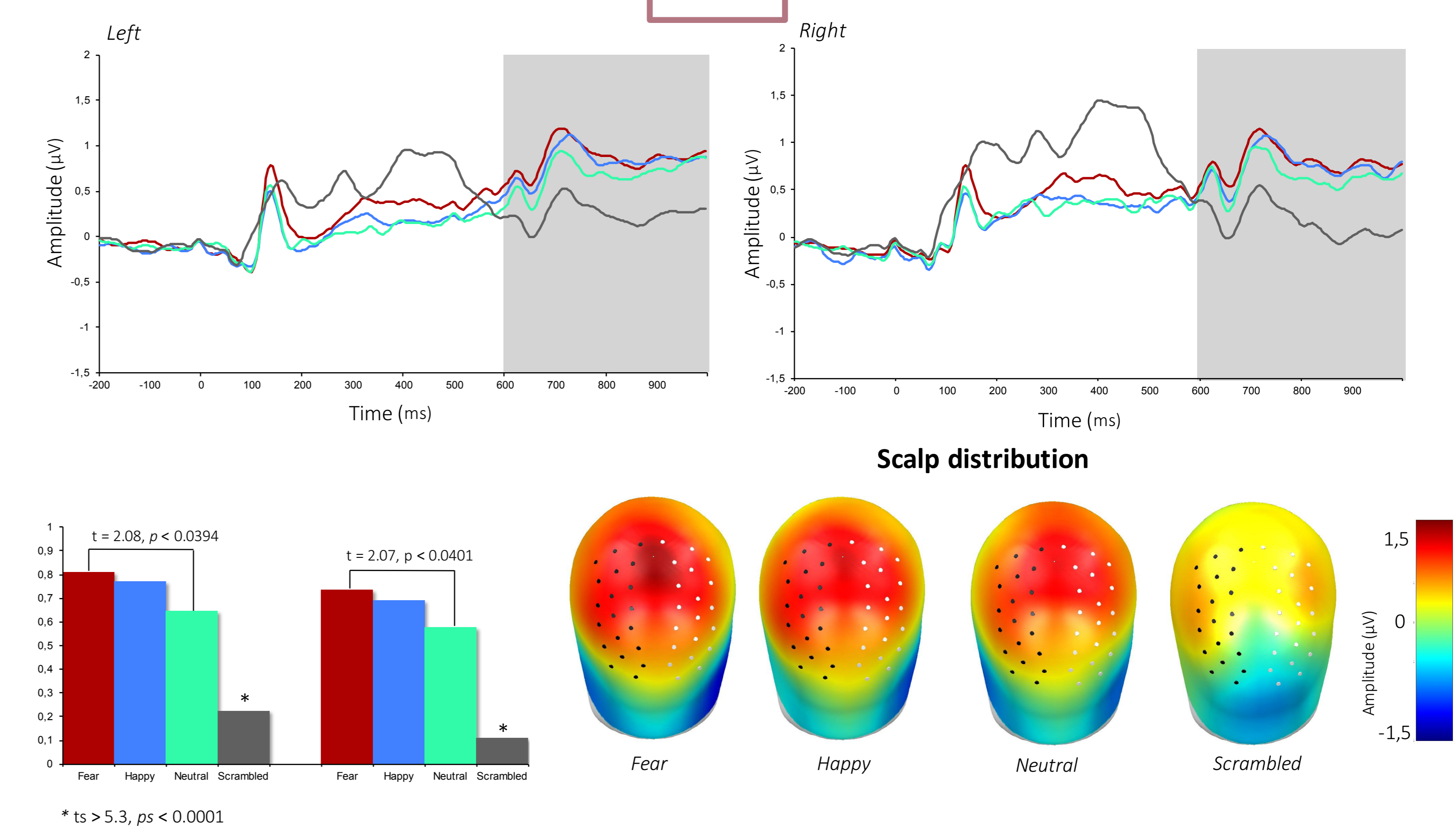
* ts > 3.09, ps < 0.002

P1 peak amplitude was larger for **Face** than for Scrambled stimuli (*Emotion*; $F_{3,378} = 13.435$, $p < 0.0001$, $\eta_p^2 = 0.096$) and overall larger over the **Right hemisphere** (*Laterality*; $F_{1,126} = 7.661$, $p < 0.006$, $\eta_p^2 = 0.017$)

N170

Left / Right

Scalp distribution

Fear   Happy   Neutral   Scrambled

Fear-Neutral

Happy-Neutral

a,b,c Different letters indicate that there are statistical significant differences

N170 peak amplitude was larger for **Face** compared to Scrambled stimuli and, importantly, larger for **Fear** compared to the other Facial expressions (*Emotion*; $F_{3,378} = 17.571$, $p < 0.0001$, $\eta_p^2 = 0.122$), being these effects greater over the **Right hemisphere** (*Emotion x Laterality*; $F_{3,378} = 9.128$, $p < 0.0001$, $\eta_p^2 = 0.068$).

LPP

Left / Right

Scalp distribution

t = 2.08, p < 0.0394   t = 2.07, p < 0.0401

Fear   Happy   Neutral   Scrambled

* ts > 5.3, ps < 0.0001

Fear   Happy   Neutral   Scrambled

LPP amplitude was larger for **Faces** than for Scrambled stimuli, and larger for **Fear** than for Neutral stimuli (*Emotion*; $F_{3,375} = 28,757$ $p < 0.0001$).

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