

**Sensorimotor-affective and cognitive components
of empathy for pain:
dissociable and selectively sensitive to different (social) cues**

The background of the slide features several oranges on a light-colored surface. One orange in the center is cut open, revealing its segments. Several other whole oranges are scattered around it, each with a sad face drawn on it using black marker. The faces have two dots for eyes and a curved line for a mouth. The overall image has a slightly grainy, artistic quality.

Paola Sessa

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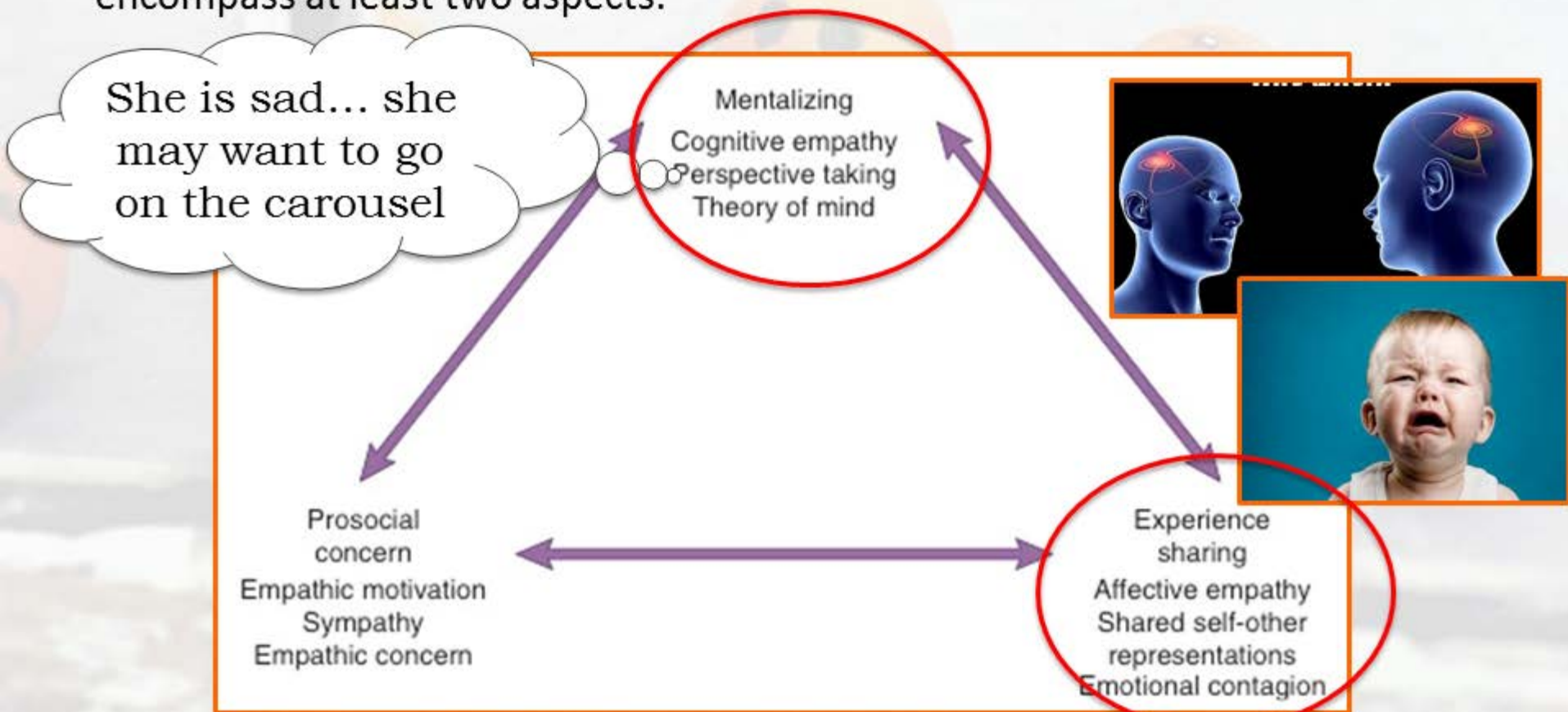
e-mail: paola.sessa@unipd.it

Federica Meconi, Shihui Han

In brief on the two-system model of empathy

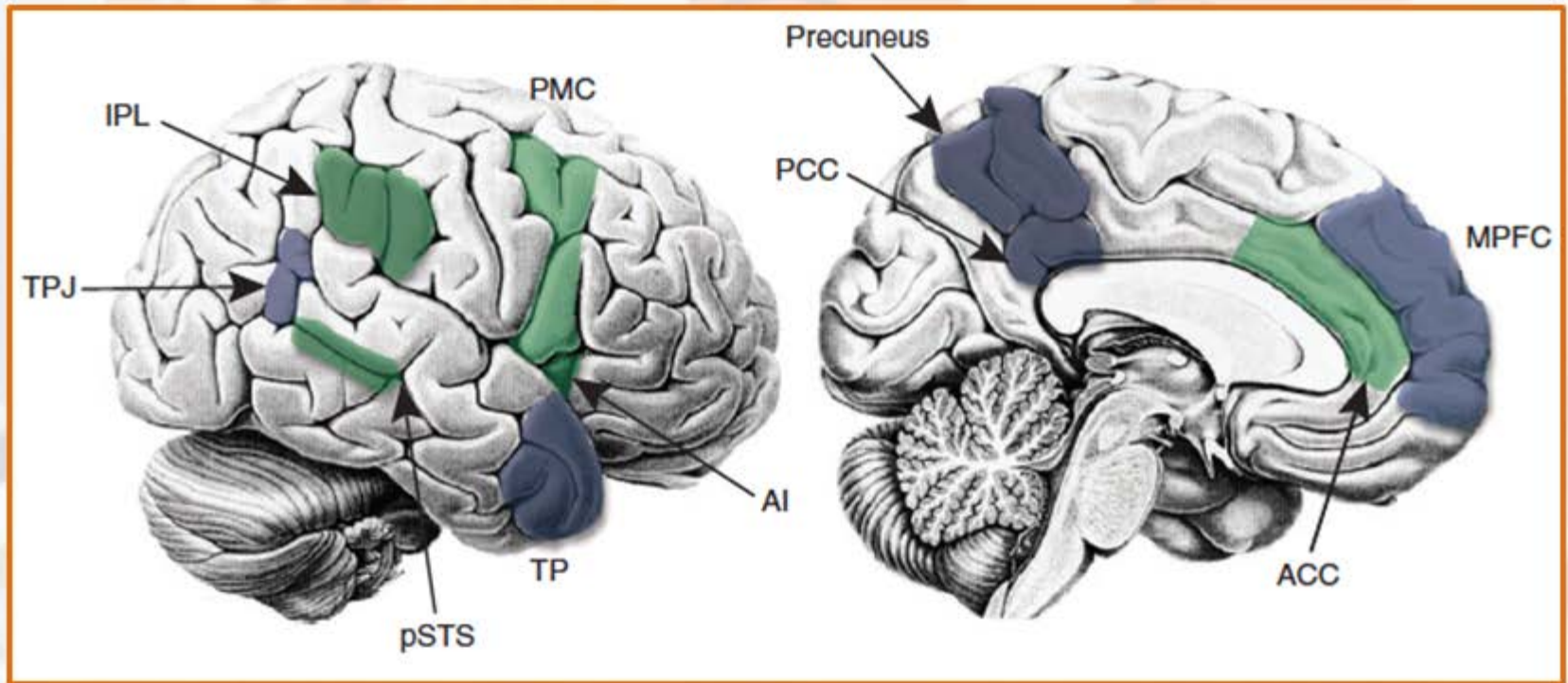
What is empathy?

Current theorizing agrees on the proposal that a definition of empathy must encompass at least two aspects.



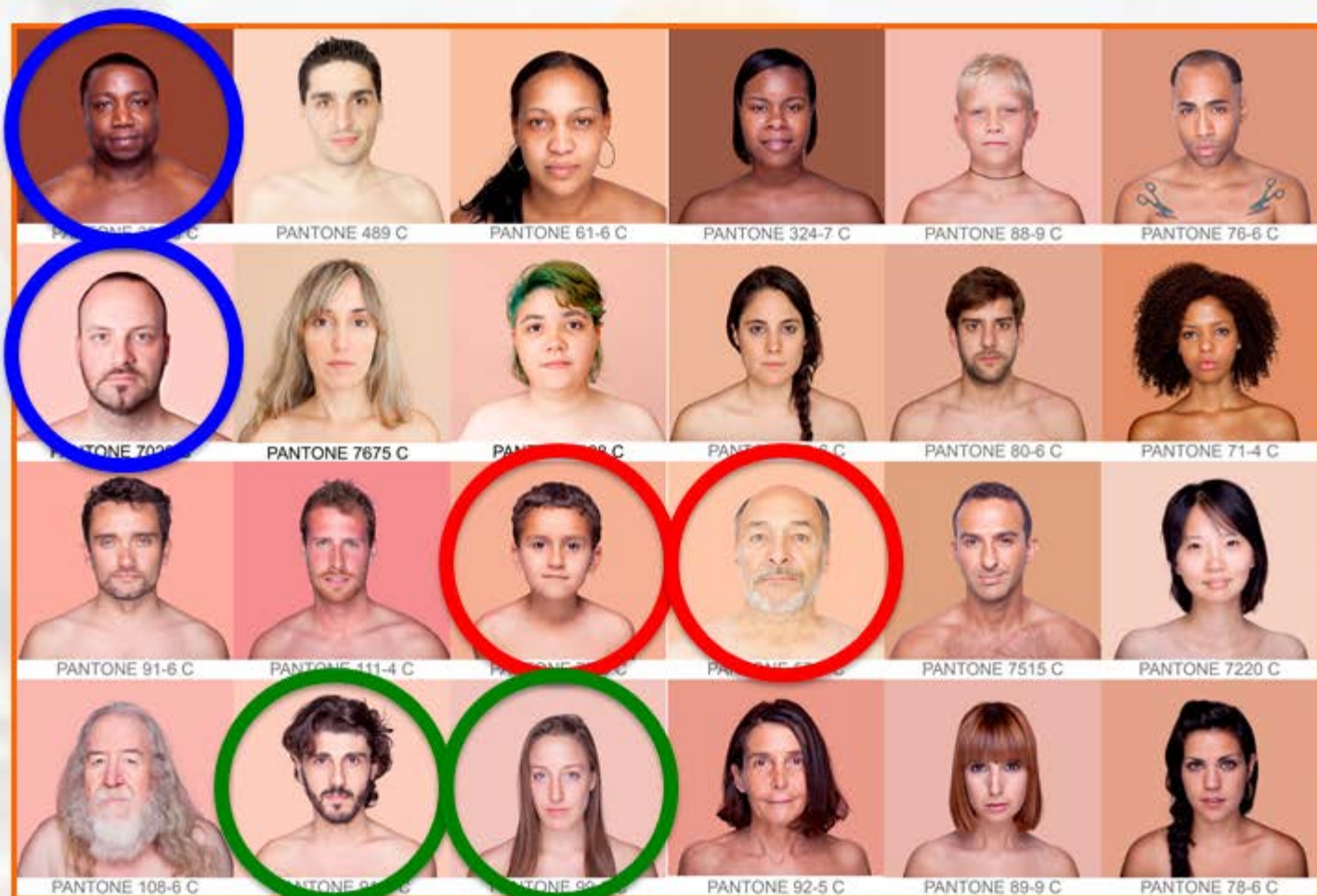
In brief on the two-system model of empathy

- This distinction, in the context of empathy for pain, is also carved at the **neuroanatomical** level.
- Empathy may be shaped by several factors (e.g., social groups, interindividual differences...)



In brief on the two-system model of empathy

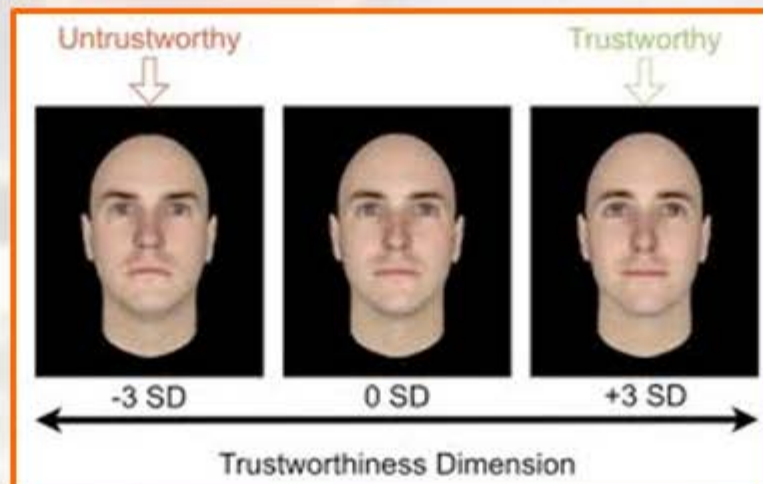
- Categorizations and evaluations on other people may shape empathy



In brief on the two-system model of empathy

- Categorizations and evaluations on other people may shape empathy

It's me before and after the flight



Experimental questions

- 🍊 Dissecting empathy: Are the two systems/components dissociable?
 - 🍊 Empathic components are anatomically dissociable (e.g., Shamay-Tsoory, Aharon-Peretz, & Perry, 2009)
 - 🍊 Time-course?
- 🍊 Cross-racial empathy: Which aspect of empathy, if any, is “impaired”?
 - 🍊 Experience sharing vs. Mentalizing

Dissecting empathy: **Are the two systems/components dissociable?**

🍊 Are the two systems dissociable? Hot theme in the field.

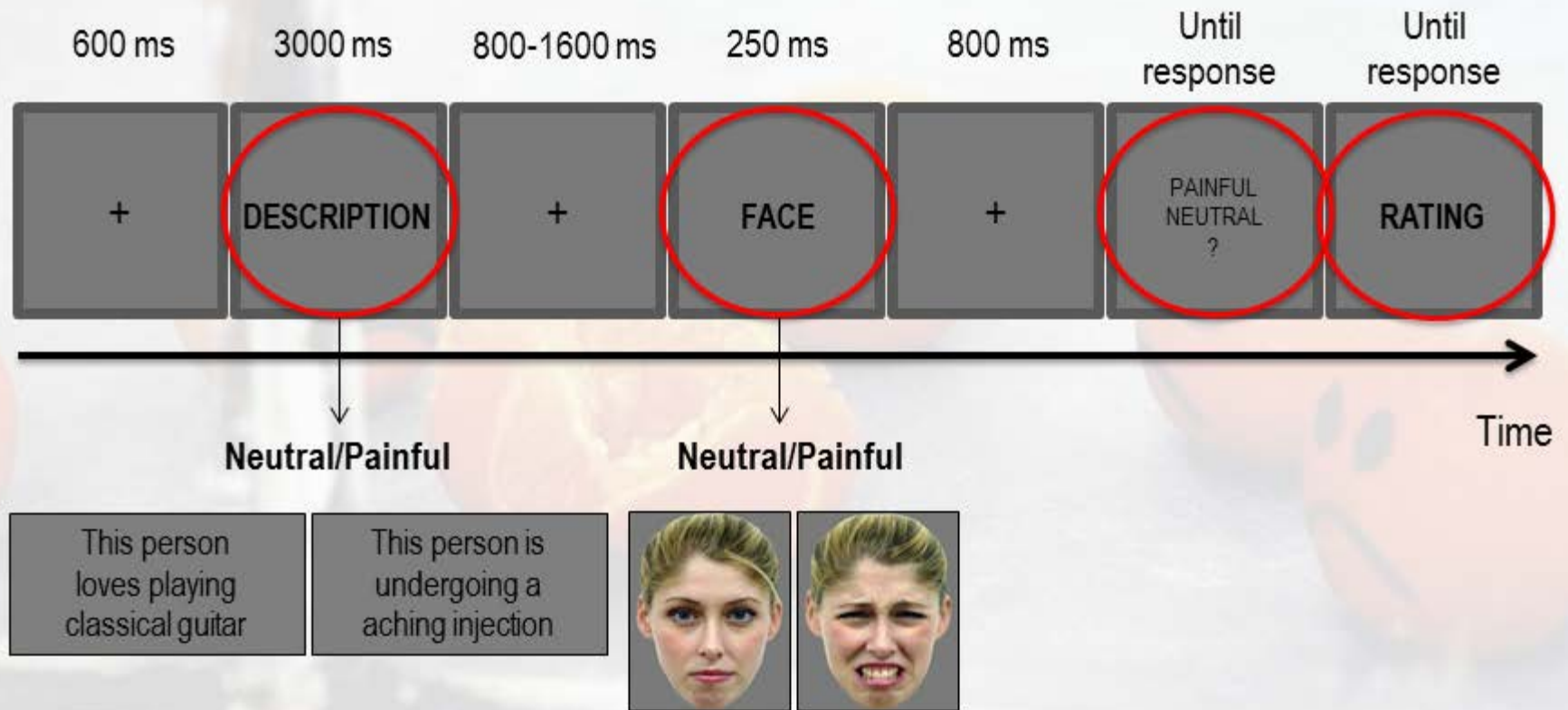
“[...] do we first perceive the pain in others (unconsciously) and then process the context (consciously), or is contextual information relevant for the unconscious evaluation of another's pain?”.

Gonzalez-Liencre, Shamay-Tsoory, & Brüne, 2013



Dissecting empathy:

Are the two systems/components dissociable?

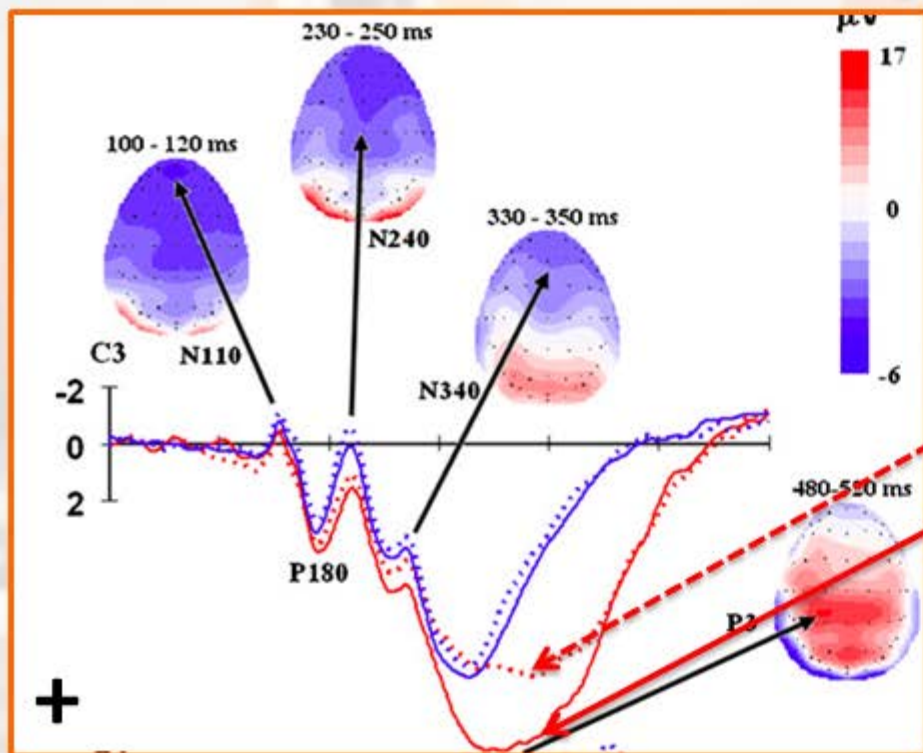


TASK: At the end of each trial participants had to decide whether the face had a neutral or a painful expression and they were required to rate their subjective impression of empathy capability on a 7-points Likert scale.

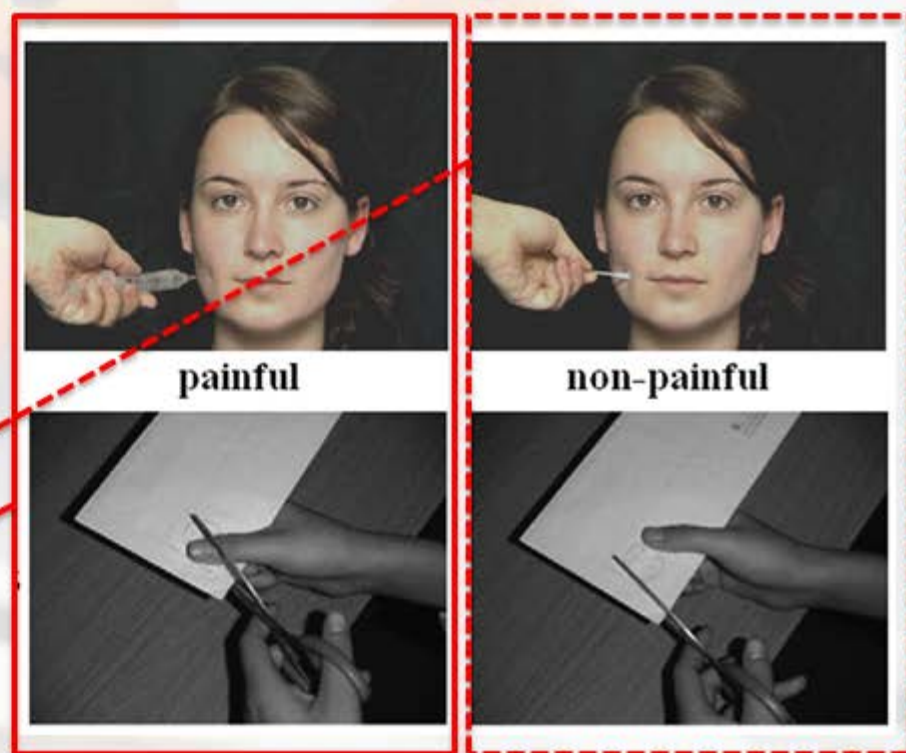
Dissecting empathy:

Are the two systems/components dissociable?

- ERP reactions to others' pain are known to manifest as positive shifts of the ERP waveforms in trials related to pain compared to trials in which neutral conditions with regard to pain are displayed



From Fan & Han, 2008, *Neuropsychologia*

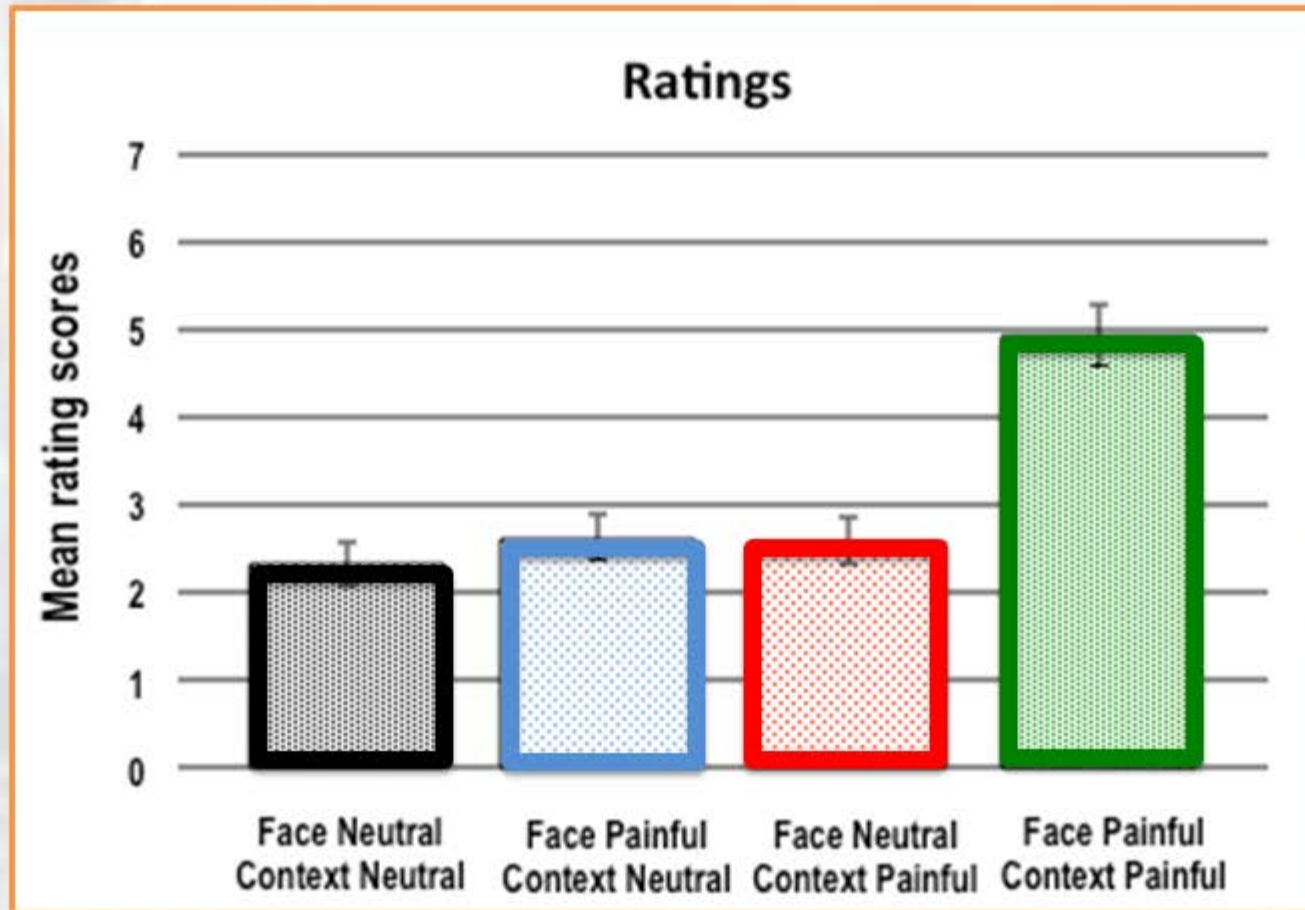


From Fan & Han, 2008 / Xu et al., 2009

Dissecting empathy:

Are the two systems/components dissociable?

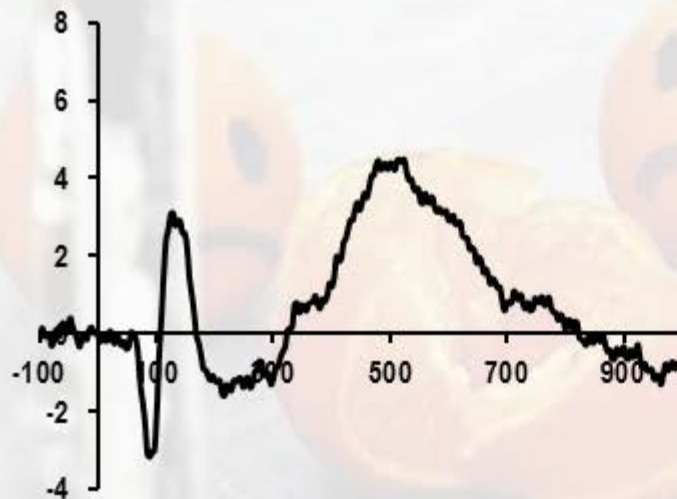
🍊 Results: Behavior (Rating subjective impression of empathy)



Dissecting empathy:

Are the two systems/components dissociable?

🍊 Results: ERPs



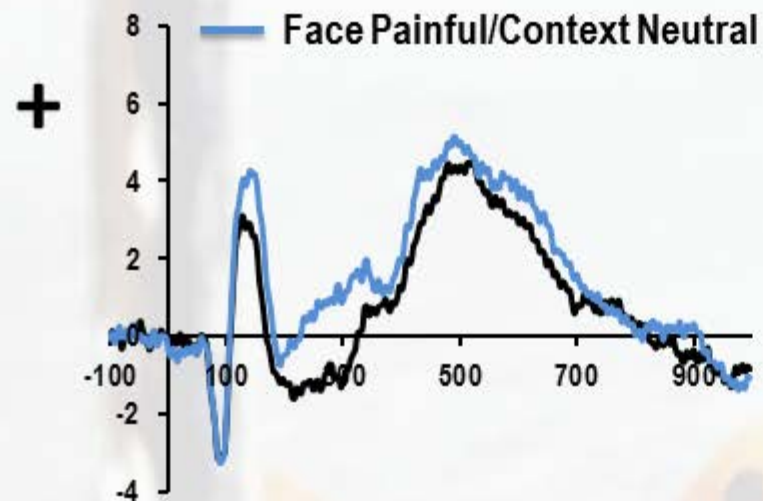
a) Pooled Fronto-Central Electrodes

This person
loves playing
classical guitar

[...]
3s



a) Pooled Fronto-Central Electrodes

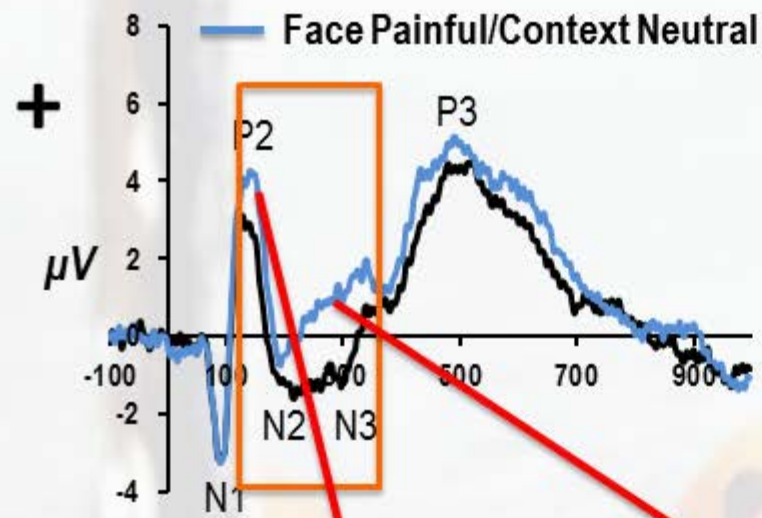


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3s

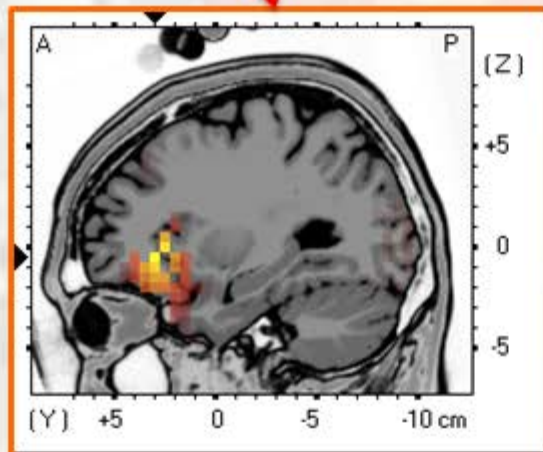


a) Pooled Fronto-Central Electrodes

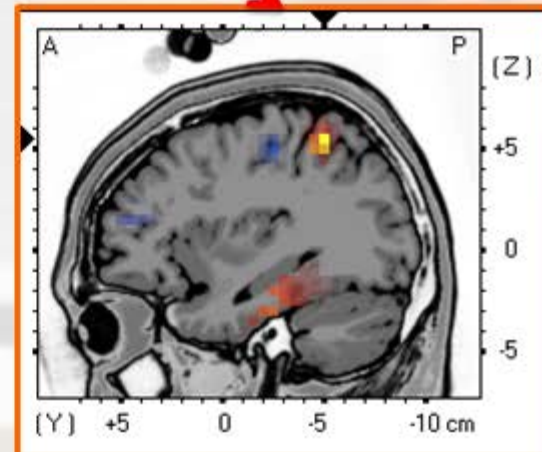


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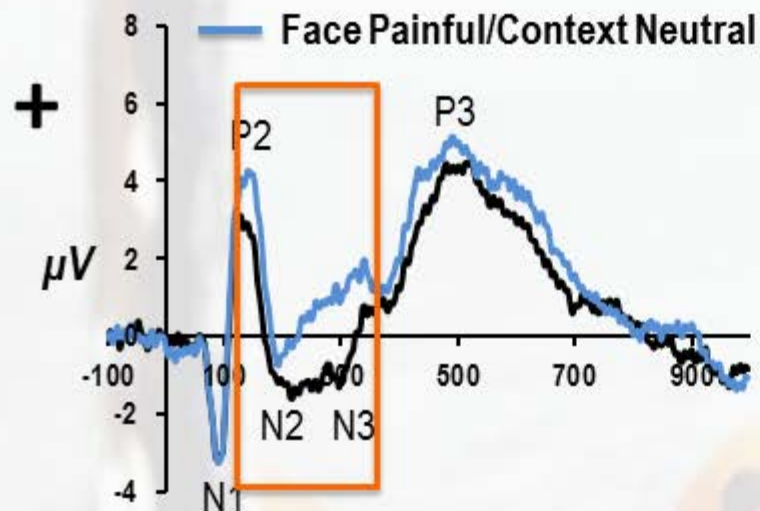


IFG/insula



Inferior parietal lobule/intraparietal sulcus

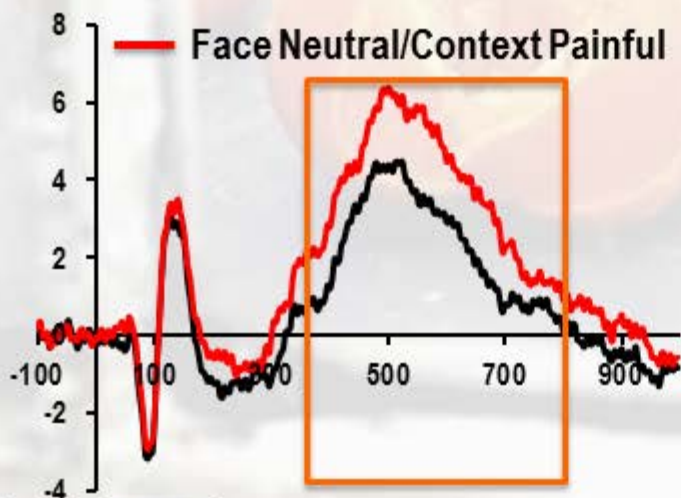
a) Pooled Fronto-Central Electrodes



— Face and Context Neutral

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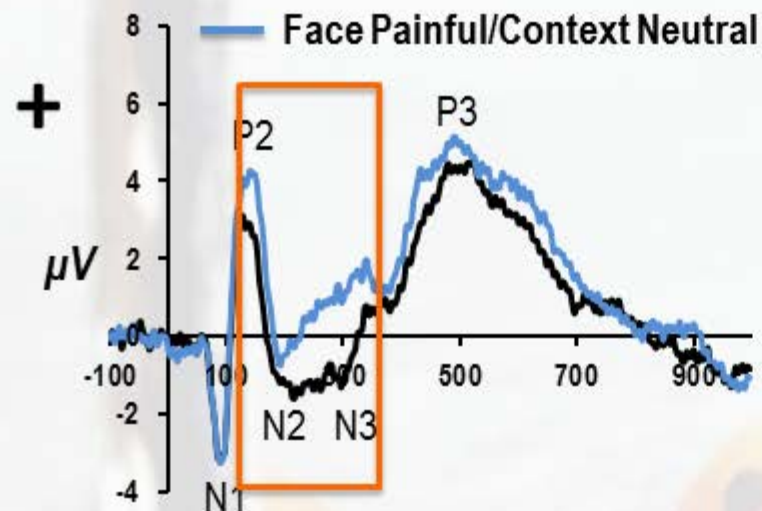


This person is
undergoing a
aching injection

[...]
3s



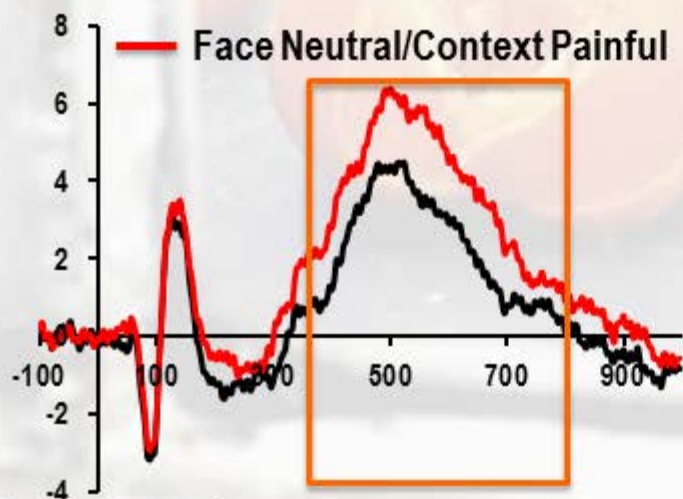
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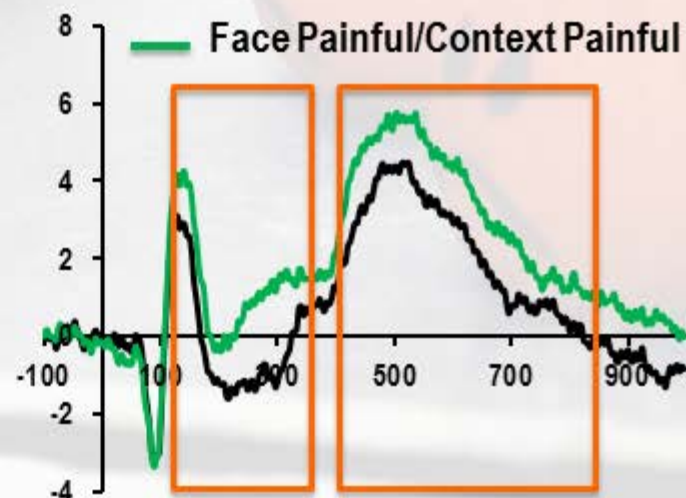


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[...] 3s



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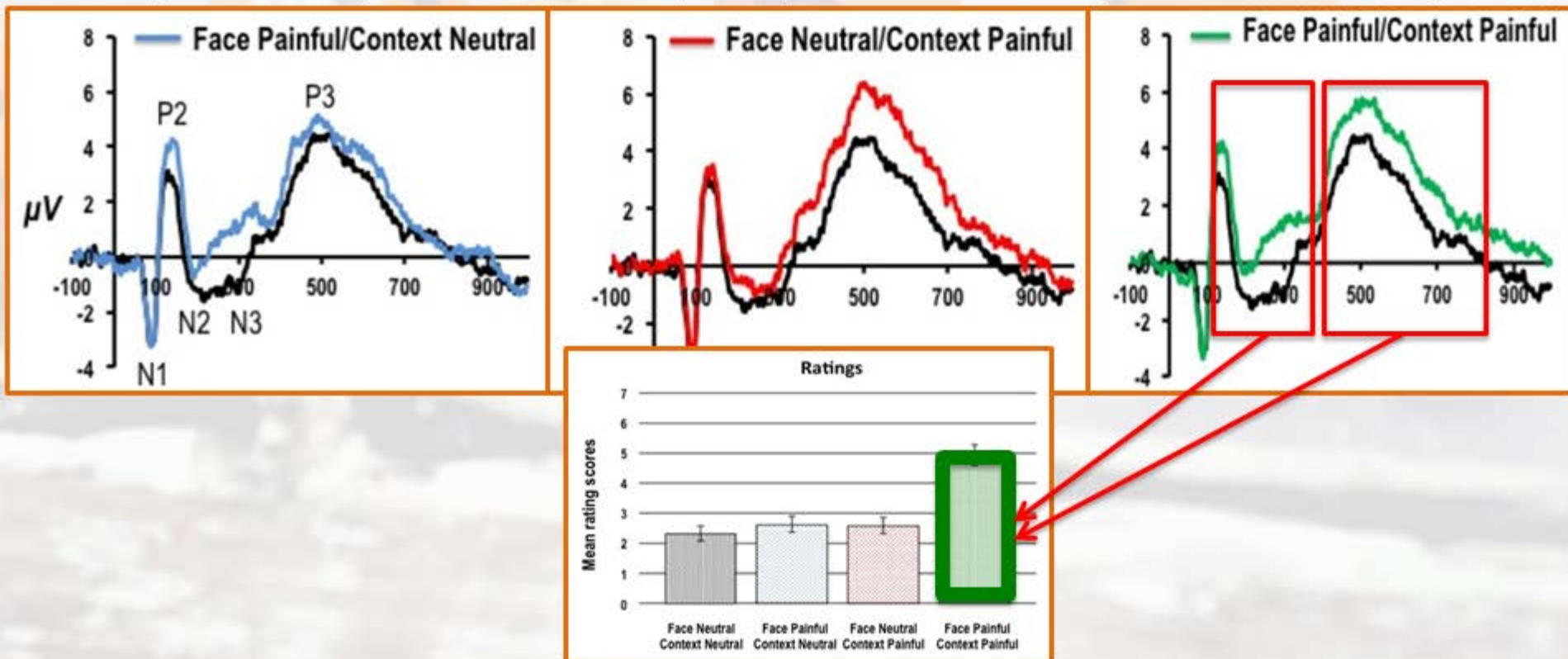
[...] 3s



Dissecting empathy:

Are the two systems/components dissociable?

- Double dissociation (in healthy participants) of neural reactions to others' pain based on perceptual and contextual information
- When both types of cues of others' pain were available, the subjective impression of empathy was doubled (additive model).

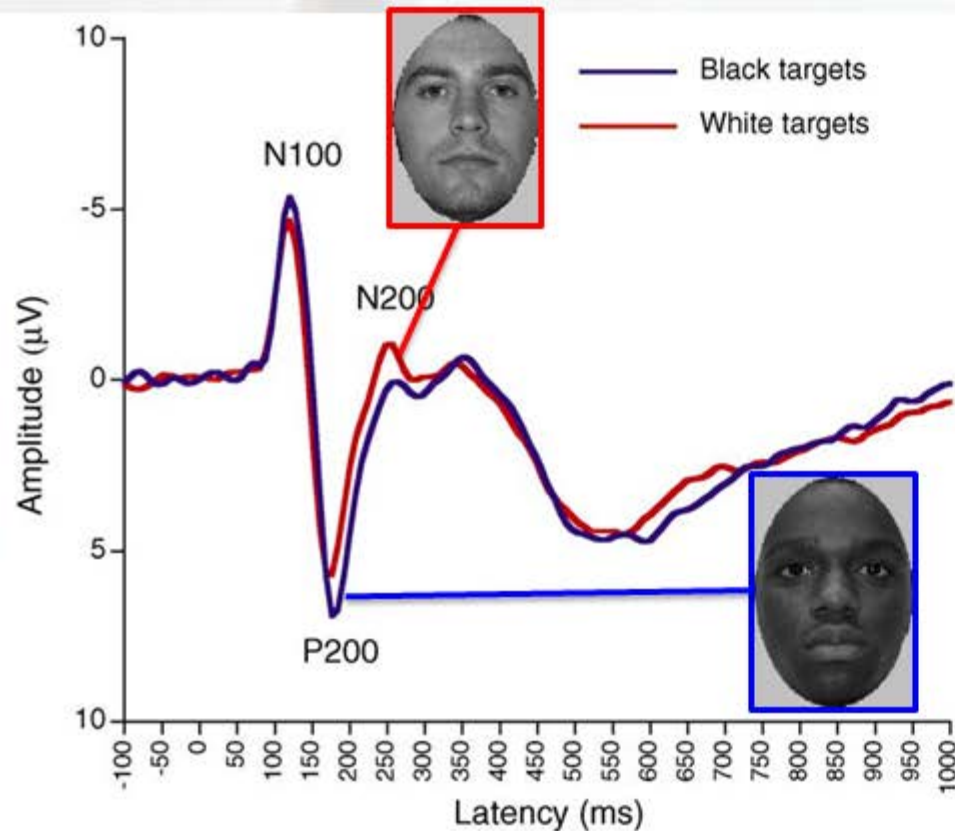


Experimental questions

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 - 🍊 Empathic components are anatomically dissociable (e.g., Shamay-Tsoory, Aharon-Peretz, & Perry, 2009)
 - 🍊 Time-course?
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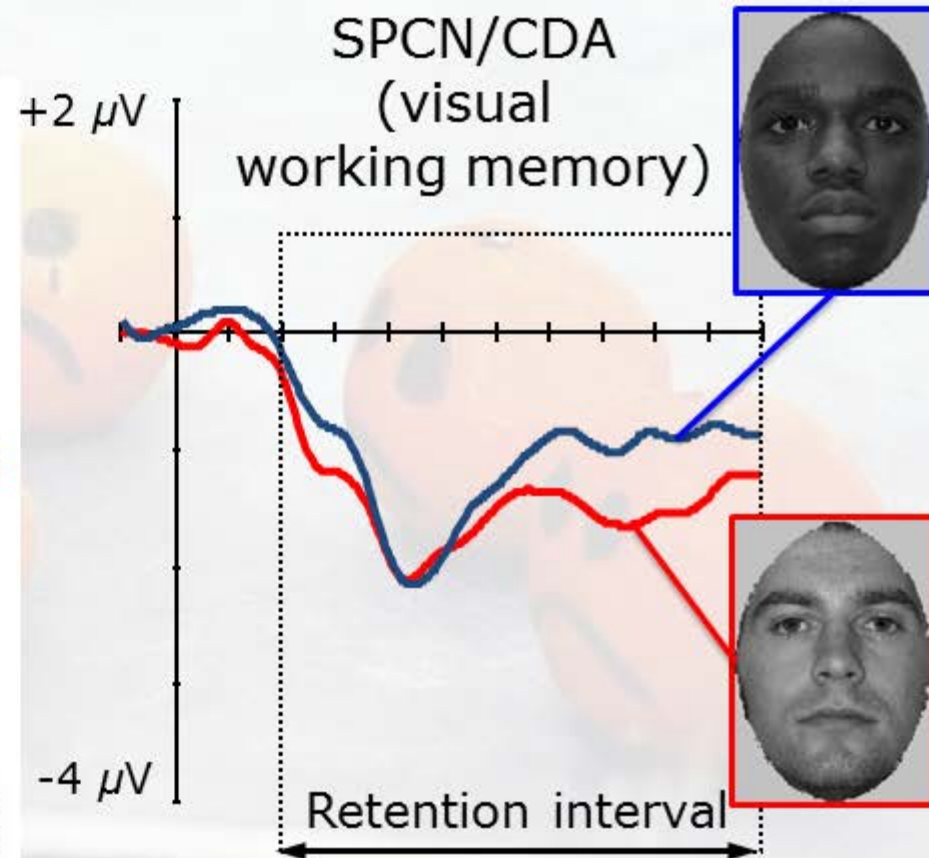
Cross-racial empathy: Which aspect of empathy is “impaired”?

🍊 Own-race and other-race faces are processed differently, likely at all stages of processing



TRENDS in Cognitive Sciences

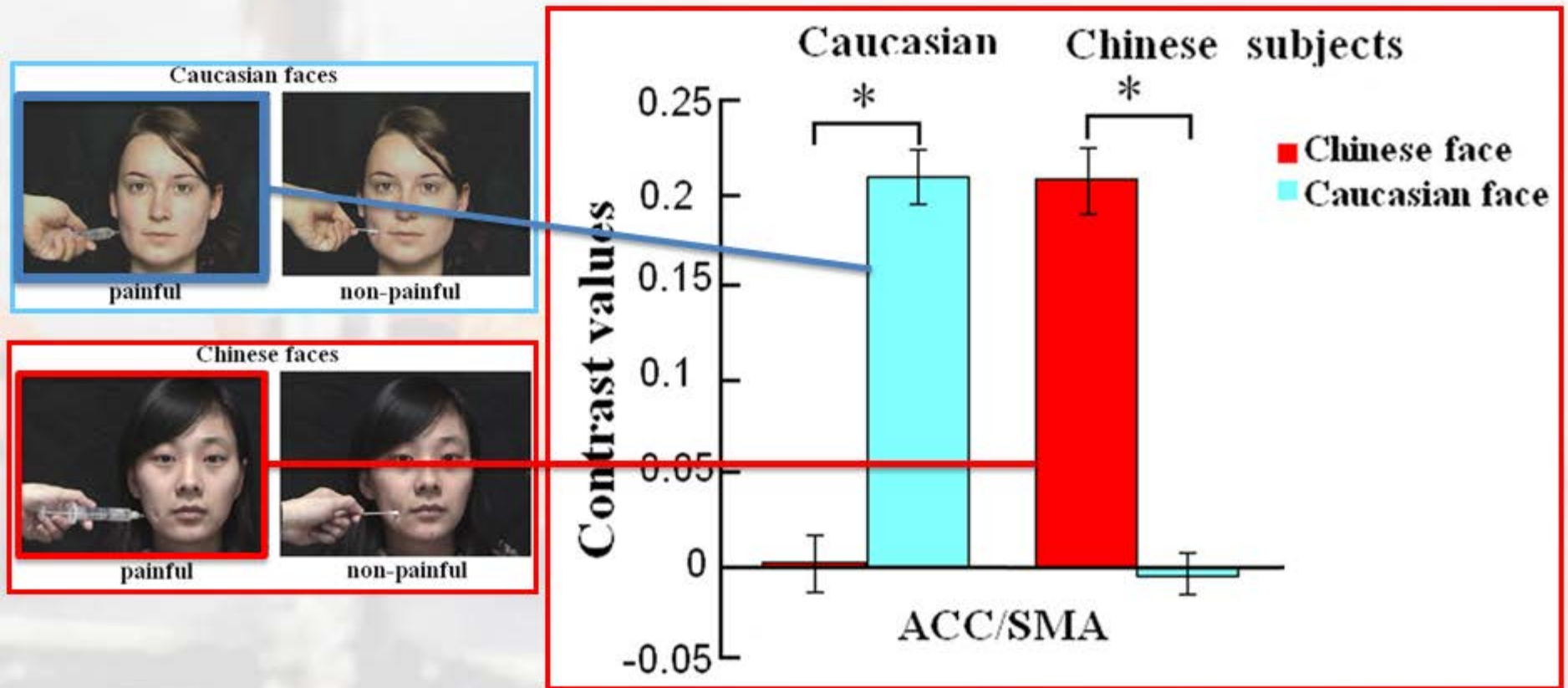
Ito & Urland, 2003, *J. Pers. Soc. Psychol.*



- Sessa et al., 2012, *SCAN*
- Sessa et al., submitted

Cross-racial empathy: Which aspect of empathy is “impaired”?

An fMRI study: Xu et al., 2009, *Journal of Neuroscience*



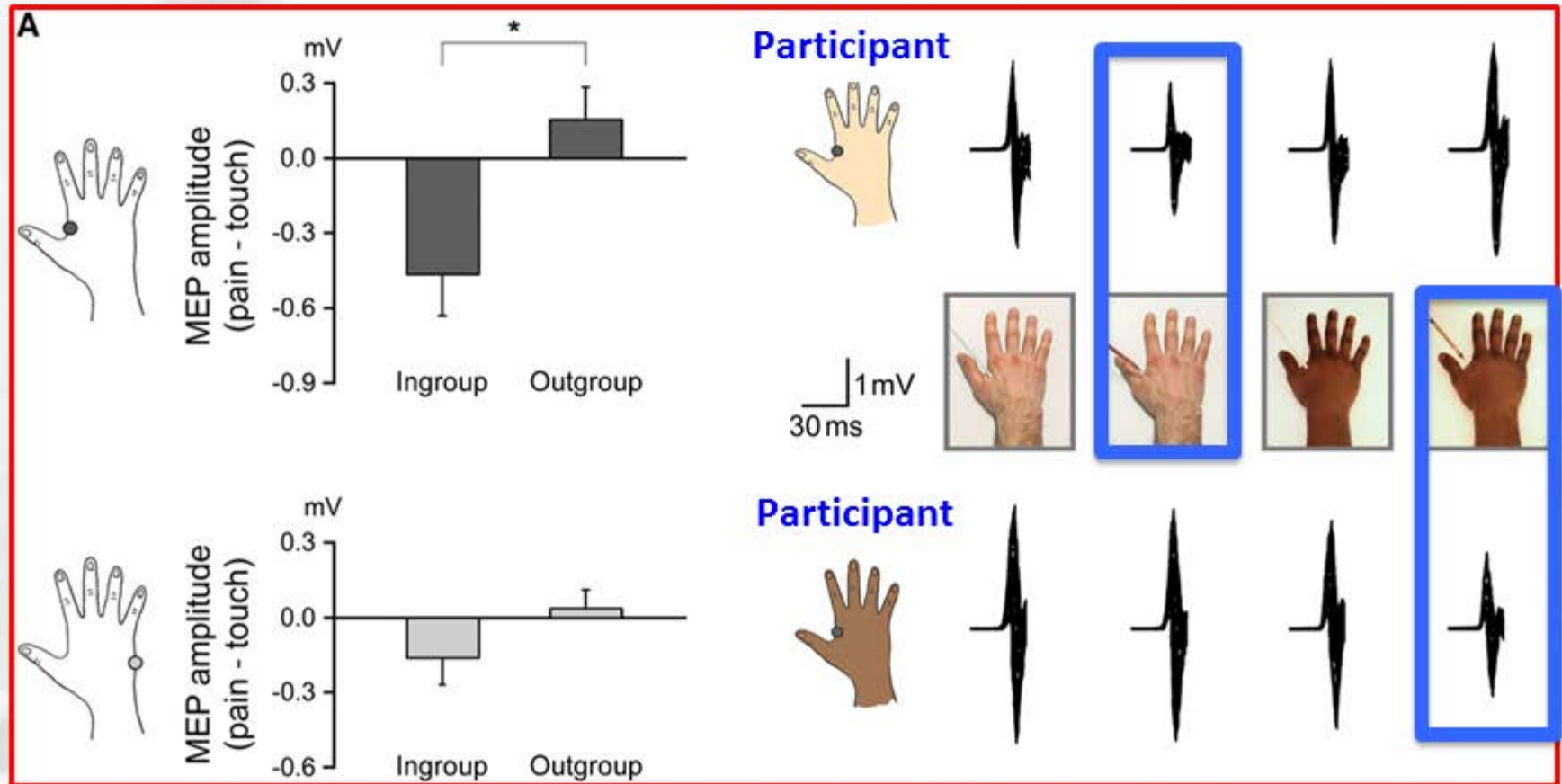
Adapted from Xu et al., 2009, *Journal of Neuroscience*

TASK: To categorize the video clips based on whether the characters were feeling pain or not, the so-called pain decision task, disregarding their race.

Cross-racial empathy:

Which aspect of empathy is “impaired”?

A TMS study: Avenanti et al., 2010, *Current Biology*











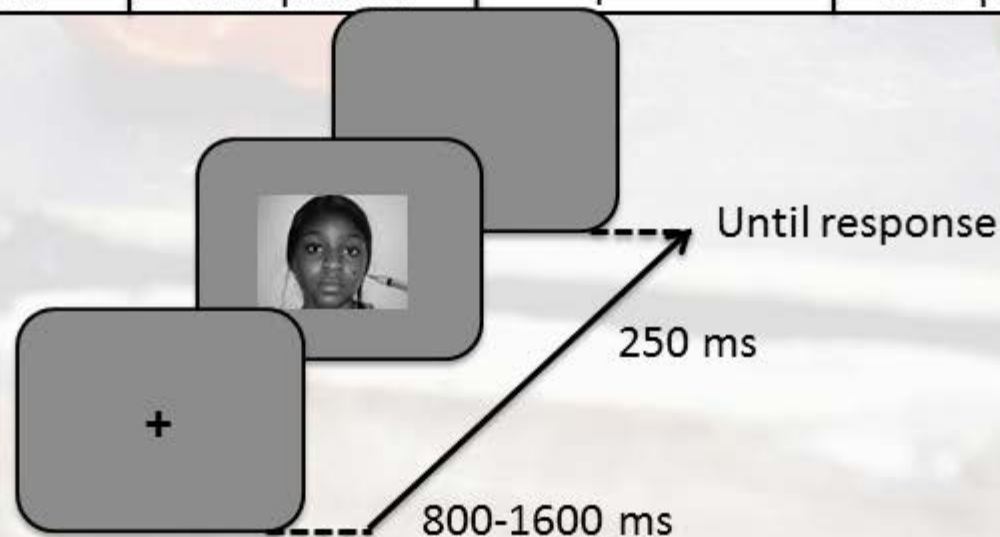
In preparation of a self-experienced painful event it is observed a reduction in excitability of sensorimotor cortico-spinal neurons.

Cross-racial empathy:

Which aspect of empathy is “impaired”?

An ERP study: Sessa, Meconi, Castelli, & Dell’Acqua, 2014, *SCAN*

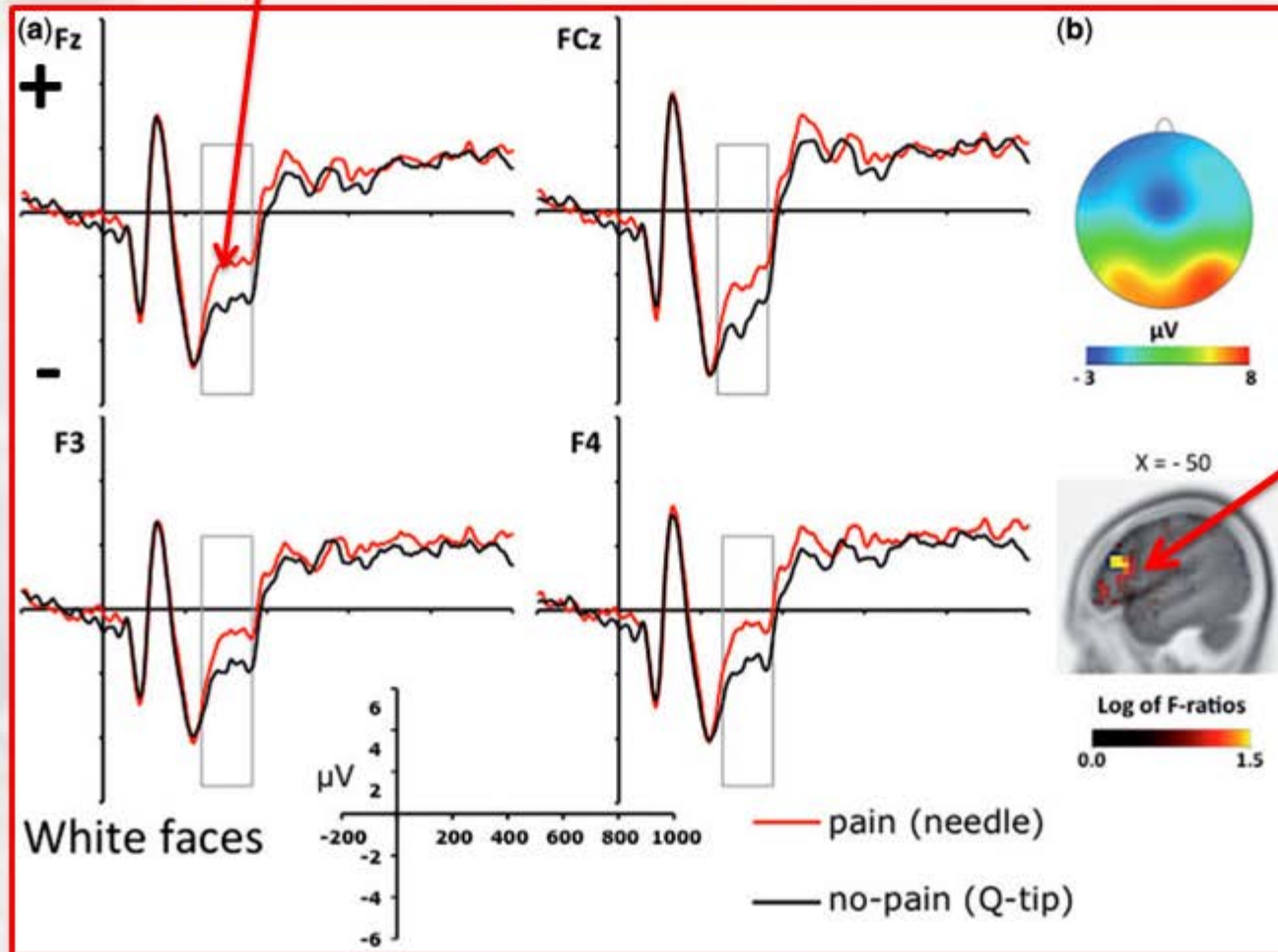
Black faces		White faces	
			
			
painful	non-painful	painful	non-painful



Cross-racial empathy: Which aspect of empathy is “impaired”?



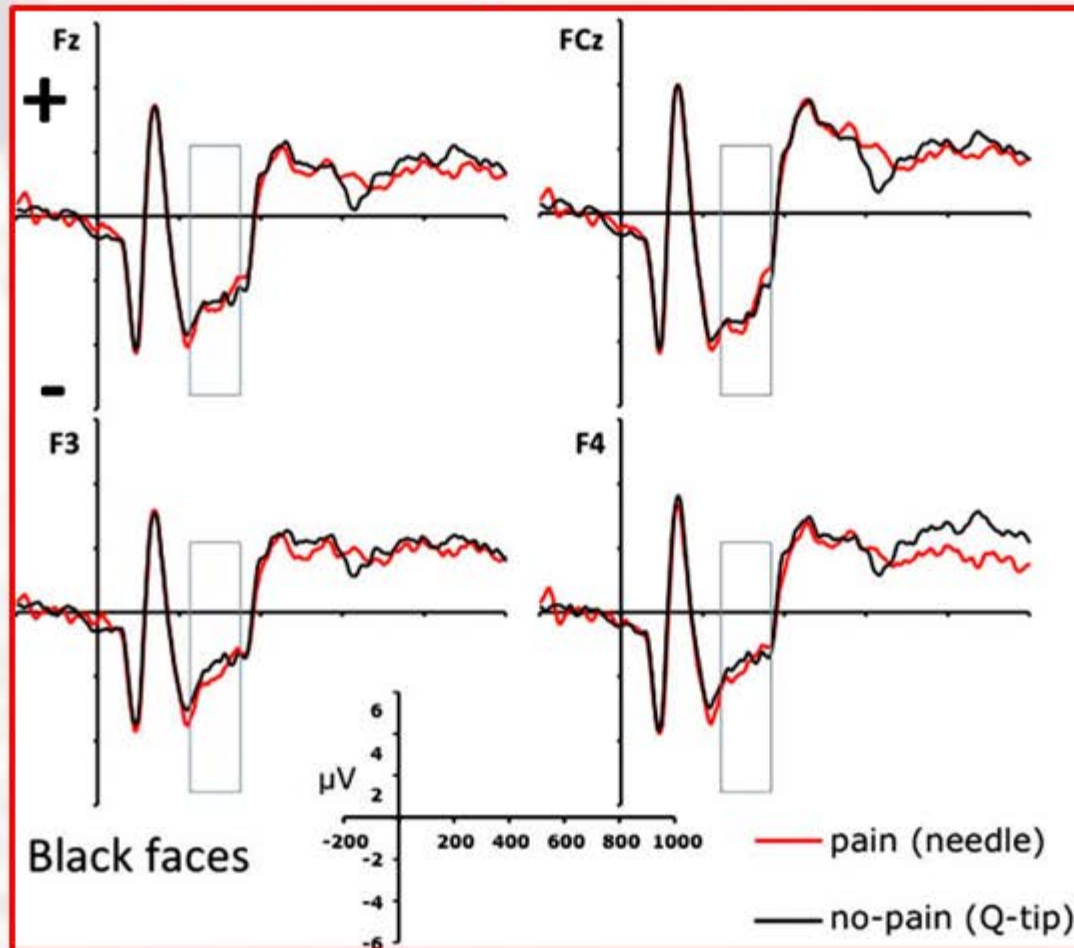
vs.



Cross-racial empathy: Which aspect of empathy is “impaired”?



vs.



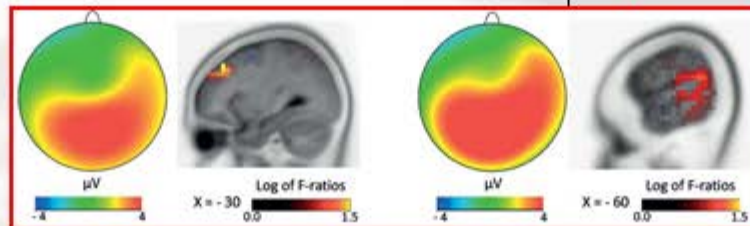
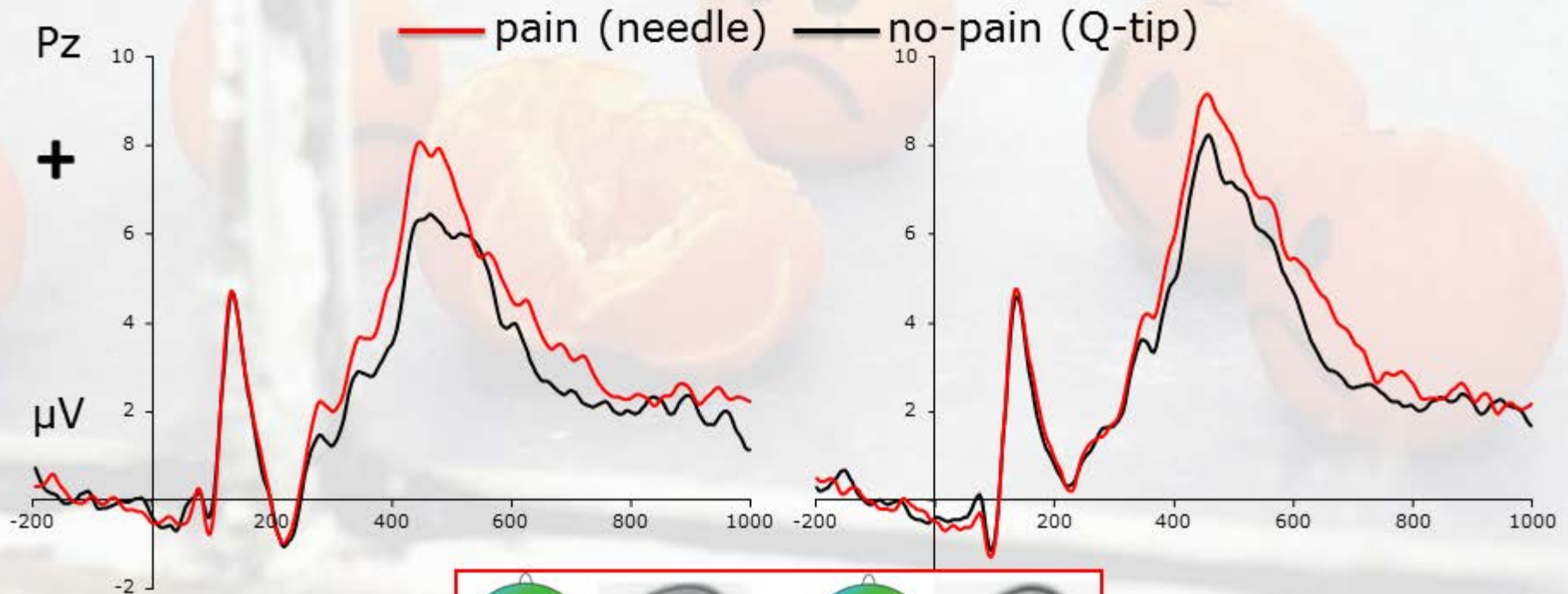
Cross-racial empathy: Which aspect of empathy is “impaired”?



vs.



vs.



Conclusions

🍊 Experiment 1:

Empathy involves two different components, one more automatic (the experience sharing component) and the other more linked to cognitive processing (the mentalizing component), **that may be fully dissociable** in the temporal domain.

🍊 Experiment 2:

Race affects the experience sharing component of empathy. The mentalizing component may be unaffected.

Aknowledgments



And thanks for your attention!

Additional slides

Craig, 2009, Nat Rev Neuroscience

On the insula

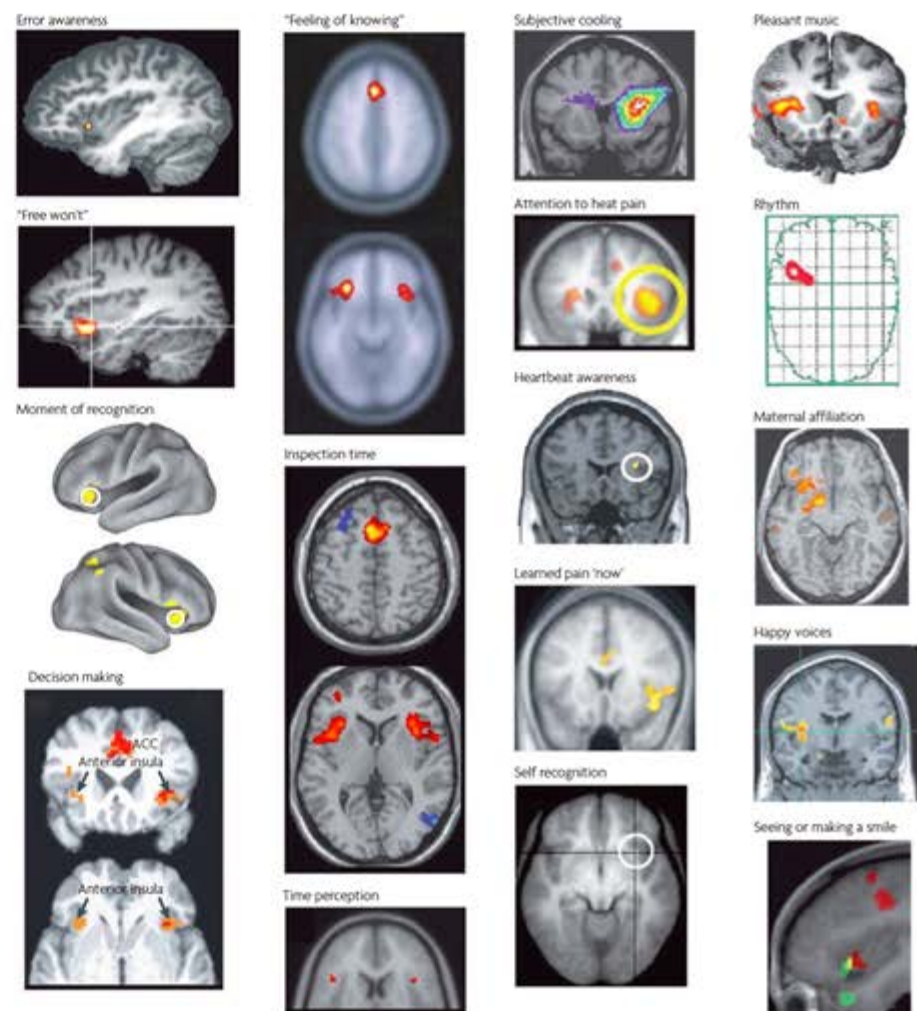


Figure 2 | Activation of the AIC. A summary of imaging results showing activation of the anterior insular cortex (AIC) during particular tasks and emotions highlighted in the text. The two right-hand columns contain images from different studies that found predominantly unilateral activation; images in the two left-hand columns show mostly bilateral activation. Stimuli that activate the right AIC are generally arousing to the body (for example, pain). The left AIC is activated mainly by positive and affiliative emotional feelings (BOLD 3). For example, activation of the left AIC was reported in mothers viewing photos of their own child¹¹¹; greater activation of the left than of the right AIC was associated with both maternal and romantic love¹¹²; activation of the left AIC was reported while subjects were either seeing or making a smile¹¹³; activation of the left AIC was found while subjects attended to happy voices¹¹⁴; activation of the left AIC was associated with hearing pleasant music¹¹⁵; selective

activation of the left AIC was observed in subjects experiencing joy¹¹⁶; and selective activation of the left AIC in females was found that correlated with self-reported orgasm ratings¹¹⁷. ACC, anterior cingulate cortex. Images are reproduced, with permission, from (in order from top to bottom and left to right): (first column) REF. 23 © (2007) Elsevier, REF. 45 © (2007) Society for Neuroscience, REF. 39 © (2007) Society for Neuroscience, REF. 40 © (2007) Society for Neuroscience; (second column) REF. 41 © (2002) Cell Press, REF. 51 © (2004) Elsevier, REF. 54 © (2007) Elsevier; (third column) REF. 2 © (2000) Macmillan Publishers Ltd (all rights reserved), REF. 7 © (2002) Elsevier, REF. 3 © (2004) Macmillan Publishers Ltd (all rights reserved), REF. 24 © (2004) Macmillan Publishers Ltd (all rights reserved), REF. 15 © (2007) Elsevier; (fourth column) REF. 17 © (2006) Wiley, REF. 16 © (1997) Oxford Journals, REF. 125 © (2004) Elsevier, REF. 127 © (2006) Oxford Journals, REF. 20 © (2005) Elsevier.

Experience sharing

- Unconscious and automatic simulation of the subjectivity of others through the function of mirror neurons and mirroring in general
- [Experience sharing] involves a near-simultaneous resonance with the other person's experience

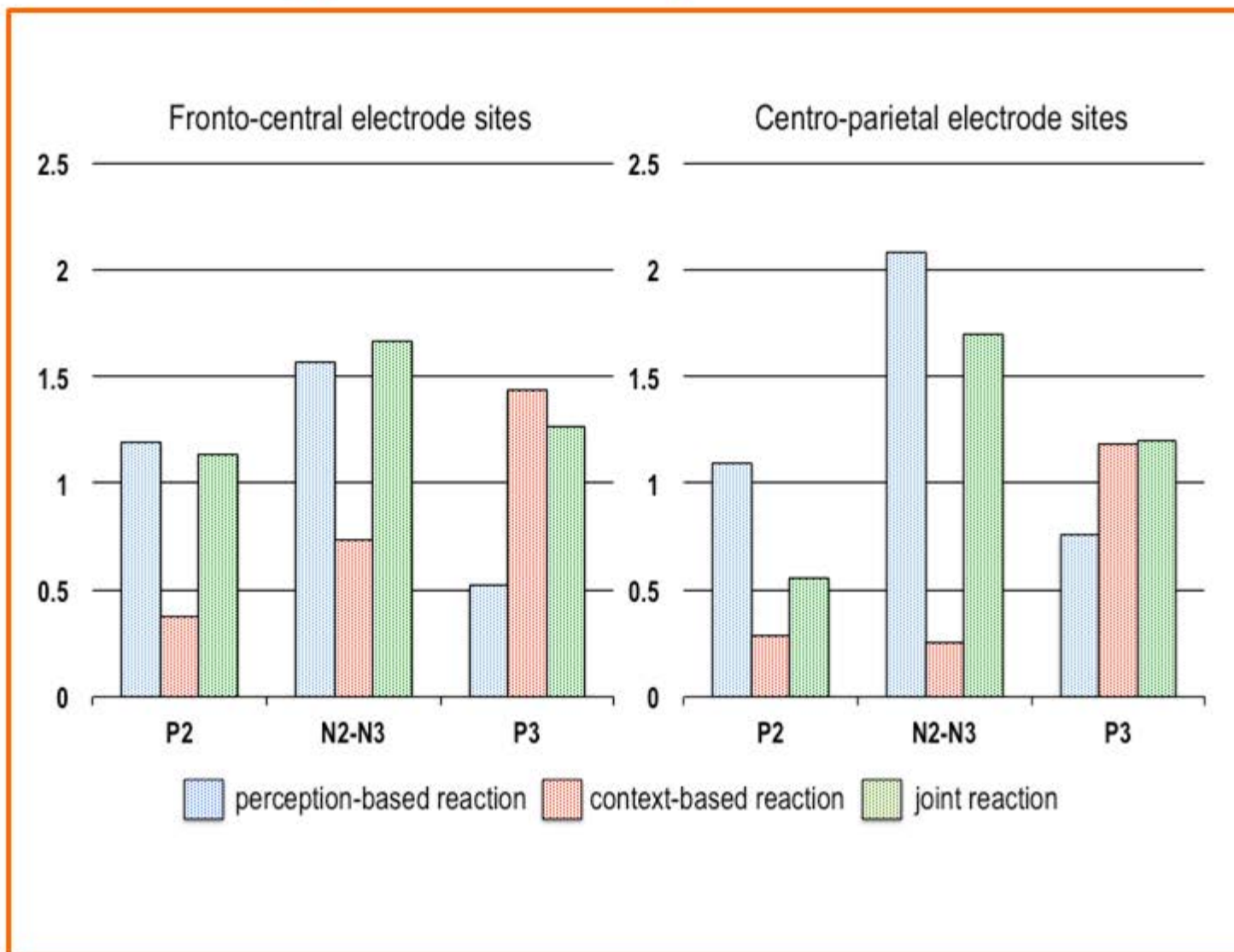
Gallese & Goldmand, 1998, *Trends in Cognitive Sciences*

Fan & Han, 2008, *Neuropsychologia*

Zaki & Ochsner, 2012, *Nature Neuroscience*

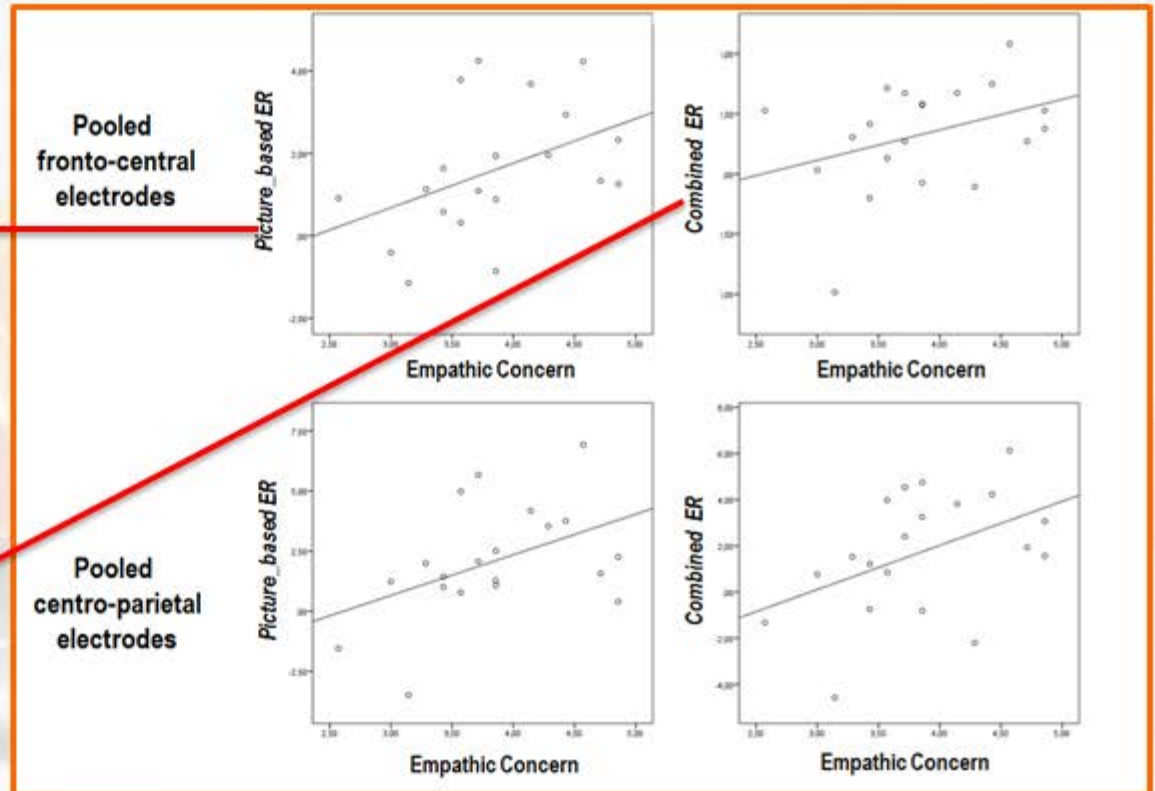
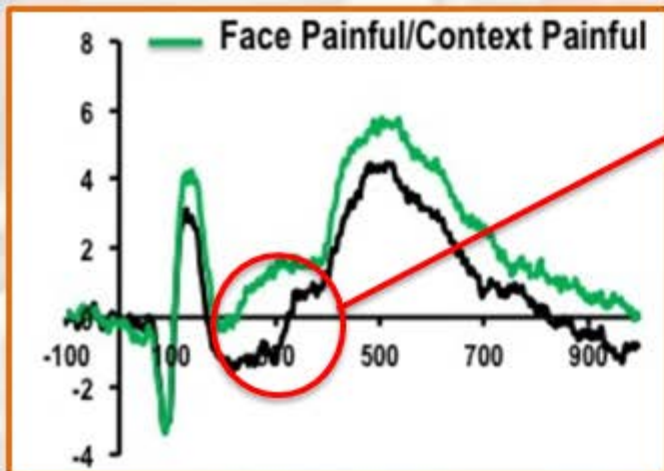
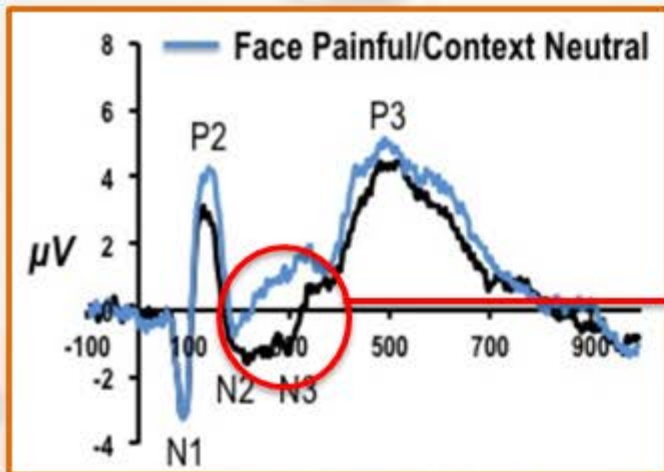
Waytz & Mitchell, 2011, *Current Directions in Psychological Science*

Dissecting empathy: Are the two systems/components dissociable?



Dissecting empathy:

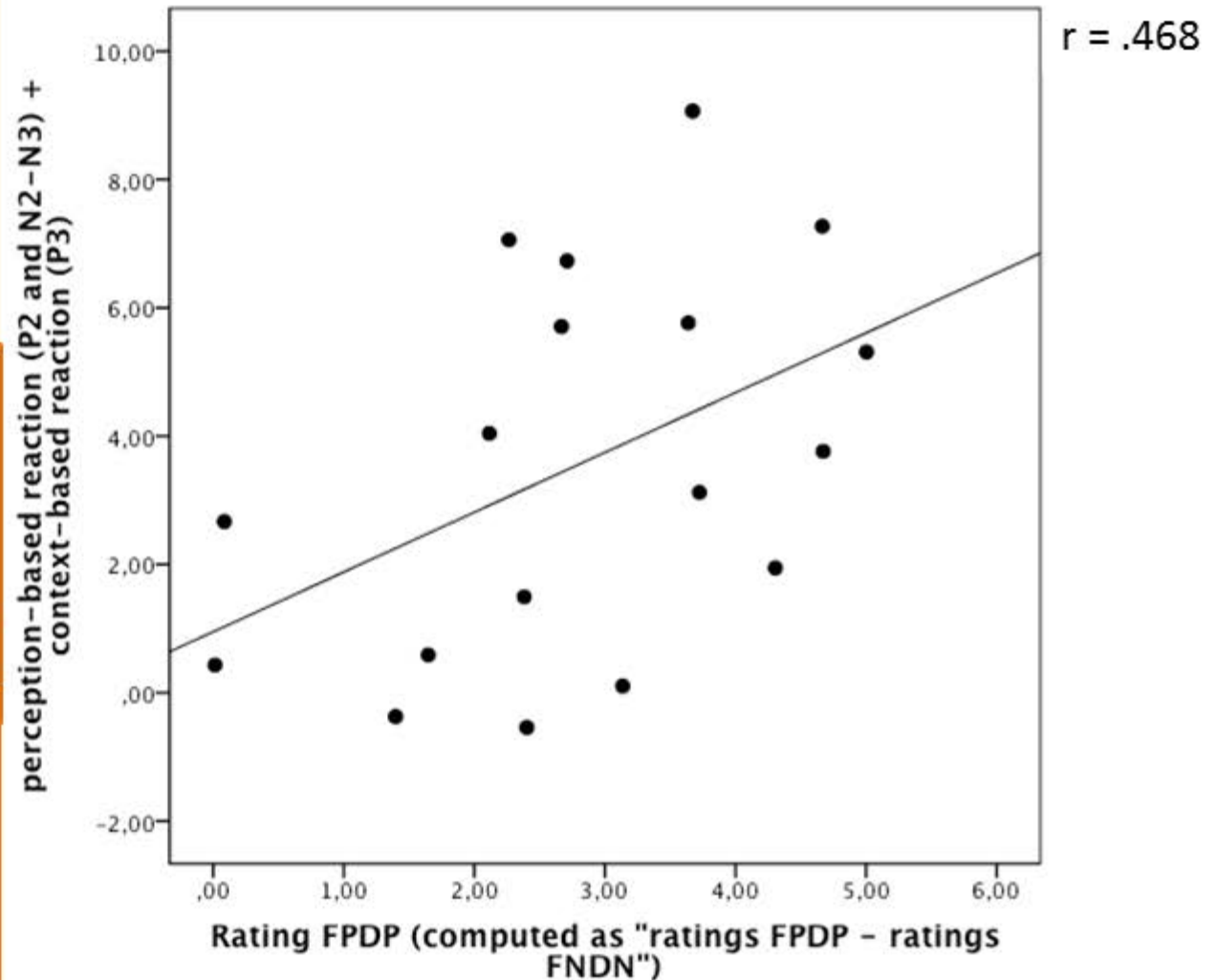
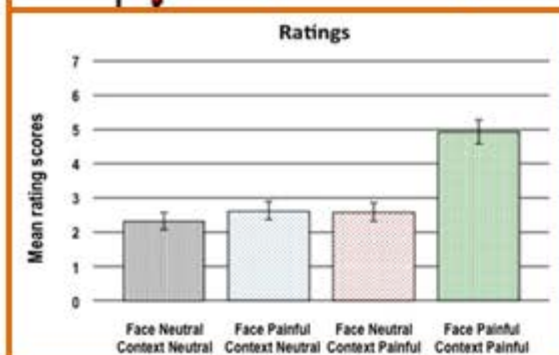
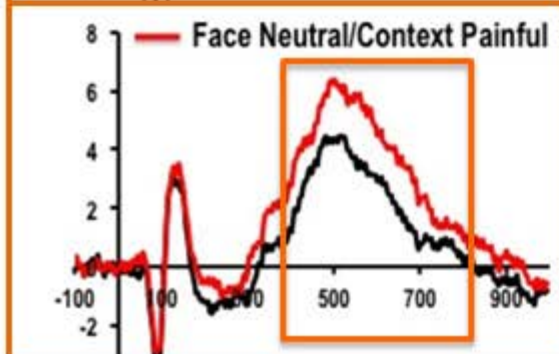
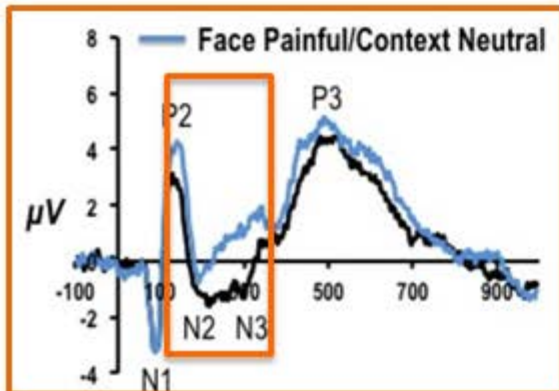
Are the two systems/components dissociable?



Dissecting empathy:

Are the two systems/components dissociable?

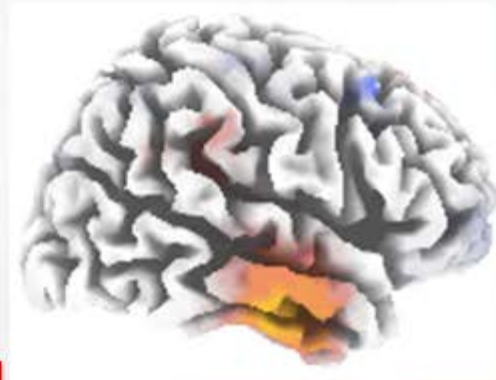
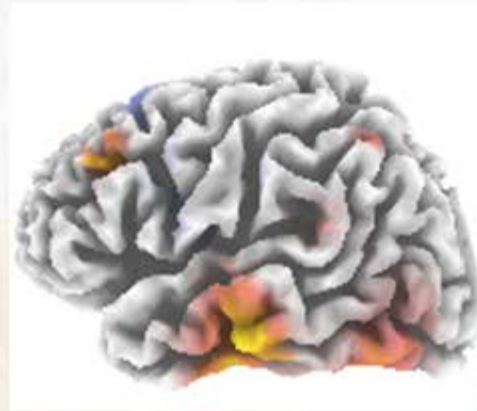
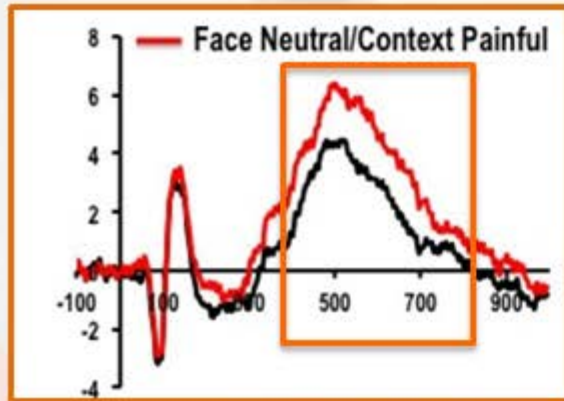
Correlation between ratings and ERPs reactions



Dissecting empathy:

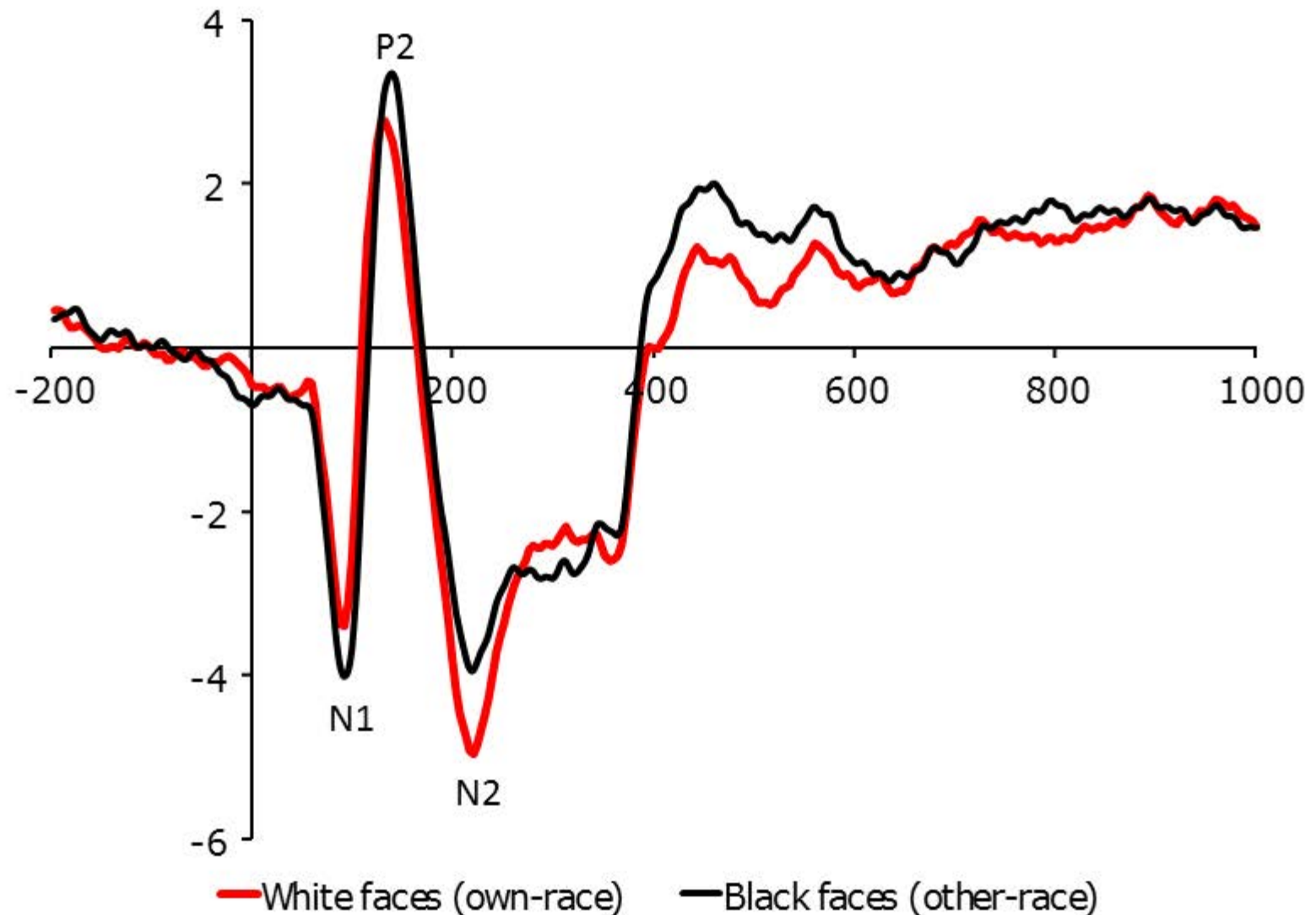
Are the two systems/components dissociable?

Source(s) of context-based reaction

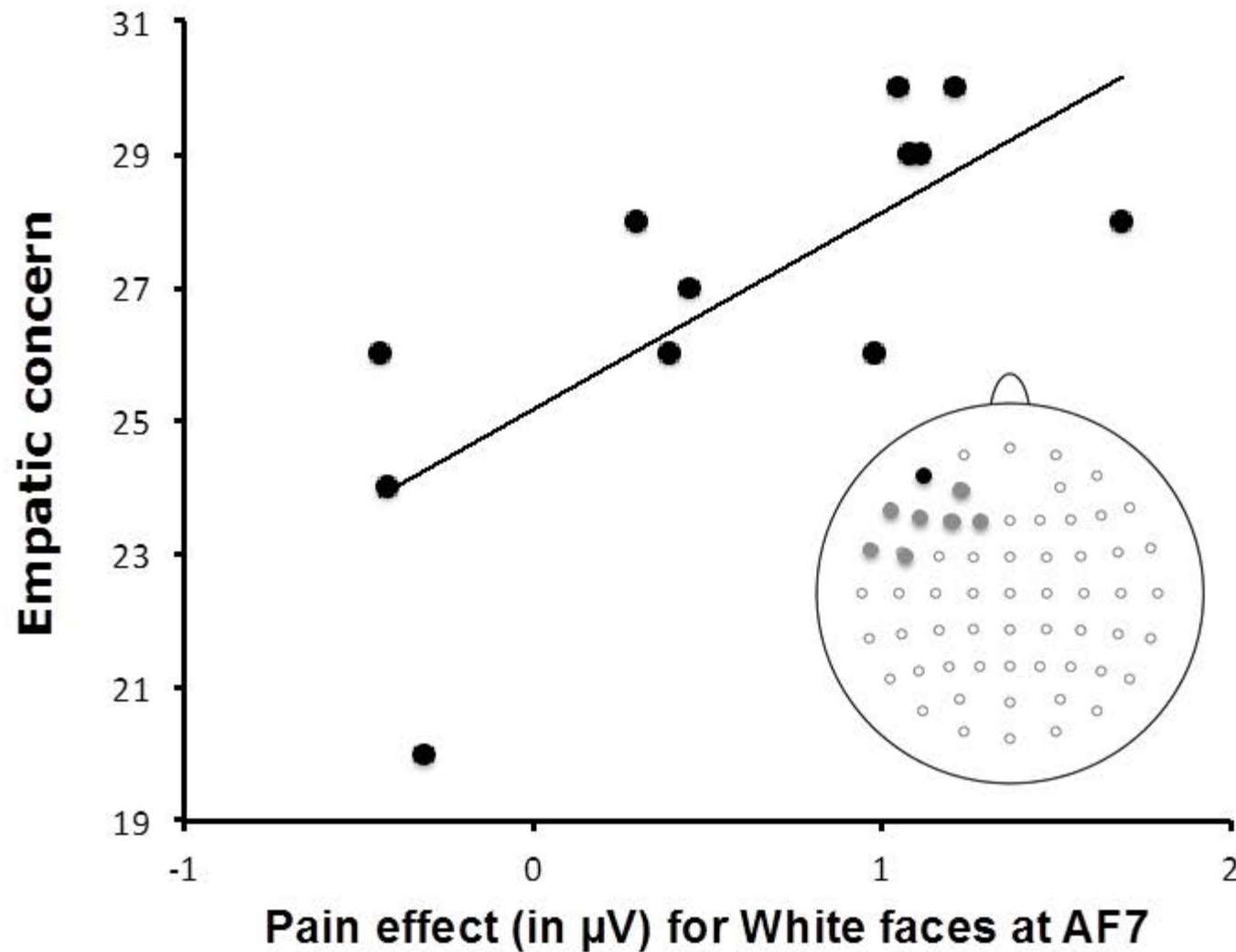


Bilateral middle and inferior temporal gyri and left fusiform gyrus

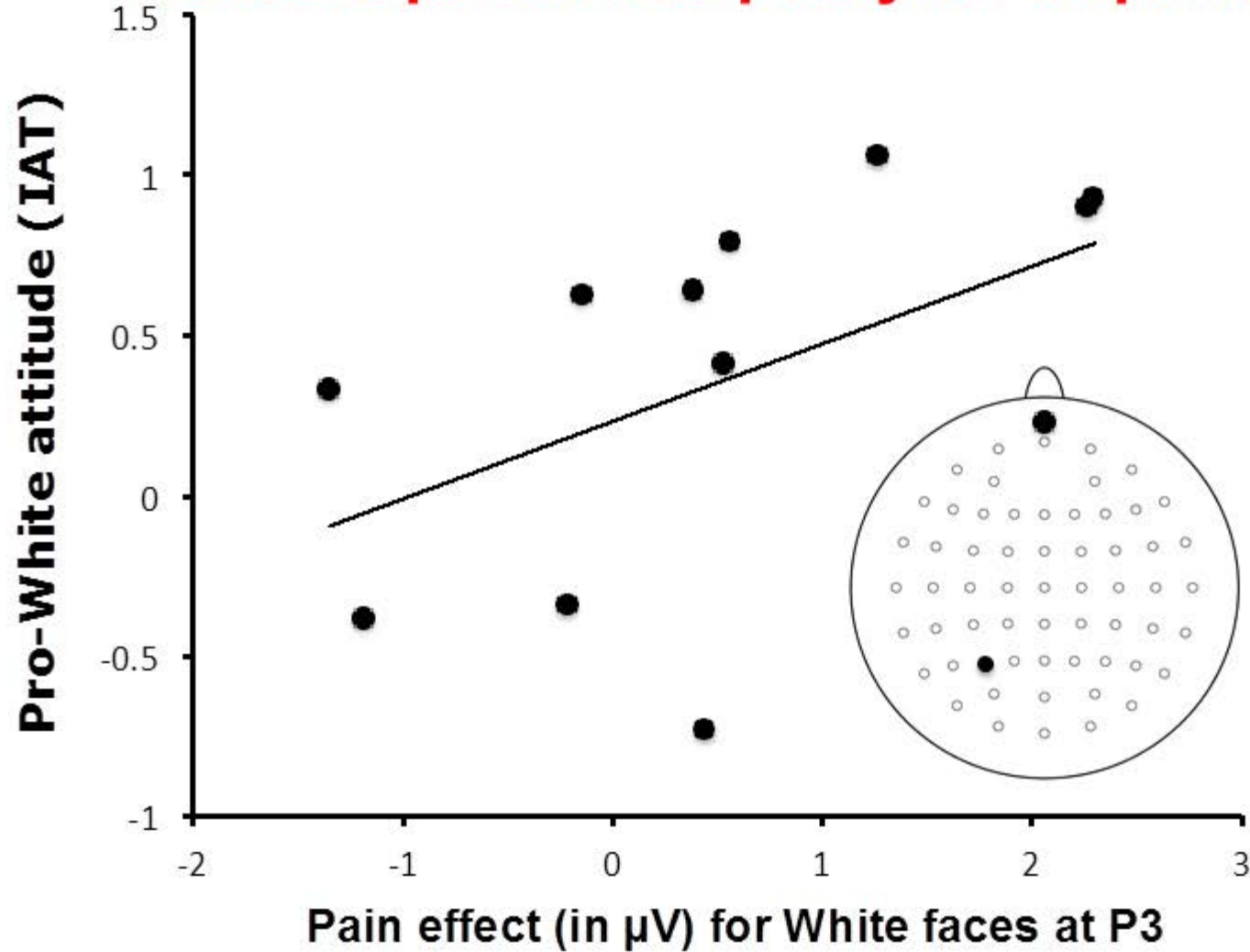
Cross-racial empathy:
Which aspect of empathy is “impaired”?



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Cross-racial empathy:
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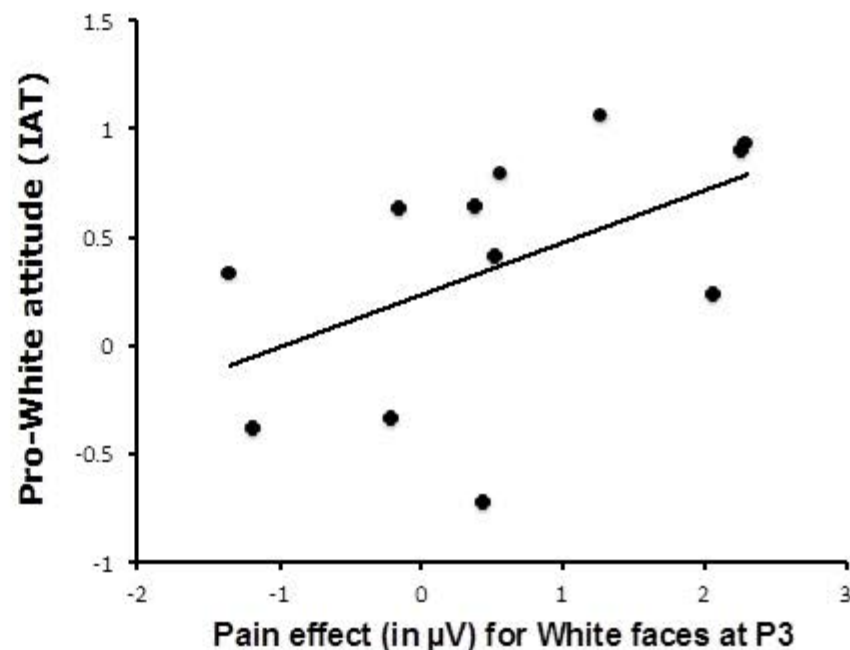
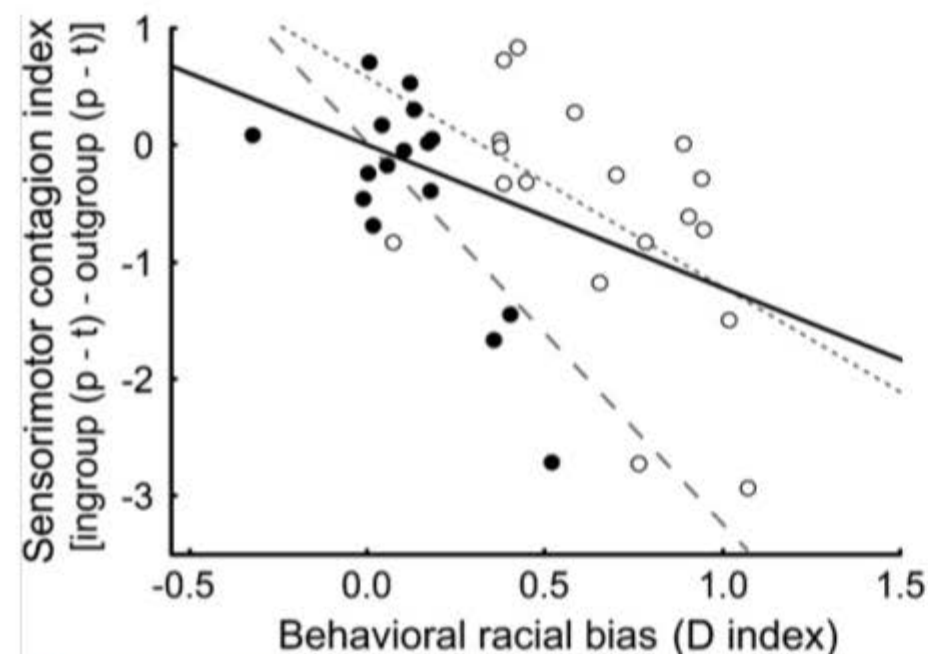
Cross-racial empathy: Which aspect of empathy is “impaired”?

Avenanti et al. 2010 (TMS)

Sensorimotor contagion and IAT scores

Sessa et al. 2014 (ERP)

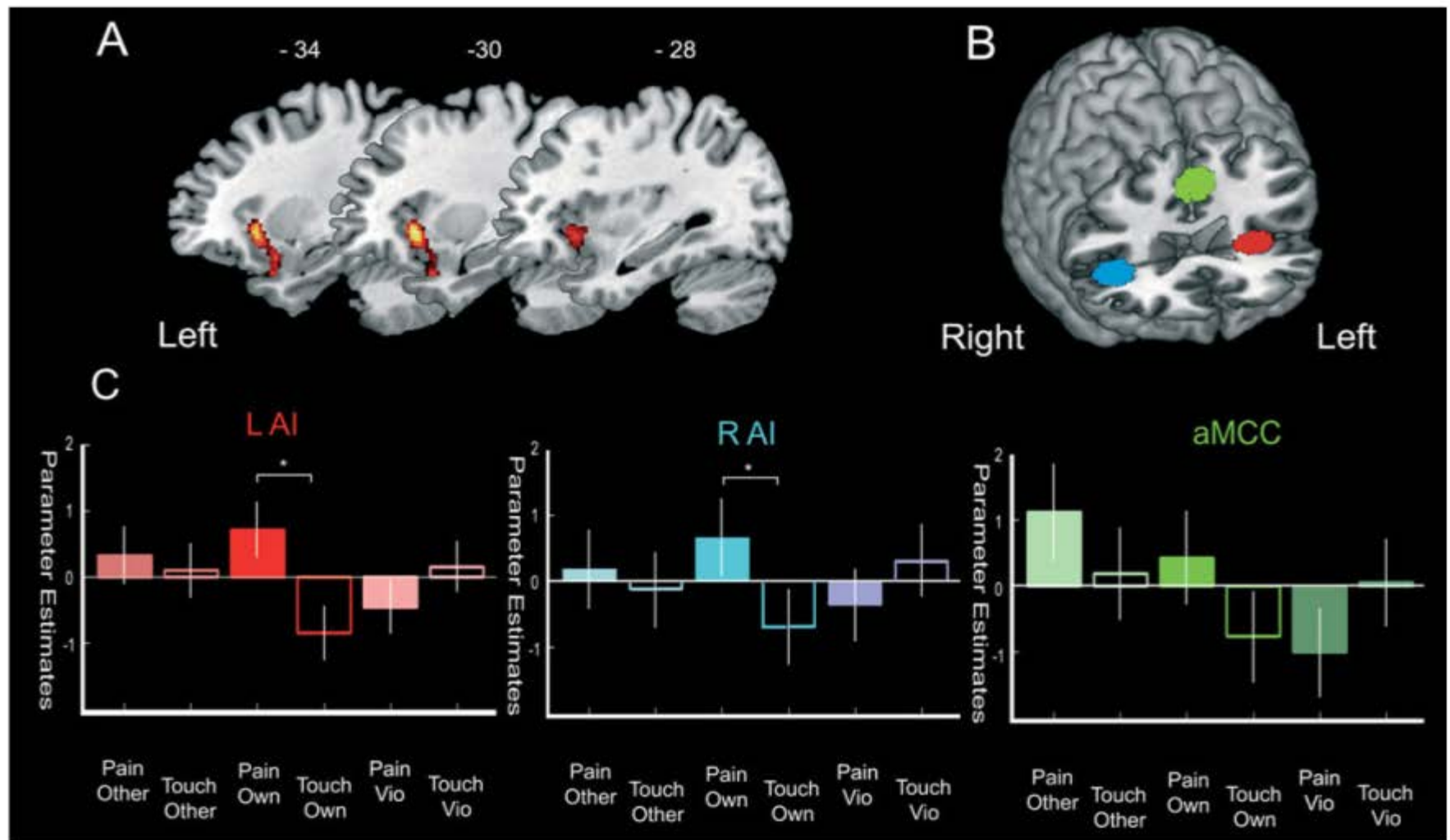
P3 and IAT scores



The portion of the effect (reduced sensorimotor contagion) linked to implicit racial prejudice may indeed reflect feedback signals rather than experience sharing per se

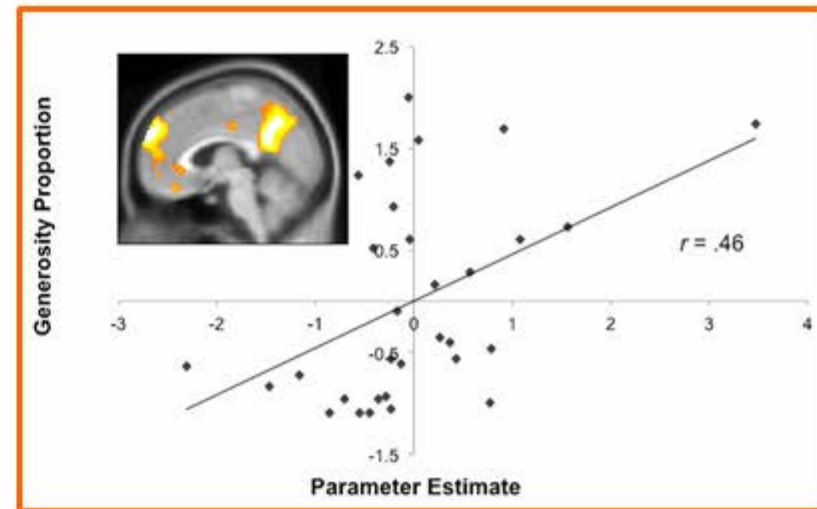
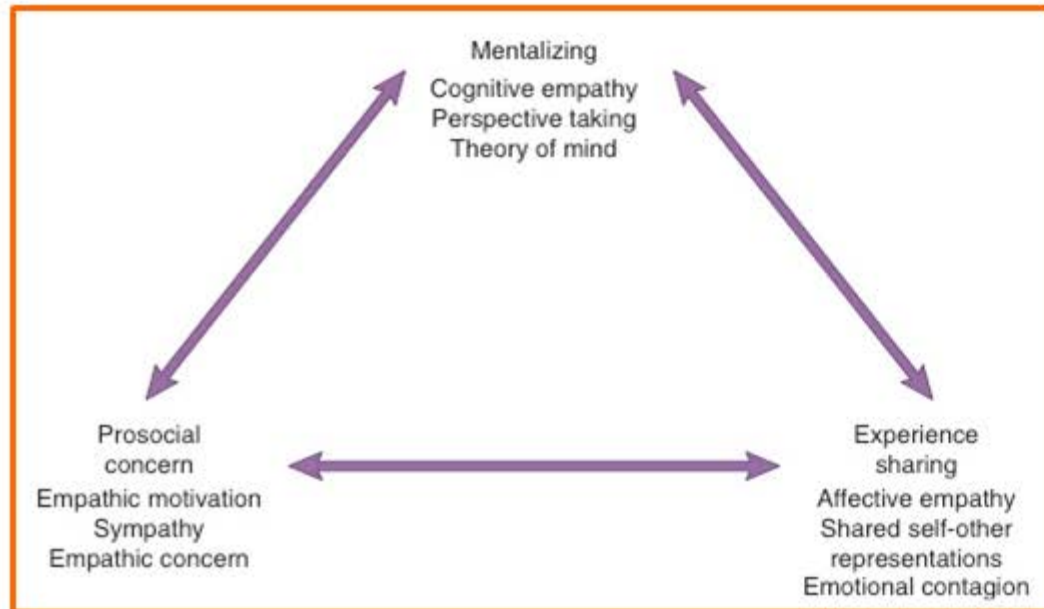
Cross-racial empathy: Which aspect of empathy is “impaired”?

An fMRI study: Azevedo et al., 2013, *Human Brain Mapping*



Other components of empathy

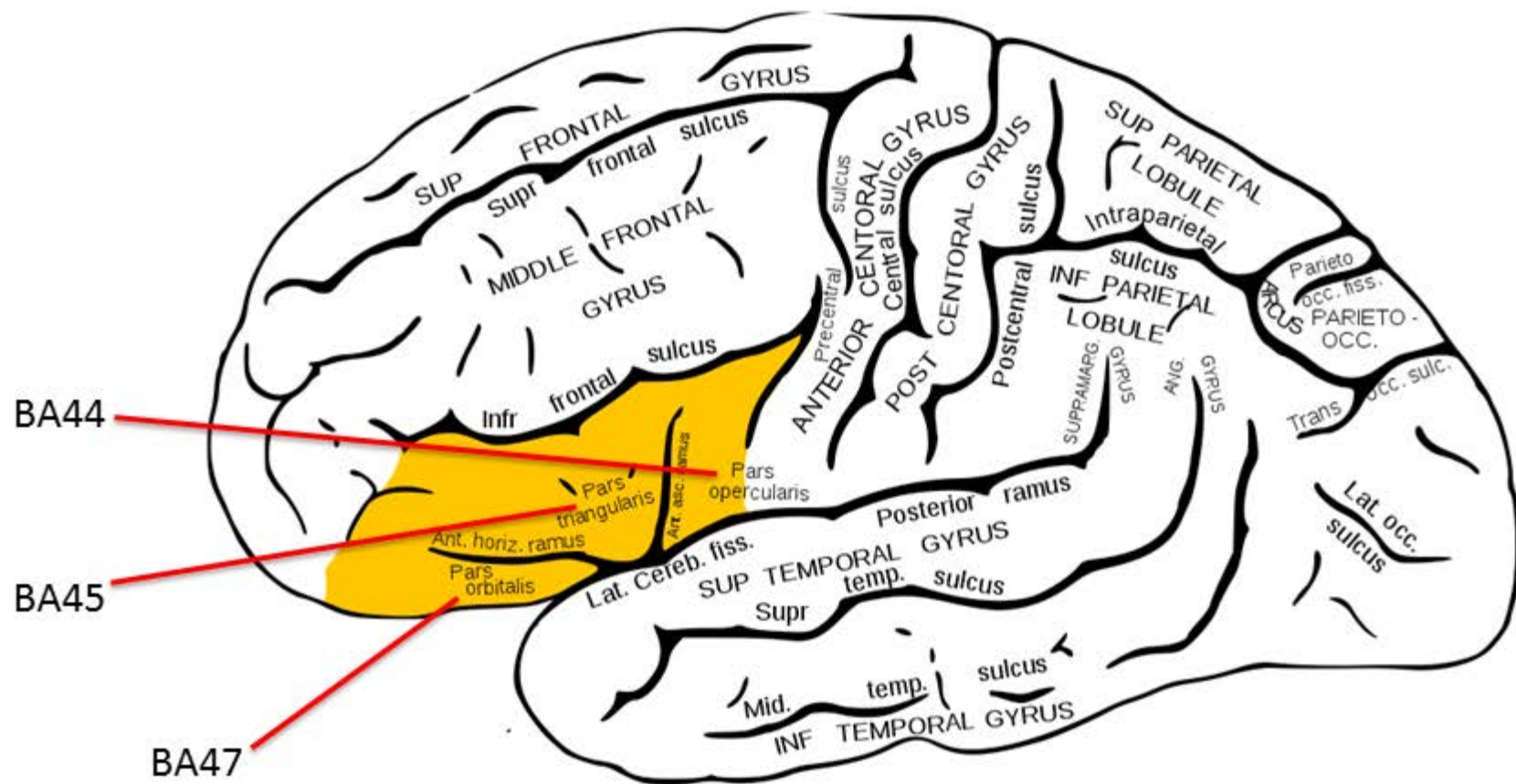
- Prosocial motivation (e.g., Waytz, Zaki & Mitchell, 2012; JoN)
- Emotional regulation (self/other and personal distress; mitigate automatic biases)



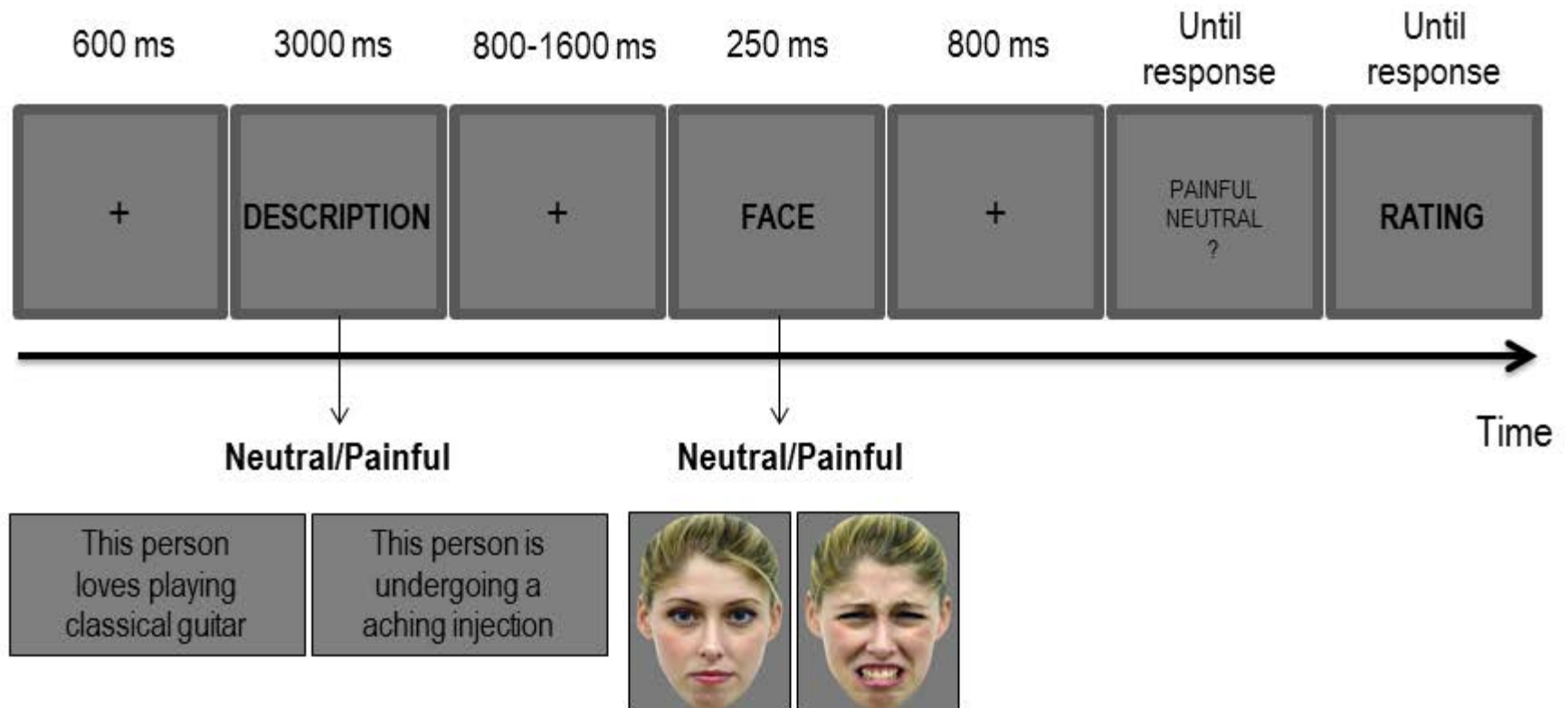
From Zaki & Ochsner, 2012, Nature Neuroscience

Inferior frontal gyrus and empathy

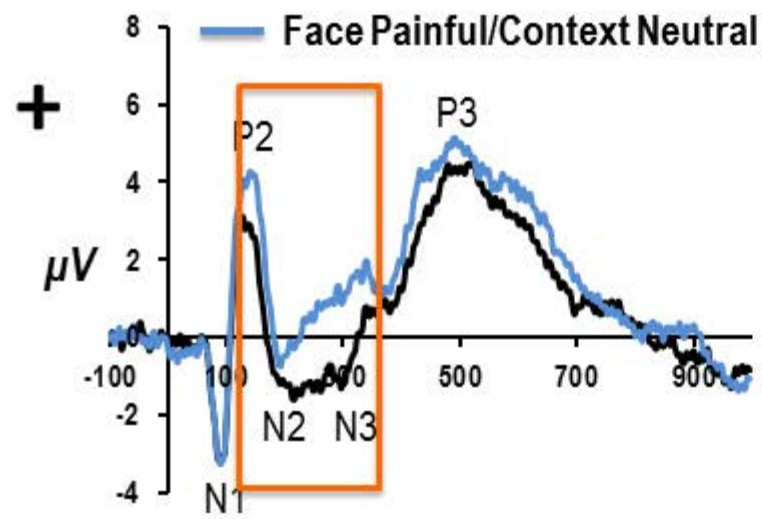
- BA 45 and BA 47 have also an important role in empathy
- Intentional empathy (de Greck et al., 2012; SCAN)
- Emotional perspective taking (Hynes et al., 2006; Neuropsychologia)



Dissecting empathy: paradigm



- **Sentence**: general vs. contextual information
- **Picture**: taken in the painful situation or in a different moment



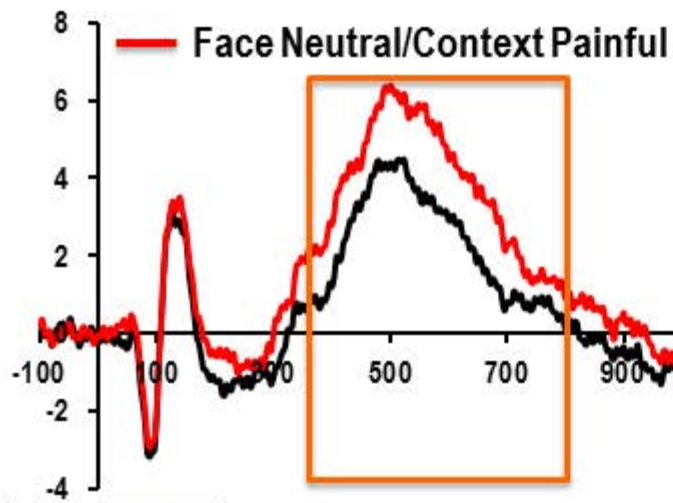
This person
loves playing
classical guitar

[...] 3s



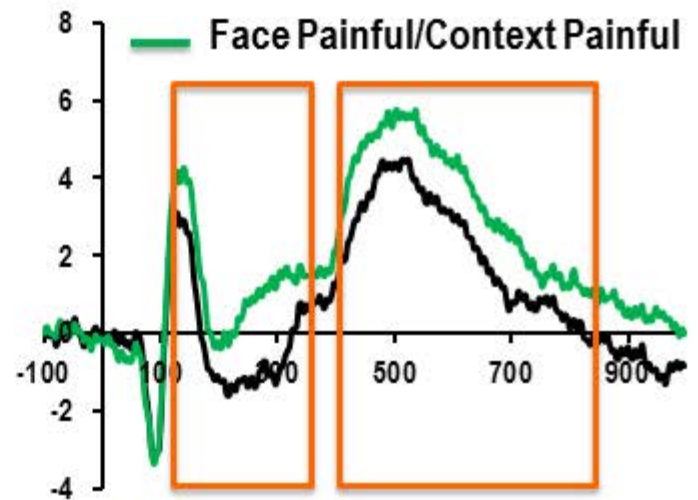
a) Pooled Fronto-Central Electrodes

— Face and Context Neutral



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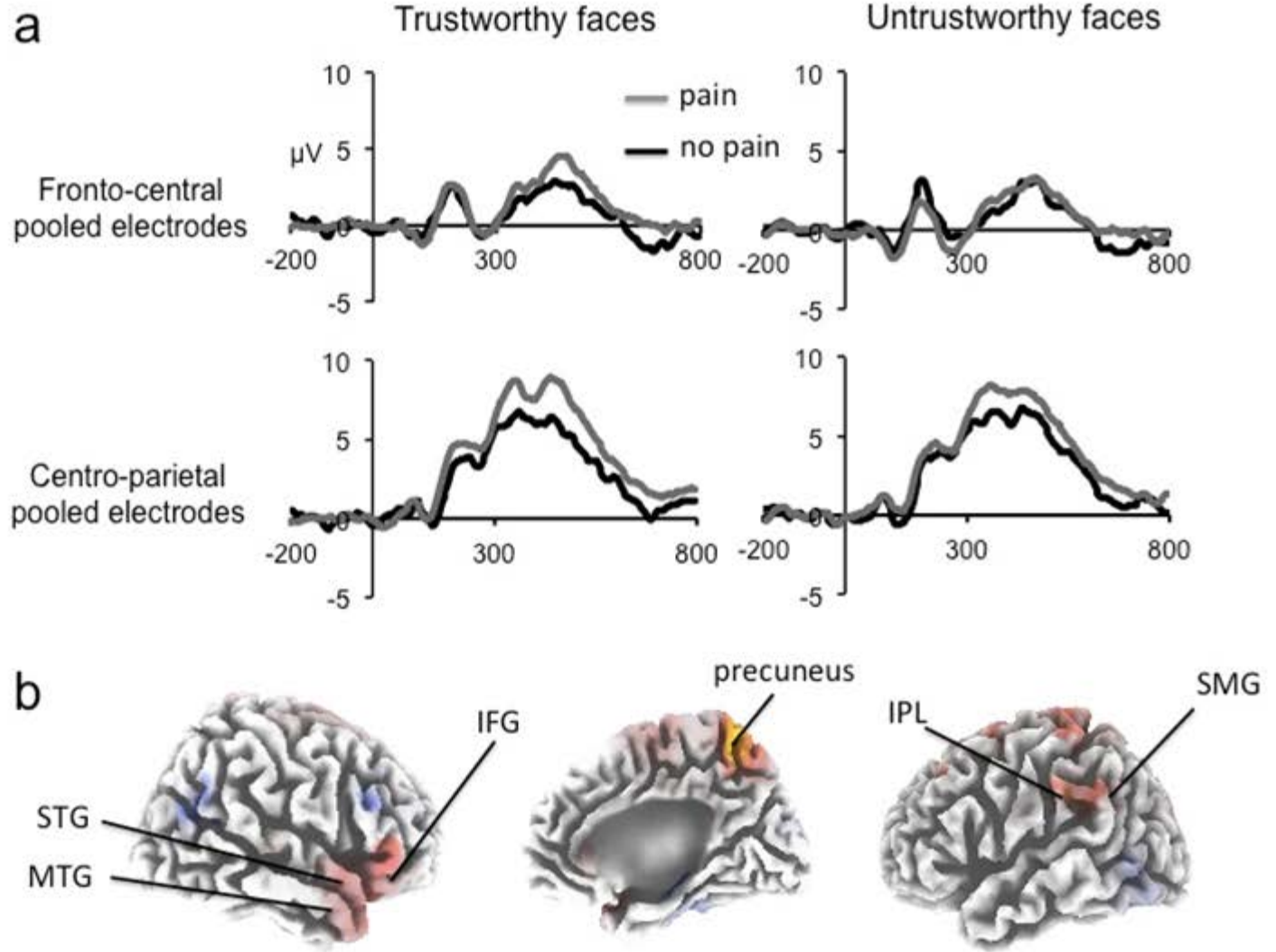


Perceived trustworthiness shapes empathy

Trustworthy



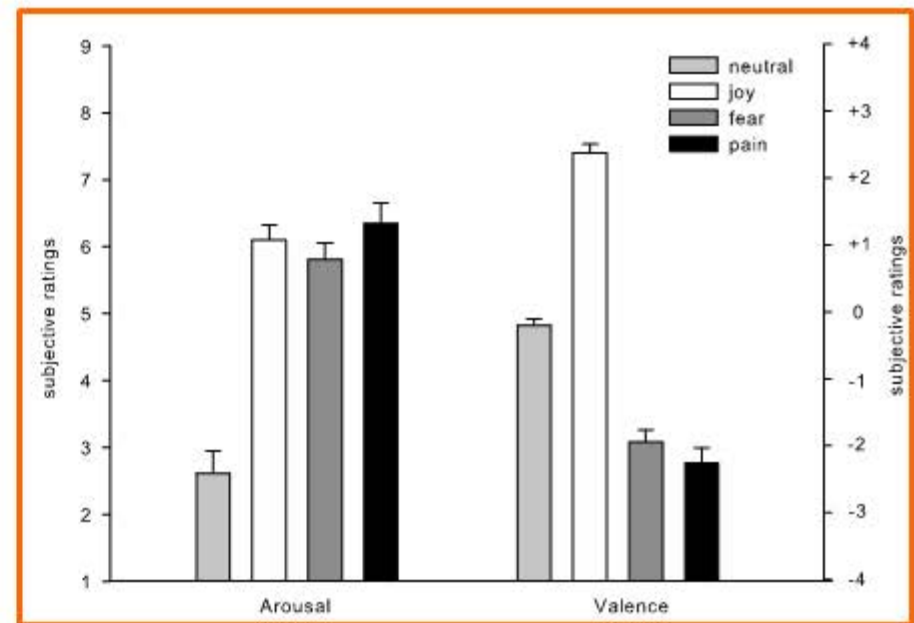
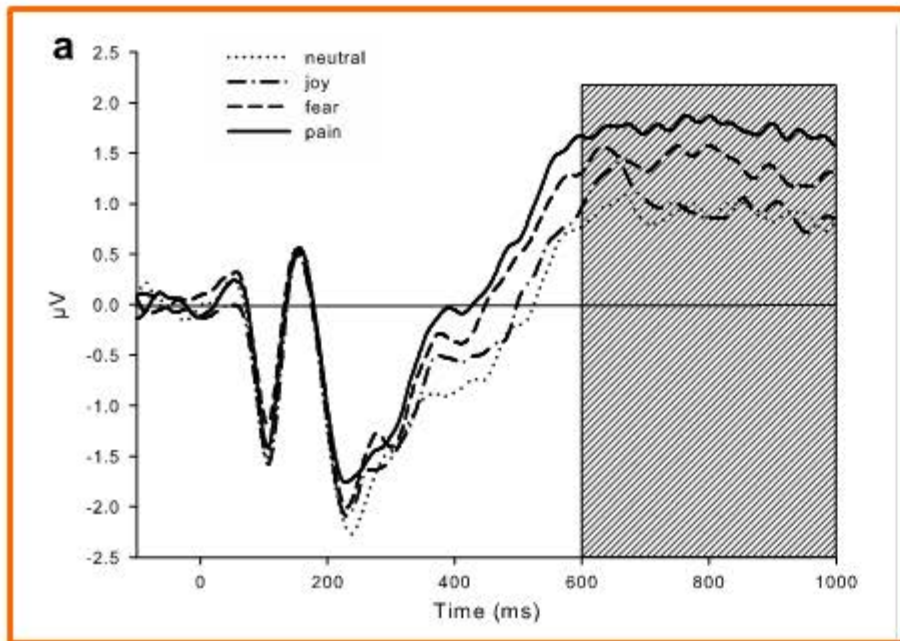
Untrustworthy



Sessa & Meconi, in preparation

Are brain/ERP reactions specific to pain?

- ACC activation for vicarious disgust, fear, sadness
- 1. AI and ACC code a common aspect of vicarious responses (?)
- 2. Different regions are specialized for different emotions (e.g., Eisenberg et al., 2003, Science, emotional vs. physical pain) (?)
- ERP studies suggest that there are differences between pain expressions and other expressions



Reicherts et al., 2012, Pain