Long-term expertise with artificial objects increases visual competition with early face categorization processes

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Journal of Cognitive Neuroscience. 2007, in press.

See also:

Jacques & Rossion, 2004, **Concurrent processing reveals competition between visual representations of faces**. *Neuroreport*, 15, 2417-2422.

Rossion, B., Kung, C.C., Tarr, M.-J., 2004. **Visual expertise with nonface objects leads to competition with the early perceptual processing of faces in the human occipitotemporal cortex**. *Proceedings of the National Academy of Science USA*, 101, 14521-14526.

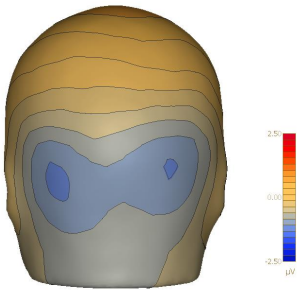
Jacques & Rossion, 2006, **Electrophysiological evidence for temporal dissociation between spatial attention and sensory competition during human face processing**. *Cerebral Cortex*, in press

Main findings and conclusions

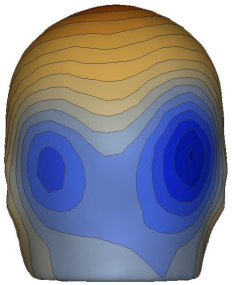
- The N170 component in response to FACES is substantially decreased in amplitude when experts process nonface objects of expertise (Cars) concurrently

- The effect of expertise is large, correlated with the amount of expertise, and takes place mainly in the right hemisphere

ERP response to



Novices

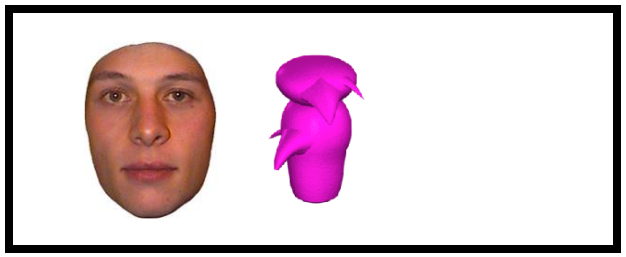


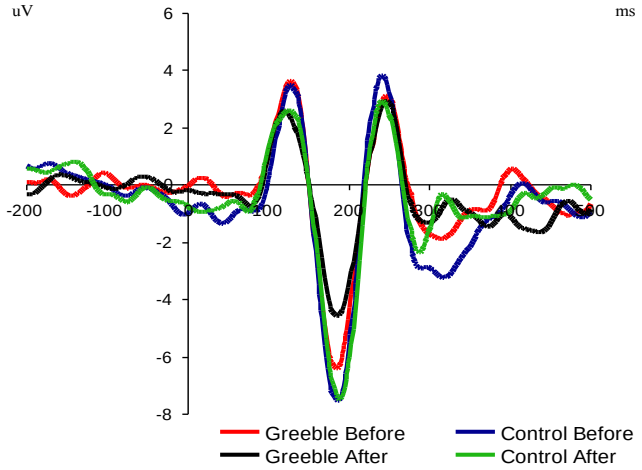
Experts

Even if the face is a special kind of stimulus for the human brain, when one becomes an *expert* in discriminating members of a visually homogenous nonface category, this expertise may rely on *shared perceptual processes* with faces.

Using an expertise training paradigm with novel objects (Greebles) and event-related potentials (ERPs), we (Rossion, Kung & Tarr, 2004) showed that:

The N170 occipito-temporal component in response to FACES is substantially decreased in amplitude when experts process Greebles concurrently





This suggests that when one becomes an *expert* in discriminating members of a visually homogenous nonface category, this expertise relies on *shared perceptual processes* with faces.

Here we aimed to strenghten these findings using:

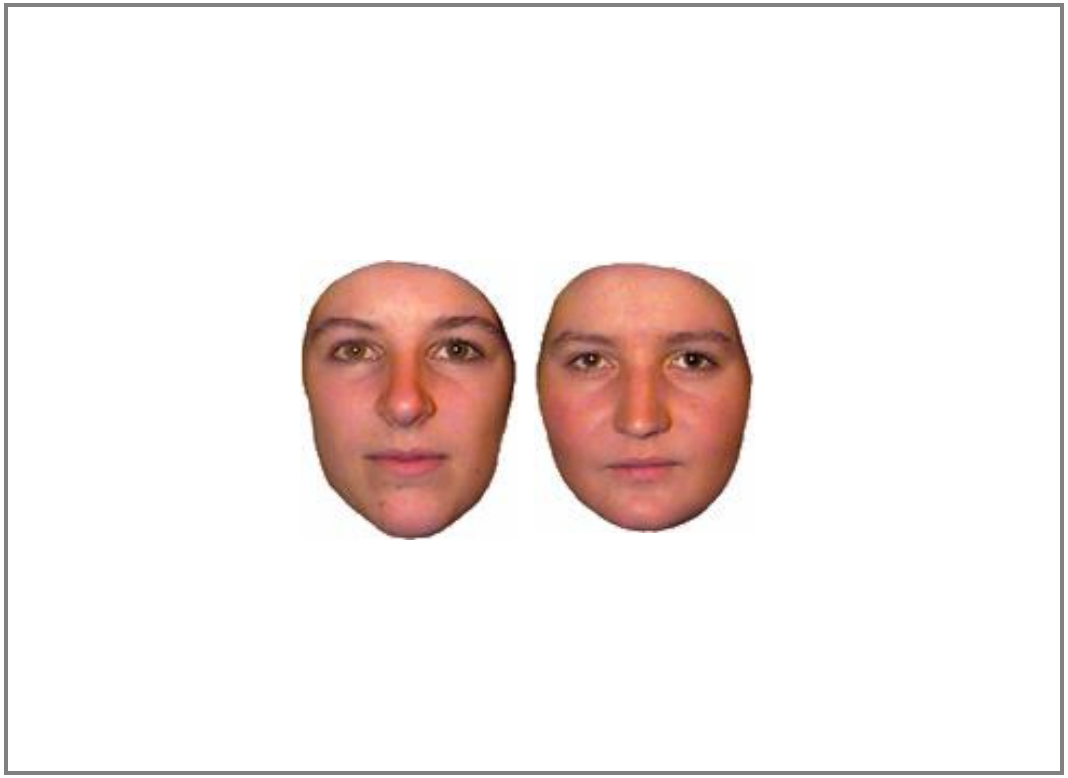
- Event-related potentials (ERPs) to faces

- Our paradigm with competing stimuli

- **Familiar objects (Cars) learned in natural conditions (no training)**

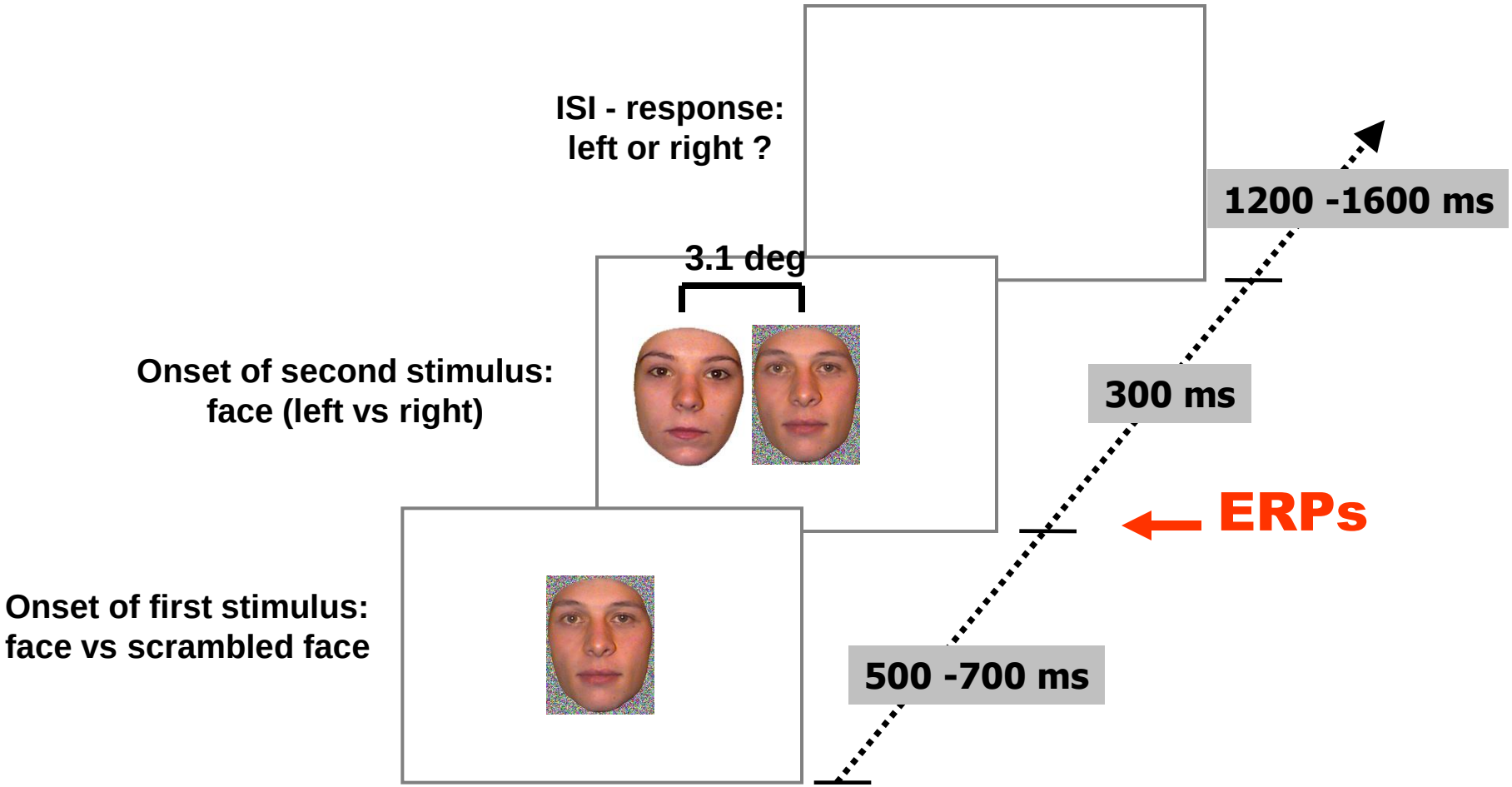
- **Correlation measures between behavioral indexes of expertise and ERP effects**

N170 response to multiple face stimuli



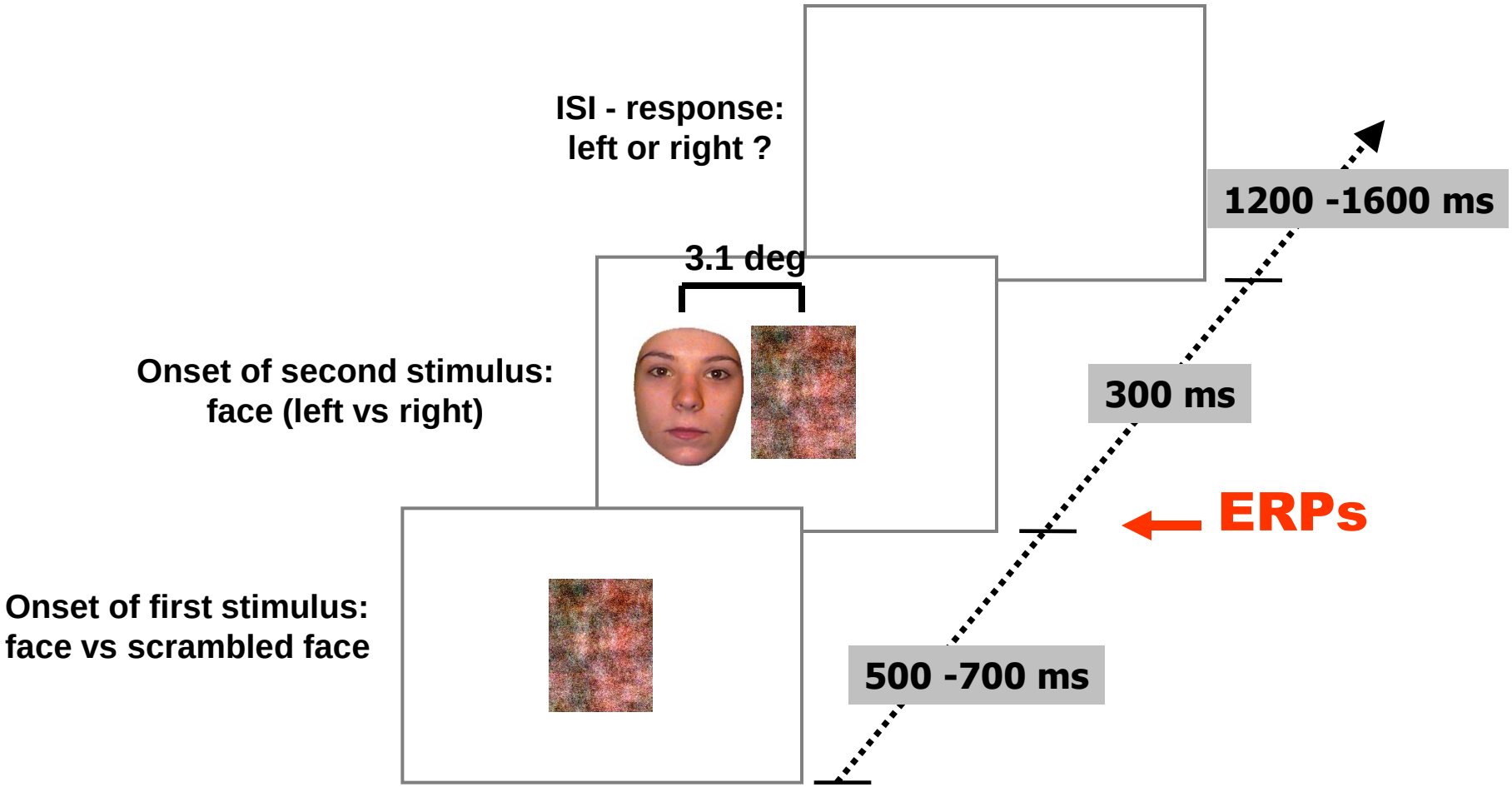
Jacques & Rossion (2004)

‘Face to face’ condition

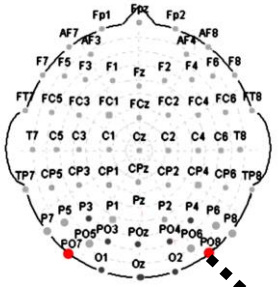


Jacques & Rossion (2004)

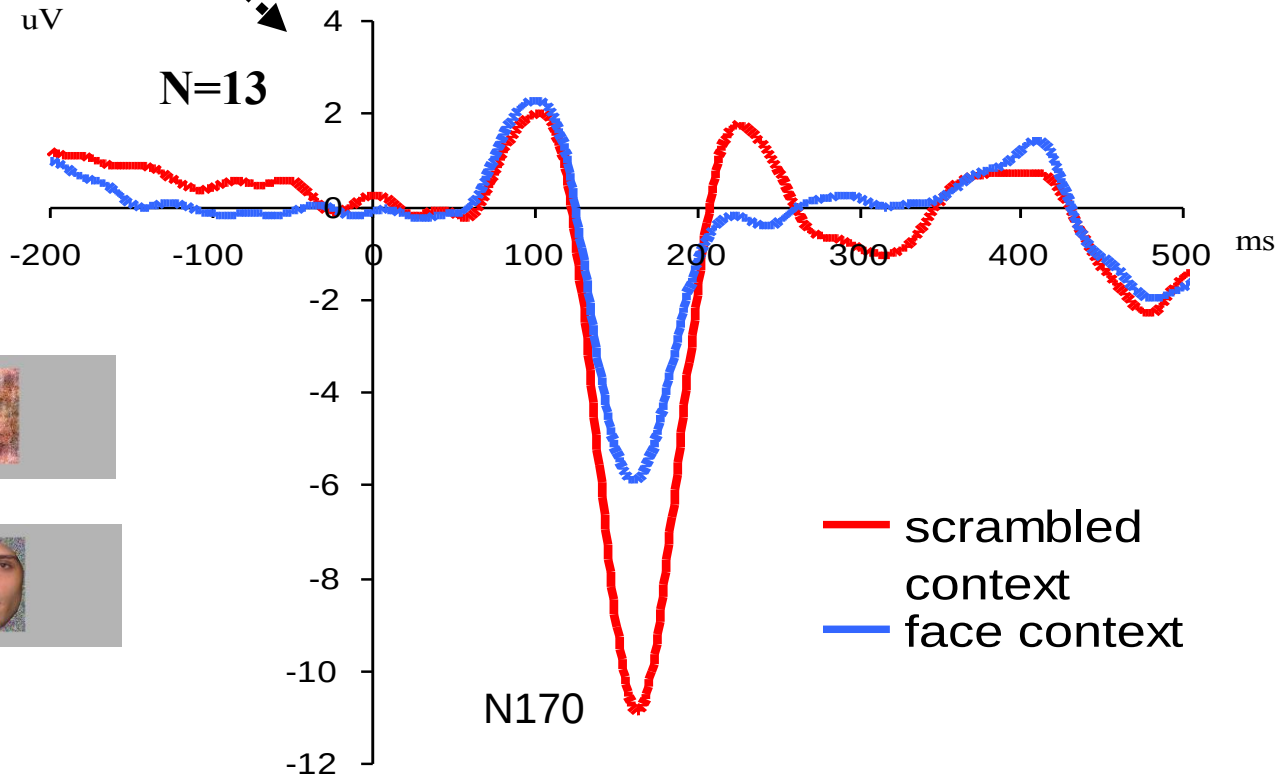
control condition (scrambled face)

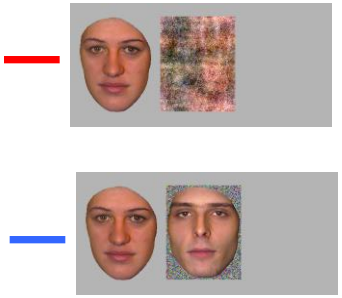


Jacques & Rossion (2004)



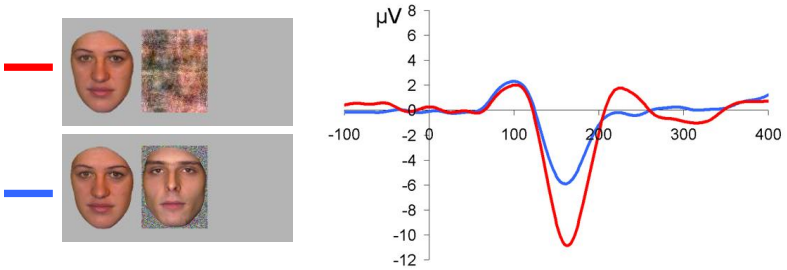
ERP to lateralized face
Left visual field - Right hemisphere





Massive reduction of amplitude of the N170

Interpretation



If two faces are presented concurrently in the visual field, they compete for neural representation …
(e.g. Miller et al., 1993; Rolls & Tovee, 1995)

… to the extent that they are recruiting a common population of neurons
(Desimone, 1998; Reynolds et al., 1999; Keysers & Perrett, 2002)

→ ERP paradigm to address the competition between faces and objects of expertise

Car expertise study

20 Car Experts, 20 Car Novices

All Male

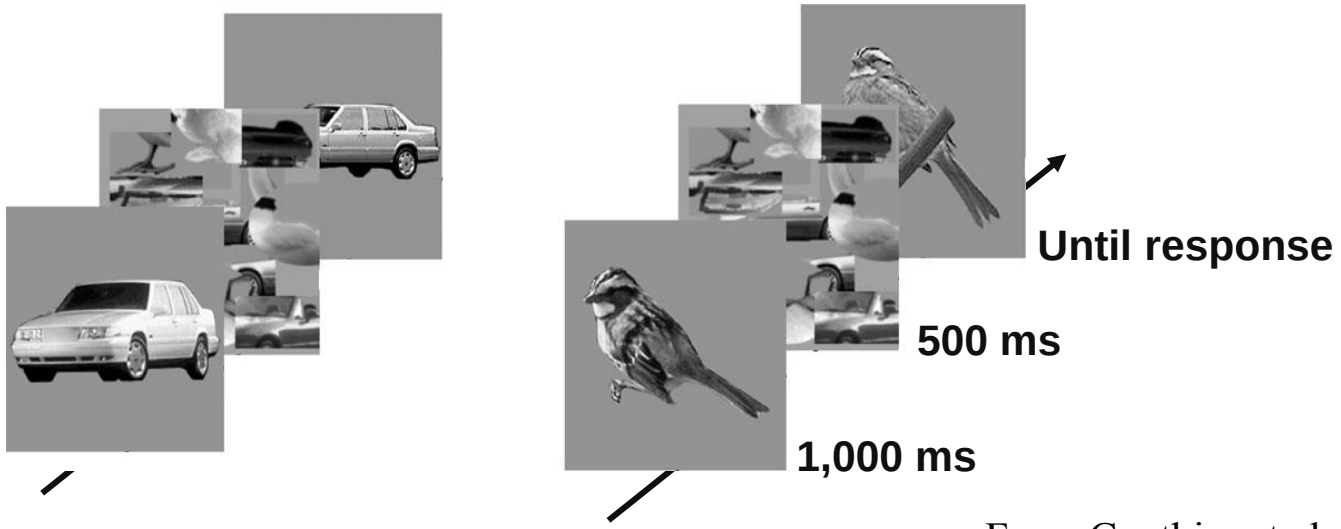
Age:

- Experts: range 18-26, average 20.60, sd 3.89
- Novices: range 18-29, average 21.75, sd 2.28

Expertise measured also by matching task performance before EEG study

Independently of ERP experiment

Matching task used to measure level of expertise



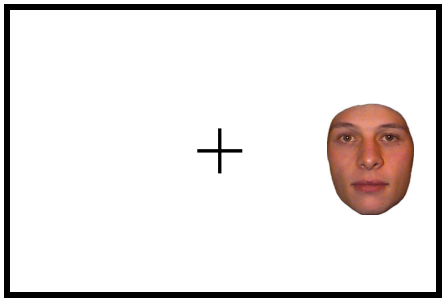
From Gauthier et al., 2003

$$\Delta d' = d'_{car} - d'_{bird}$$

		Expert	Novice
$\Delta d'$	Mean	1,59	0,43
	Min	0,89	-0,63
	Max	2,78	0,81

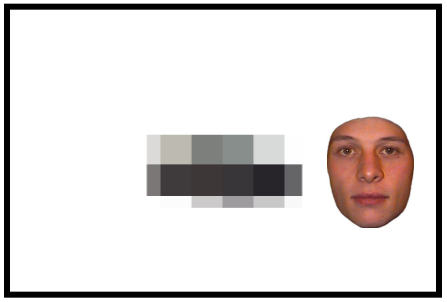
Then: Continuous EEG recordings during 3 conditions

1. Fixation + Face

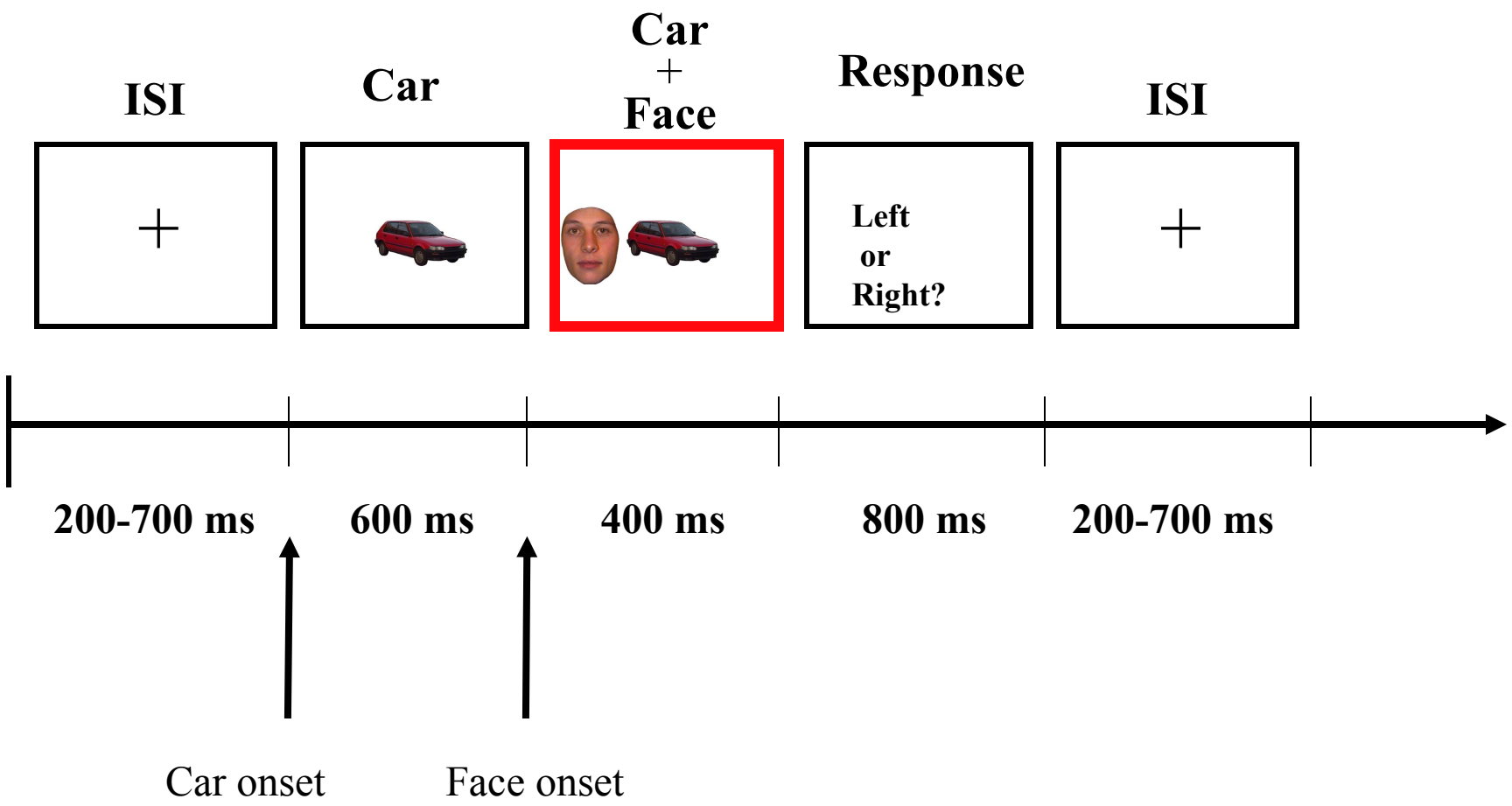


2. Car + Face

3. ‘Scrambled car’ + Face

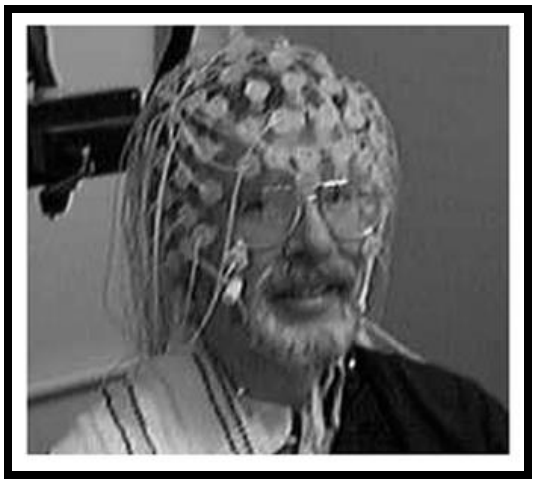


Timeline of Task Events



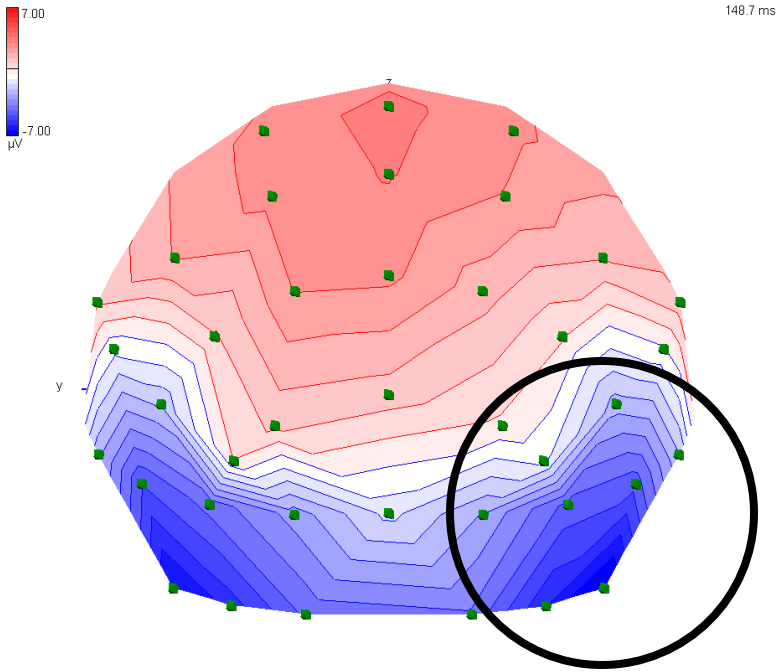
Methods details

128 channels system (250Hz sampling; 0.01 to 100 Hz)



Stimulus 1 (Car, Shape, Fixation cross) duration: random between 500-700 ms
Stimulus 2 (face) presented for 200ms
ISI = 1000ms
Left/Right decisions

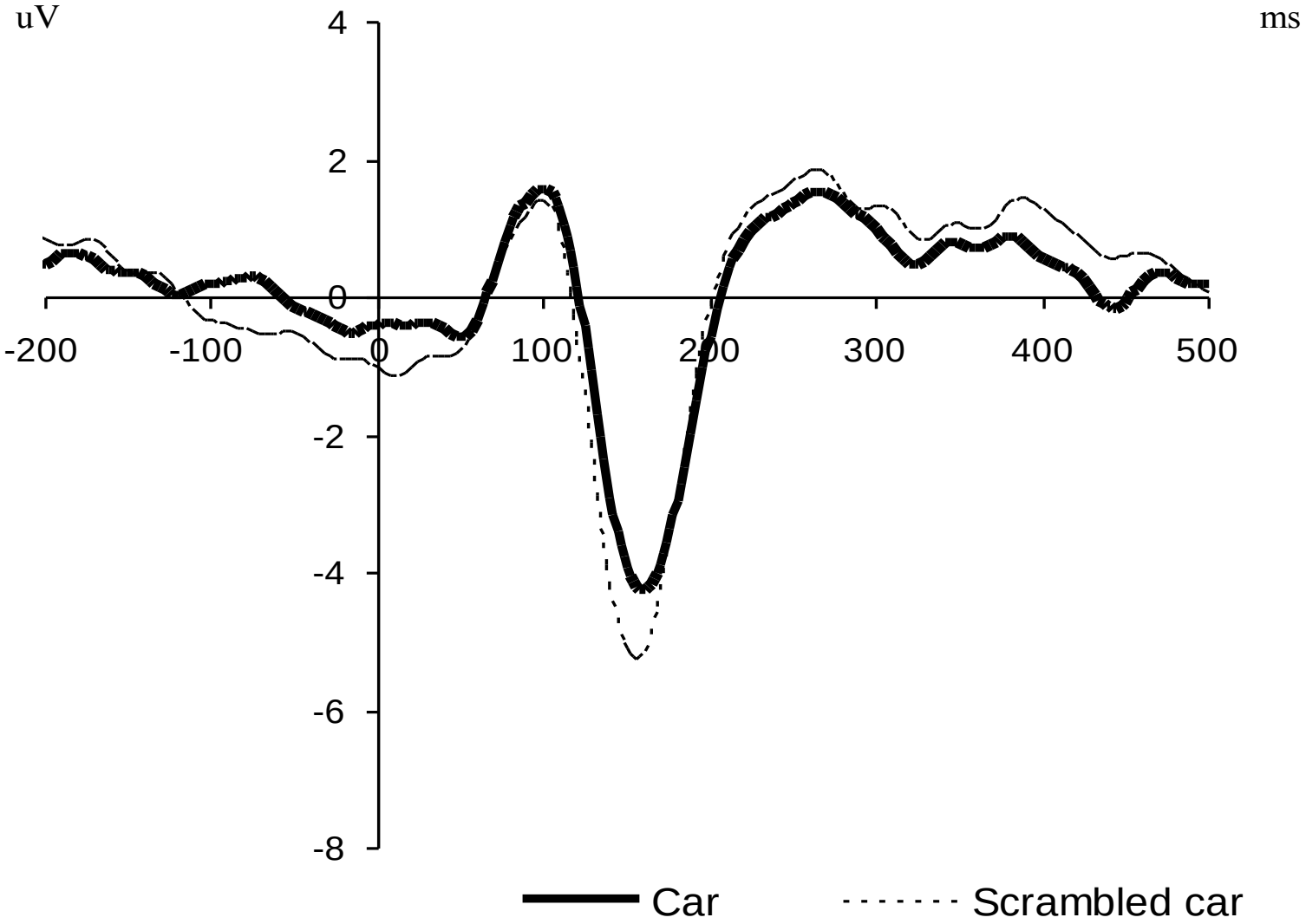
Right Hemisphere - Face in Left Visual Field



Methods

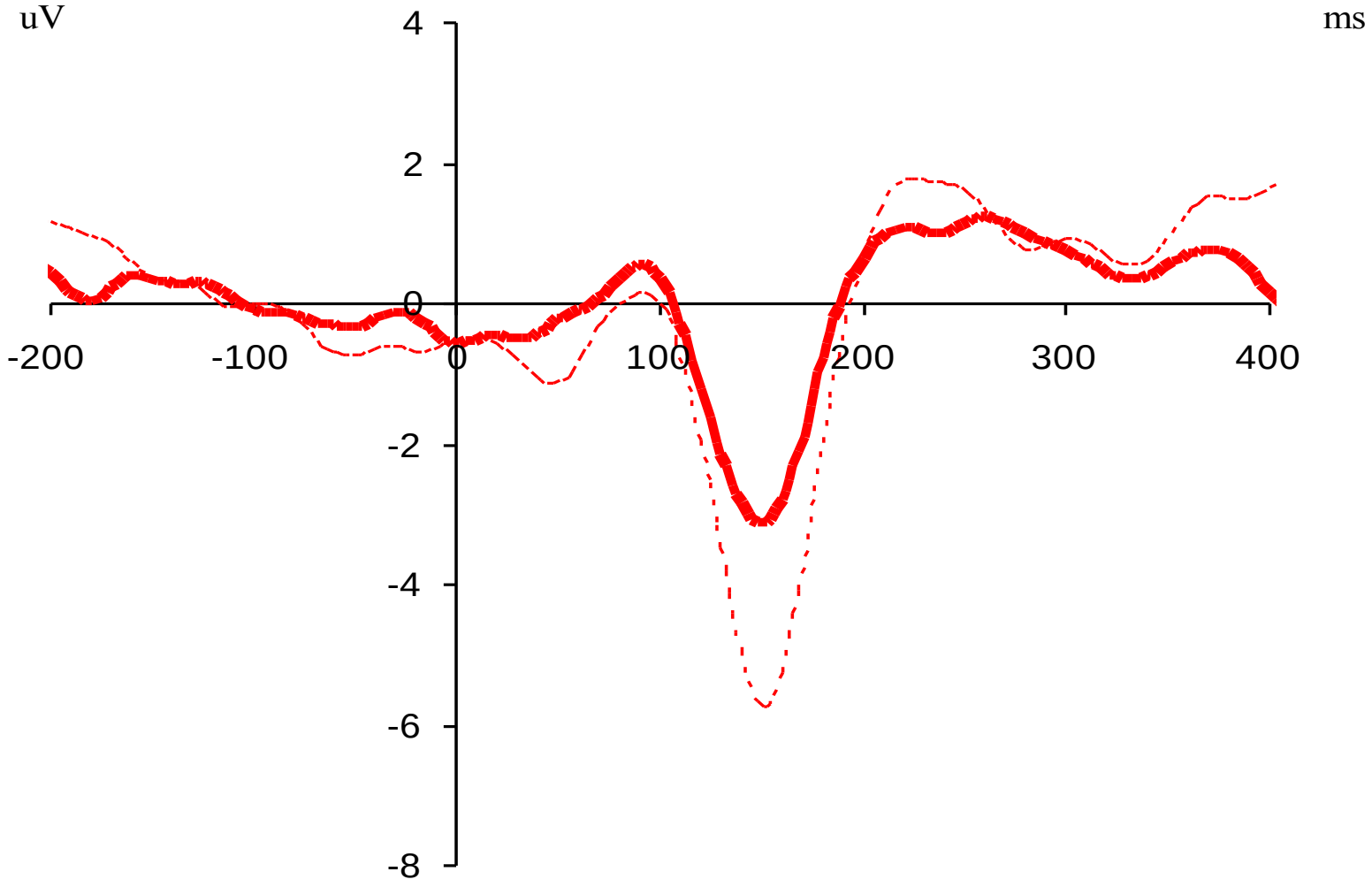
CAR NOVICES

ERP response to 



CAR EXPERTS

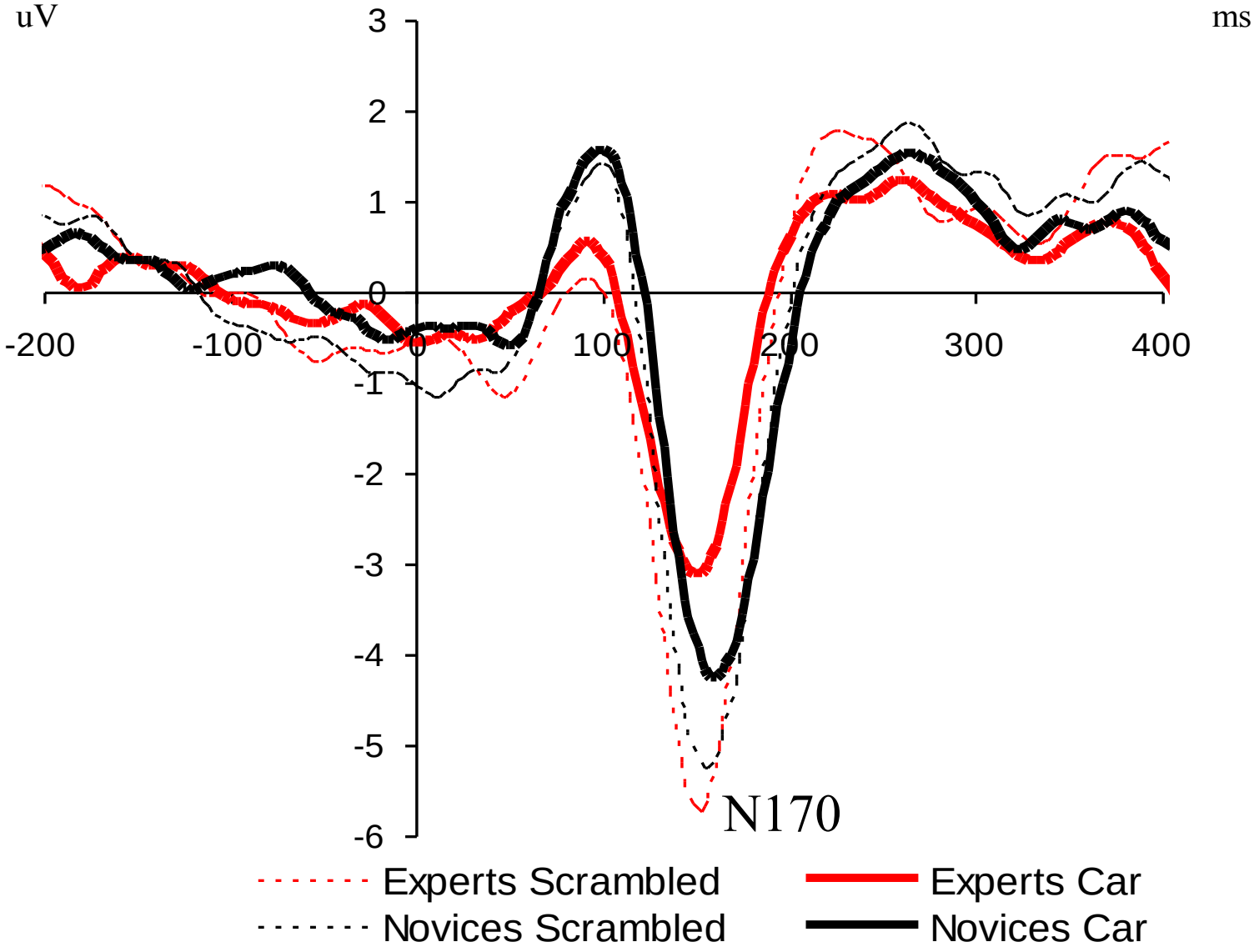
ERP response to 



Right hemisphere (T6)
- left visual field

Right hemisphere (T6) - left visual field

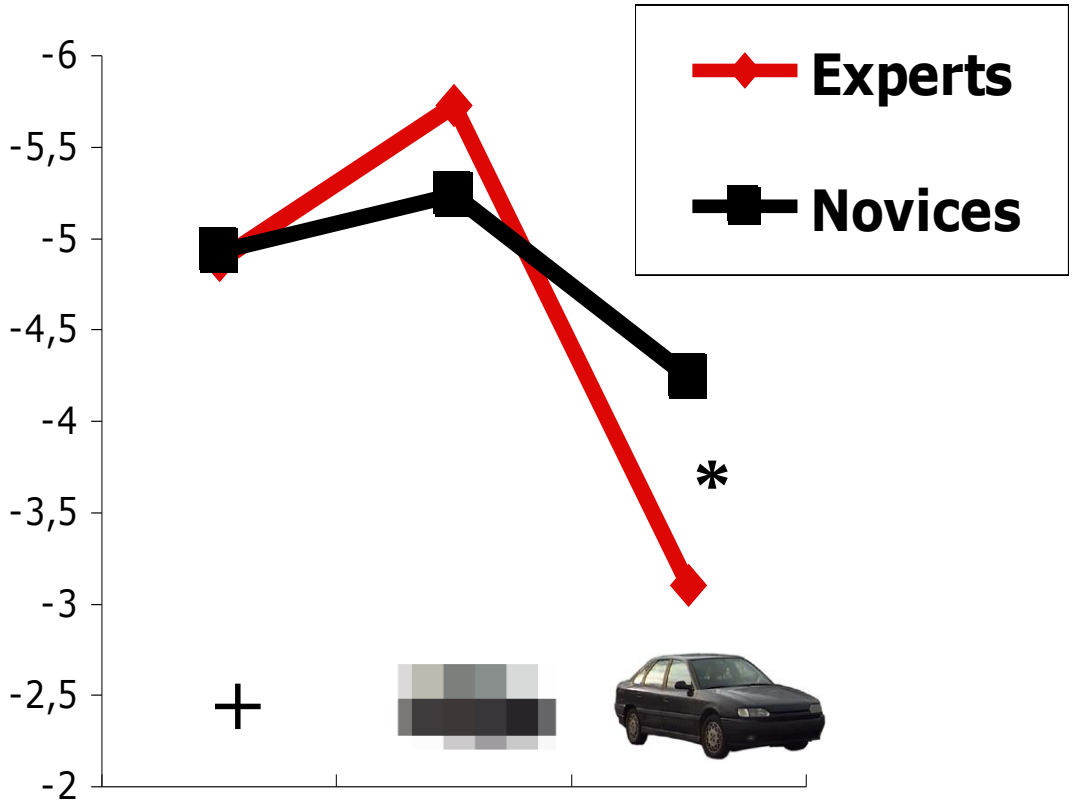
ERP response to 



Left visual field

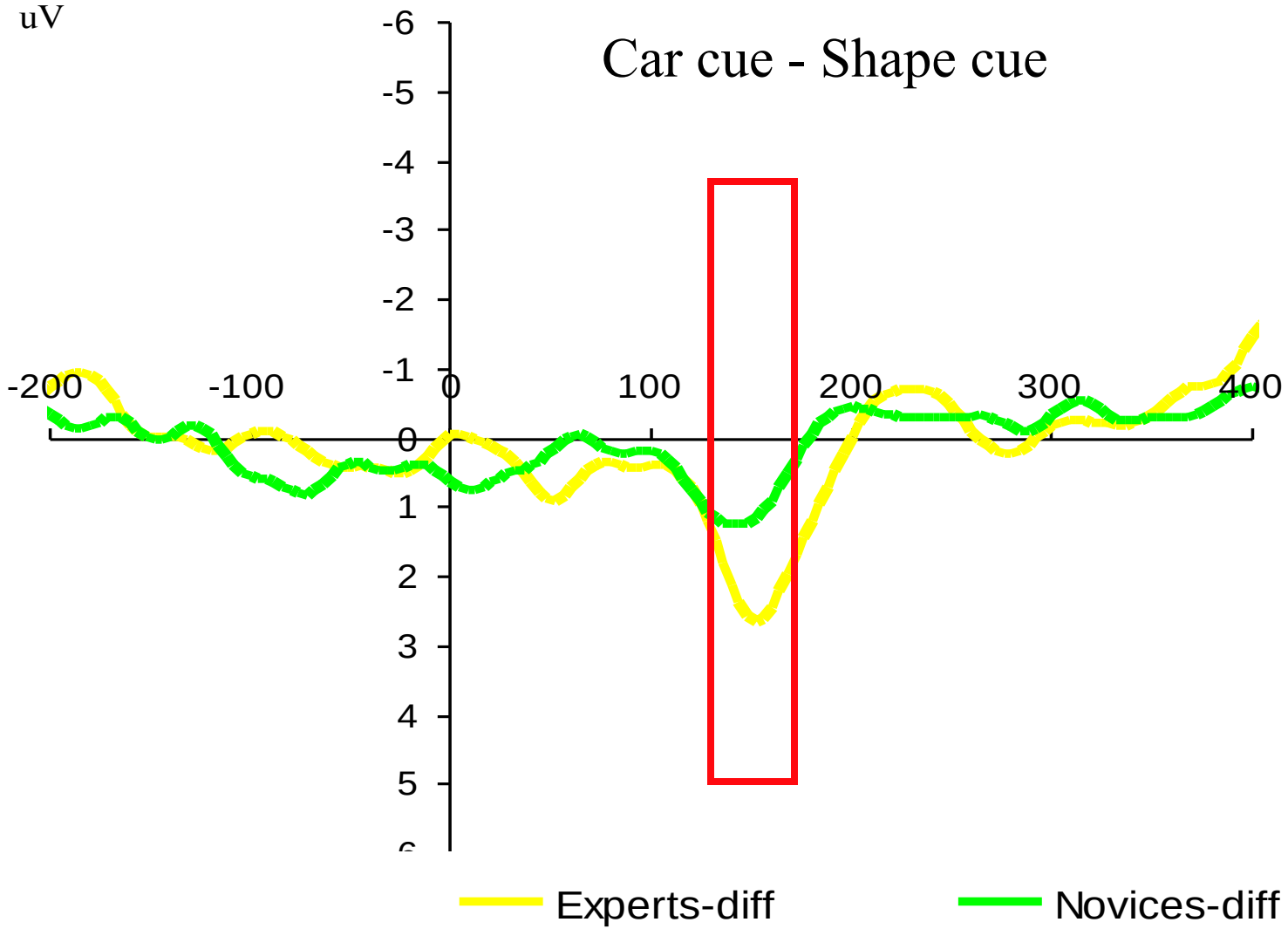
Right hemisphere (T6)

N170 amplitude



Right hemisphere (T6) - left visual field

ERP response to 

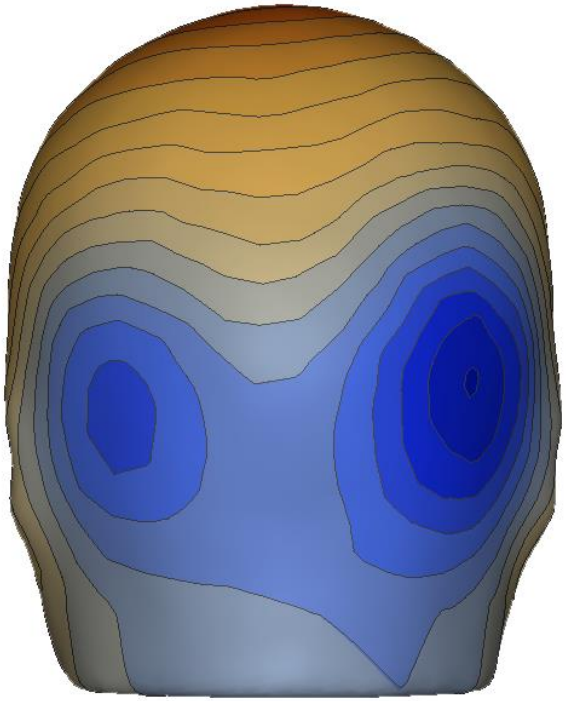


Results

Experts

Novices

160 ms

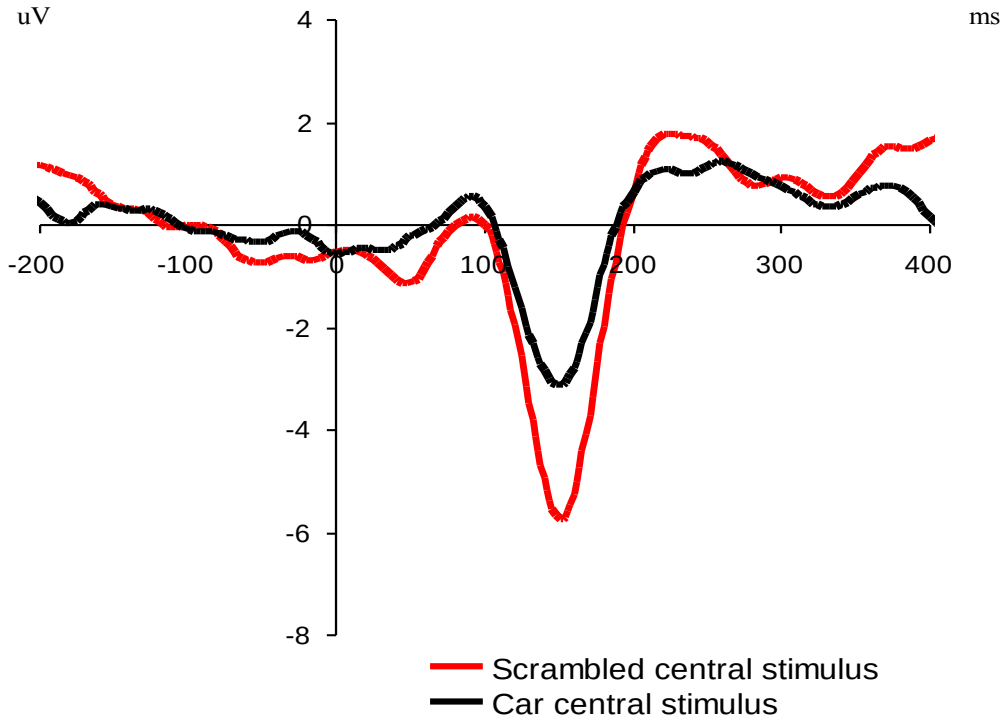


ERP response to 

Car context - Scrambled context

If one is an expert at processing cars …

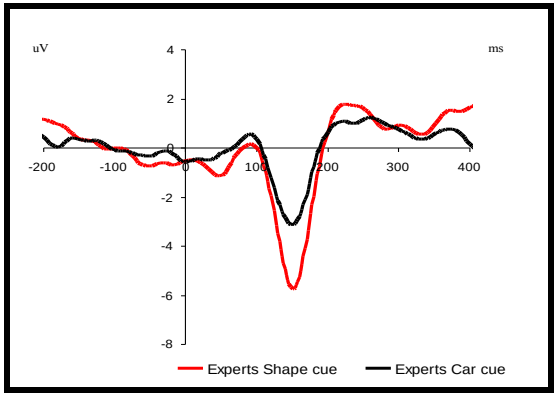
Large decrease of N170 in response to faces when processing cars concurrently



Effect larger in the right hemisphere

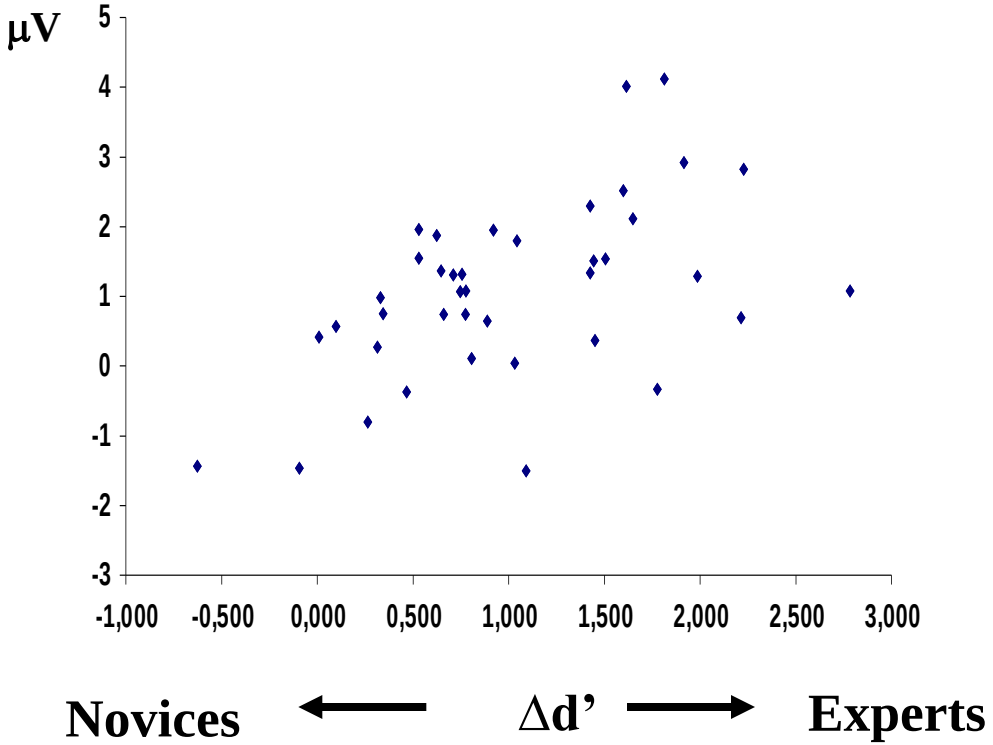
Results

Correlation analysis between N170 effect and behavioral measure of expertise



N170 competition effect (car context - shape context)

r=0.54 (p<0.001)



Δd'

	Expert	Novice
Mean	1,59	0,43
Min	0,89	-0,63
Max	2,78	0,81

Results

Conclusions

If you are an expert with an non-face object category, your visual system will use the same perceptual mechanisms as used for faces

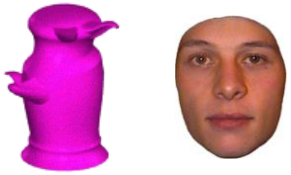
When the 2 categories are presented at the same time

→ Competition between the 2, at the level of the N170

The processing of faces is reduced when experts concurrently process objects of expertise

= Evidence for partially overlapping representations between faces and objects of expertise

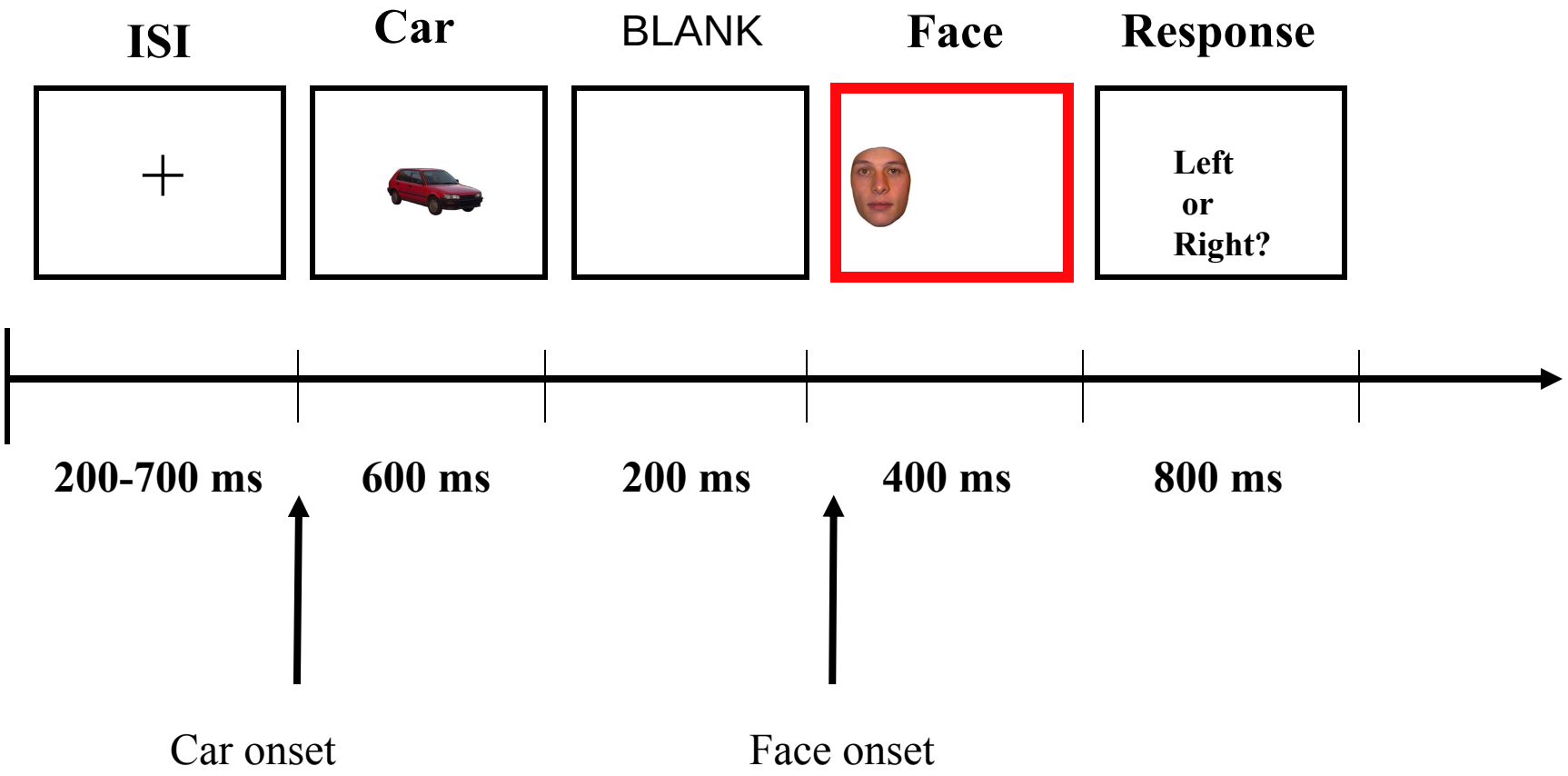
Rossion, Kung & Tarr, 2004



Rossion, Goffaux, Collins & Curran, 2007

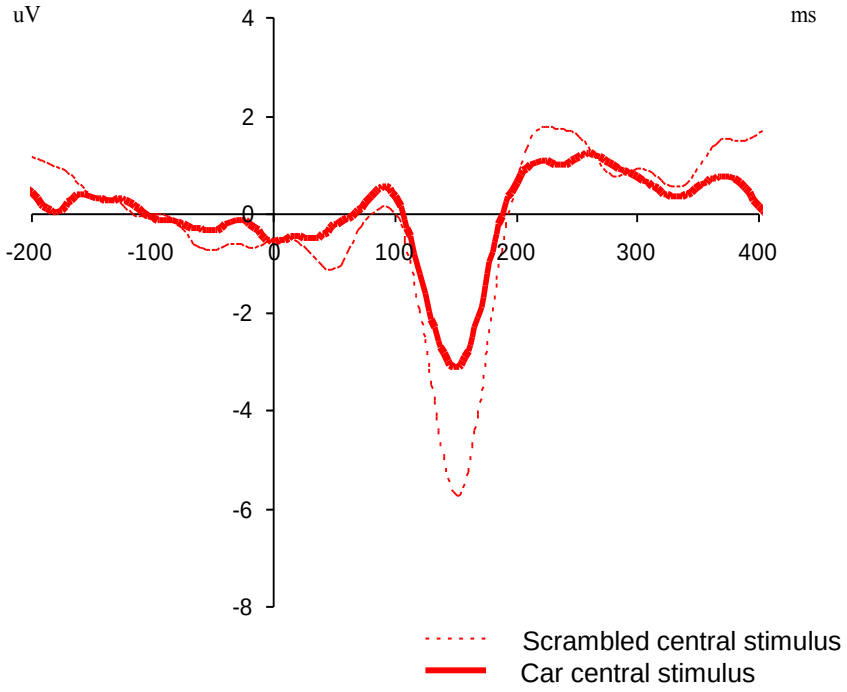
How important is it to have the 2 stimuli presented concurrently to observe large effects?

Experiment 2: 200 ms delay between the car and the face stimuli

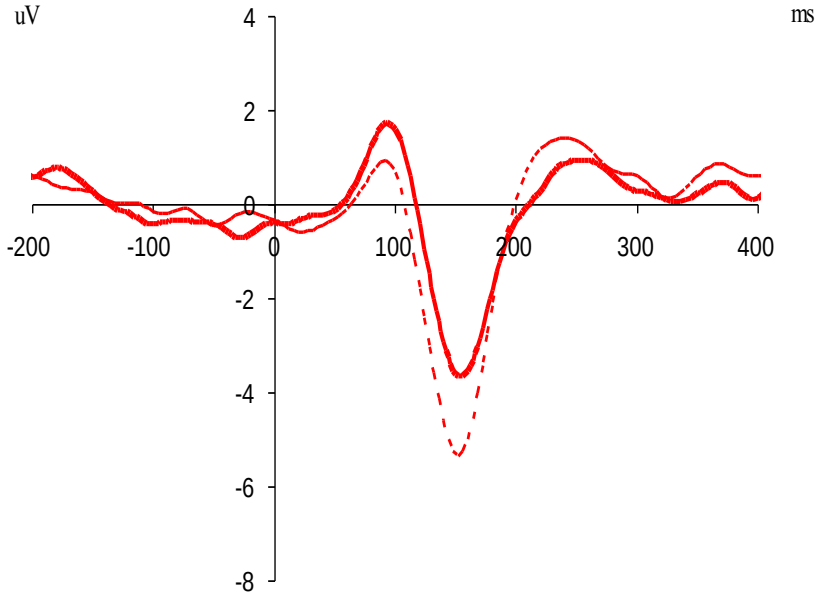


Much smaller effect overall, even though the correlations with expertise remain significant

Concurrent presentation



200 ms delay



Alternative explanations/limitations?

1. Can this effect reflect a simple increase of attention rather the recruitment of shared mechanisms?

e.g. experts would pay more attention to the Cars in the center, leading to reduced N170 to the lateralized face

Highly unlikely:

- Who would pay more attention? Experts or novices?

- The task is irrelevant, performance at ceiling, and no RT difference between conditions

-The effect is not sustained, but take place in a very narrow time window (130 -180 ms)

→ No evidence for a attention as an alternative explanation

+ Effects of attention (when manipulated) in this paradigm are independent from effects of spatial attention:

Jacques & Rossion, 2006, **Electrophysiological evidence for temporal dissociation between spatial attention and sensory competition during human face processing**. *Cerebral Cortex*, in press

Alternative explanations/limitations?

2. The N170 component measured is not really face-specific

e.g. should have been identified by an independent 'face localizer'

Irrelevant because:

- The N170 is measured in response to FACES

- The effect takes place where it is larger for faces: right occipito-temporal sites (T6 or PO8 and surrounding sites).

- Even if the N170 suppression for faces reflect a competition from different populations of cells coding for faces and objects of expertise, the competition suggest that these populations carry similar processes in the same areas.