

Visual expertise with nonface objects leads to competition with the early perceptual processing of faces in the human occipitotemporal cortex

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PNAS. 101, 14521-14526, 2004

See also:

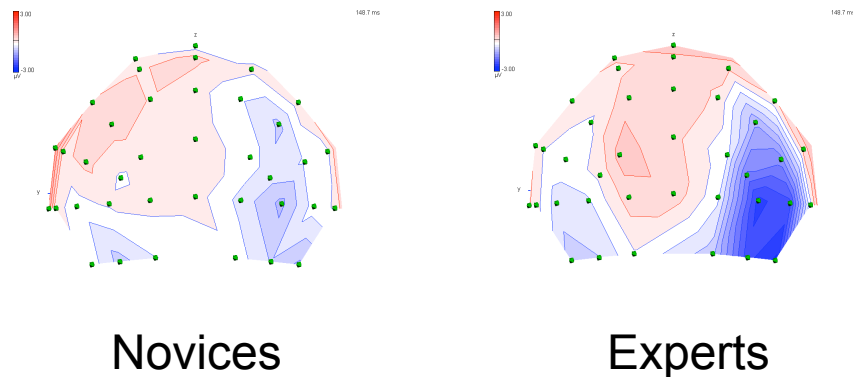
Jacques & Rossion, 2004, **Concurrent processing reveals competition between visual representations of faces**. *Neuroreport*, 15, 2417-2422.

Jacques & Rossion, 2006, **The time course of visual competition to the presentation of centrally fixated faces**. *Journal of Vision*, 6, 154-162.

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 subjects process nonface objects of expertise (Greebles) concurrently
- The effect of expertise is **large, gradual** over the course of training, and takes place mainly in the **right hemisphere**



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.

The question: When one becomes an *expert* in discriminating members of a visually homogenous nonface category, can this expertise rely on *shared perceptual processes* with faces?

No? → The processing of faces rely on **domain-specific** (modular) mechanisms

Yes? → The mechanisms used to recognize faces can be adapted to deal with other object categories. They are not attached to a domain, but **more general**, and **plastic**.

Here, we address this question using:

- Event-related potentials (**ERPs**)
- Faces and **novel objects**
- An **expertise** training study
- A paradigm with **competing stimuli**

The question of the **modularity of face processing** mechanisms is a **very old debate** in the literature (e.g. Bodamer, 1947; Yin, 1969; Ellis & Young, 1989; Nachson, 1995)

Faces appear to rely on *specific mechanisms* for most of us:

- * Behavioral evidence: Larger effects of **inversion** (Yin, 1969), stronger **integration of parts** (Tanaka & Farah, 1993)...

- * Neurophysiological evidence: cells in **infero-temporal cortex** responding only for faces (Gross et al., 1972; Perrett et al., 1982)

- * Neuropsychological evidence: brain lesions can lead to face-specific impairments in rare cases, **prosopagnosia** (Bodamer, 1947; Sergent & Signoret, 1992)

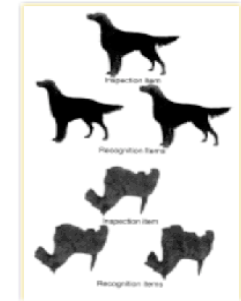
- * Neuroimaging evidence: occipito-temporal **brain areas** responding more to faces than objects, particularly in the **right hemisphere** (e.g. Sergent et al., 1992; Kanwisher et al., 1997)

- + ERPs: faces evoke a large component starting at 130 ms, much smaller for other object categories, the VPP/N170 complex (Jeffreys, 1989 ; Bentin et al., 1996)

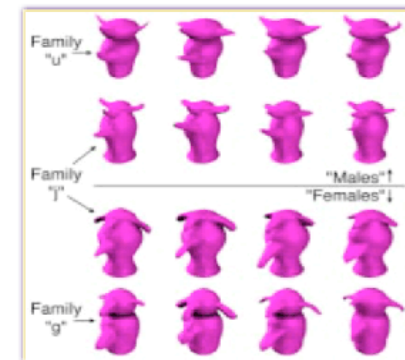
However, these observations do not contradict the view that certain mechanisms used for faces remain plastic even in adults, and can be recruited for other object categories following an extensive visual experience

e.g:

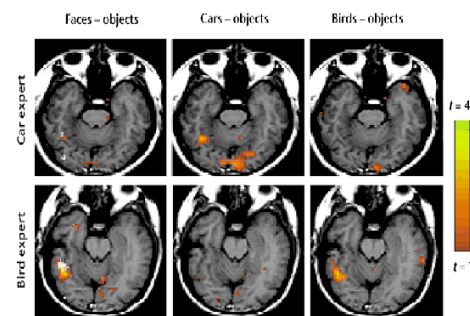
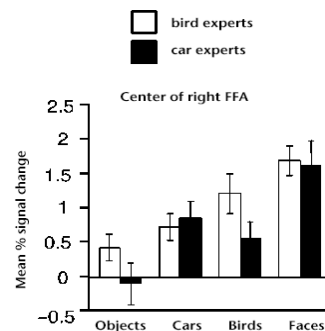
Evidence of increased costs of upside-down **inversion in dog experts** presented with dog pictures (Diamond & Carey, 1986)



Increased integration of parts (sensitivity to configuration) in novel objects (**Greebles**) following ~ 10 hours training (Gauthier & Tarr, 1997)



Increased activation in ‘face areas’ of the fusiform gyrus to pictures of birds and cars in **bird and car experts** (Gauthier et al., 2000)



Introduction

A few comments ...

- The effects of visual expertise **do not have to be as large as for faces** to invalidate the modularity hypothesis, but show the same pattern, increasing with visual expertise.

Yet, admittedly, these effects could be stronger ...

- **Any kind of visual expertise** with nonface objects will **not** necessarily increase the reliance on **mechanisms** used for **faces**
- Behavioural and neuroimaging findings are **indirect evidence** that faces and objects of expertise may share common **perceptual** mechanisms

————→ With ERPs, we are looking for strong effects of visual expertise, taking place at the early stages of face categorization

= on the N170 component

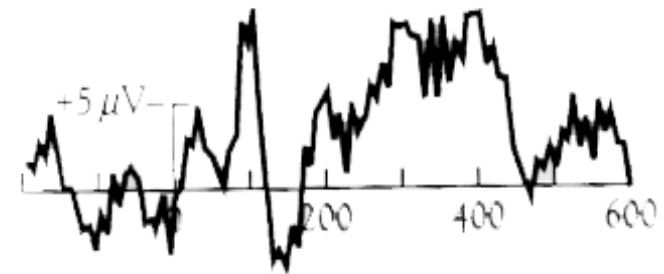
Introducing

- Event-related potentials (ERPs) to faces
- A paradigm with competing stimuli
- Novel objects (Greebles) in an expertise training study

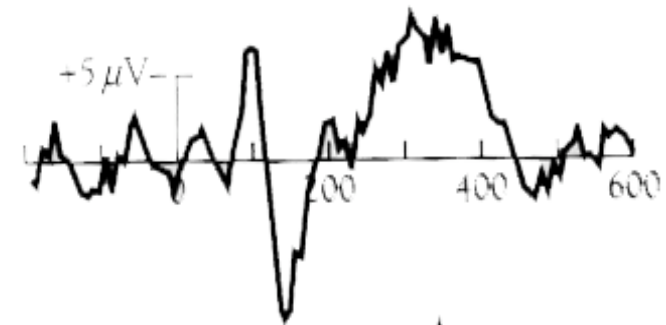
Method = averaging epochs of EEG time-locked to the onset of a face stimulus



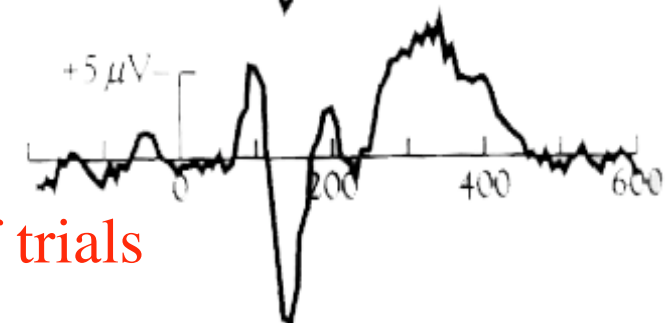
1 trial



10 trials



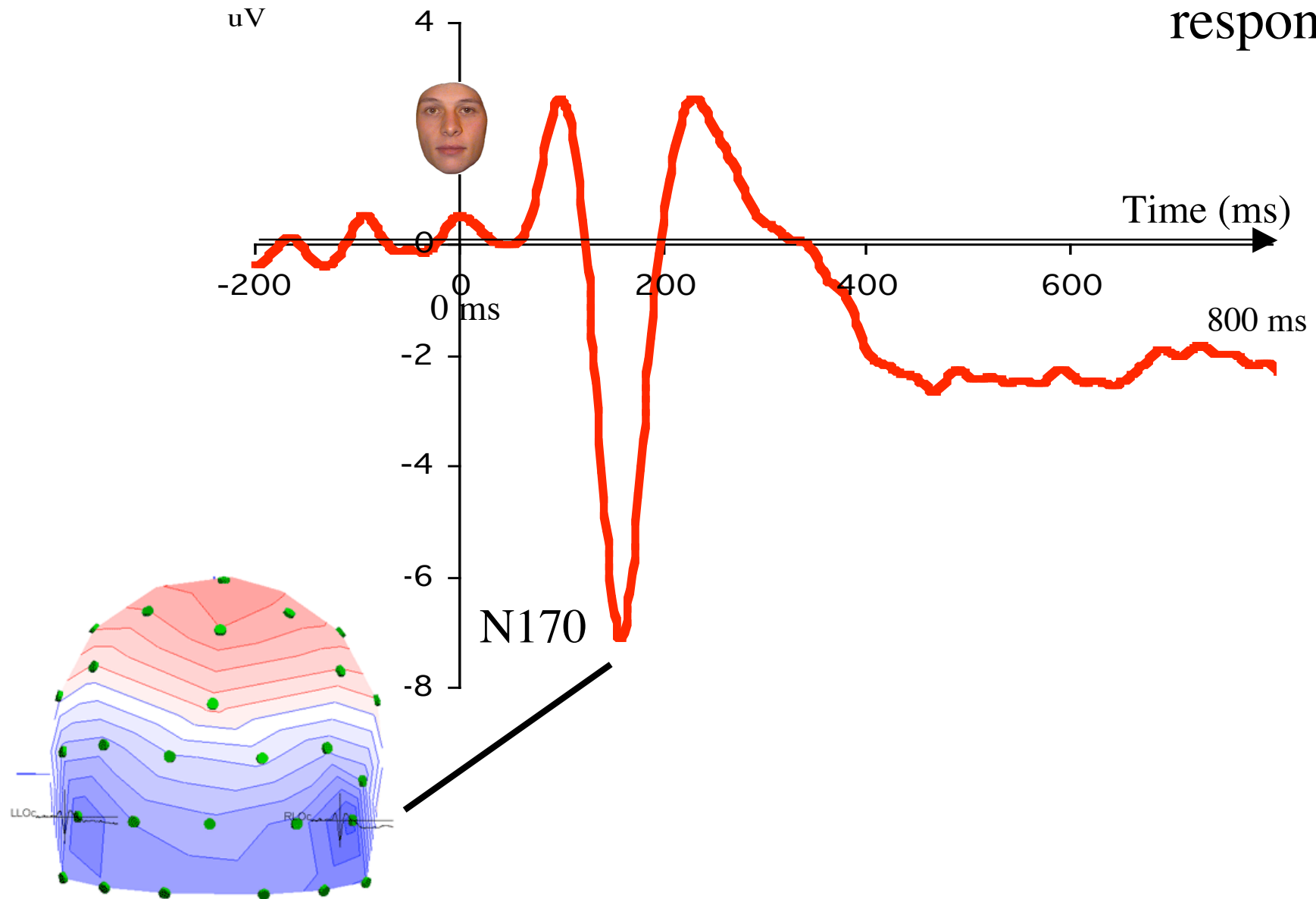
Tens of trials



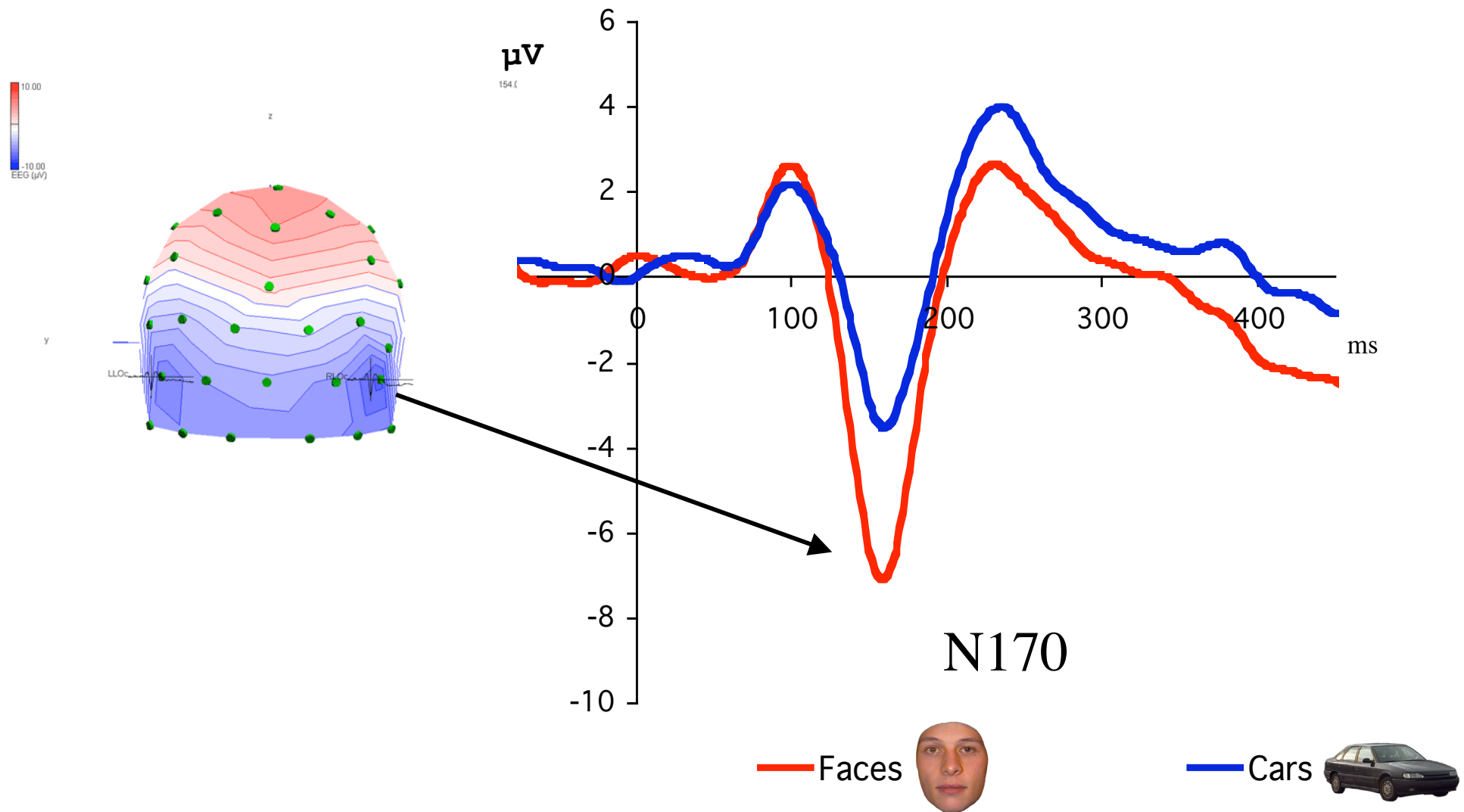
Introduction

Stimulation

Motor response



Introduction

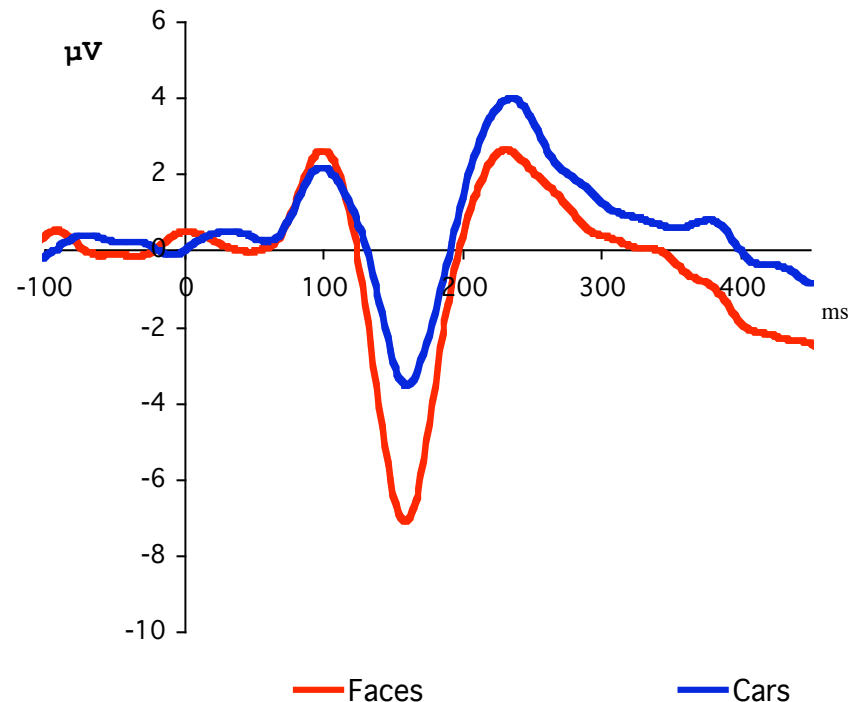


The **N170** is larger for faces compared to other objects categories (e.g. Bentin et al., 1996; Bötzel et al., 1995; Eimer, 2000; Rossion et al., 2000)

Introduction

N170

= Earliest and only consistent scalp electrophysiological response in humans that differentiates between faces and other object categories.

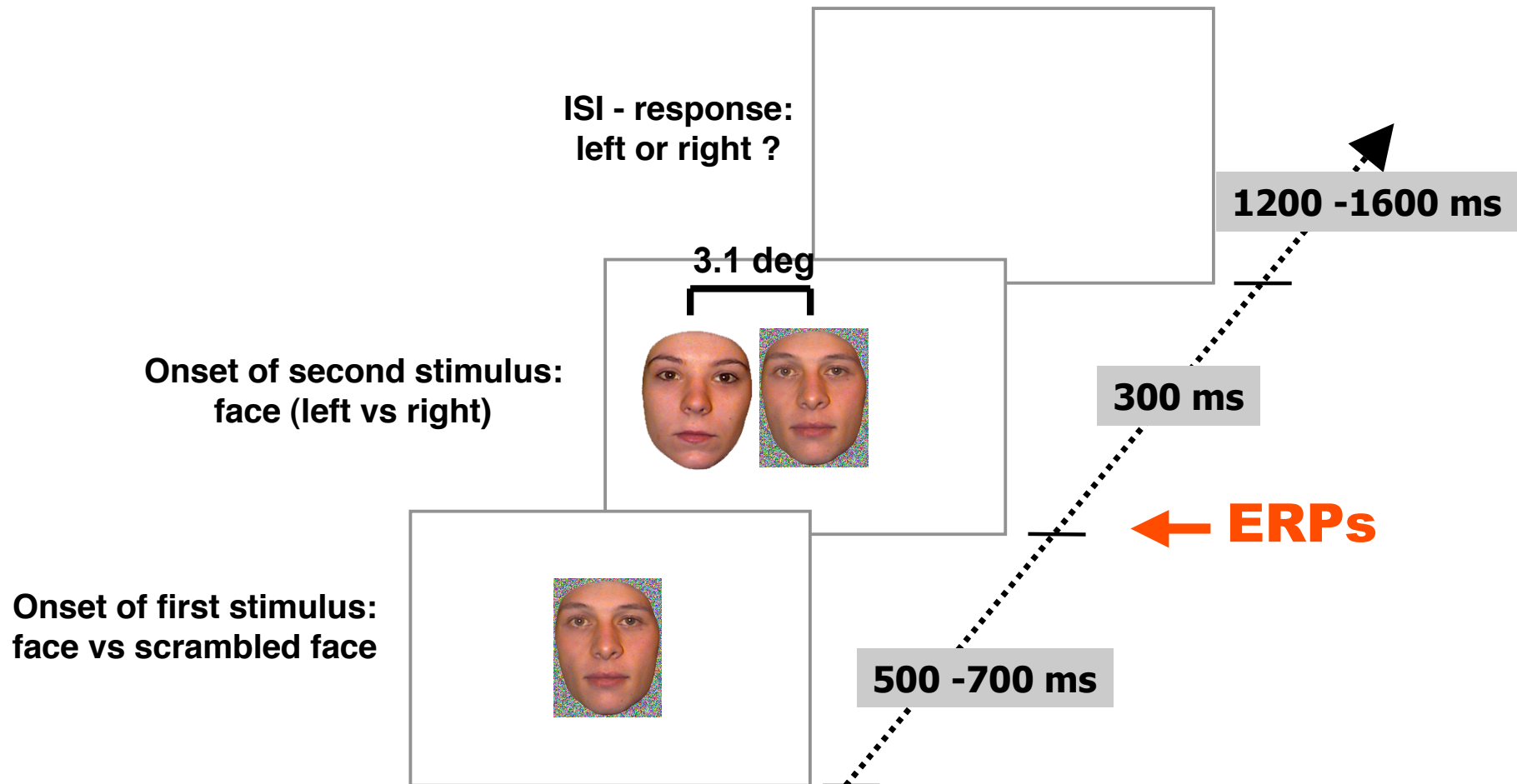


Jacques & Rossion (2004):

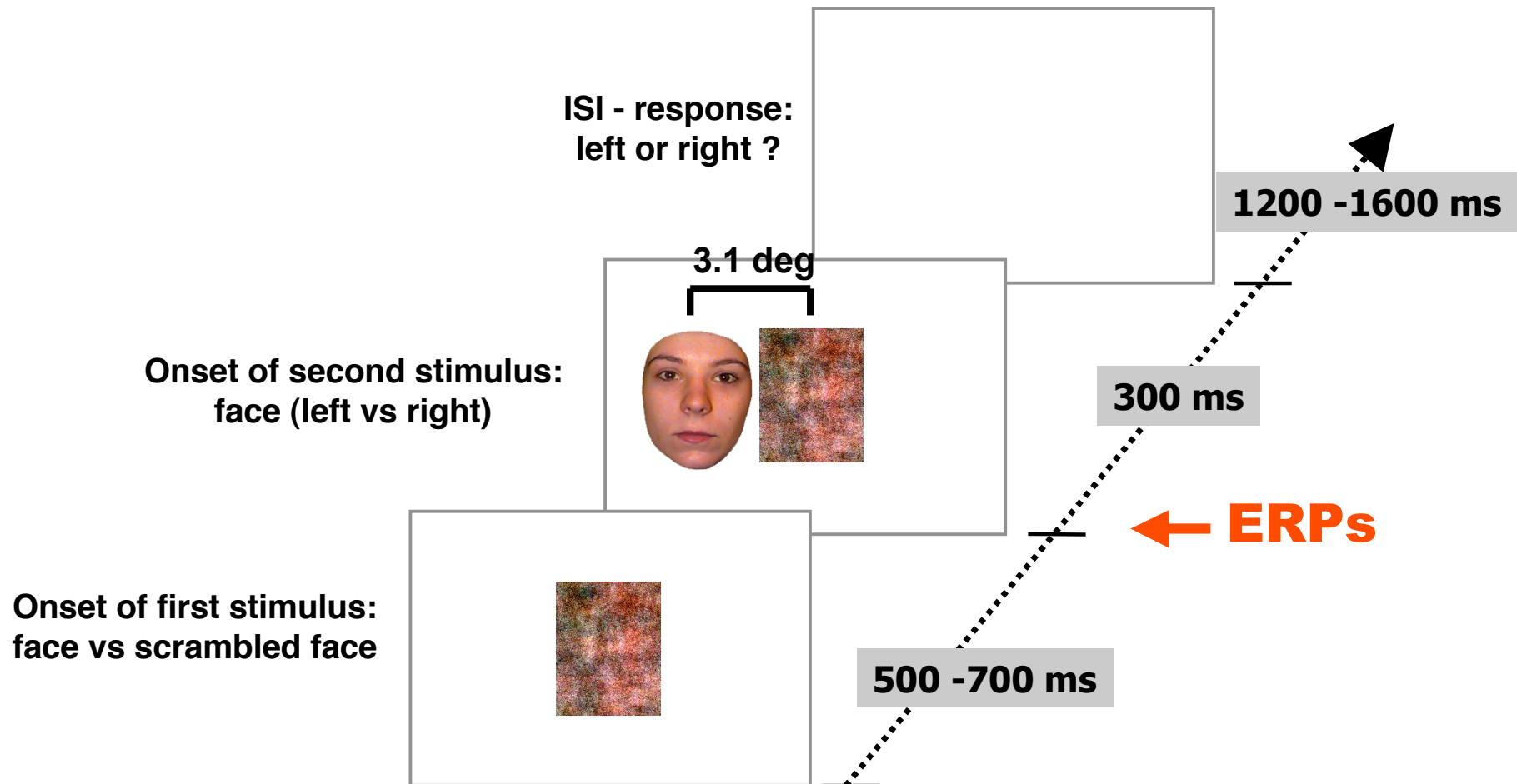
N170 response to multiple face stimuli

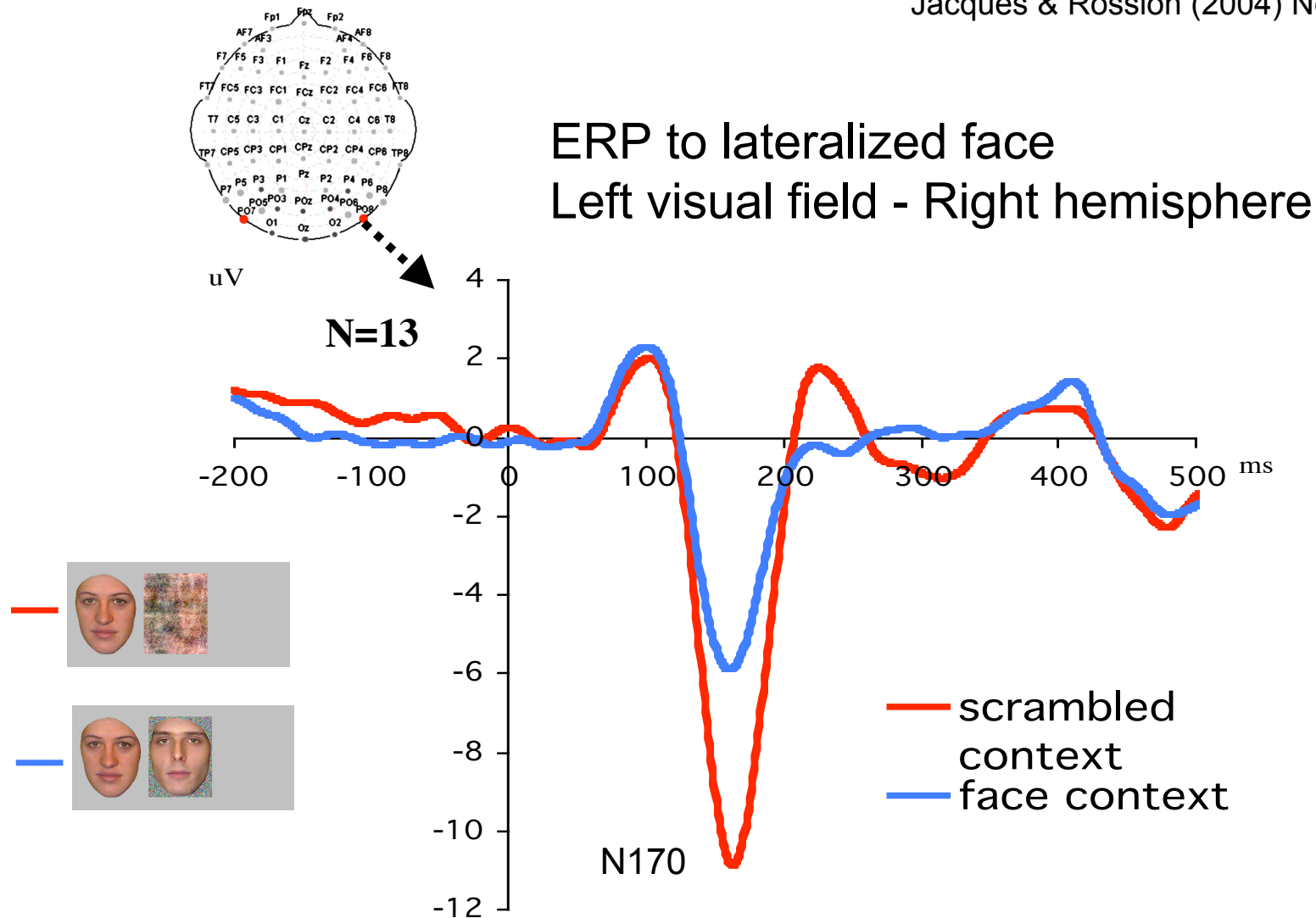


'Face to face' condition



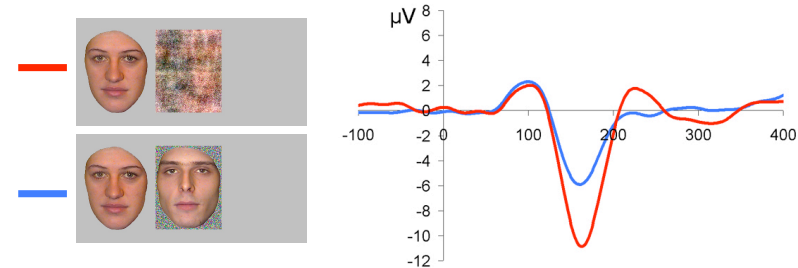
control condition (scrambled face)





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



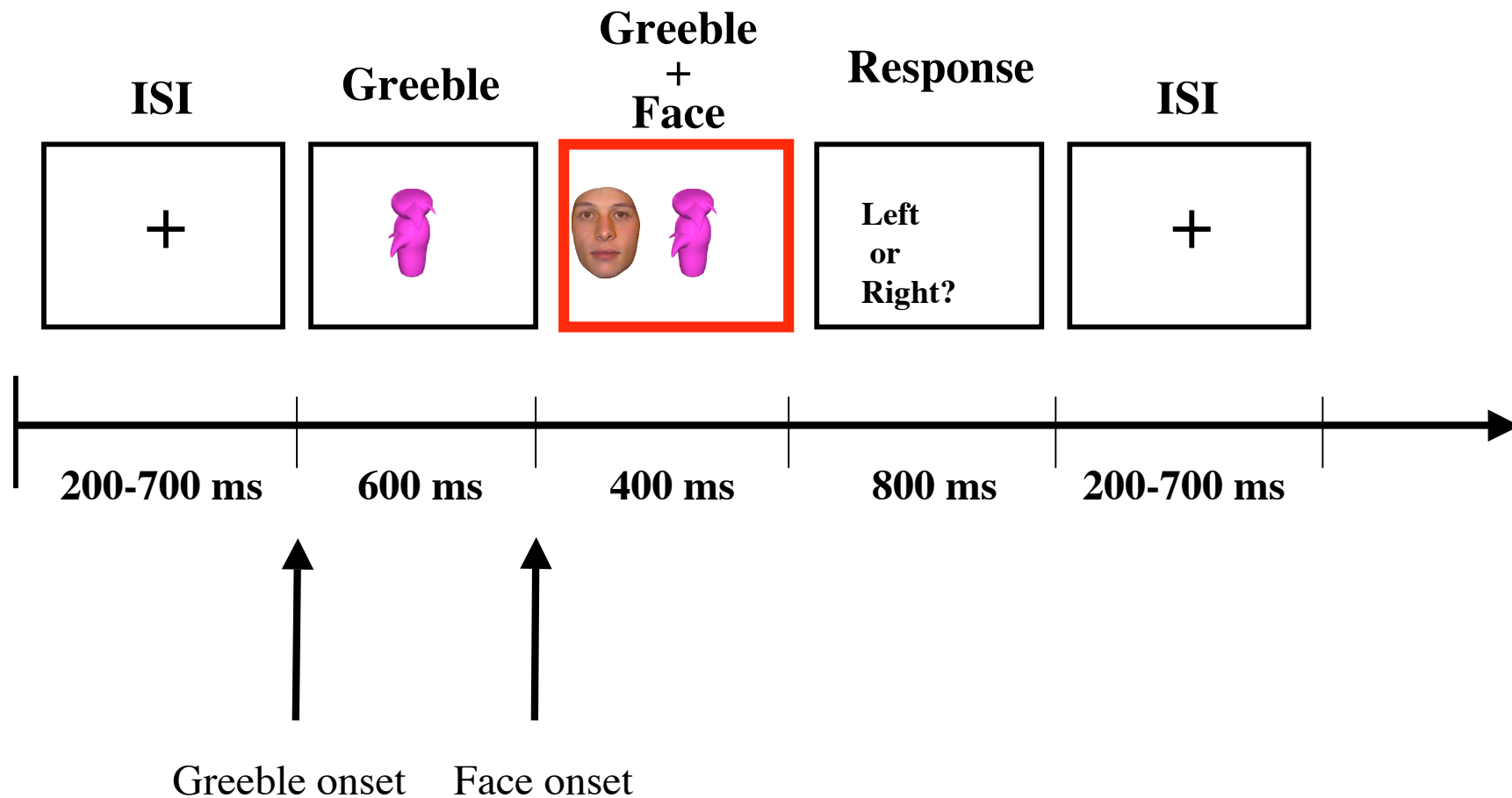
Onset 600 ms



Onset 0 ms

Methods

Timeline of Task Events

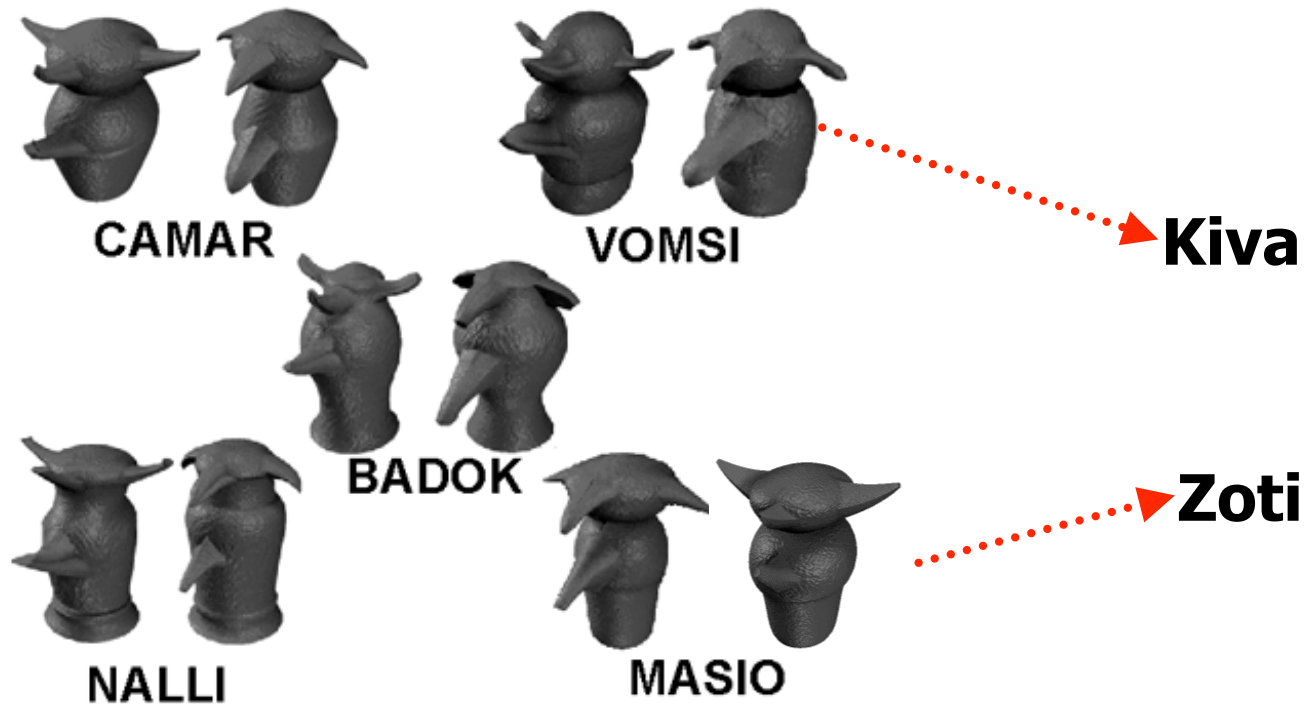


Hypothesis: the N170 response to faces during the Greeble presentation will **DECREASE** with expertise training.

EEG recordings (64 channels) in 5 subjects

1. Before expertise training
2. In between training (session 4)
3. Following expertise training (session 8)

Developing visual expertise with non-face objects

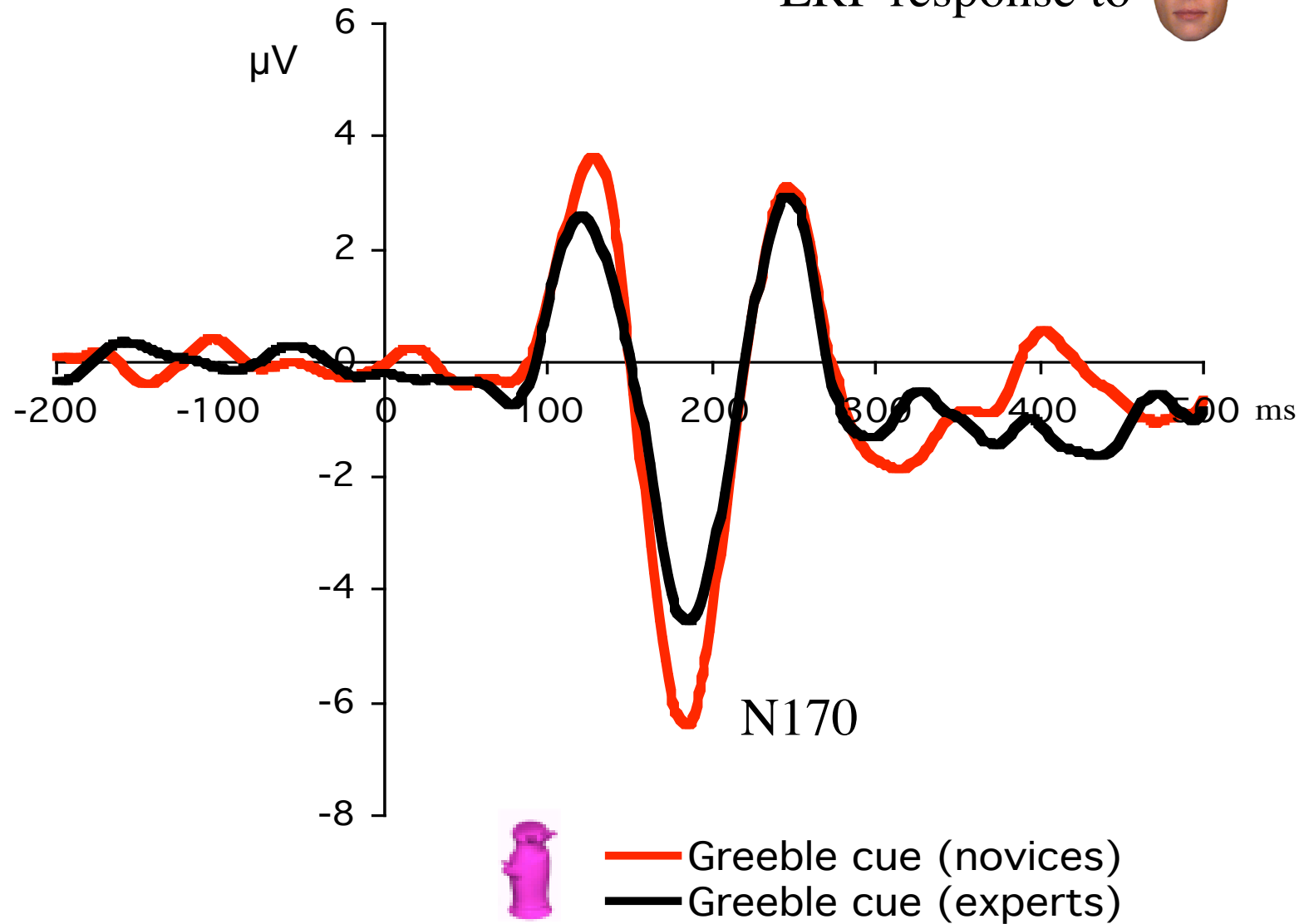


The 'Greebles' (Gauthier & Tarr, 1997)

Methods

RESULTS

ERP response to 



Results

Massive reduction of the N170 in response to **faces** following expertise training with a nonface object category !

To sort out general effects from real effects of training ...



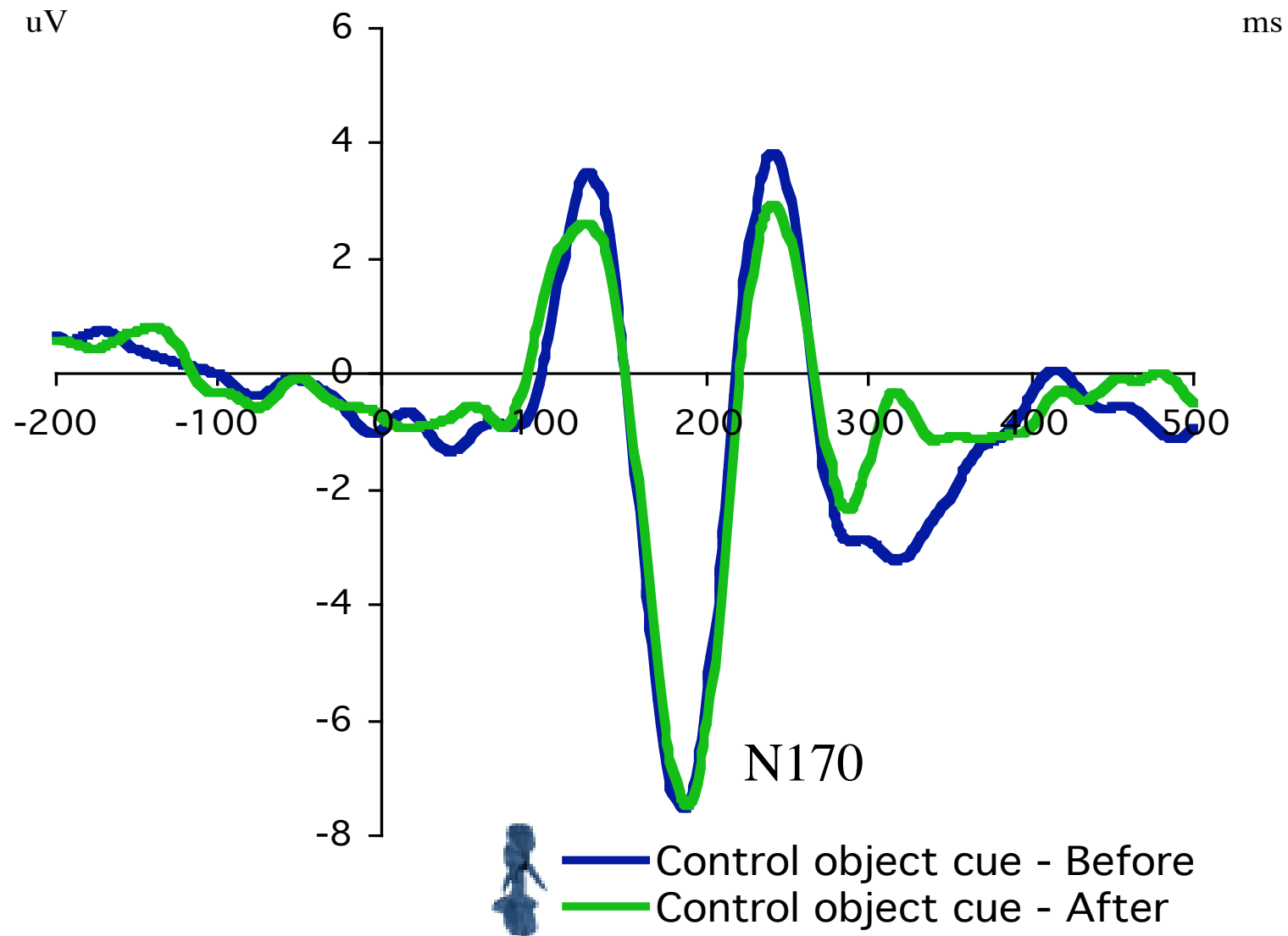
Control stimuli
(untrained)



= 3 (expertise level) x 2 (stimulus) design

Results

ERP response to



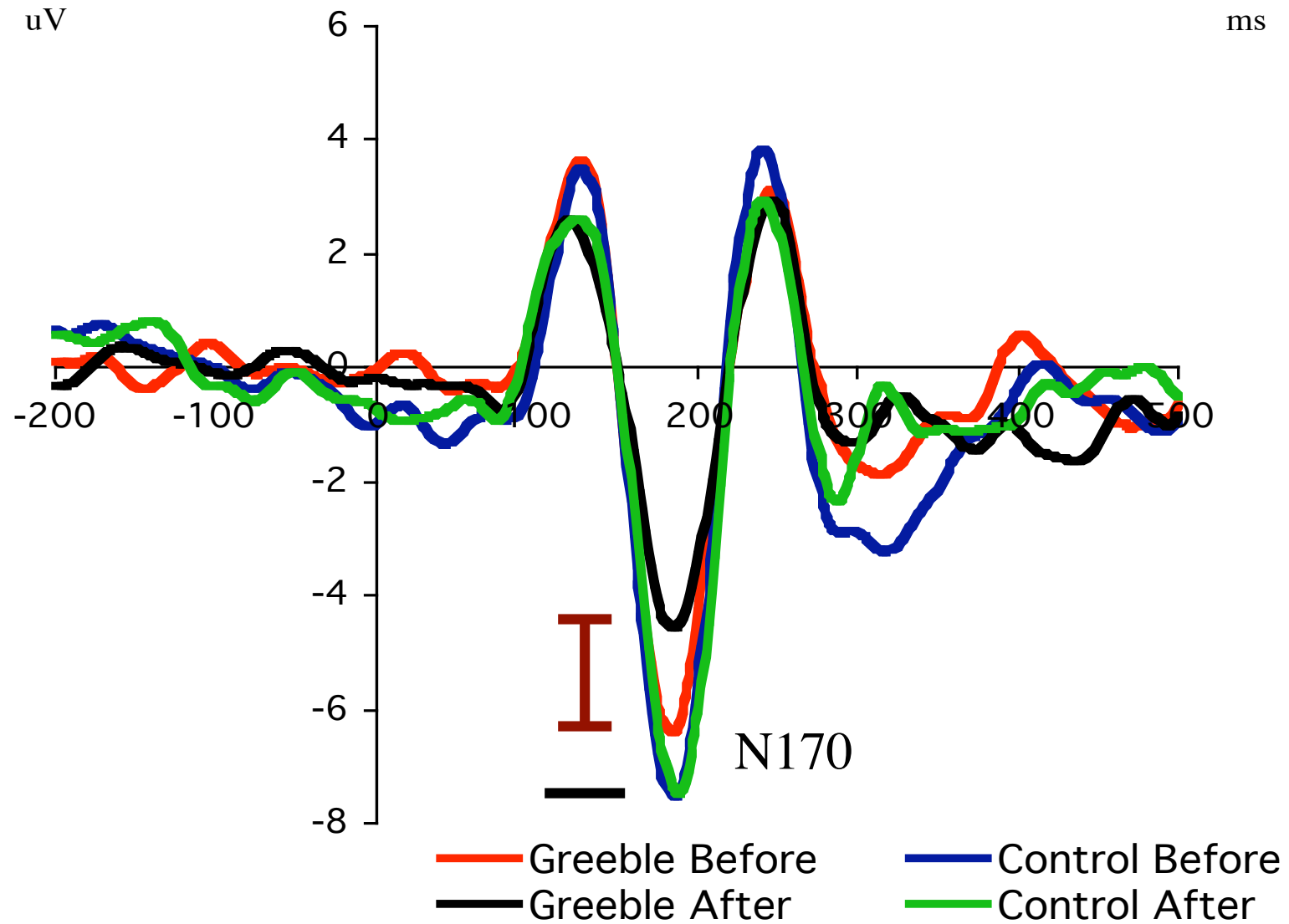
Results

Right hemisphere - right visual field

ERP response to



ms



Results

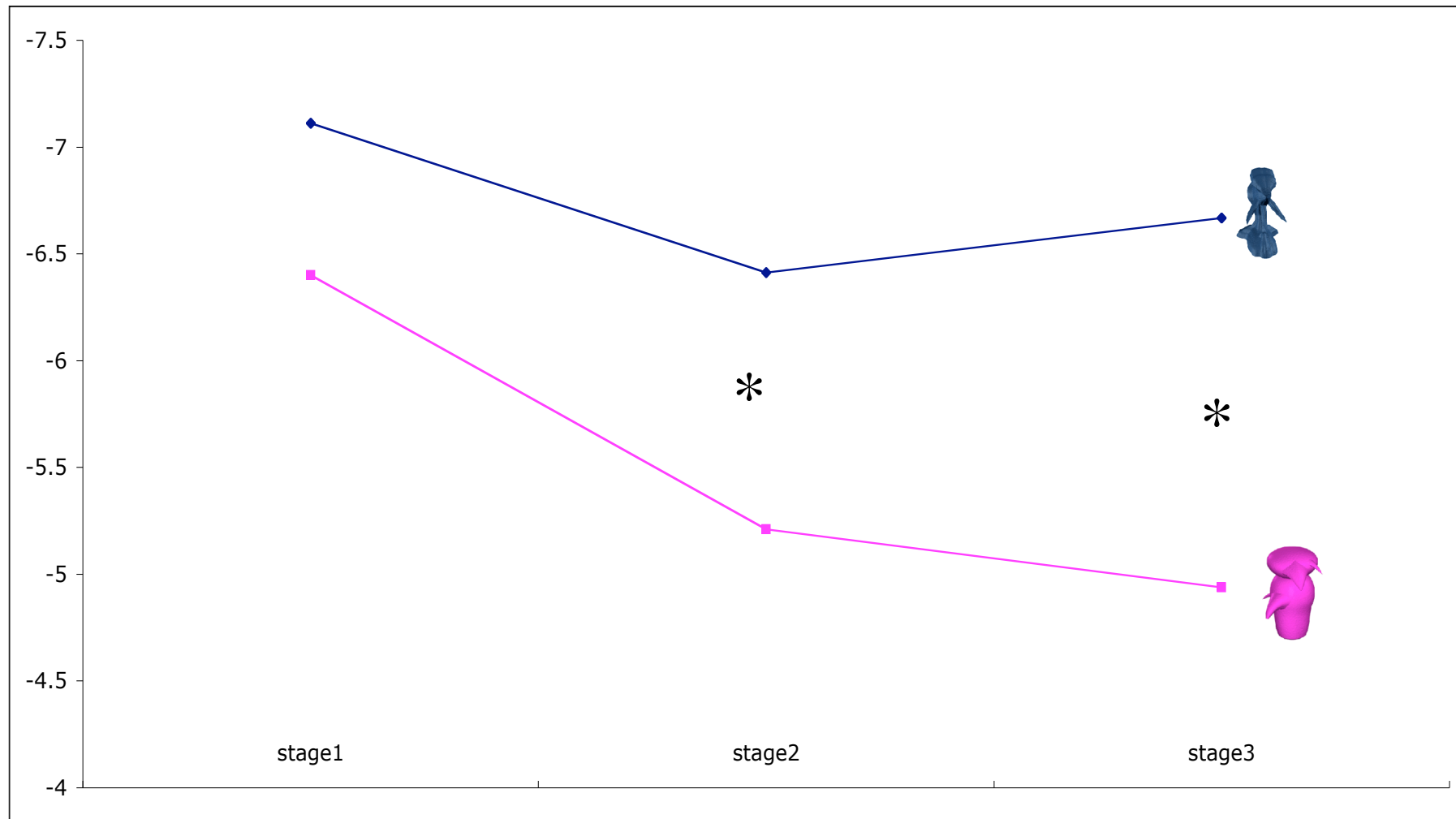
Massive reduction of the N170 in response to **faces** following expertise training with a nonface object category.

Specific to the N170 (earlier P1 effects reflects main differences between recording sessions)

Specific to the objects trained (Greebles). Difference before and after for the same subjects and same stimuli.

N170 amplitude to 

2 hemispheres and 2 visual fields
confounded



Interaction stimulus x training stage: $p=0.02$

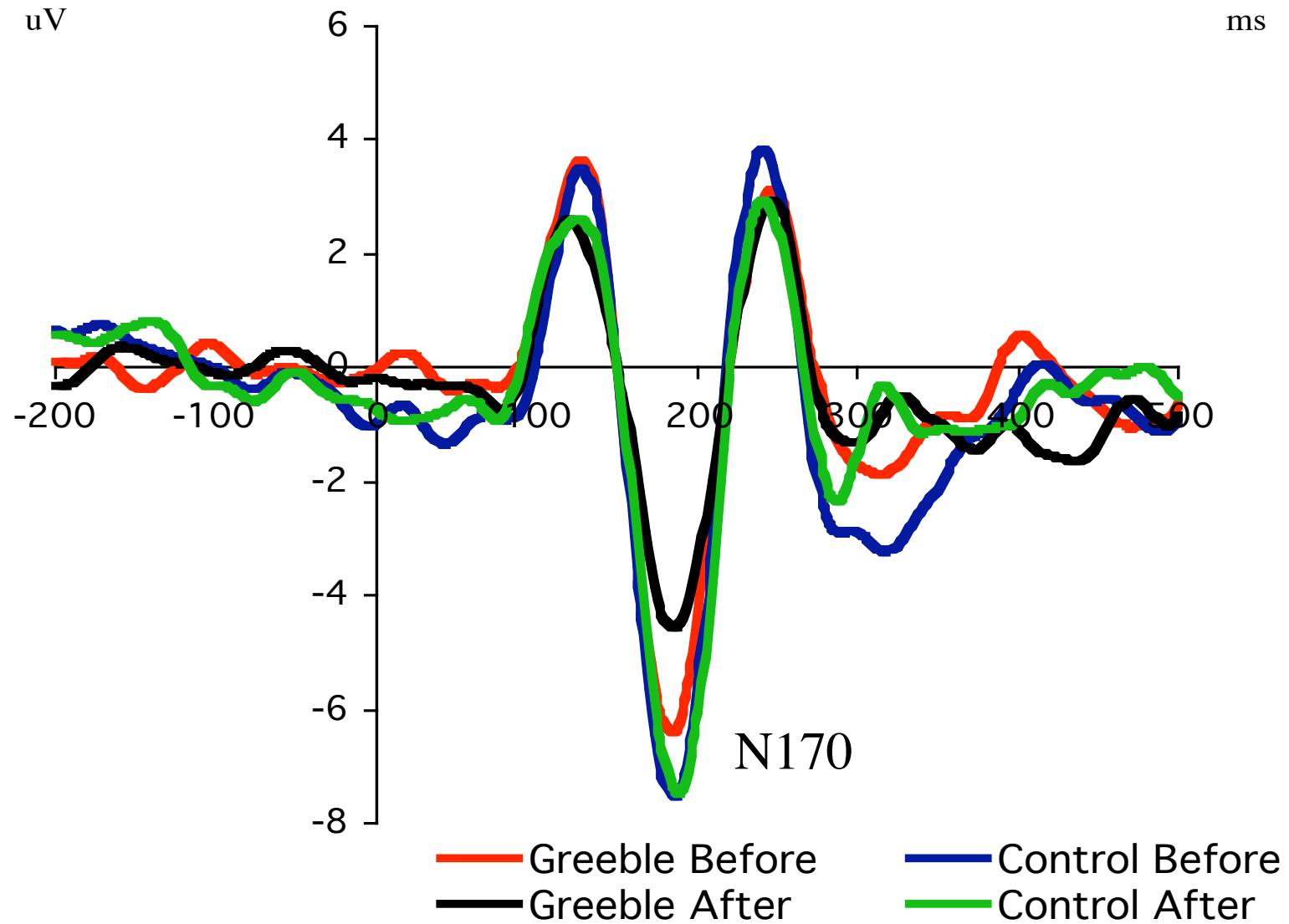
Results

Right hemisphere - right visual field

ERP response to



ms



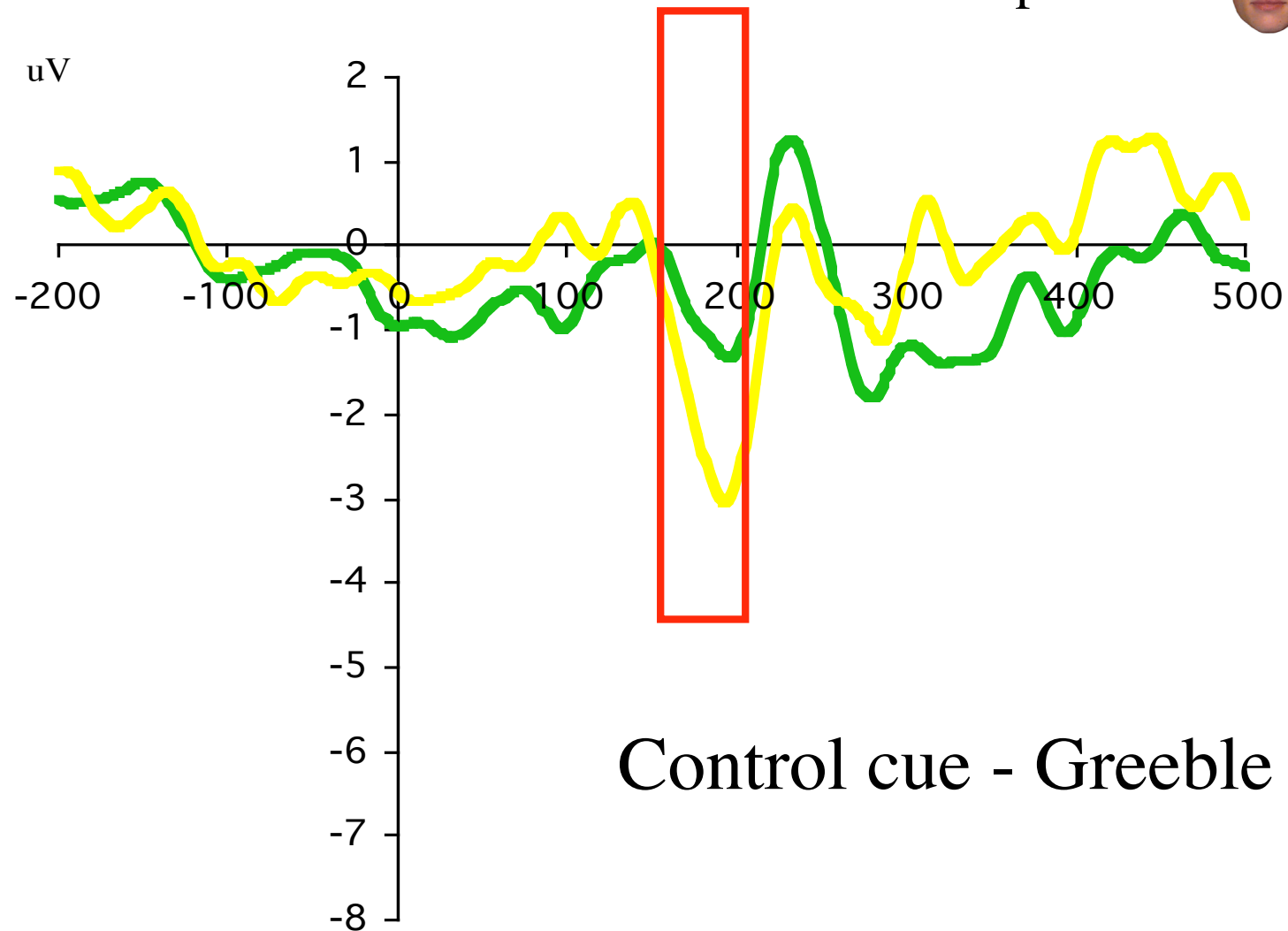
Results

Right hemisphere - right visual field

ERP response to



ms



Control cue - Greeble cue

— Difference Before

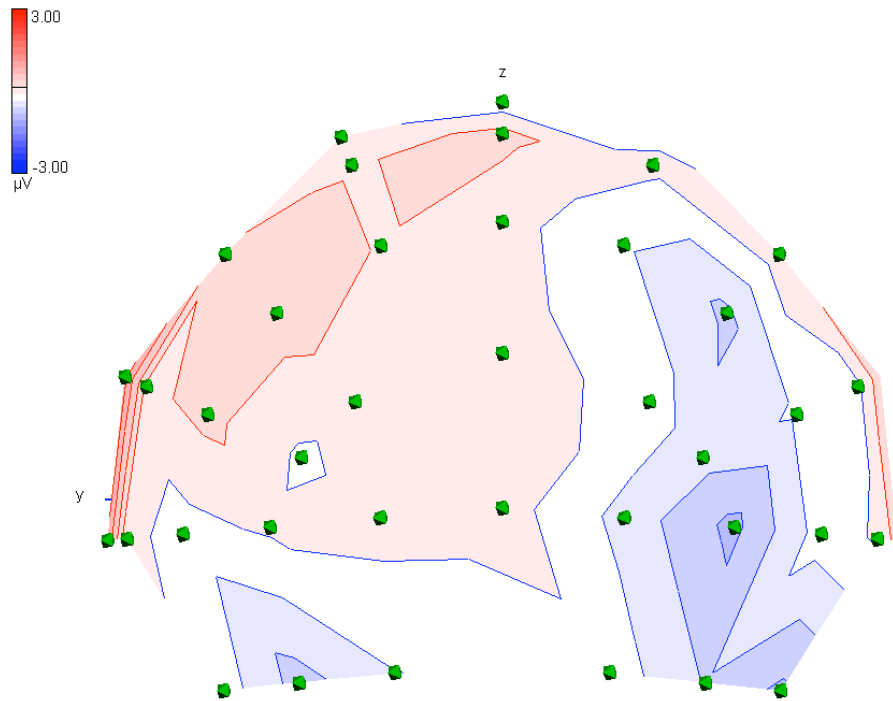
— Difference After

Results

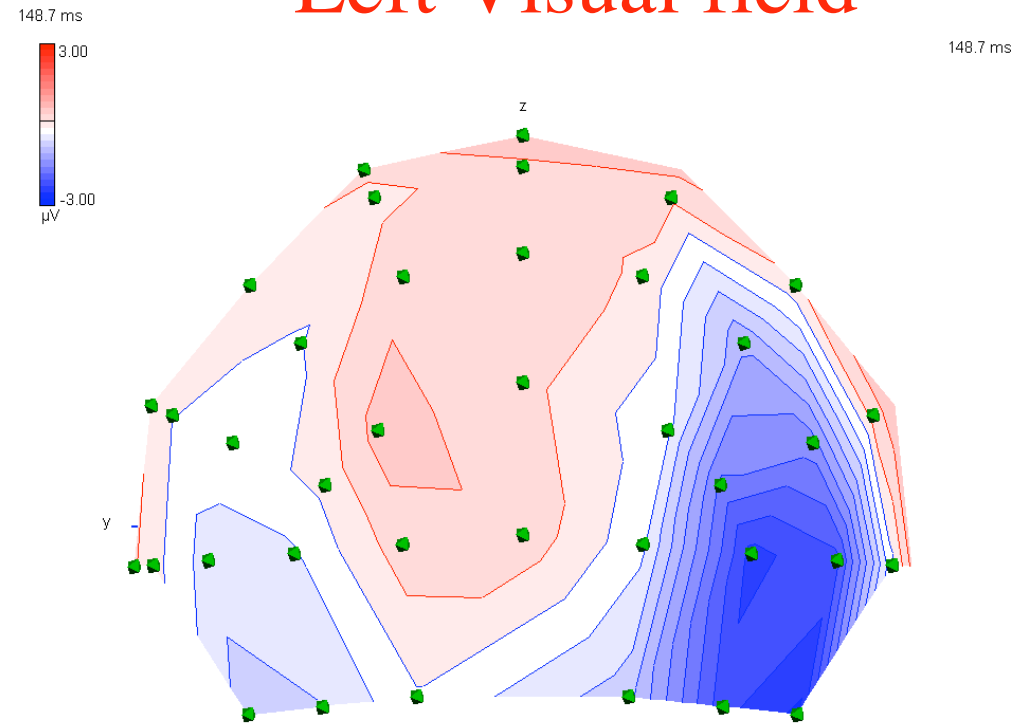
150-180 ms - N170 to



Control MINUS Greebles
Left Visual field



BEFORE



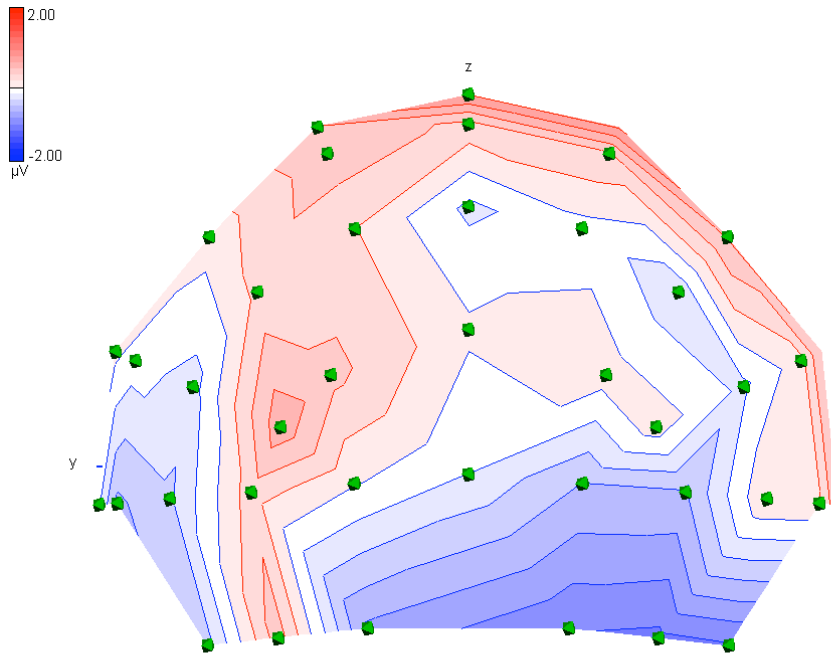
AFTER

Results

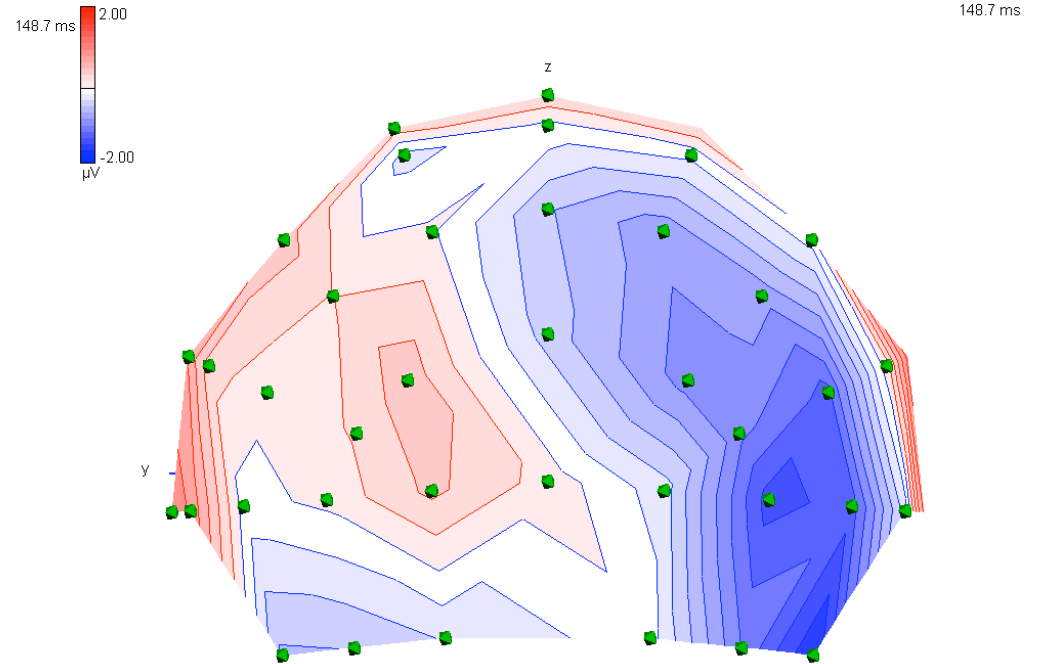
150-180 ms - N170 to



Control MINUS Greebles
Right Visual field



BEFORE



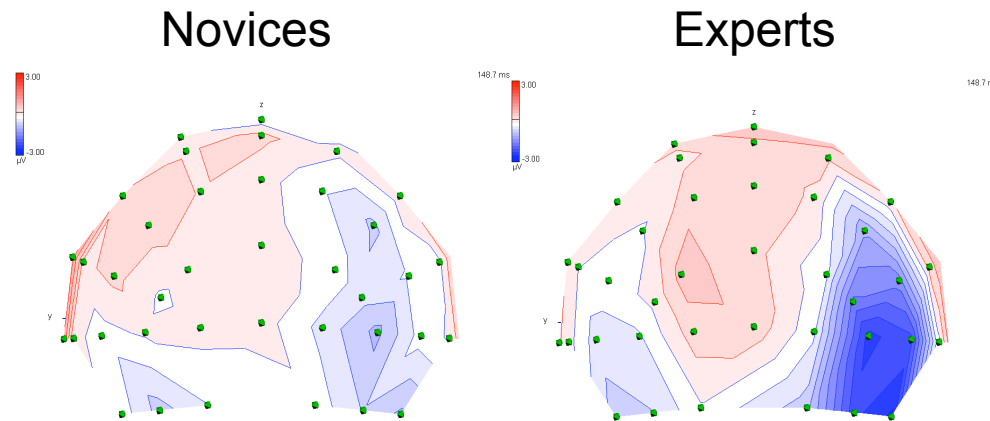
AFTER

Effects are stronger in the right hemisphere, even for ipsilateral presentations of the face

Results

Conclusions

N170 in response to **faces** is **decreased** following training, during **concurrent processing** with objects of expertise



When one becomes an *expert* in discriminating members of a visually homogenous nonface category, this expertise may rely on *shared perceptual processes* with faces.

>< Modularity view of face processing

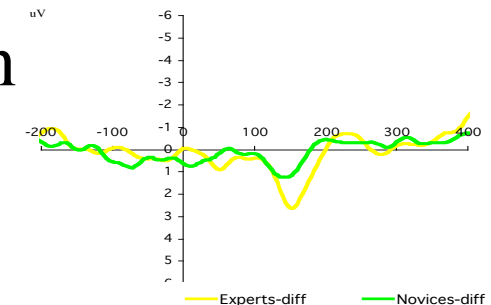
Alternative explanations/criticisms?

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 Greebles 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)**



Discussion

→ No evidence for an 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/criticisms?

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**.