



The synchronization phenomenon in emotional processes

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Emotional processes

"Emotions are – "episodes of massive, synchronized recruitment of mental and somatic resources allowing to adapt to or cope with a stimulus event subjectively appraised as being highly pertinent to the needs, goals, and values of the individuals".

In this definition the notion of synchronization is a central feature. Emotions are seen as occurring when the cognitive, physiological and motor/expressive components – which are usually more or less dissociated in serving separate functions – synchronize, as a consequence of a situation/event appraised as highly relevant for an individual.

Scherer, 2001, 2004

Grandjean, Sander, & Scherer, Consciousness and Cognition, 2008



Definition

The synchronization phenomenon refers to:

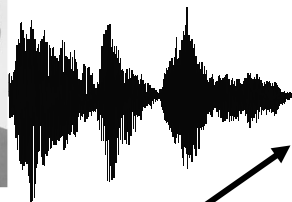
- 1) the establishment of some degree of **coherence** or synchronization of the different **components of emotion** during an emotional episode, organized as temporal and functional emergent patterns
- 2) the synchronization of **neuronal assemblies** at the central nervous system level, brought about by functional coupling of different close or distant neuronal populations.



Synchronization of the emotional components

Emotional expression

(inside or outside the focus of attention)

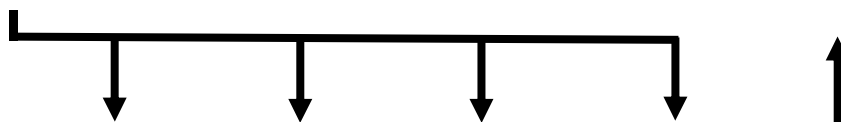


Attentional processes

Memory processes

Perceptual processes

Appraised



Expressions

Peripheral physiology

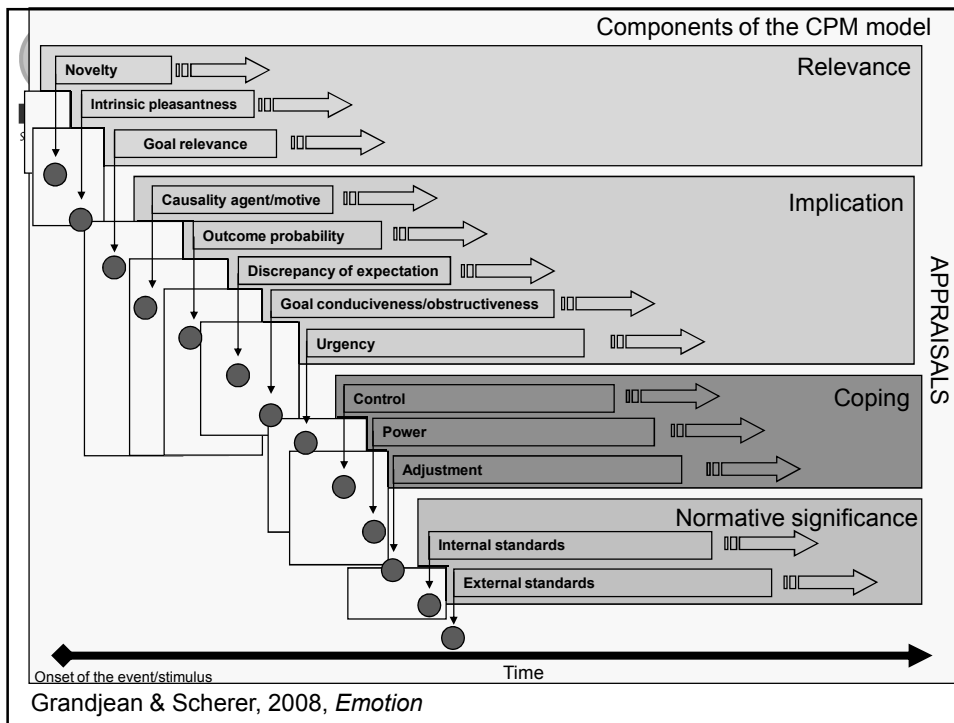
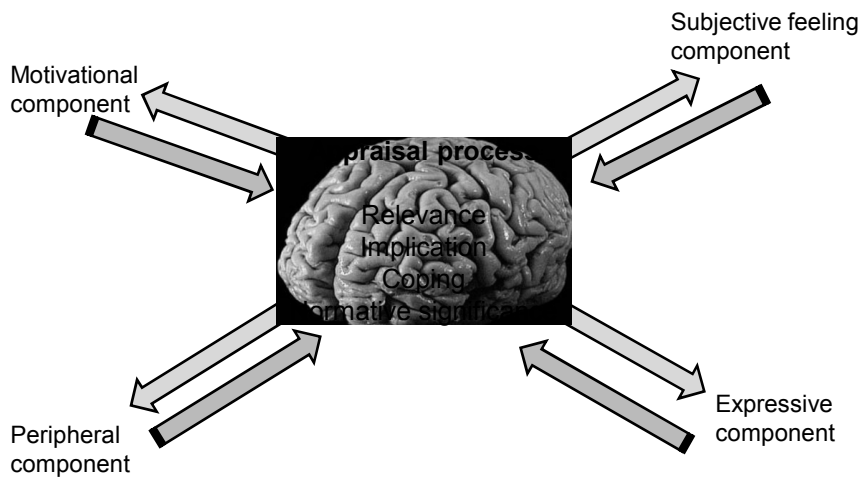
Action tendencies

Feeling

(See Scherer, 2001)



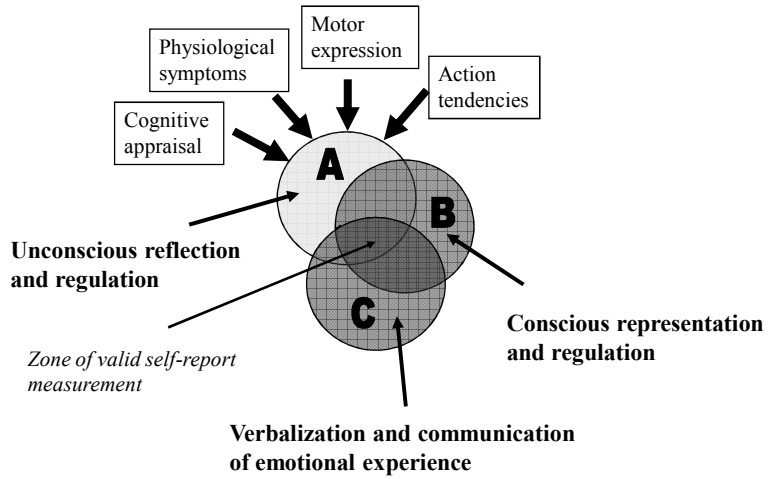
Appraisal and efferent effects





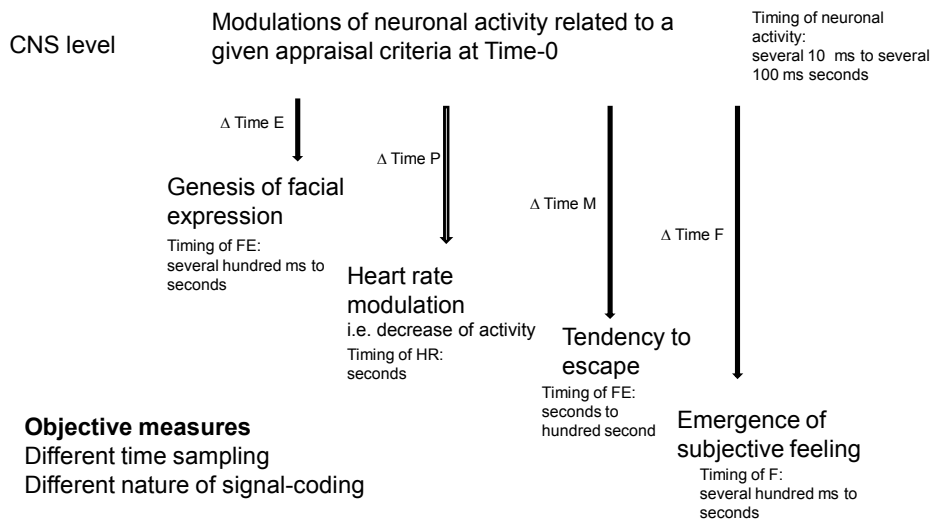
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Component process model - Internal representation and feeling



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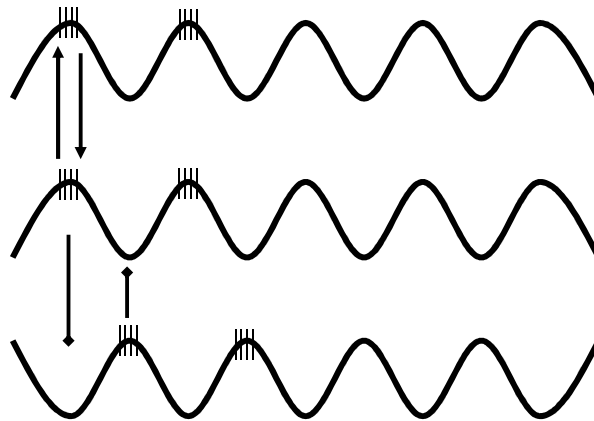
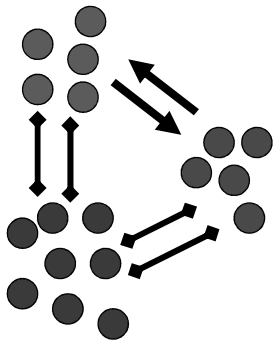
Timing of the efferent effect of the different components





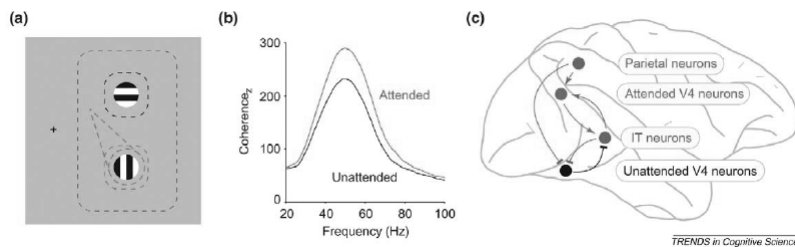
Synchronization of neuronal activity

Communication Through Coherence (CTC, Fries, 2005, *TICS*)



Functional aspects of synchronized neuronal activity

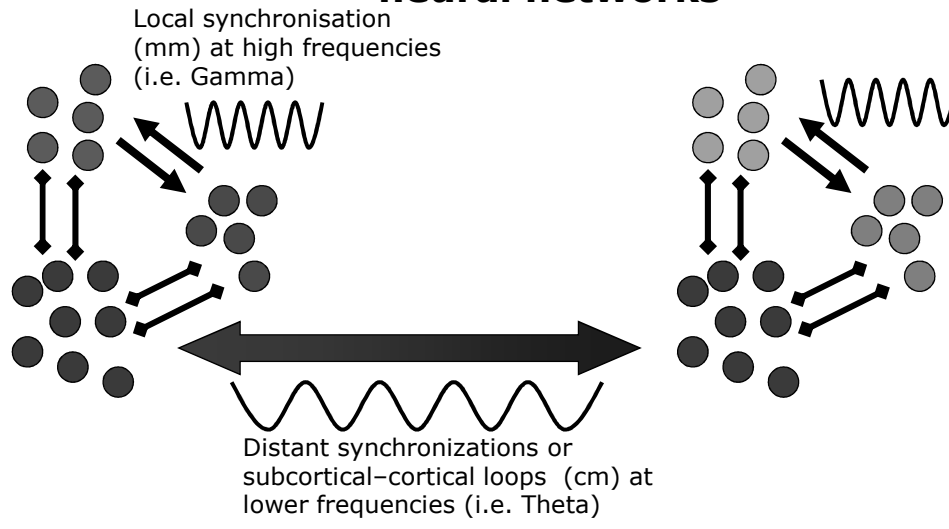
Different neuronal assemblies are able to communicate and influence each other through firing coupling, particularly at high frequency.



Fries, 2005, *TICS*



Neuronal oscillations and synchronization of distant neural networks



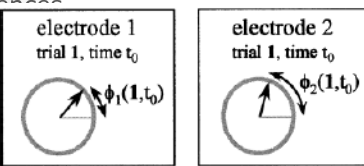
Guderian & Duzel 2005, *Hippocampus*; Canolty et al., 2006, *Science*



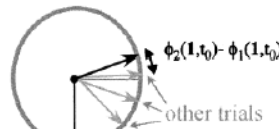
Measures of the phase synchrony of brain oscillations

Measure of the oscillation coupling between distant brain regions in animal studies using neural responses have been used (Neuenschwander et al., 1999).

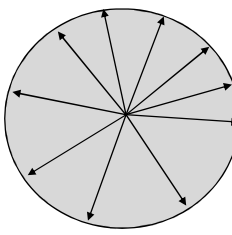
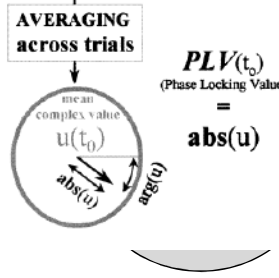
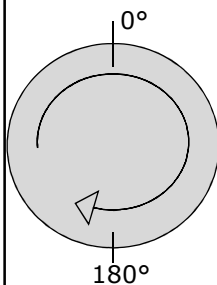
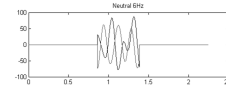
In the following analysis, we will compute the phase synchrony from 5 Hz to 25 Hz.



indicator of functional coupling (Neuenschwander et al., 1999). Based on the phase synchrony between neuronal oscillations (Neuenschwander & Gray, 1995);



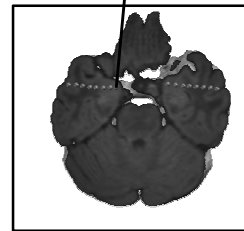
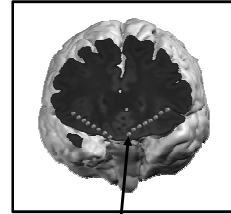
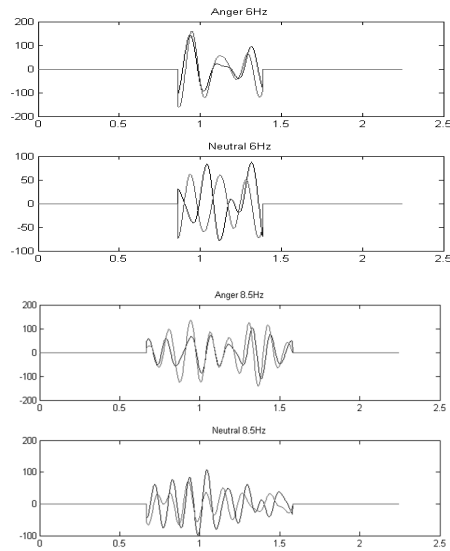
Wavelet (+/- 2Hz) is applied at each electrode.





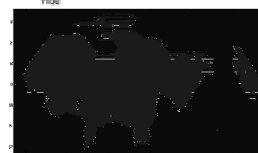
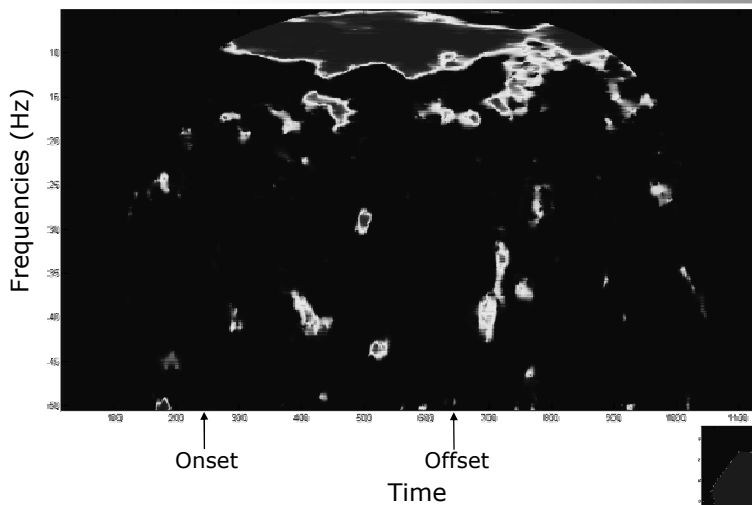
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Measures of the phase synchrony of oscillations of distant brain regions



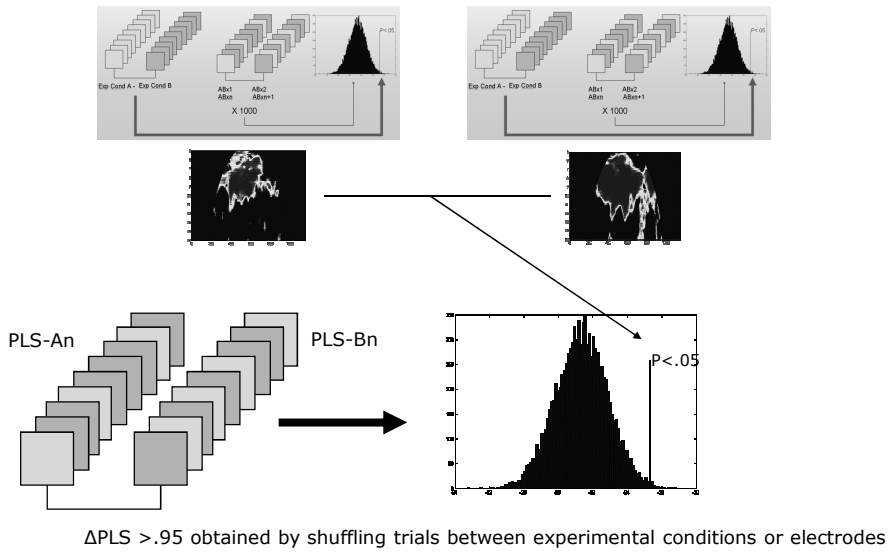
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PLS between left amygdala and left medial OFC during angry prosody exposure

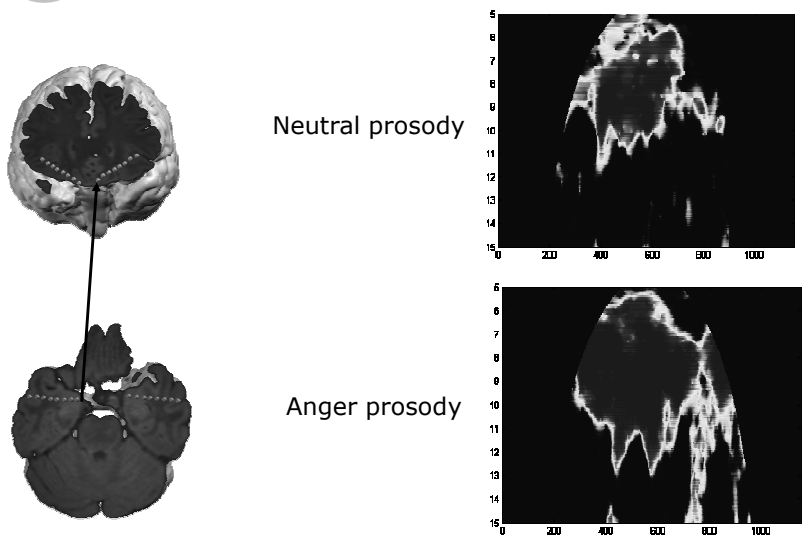




Statistical comparison of synchrony between experimental conditions for one pair of electrode or for two pairs of electrodes



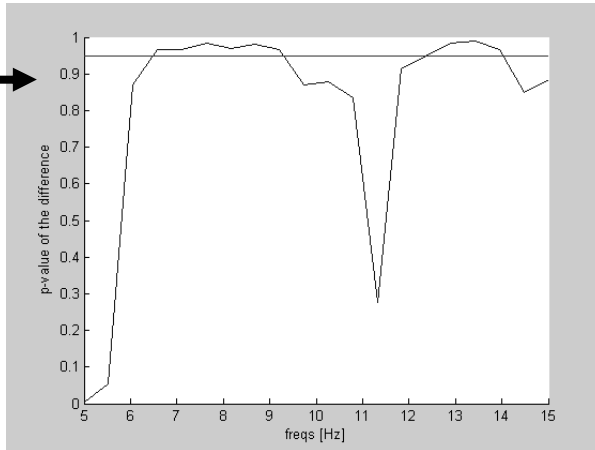
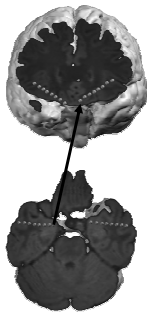
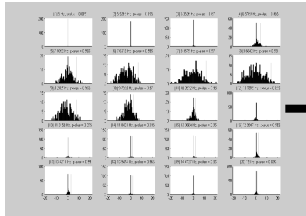
Synchrony between left medial OFC and left amygdala: comparison between anger vs neutral prosody





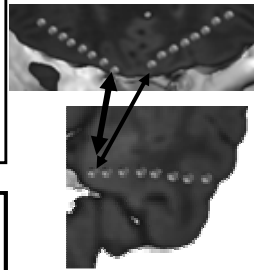
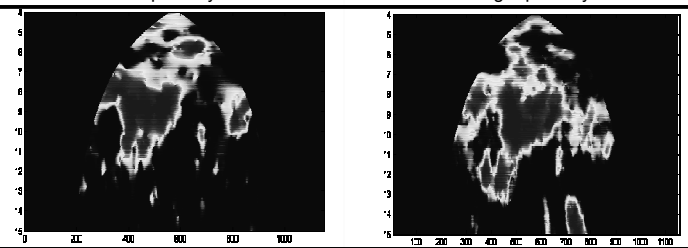
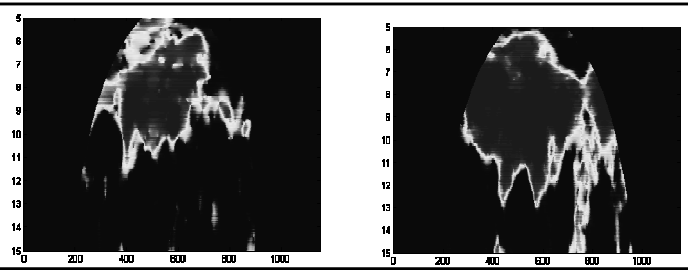
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Comparison between Anger > Neutral for coupling between left Amygdala and left OFC



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Comparison between intra-hemispheric and inter-hemispheric emotional modulated coupling between Amygdala and OFC neuronal activity

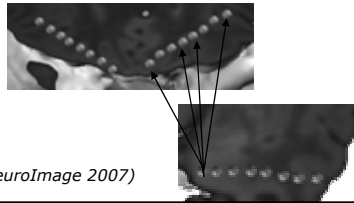
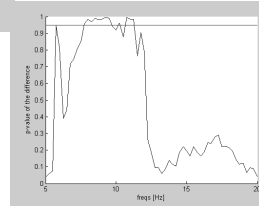
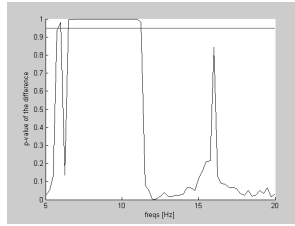
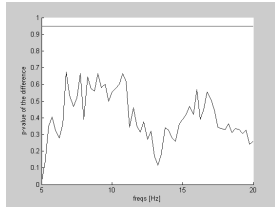




Decreasing of coupling on the medial-lateral axis of OFC

Anger

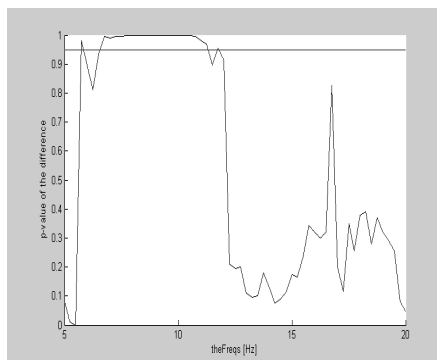
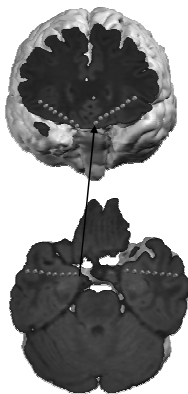
Medial
↓
Lateral



(Ghashghaei, et al., NeuroImage 2007)



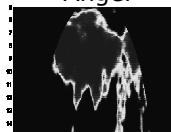
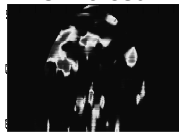
Neutral vs Control stimuli Unvoiced Envelope



Unvoiced

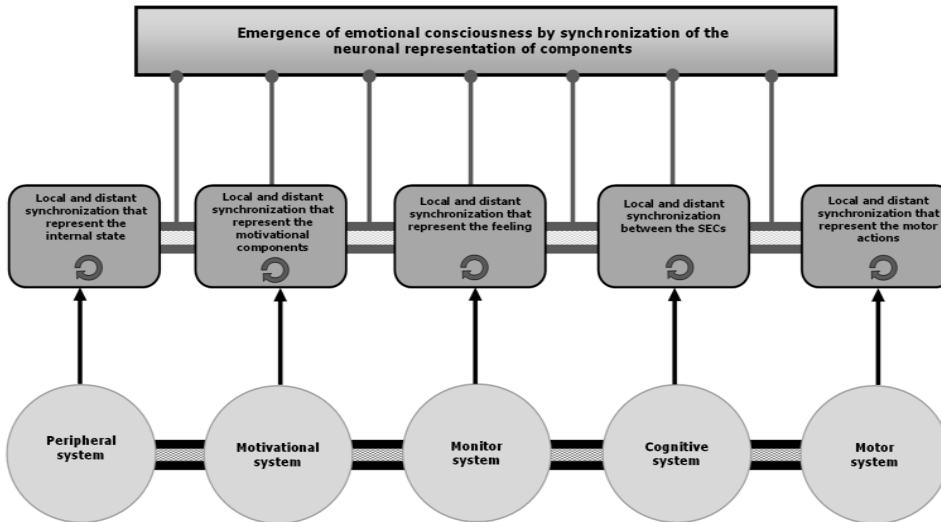
Neutral

Anger





Neuronal coupling and the components of emotion

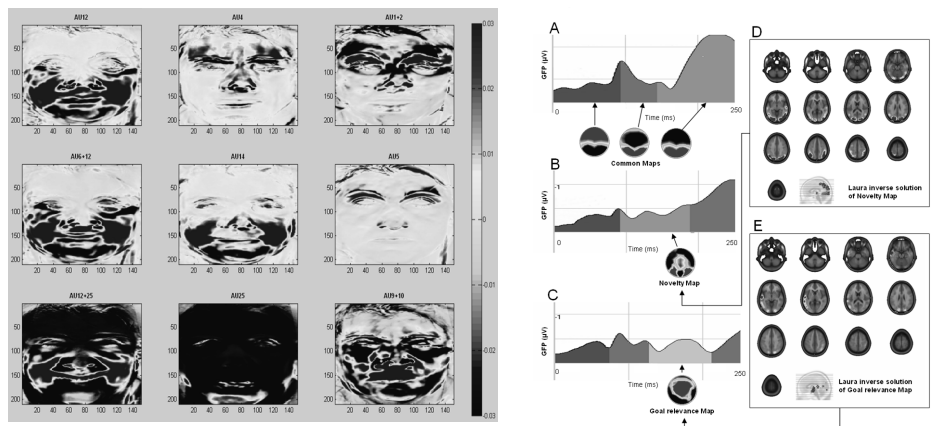


Grandjean, Sander, & Scherer, *Consciousness and Cognition*, 2008



Thermography and EEG

How, for example, measure the synchronization between thermography modulations (several hundred ms) and EEG (several 10 ms)





Conclusions and further discussions

The synchronization phenomenon can be studied at least two levels:

- The synchronization of the emotional components
 - GEMEP team
- The synchronization at CNS level
 - Neuronal synchronization: more than two regions

The relationship between these two levels of synchronization

- Sebastian Korb : EEG and EMG
- Sophie Jarlier : Facial thermography and EEG

How to measure synchronization between different phenomenon characterized by different time sampling and for which the measurable effects appear at different latencies?

How to modeling complex neuronal interactions between several regions?