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
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.

(See Scherer, 2001)
Appraisal and efferent effects

Components of the CPM model

- **Novelty**
- **Intrinsic pleasantness**
- **Goal relevance**
- **Causality agent/motive**
- **Outcome probability**
- **Discrepancy of expectation**
- **Goal conduciveness/obstructiveness**
- **Urgency**
- **Control**
- **Power**
- **Adjustment**
- **Internal standards**
- **External standards**

**Time**

Onset of the event/stimulus

**Grandjean & Scherer, 2008, Emotion**
Component process model - Internal representation and feeling

Unconscious reflection and regulation

Conscious representation and regulation

Verbalization and communication of emotional experience

Physiological symptoms

Motor expression

Action tendencies

Cognitive appraisal

Unconscious reflection and regulation

Zone of valid self-report measurement

Timing of the efferent effect of the different components

CNS level

Modulations of neuronal activity related to a given appraisal criteria at Time-0

Timing of neuronal activity: several 10 ms to several 100 ms seconds

Genesis of facial expression

Heart rate modulation i.e. decrease of activity

Timing of HR: seconds

Tendency to escape

Emergence of subjective feeling

Objective measures

Different time sampling
Different nature of signal-coding
Synchronization of neuronal activity

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

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

Local synchronization (mm) at high frequencies (i.e. Gamma)

Distant synchronizations or subcortical–cortical loops (cm) at lower frequencies (i.e. Theta)


Measures of the phase synchrony of brain oscillations

Measure of the oscillatory phase synchrony as an indicator of functional coupling between neuronal responses (i.e. Singer & Gray, 1995; Neuenschwander et al., 1995).

In the following analysis, we computed the phase frequency from 5 Hz to 40 Hz using a complex Gabor wavelet (+- 2 Hz) to compute the phase locking value (PLV).
Measures of the phase synchrony of oscillations of distant brain regions

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

ΔPLS > .95 obtained by shuffling trials between experimental conditions or electrodes

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

Neutral prosody

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

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

(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?