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Facial expression, electroencephalography (EEG), and electromyography (EMG)

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Outline

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- Facial expression
  - Subtypes
- Neural bases of spontaneous and voluntary facial expressions
- A movement preceding ERP
  - The readiness potential
- Research line
  - 2 experiments
- Conclusions

Facial expression

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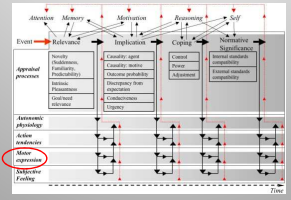
- One of the components of emotional episodes



- A ***window to the soul*** (expressions are spontaneous, automatic, difficult to control...)
  - E.g. signaling to others the presence of a common danger, or one's intention to attack, etc...

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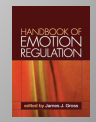
- Facial expressions can also be a means for strategic social communication
  - **Regulation** of one's emotional facial expression
    - Hide, inhibit, or modify
    - Emotion regulation
  - **Voluntary** production of an emotional expression (w/o underlying emotion)



Where to look at...

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- One and the same facial expression (e.g. a smile) can be either
  - **Sincere**, and thus express the sender's true feelings (spontaneous expression), or
  - **False**, artificial, and unrepresentative of the underlying feelings (voluntary or posed expression)
- Is it possible to distinguish between these (and other) types of facial expression?
  - A common approach is based on the visual inspection (FACS) of patterns of muscular activation of the face (muscles activated; time of onset, apex, offset; overall smoothness of the expression, etc.)
  - An alternative may be to look directly at **the brain**!

A neurological double dissociation

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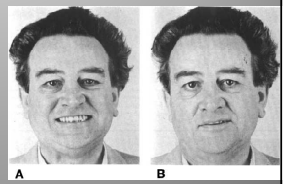
- Volitional facial paresis (VFP):
  - **loss of voluntary control** w/o impairment of emotional expression.
  - Lesion of: corticobulbar tract (e.g. internal capsule), M1

(A) Left VFP, (B) symmetric activation with emotion

- Emotional facial paresis (EFP)
  - **loss of emotional expression** w/o impairment of voluntary muscle control.
  - Lesions of: thalamus, striatocapsular area, frontal subcortical white matter, medial frontal lobe including SMA, dorsolateral pontine tegmentum area



(A) Symmetric voluntary activation; (B) right EFP while smiling.

Hopf et al. (1992). Neurology, 42, 1918-23.

Spontaneous and voluntary facial expressions

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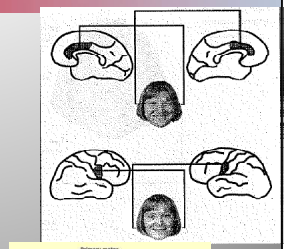
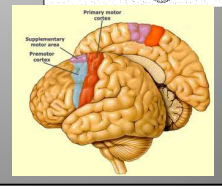
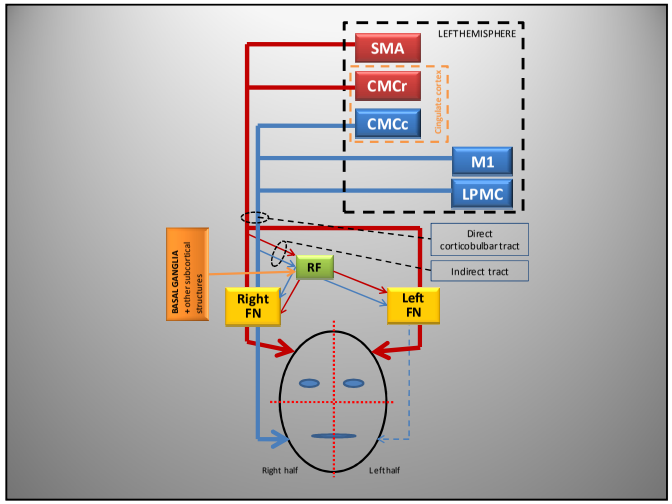
- Damasio (1994):
  - ***Spontaneous*** (emotional) facial expressions triggered by the **ACC**, **limbic regions** in the medial temporal lobe, and the **basal ganglia**
  - ***Voluntary*** facial expressions controlled by **M1** in lateral PFC and the pyramidal tract.





Damasio (1994). *Descarte's error.*



The research line

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- Bring together 2 topics
  - Difference between spontaneous vs. voluntary facial expressions at the neural level
  - Study of voluntary suppression of one's facial expression
    - One of the less investigated emotion regulation strategies
- Use EEG and facial EMG
- Focus upon period preceding facial expression
  - Less trouble with movement artifacts

A movement preceding potential

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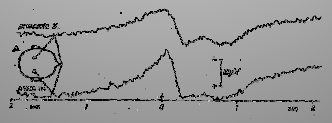
- The readiness potential (RP)
  - Evoked potential (EP) with negative polarity preceding the beginning of a movement and reflecting its motor preparation
  - Sources mainly in cortical motor and premotor areas (but also basal ganglia, thalamus)
  - Typically recorded before voluntary, self-paced movements of the limbs (finger/foot)



RPs before spontaneous movements

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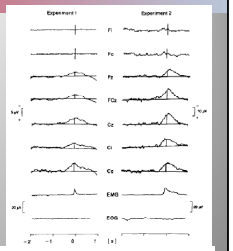
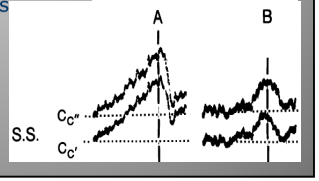
- Keller & Heckhausen (1990)
  - Voluntary vs. involuntary movements of the hand
  - Higher amplitude for voluntary movements
- Libet et al. (1982)
  - Preplanned vs. spontaneous finger/hand movements





Keller & Heckhausen (1990). *Electroencephalography and clinical neurophysiology, 76*, 351-361.

Libet et al. (1982). *Electroencephalogr Clin Neurophysiol, 54(3), 322-335.*

RPs before voluntary movements in the face

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- Readiness potentials (RPs) have also been recorded prior to voluntary, self-paced movements of facial muscles (swallowing; mouth-opening; jaw movements; horizontal eye saccades [ECoG])
- But no report of RP before facial expressions
- In a first experiment, we found evidence for the presence of a RP before voluntary (posed) smiles

Experiment 1

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- 64 EEG, EMG *zygomaticus*, *extensor digitorum*
- Self-paced movements approx. every 5 seconds
- 5 conditions:
  - Right index finger elevation
  - Left index finger elevation
  - Right unilateral smiling
  - Left unilateral smiling
  - Bilateral smiling
- EEG epoched according to EMG-onset

2nd experiment

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- Investigate the neurophysiological underpinnings of **spontaneous** and **suppressed smiles**, focusing on the RP
- Main questions:
  - is there a RP before spontaneous smiles ?
  - is there a RP before suppressed smiles ?
- Minor question:
  - Can we replicate our previous finding of a RP before voluntary smiles?

Results experiment 1

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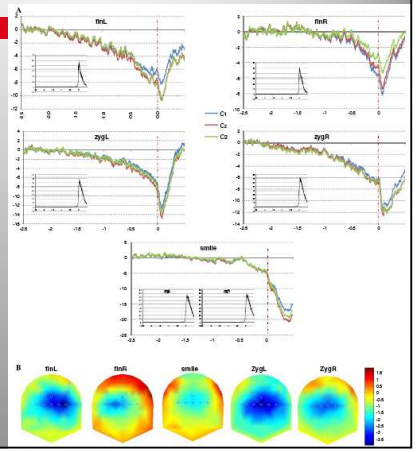
- RP before posed smiles with **later onset**, **symmetrical** bilateral distribution over the scalp, and **smaller amplitude** at time of movement onset, compared to finger movements



Korb, Grandjean, & Scherer (2008)

Methods

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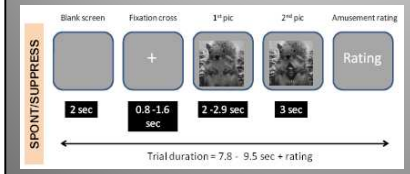
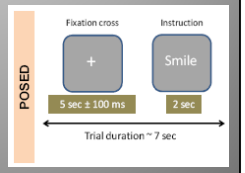
- 64 EEG, EMG *zygomaticus*, corrugator, orbicularis oculi
- Amusing visual stimuli to evoke smiling/laughing
- **Condition Spont**: 75 neutral and 75 amusing pairs of pictures; amusement rating after each pair
- **Condition Suppress**: same as Spont, but with instruction to suppress smiling/laughing
- **Posed** (50 trials): smile on command every 5 sec
- EMG-onset Spont for segmentation ERPs conditions Spont and Suppress





Funny pics

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Results posed smile

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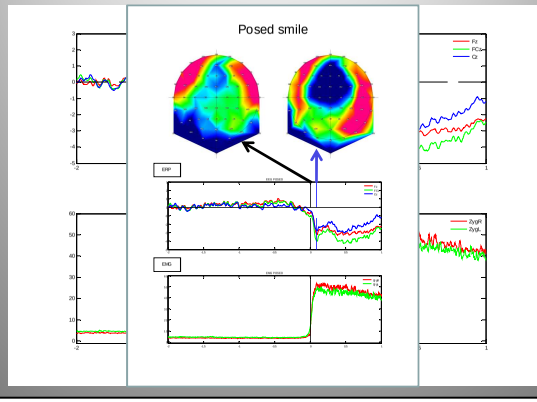

Neutral pics

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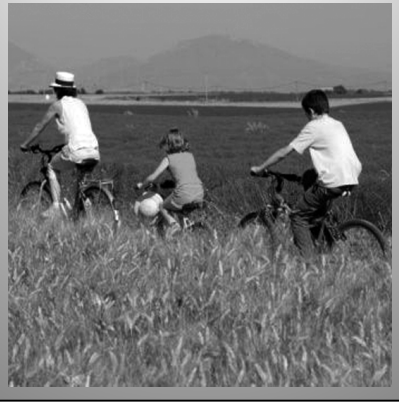

Condition Spont, pics rated funny to very funny

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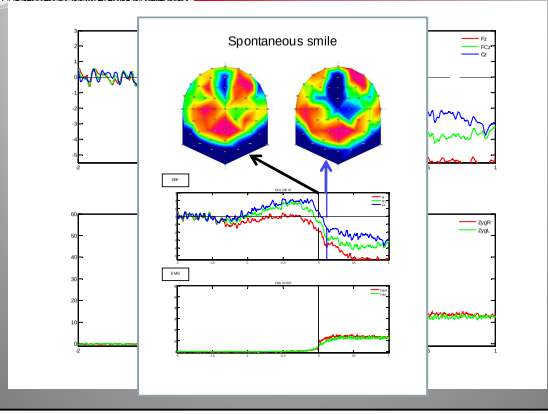

Condition Supp, pics rated funny to very funny

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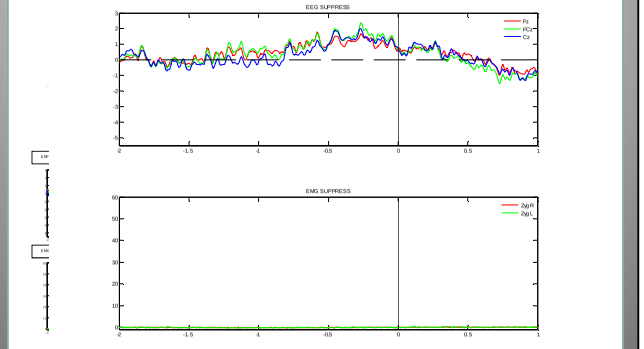

Results, summary

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- Traces at midline fronto-central electrodes, as well as overall topographies, suggest that **spontaneous, humour induced smiles** are **preceded by a RP** with frontal and median distribution
- However, this RP is less pronounced compared to voluntary smiles
- In this data set: For spontaneous, as well as for voluntary smiles, the more typical RP-topography is reached shortly after (and not at time of) EMG-onset
- **No RP** was found for **suppressed smiles**
- A positivity preceded EMG-onset of both spontaneous and suppressed smiles, and may be related to humor perception

Conclusions

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- This type of research is complicated by the fact that it is not easy to make people smile/laugh spontaneously in a laboratory setting, and the resulting number of trials one can average for the ERPs is thus rather small
- Our results are preliminary, and further analyses + experiments will have to be conducted
- Nevertheless, I believe that this new and ambitious type of analysis of facial expressions and their neural antecedents/correlates may turn out to be valuable
- Ultimately, differentiating types of facial expressions at the level of the CNS (i.e. at the source) may be more powerful than doing so at the peripheral level (the face)

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...Thank you for your attention...