

## **Functional Integration of the Visceral CNS Web.**

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The characterization of visceral pain is one of the most important parameters in the diagnosis and assessment of organ dysfunction. In clinical work characterization of pain is confounded by many other symptoms caused by the diseases, making the assessment of visceral pain in clinical studies difficult.

The aim of the project is to establish a model for the visceral pain integration across the CNS in health and disease, by utilizing functional connectivity techniques (Drewes et al, 2006;Sami et al, 2006). The methods could be used in the clinic to characterize patients with sensory dysfunction and/or pain in organic and functional diseases. The outcome of this research could lead to better insight into visceral mechanisms and will ultimately improve the treatment of the patients.

### References

- Drewes AM, Sami AKS, Dimcevski G, Nielsen KD, Funch-Jensen P, Valeriani M, Arendt-Nielsen L. Cerebral Processing of Painful Oesophageal Stimulation – A Study Based on Independent Component Analysis of the EEG. GUT May 2006
- Sami SAK, Rössel P, Dimcevski G, Nielsen KD, Funch-Jensen P, Valeriani M, Arendt-Nielsen L, Drewes AM. Cortical changes to experimental sensitization of the human esophagus. Neuroscience 2006 in press

# Functional Integration of the Visceral CNS Web

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## Background

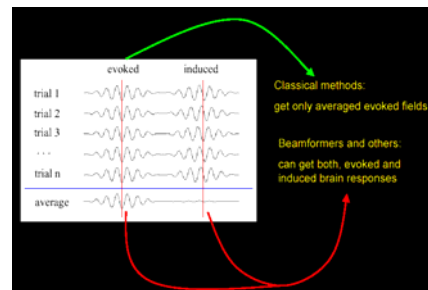
- Our understanding of gastrointestinal sensation remains limited.
- Questions such as why patients with functional GI disorders have severe symptoms and no apparent GI abnormality?
- What is it that determines whether acid in the oesphagus results in the sensation of heartburn and even cause angina like symptoms?

## Gut stimulation

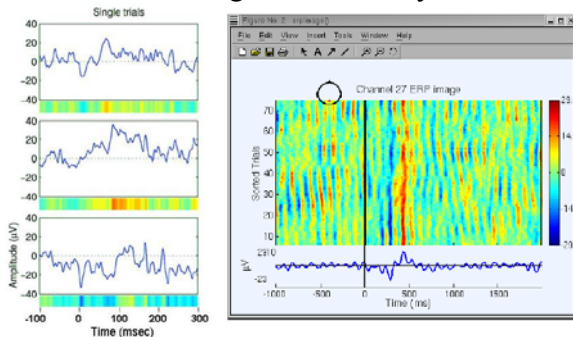
- EEG was recorded from 64 surface electrodes
- Intubation was done with a 6 mm nasal endoscope (Ultra Slim Gastroscope, without any sedation



## Non-phase locked activity

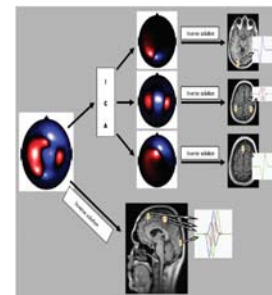


## Single trial analysis

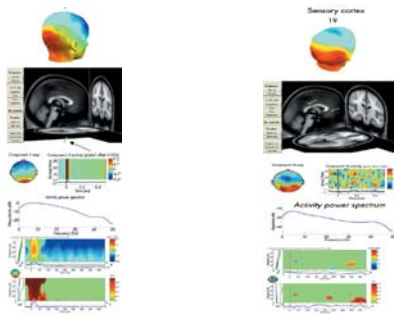


## ICA

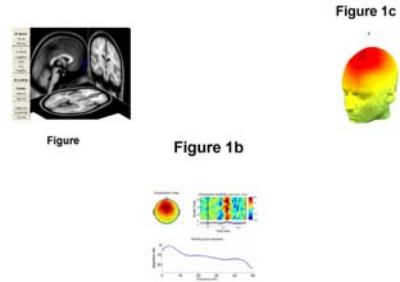
- Blind source separation BSS algorithms have been widely used in the past decade for separating source signals from signal mixtures
- BSS has many different subtypes



### ICA (InfoMax) analysis



### ICA (InfoMax) analysis



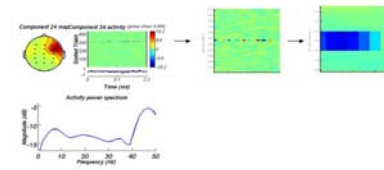
### functional connectivity

**SOURCE COHERENCE ANALYSIS**

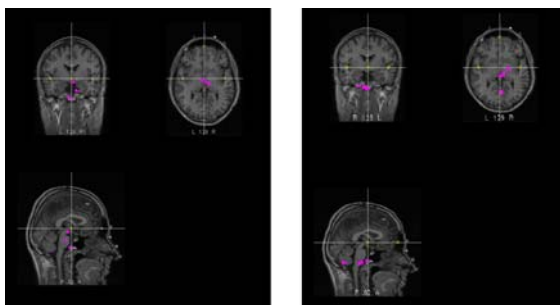
	Thalamus	Insula	PCC	MCC	ACC
Insula	75, $\beta$				
PCC	75, $\beta$	150, $\gamma$			
MCC	100, $\beta$	350, $\gamma$	120, $\beta$		
ACC	200, $\gamma$	150, $\beta$	100, $\alpha$	150, $\gamma$	
Sensory	60, $\gamma$	50, $\beta$	130, $\gamma$	150, $\beta$	100, $\gamma$

Cross correlation was performed to identify the degree of phase synchronisation between the components. The latency (ms) of the first synchronous correlation with a correlation coefficient above 0.45 is shown together with the dominant frequency content of the first synchronic activity.  
 ACC, MCC, and PCC, anterior, middle, and posterior cingulate cortex; Sensory, sensory cortex  
 $\alpha$ =8-14 Hz;  $\beta$ =14-25 Hz;  $\gamma$ =25-50 Hz.

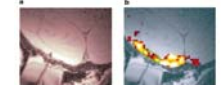
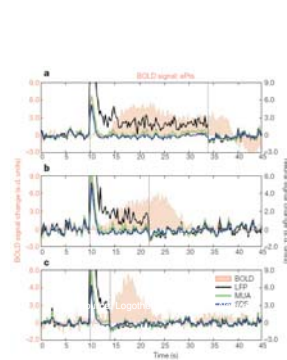
### SOBI artifact identification



### Can EEG identify sub-cortical activity?



### BOLD correlations



- Local Field Potentials (LFP)
- reflect post-synaptic potentials
  - similar to what EEG (ERPs) and MEG measure
- Multi-Unit Activity (MUA)
- reflects action potentials
  - similar to what most electrophysiology measures
- Logothetis et al. (2001)
- combined BOLD fMRI and electrophysiological recordings
  - found that BOLD activity is more closely related to LFPs than MUA

