Dynamic Brain Sources of Visual Evoked Responses

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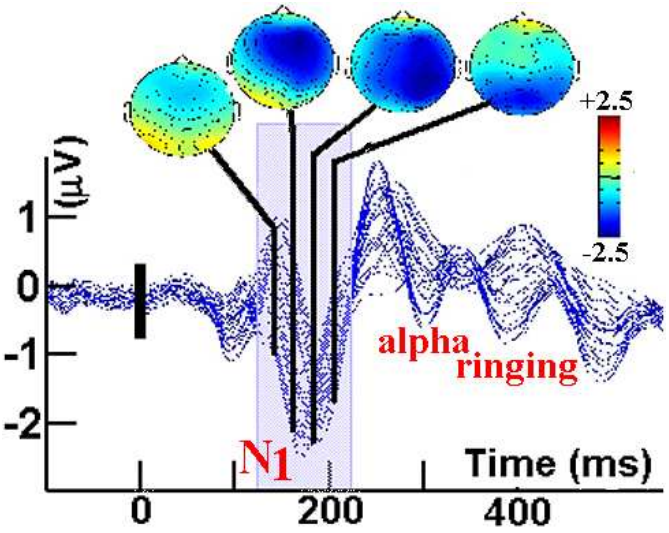
Scope

- Understanding the averaged electrical responses :



Stimulus-Evoked brain events

vs

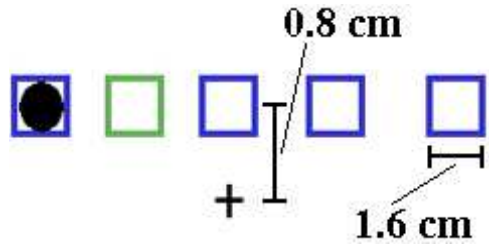
Stimulus-Induced changes in ongoing brain dynamis

- Exploratory-Data Analysis of multichannel data + source identification

- Phase resetting of multiple processes : a Single-Trial characterization

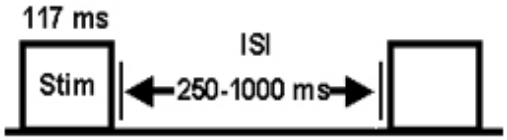
from *Winfree & Sayers* to *Brandt , Tass & Nicolelis*

Experimental Set-up



spatial visual selective attention experiment
76-s block of trials, green was the target location

task: button-press when stimuli (flashed disks) appeared in the attended location



30 block per subject / 15 subjects

EEG data, 29 scalp sites + 2 EOG,
SF: 256 HZ, BW:0.01-100 Hz , low-pass : 40 Hz.

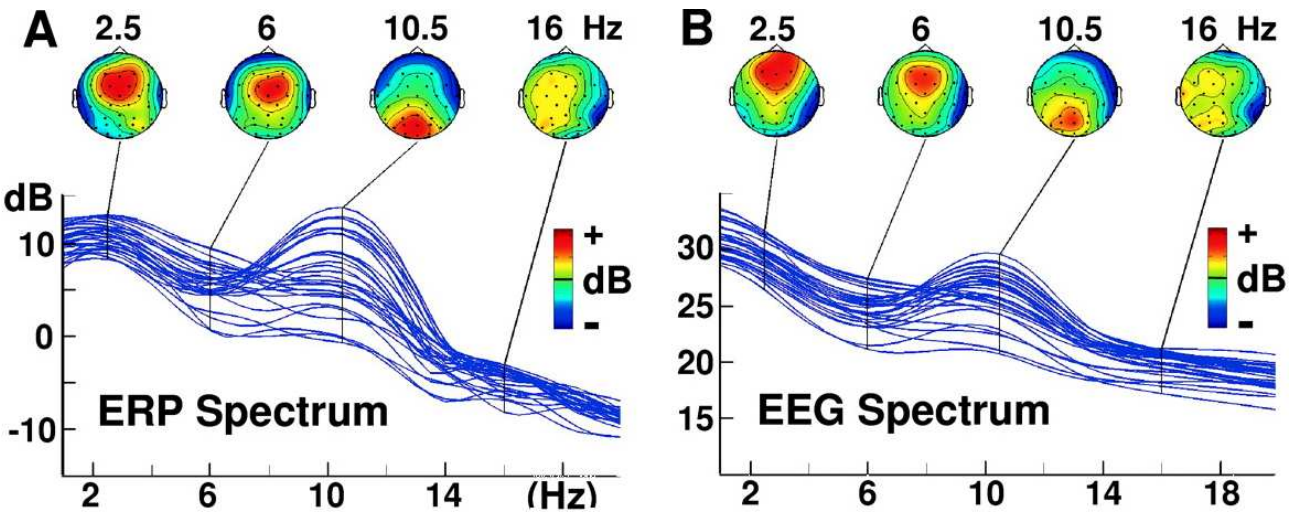
Responses to nontarget stimuli presented to the left of fixation were analysed (after artifact rejection **922 in average**, since nontarget trials per location was 480)

METHODS

1. ERP spectrum vs ST-EEG spectrum (Short-FT)
2. ***Event-Related Spectral Perturbation*** : Averaged vs ST response
3. ***Event-Related Intertrial Coherence*** *ITC* (phase-locking factor)
4. ***Sorting*** Single-Trials
5. ***ERP-Image*** tool
6. ***ICA***
7. **Clustering**

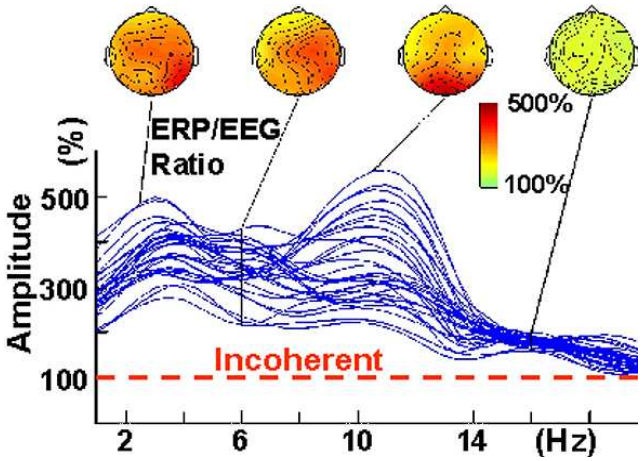
RESULTS

➲ Power spectra of 1-s post-stimulus epochs : ave. vs ST-epochs

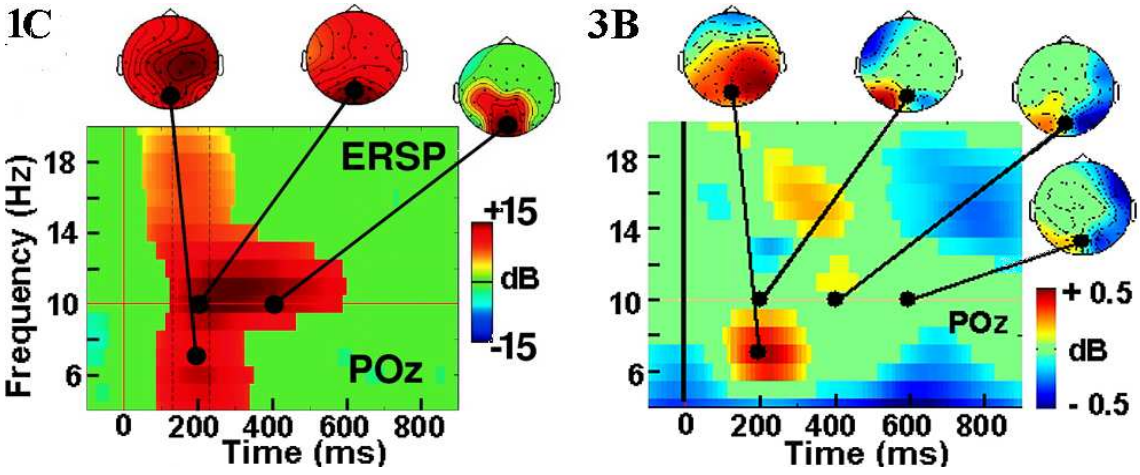


Similarity in frequency dependence and scalp topography.

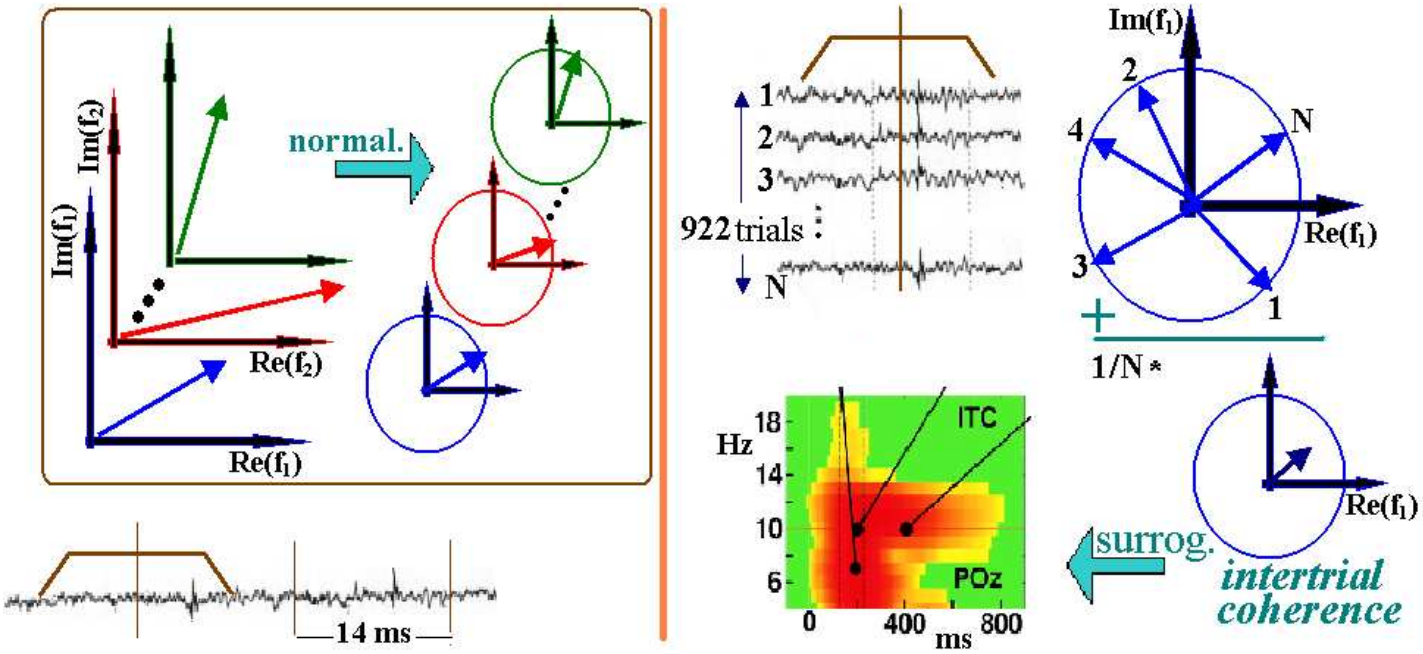
Below < 20Hz,
spectral amplitude of ave-epochs
5 times higher than expected:
in a Signal + Noise model ,
where averaging suppresses
the variance of noise 1/N times



➲ pre to post-stimulus ↑ in α-power : ave. vs ST-epochs

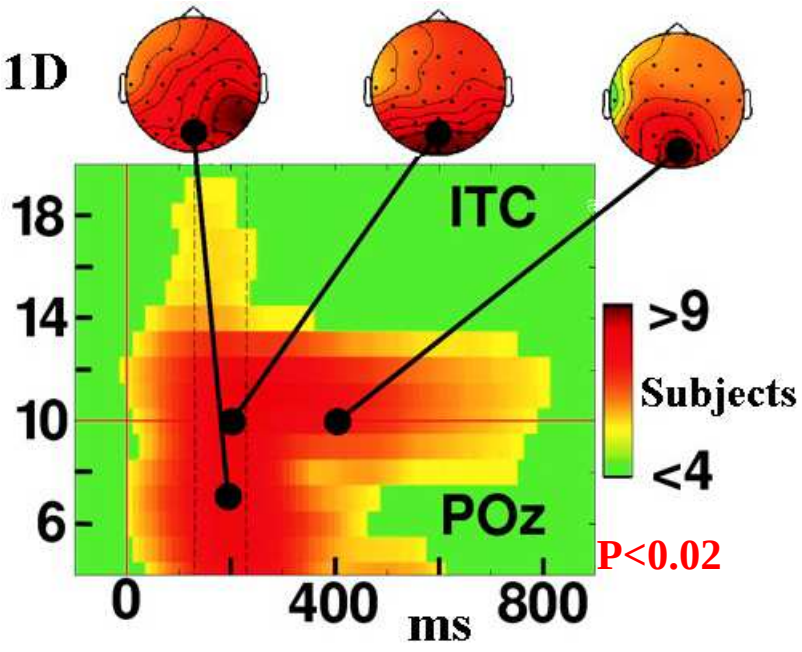


➲ at each frequency and latency window,
the consistency across trials of EEG spectral phase was measured



➥ ***phase resetting***
during N1 period,
in all channels
and frequencies <20 Hz

At 10 Hz,
in central posterior channels,
ITC remains high for 700 ms



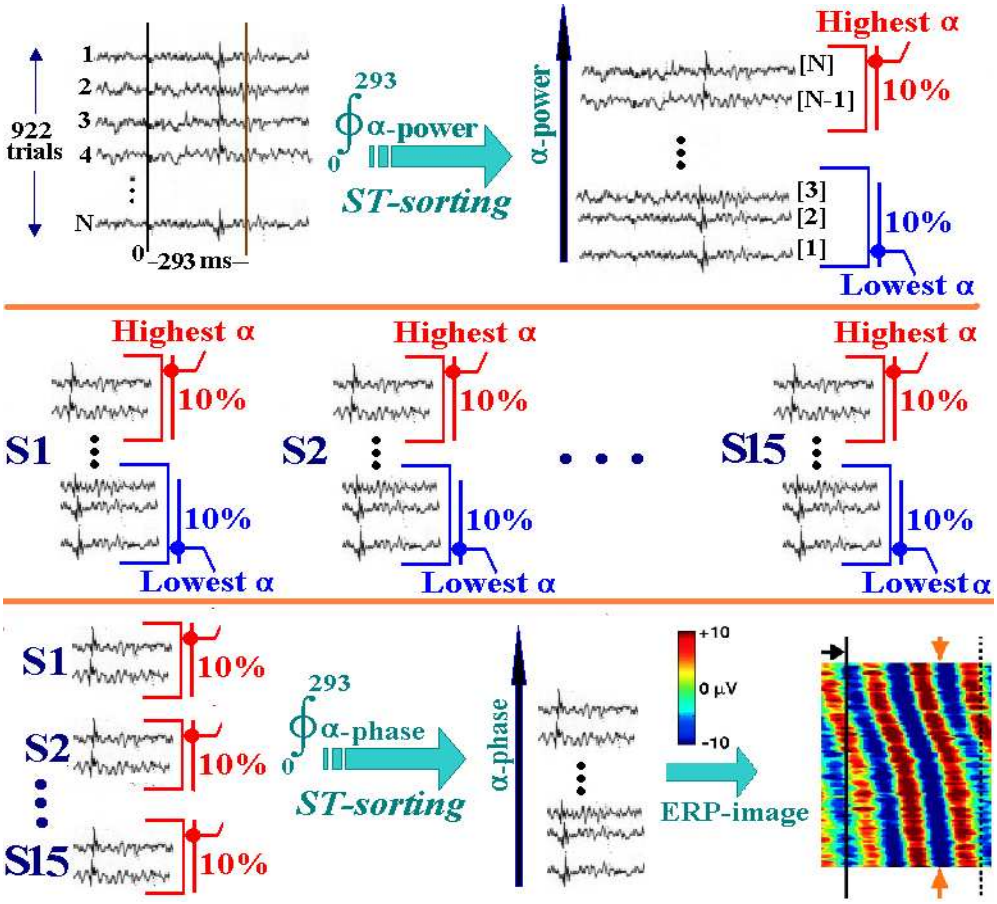
Visual ERPs are not sums of a sequence of brief fixed-latency,

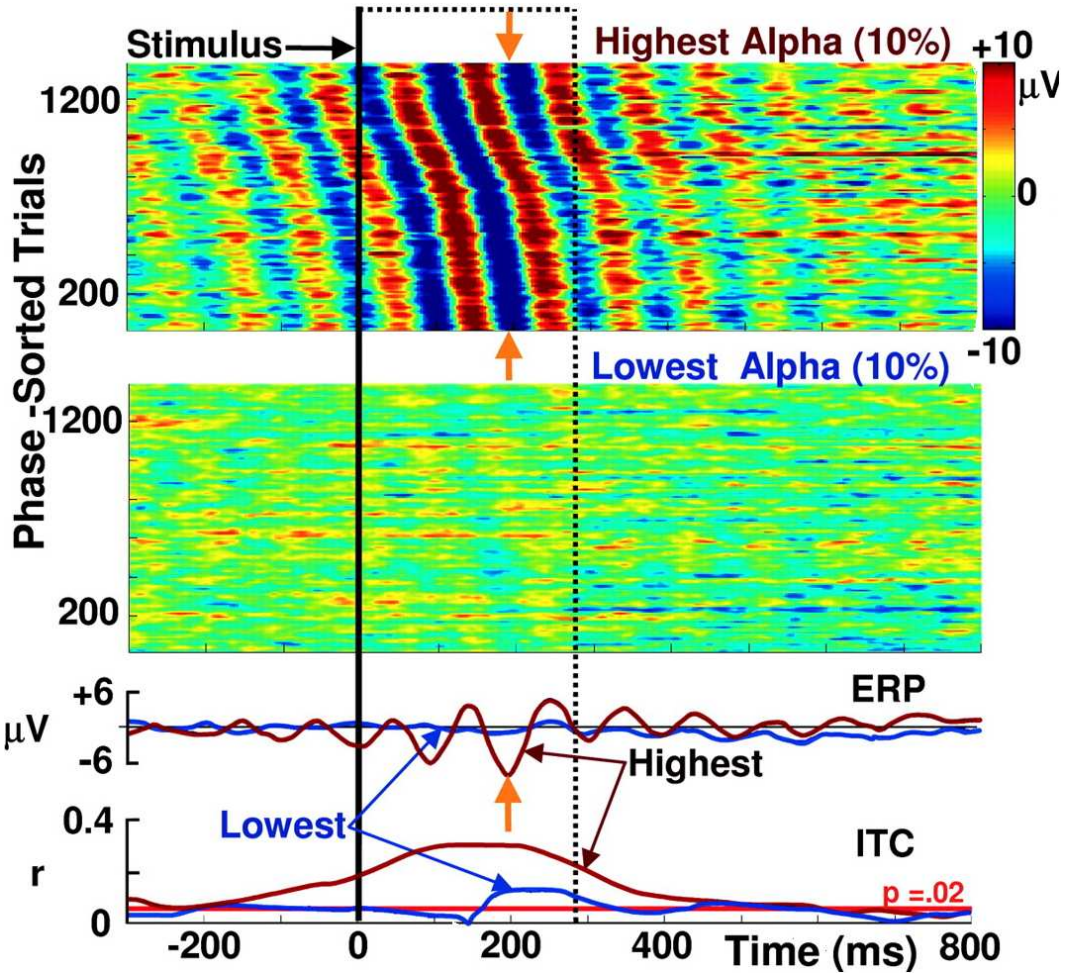
fixed polarity potential events:

Coupling with the ongoing activity

The relationship between the ST rhythmic EEG activity and its ERP-aver.

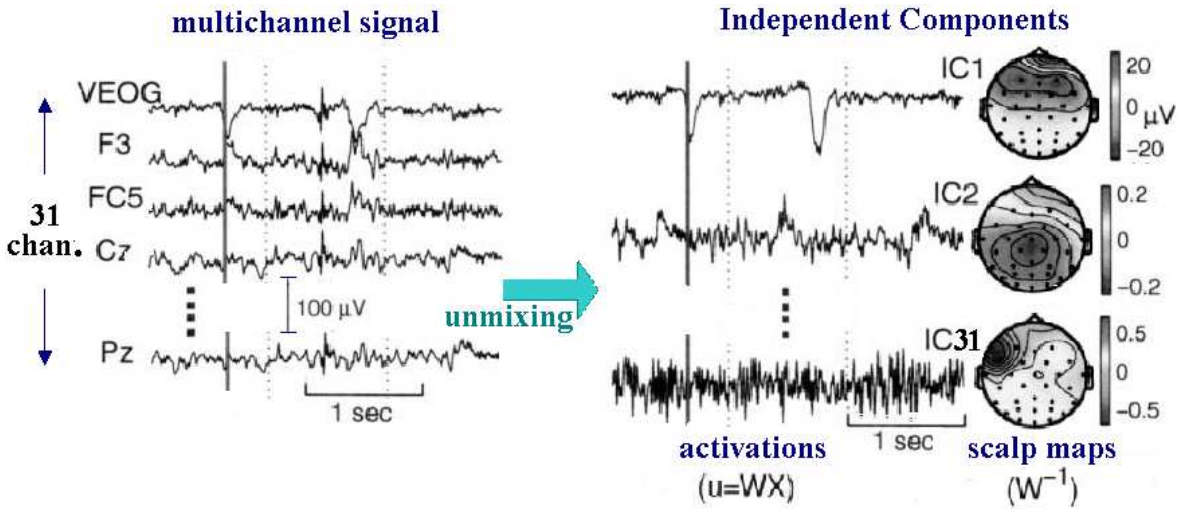
was investigated via the sorting of STs according to their poststimulus (0-293ms) α-power (10.25 Hz)



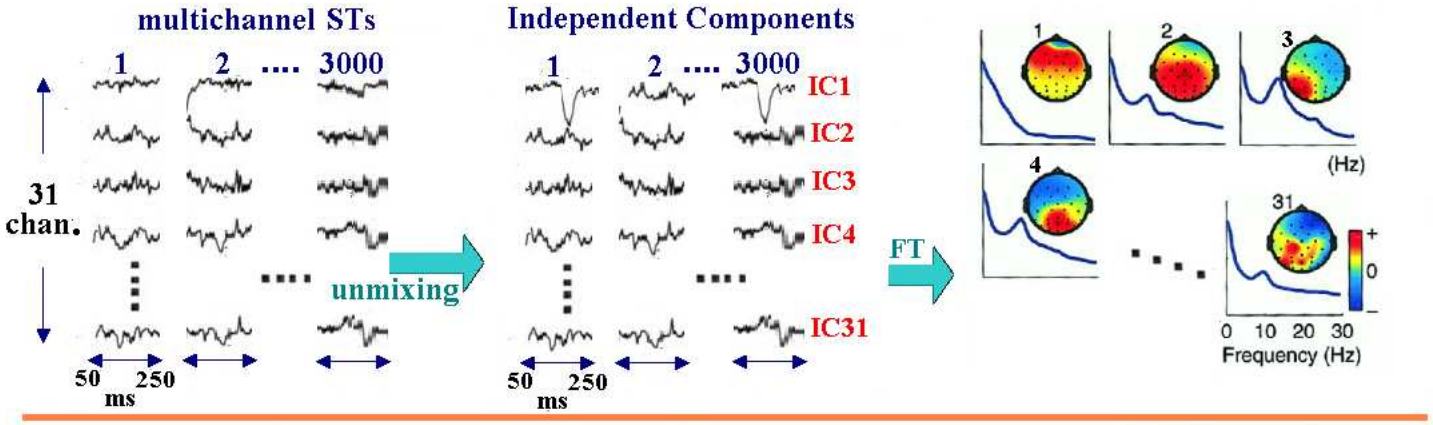


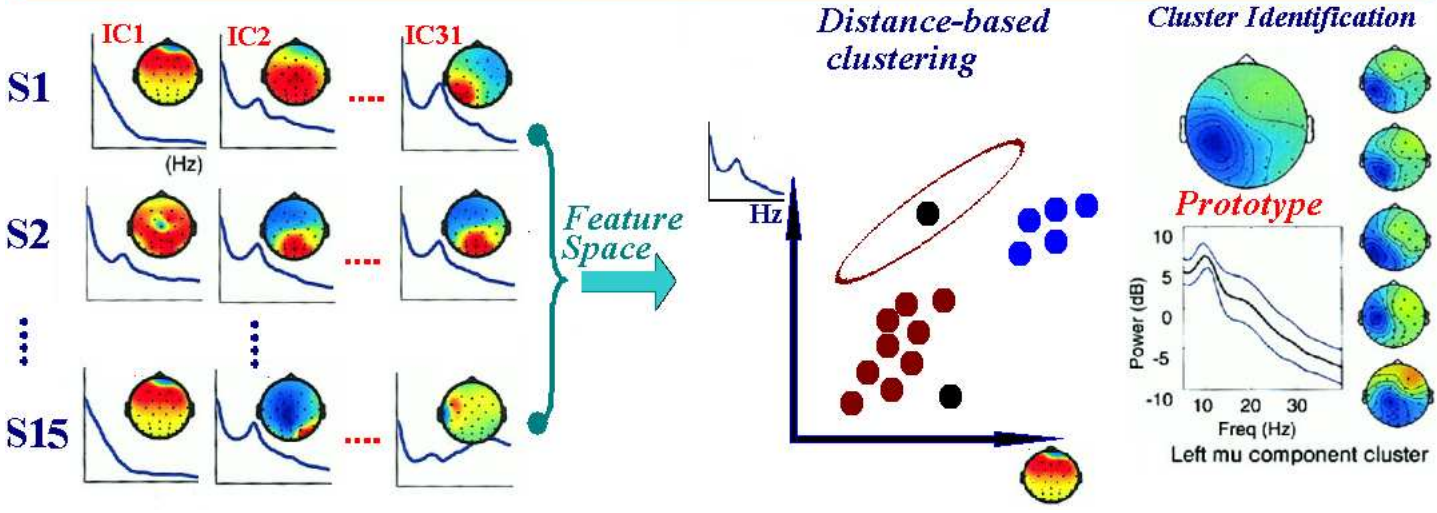
Prestimulus phase bias

Signal separation: spatially fixed, temporally independent processes



Single-trial signals **from all conditions** [50 250]ms were concatenated





Cluster Analysis was used to group the ICs across subjects.

The clusters containing components in common, but not corresponding to non-brain artifacts were considered as responsible for the ERP-generation.

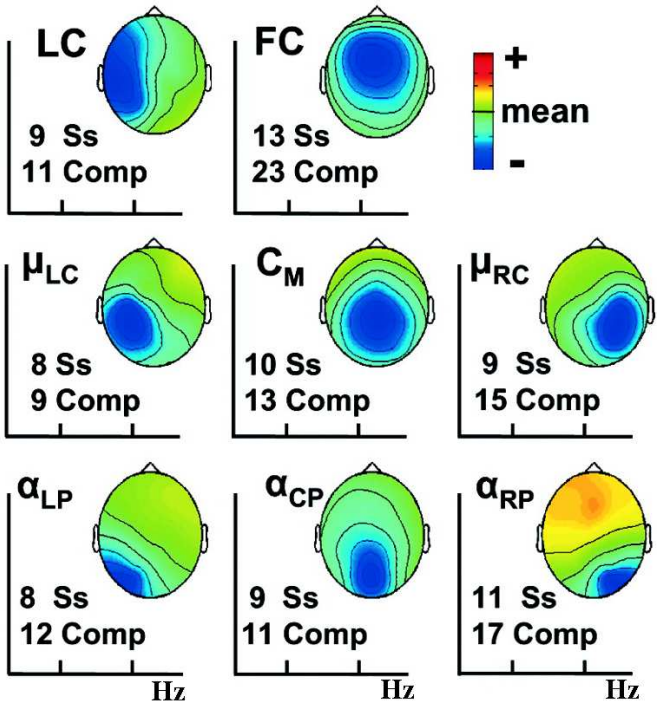
8 clusters were detected:

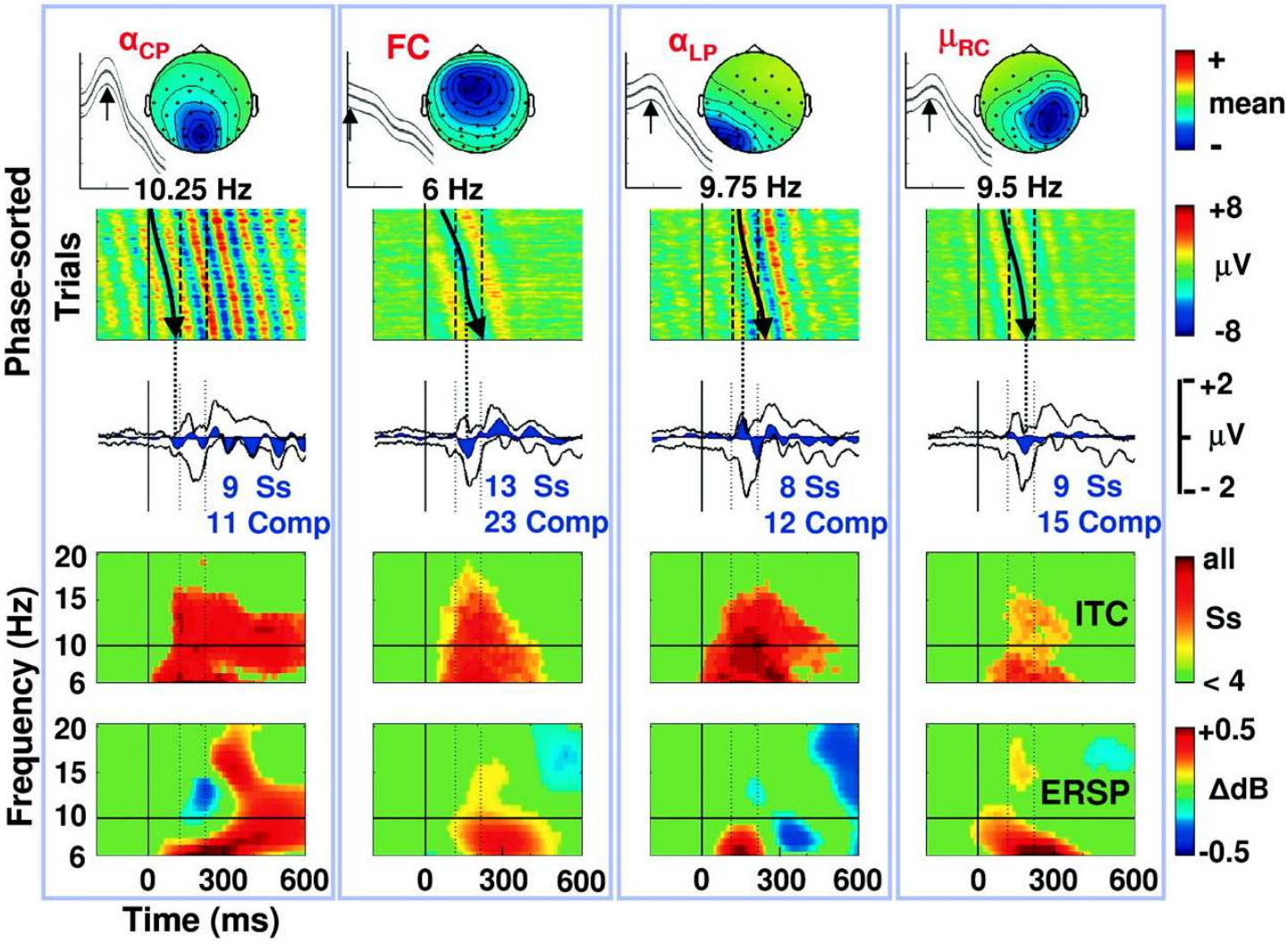
A Rhythmic α_{CP} responsible for α-ringing and fitted by two dipoles in left/right calcarine cortices

A FC cluster with phase resetting in θ/α-band responsible for frontal N1

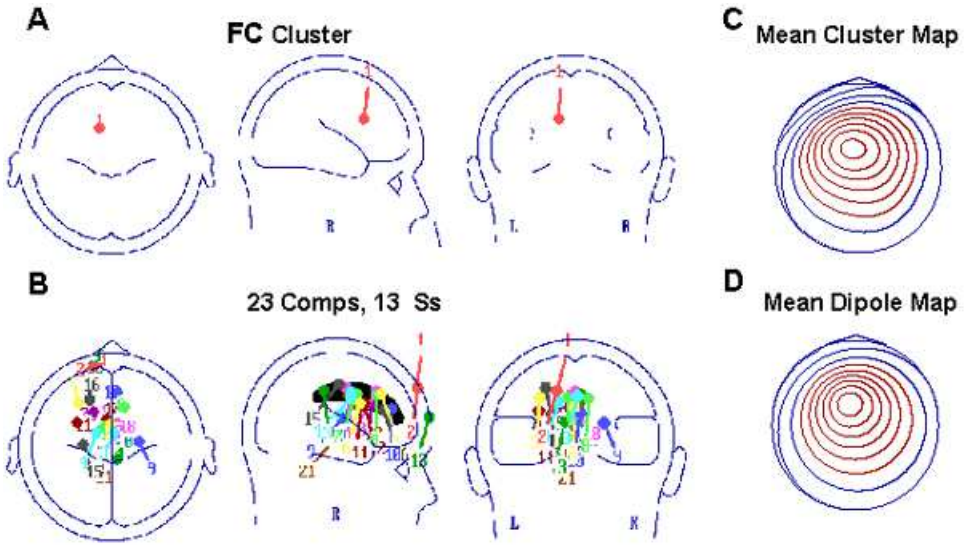
Two lateral posterior ones accounted for the early-P1, N1

Two μ-rhythm related clusters

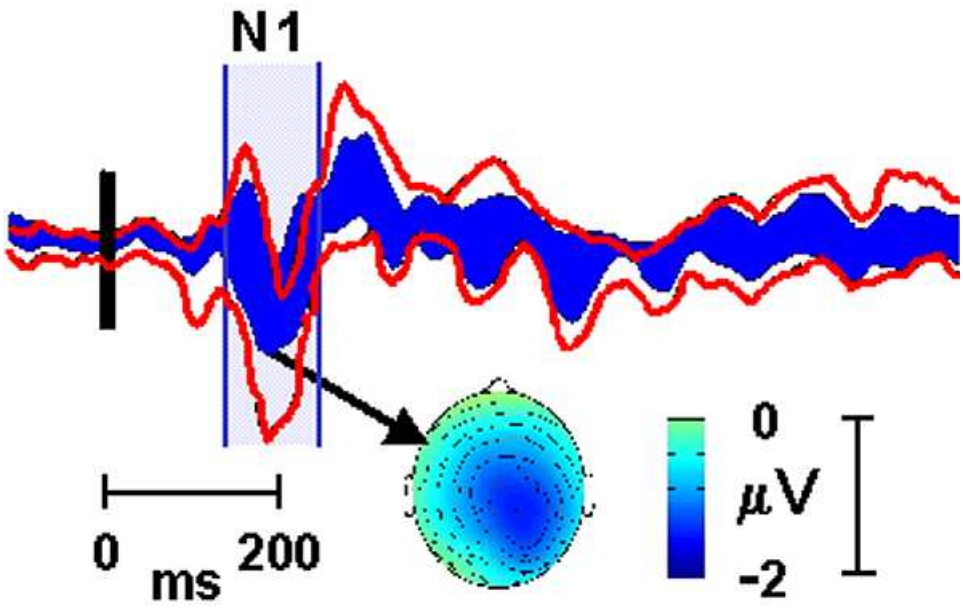




Single-dipole modeling of FC-components resulted to localization of activity in or near left dorsal anterior cingulate cortex



The selected components can explain 80% of the grand-average signal



Conclusions

❒ background oscillatory EEG processes
are not irrelevant to brain stimulus processing

❒ ❒ Phase resetting of EEG processes can explain
(i)why epochs of small α-energy
result to an ERP-average of small amplitude
(ii) the α-ringing effect
(iii) why ERP latencies do not match the 50-100 ms latency
of initial neural activation in visual areas

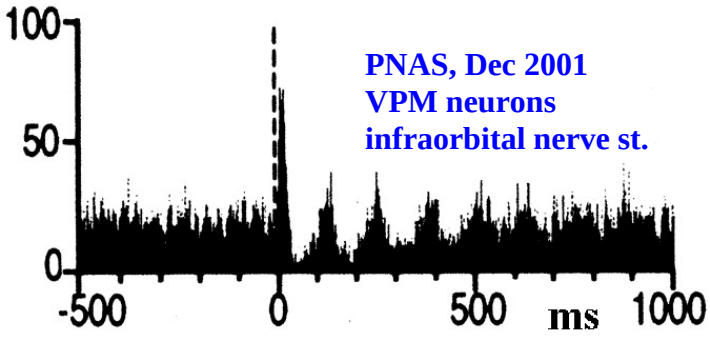
❒❒❒ The role of ST-analysis for understanding the cortical dynamics.

The conjunction of ***Source-separation*** and ***Source-localization***.

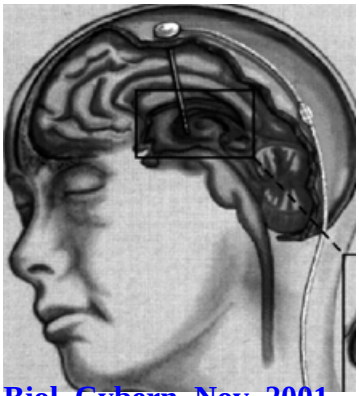
Discussion

❶ ICA limitations / mixing all conditions during ICA computations

❷ phase resetting



PNAS, Dec 2001
VPM neurons
infraorbital nerve st.



Biol. Cybern. Nov. 2001
Deep brain stimulation

❸ Exploratory Data Analysis