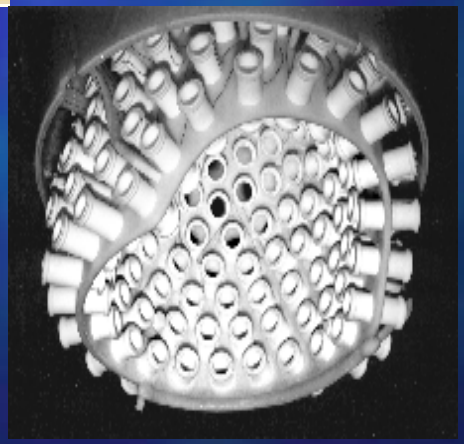
N. Laskaris

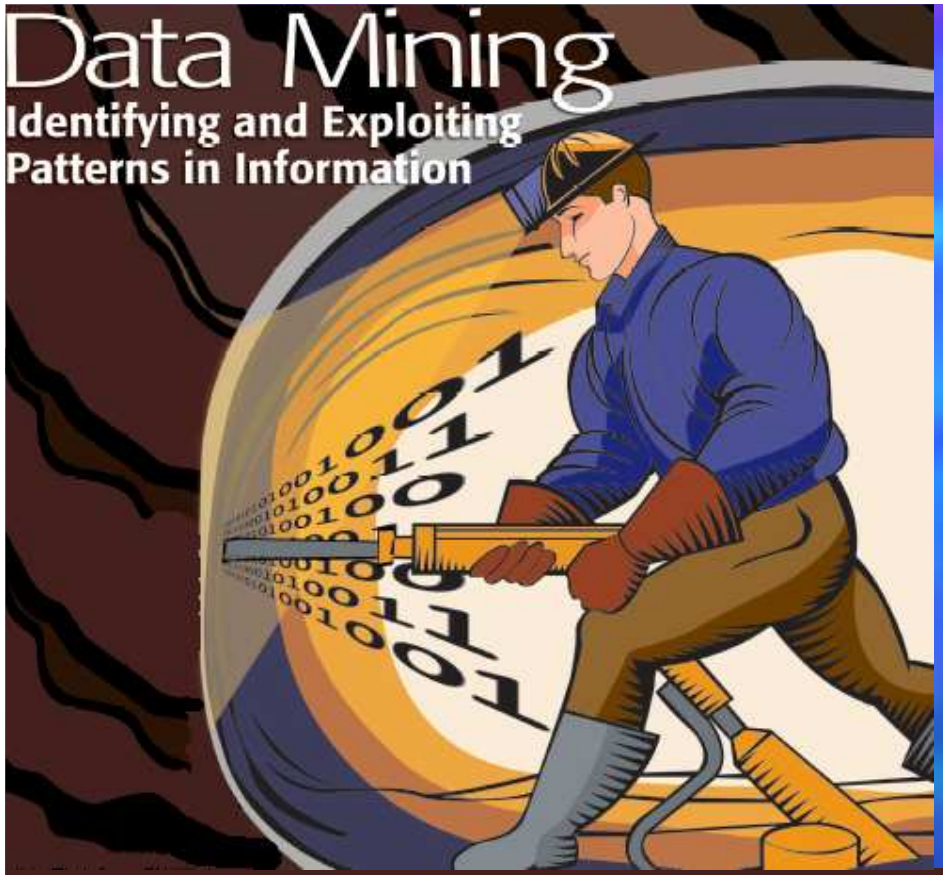
A dual Congress
PSYCHIATRY AND THE NEUROSCIENCES

5th International Congress of Neuropsychiatry

1st Mediterranean Regional Congress of the
World Federation of Societies of Biological Psychiatry

N. Laskaris





[**IEEE SP Magazine,** May 2004]

N. Laskaris,
S. Fotopoulos,
A. Ioannides

ENTER-2001

Electronics Laboratory
Εργαστήριο Ηλεκτρονικής
ELLAB
University of Patras
Πανεπιστήμιο Πατρών

Brain Science Institute
RIKEN

Cognitive Brain Science Research Group
Group Direct
Keiji Tanak
Group Laboratories
Laboratory for Cognitive Brain Mapping
Lab. for Human Brain Dynamics
Laboratory for Integrative Neural Systems
Laboratory for Cortical Organization and Systematics

Analysing Event-Related Dynamics

new tools

for Mining Information from multichannel encephalographic recordings

& applications

10 Questions

What is *Data Mining ?*

How is it applied ?

Why is it useful ?

What is the difficulty with single trials ?

How can *Data Mining* help ?

Which are the algorithmic steps ?

Is there a simple example ?

Is there a more elaborate example ?

What has been the gain ?

Where one can learn more ?

What is *Data Mining* & *Knowledge Discovery* in databases ?

Data Mining

is "the data-driven discovery and modeling of hidden patterns in large volumes of data."

- **It is a multidisciplinary field,**

borrowing and enhancing ideas from diverse areas such as statistics, image understanding, mathematical optimization, computer vision, and pattern recognition.

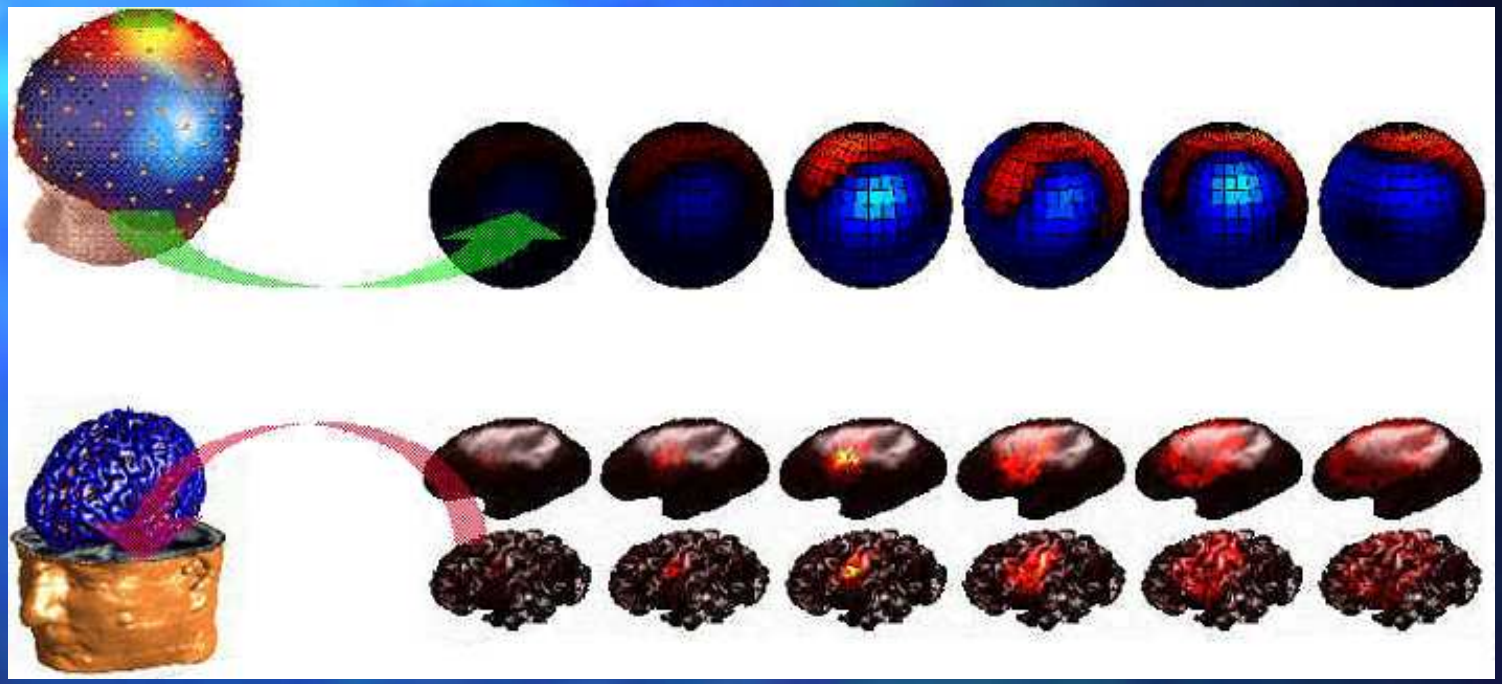
- **It is the process of nontrivial extraction of implicit, previously unknown, and**

potentially useful information from voluminous data.

Question ②

How is it applied in the context of

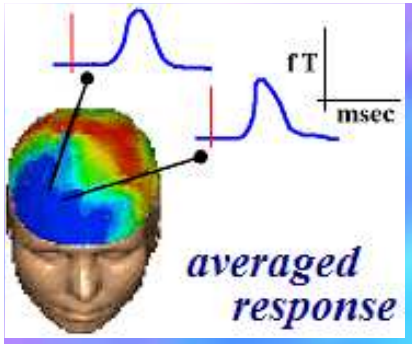
multichannel encephalographic recordings ?



Studying Brain's *self-organization*
by monitoring the dynamic pattern formation
reflecting neural activity

Question 3

Why is it
a potentially valuable methodology
for analyzing
Event-Related recordings ?



The traditional approach is based on identifying peaks in the averaged signal

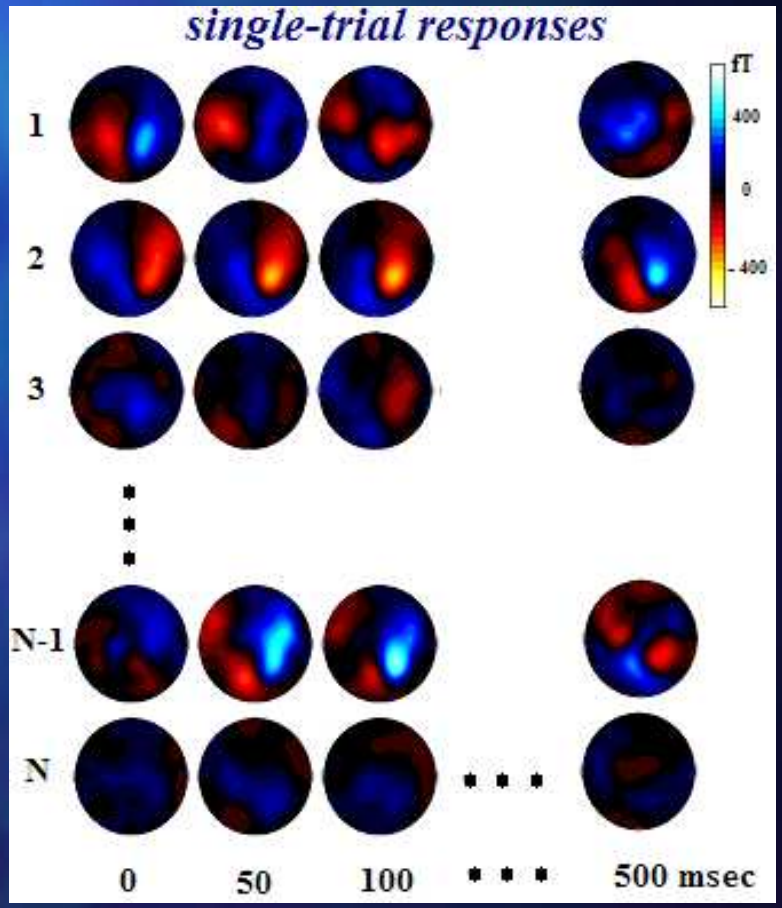
-It blends everything happened during the recording

The analysis of

Event-Related Dynamics

aims at understanding the ***real-time processing*** of a stimulus performed in the cortex

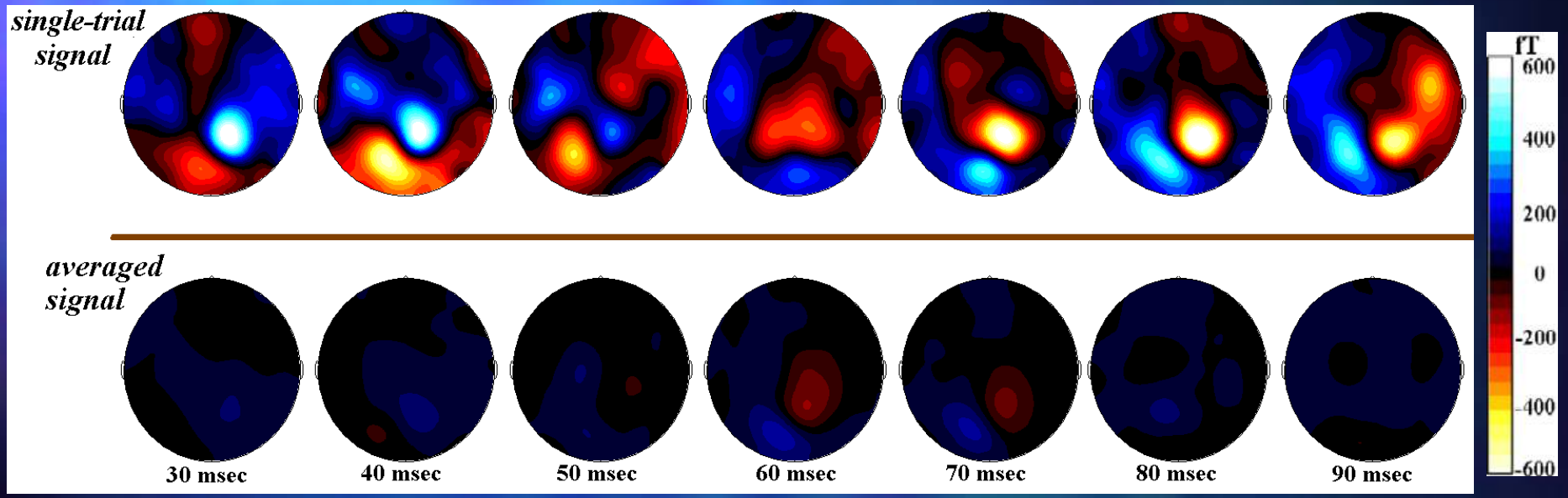
and demands tools able to deal with ***Multi-Trial data***



Question 4

What is the difficulty in analyzing ***Single-Trial*** responses ?

At the single-trial level, we are facing *Complex Spatiotemporal Dynamics*



Question 5

How can ***Data Mining*** help
to **circumvent** this complexity
and **reveal**
the underlying brain mechanisms ?

☞ directed queries are formed
in the Single-Trial data
which are then summarized

using a very limited vocabulary
of information granules

that are easily understood,
accompanied by well-defined semantics
and help express relationships existing in the data

The ***information abstraction***
is usually accomplished
via ***clustering*** techniques

and followed by a proper ***visualization scheme***
that can readily **spot** **interesting events**
and **trends** in the experimental data.

- *Semantic Maps*

The ***Cartography*** of neural function
results in a topographical representation
of response variation
and enables the virtual navigation
in the encephalographic database

Question 6

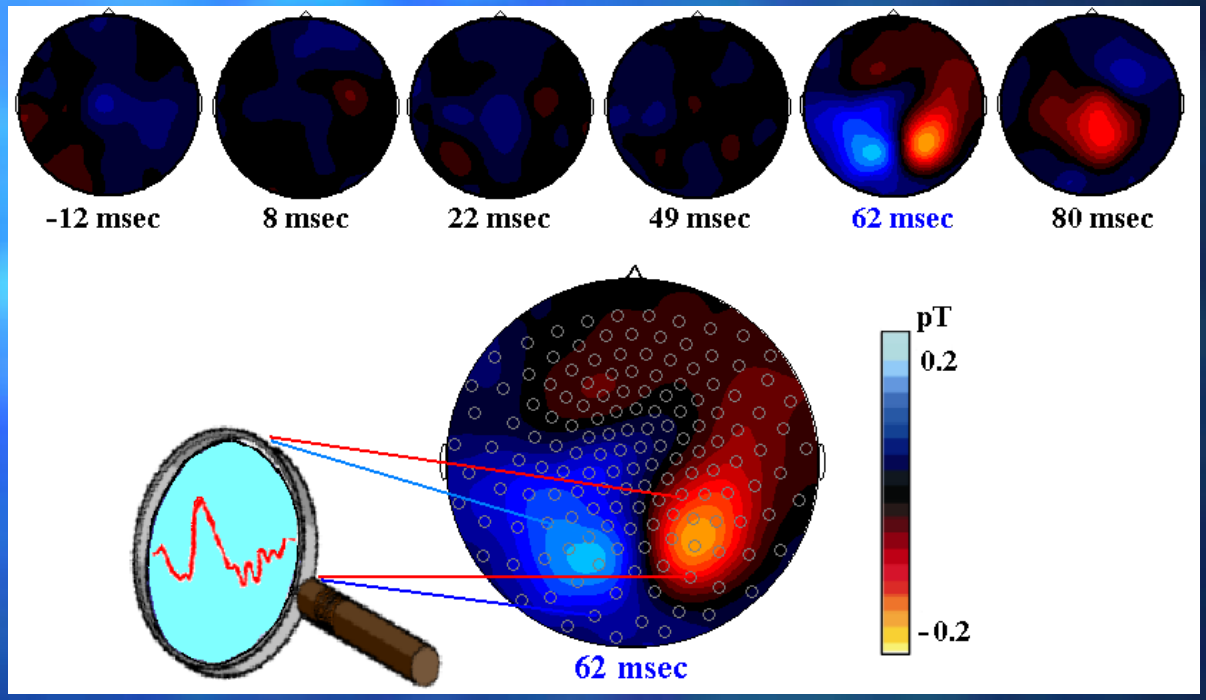
Which are the intermediate algorithmic steps ?

➢ A Hybrid approach

Pattern Analysis

& Graph Theory

Step_❶
the spatiotemporal dynamics are decomposed

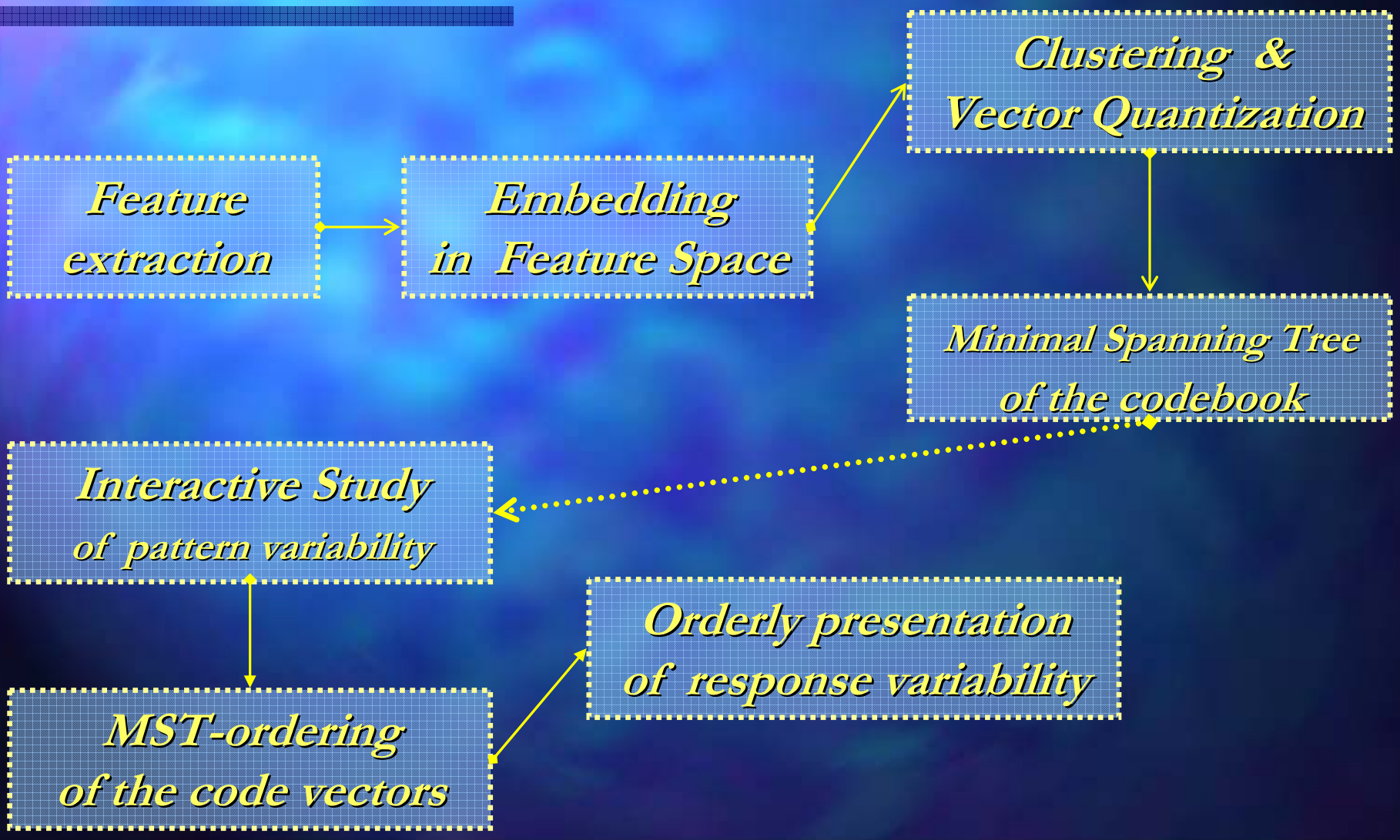


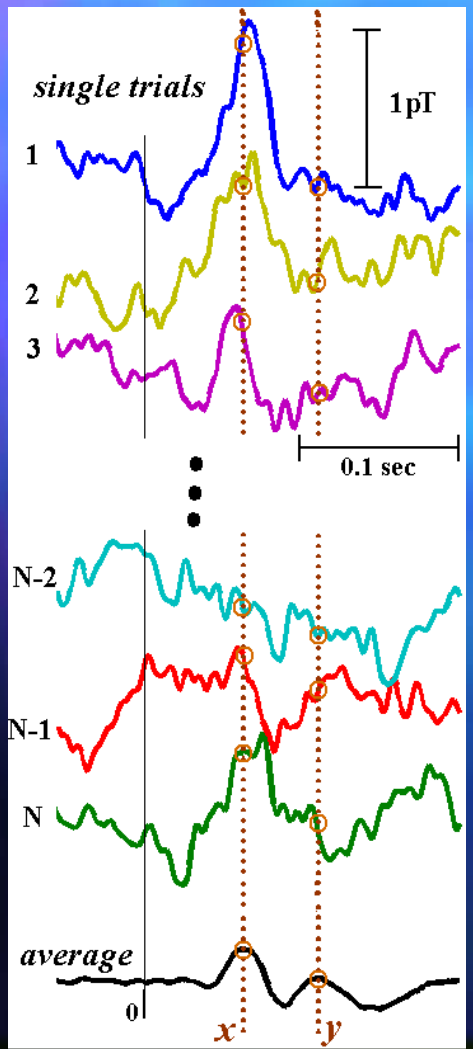
Design of the ***spatial filter*** used to extract

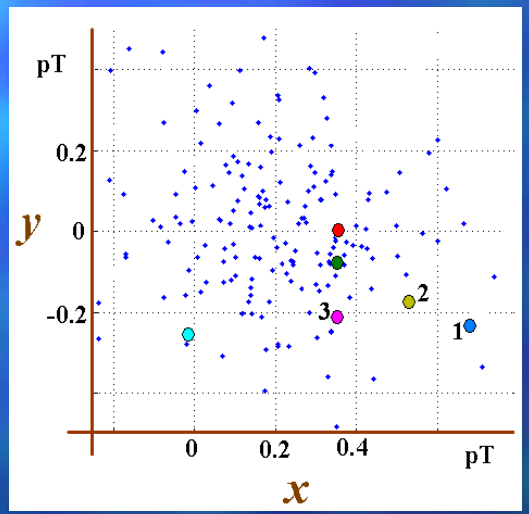
the ***temporal patterns*** conveying

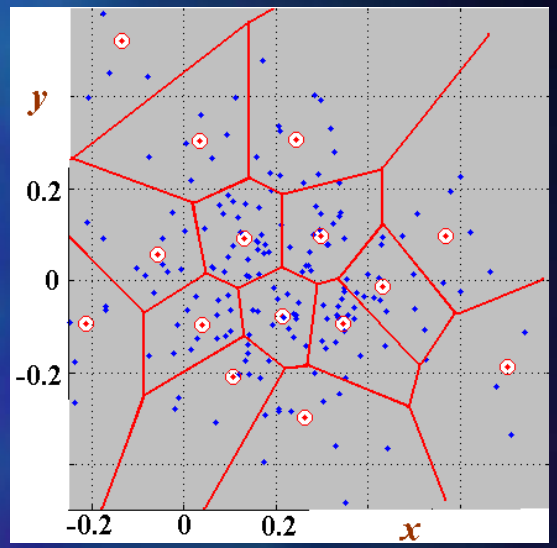
the ***regional response dynamics***

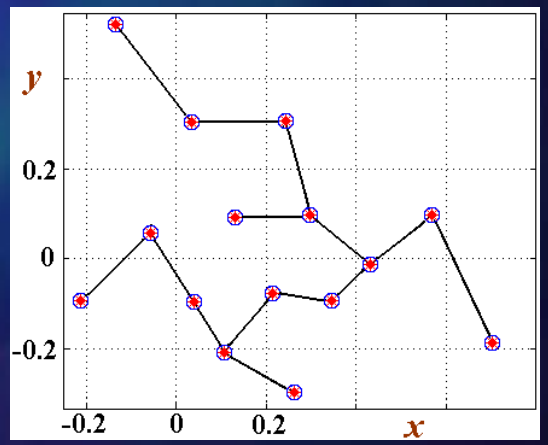
Step_❷
Pattern Analysis
of the extracted ST-patterns

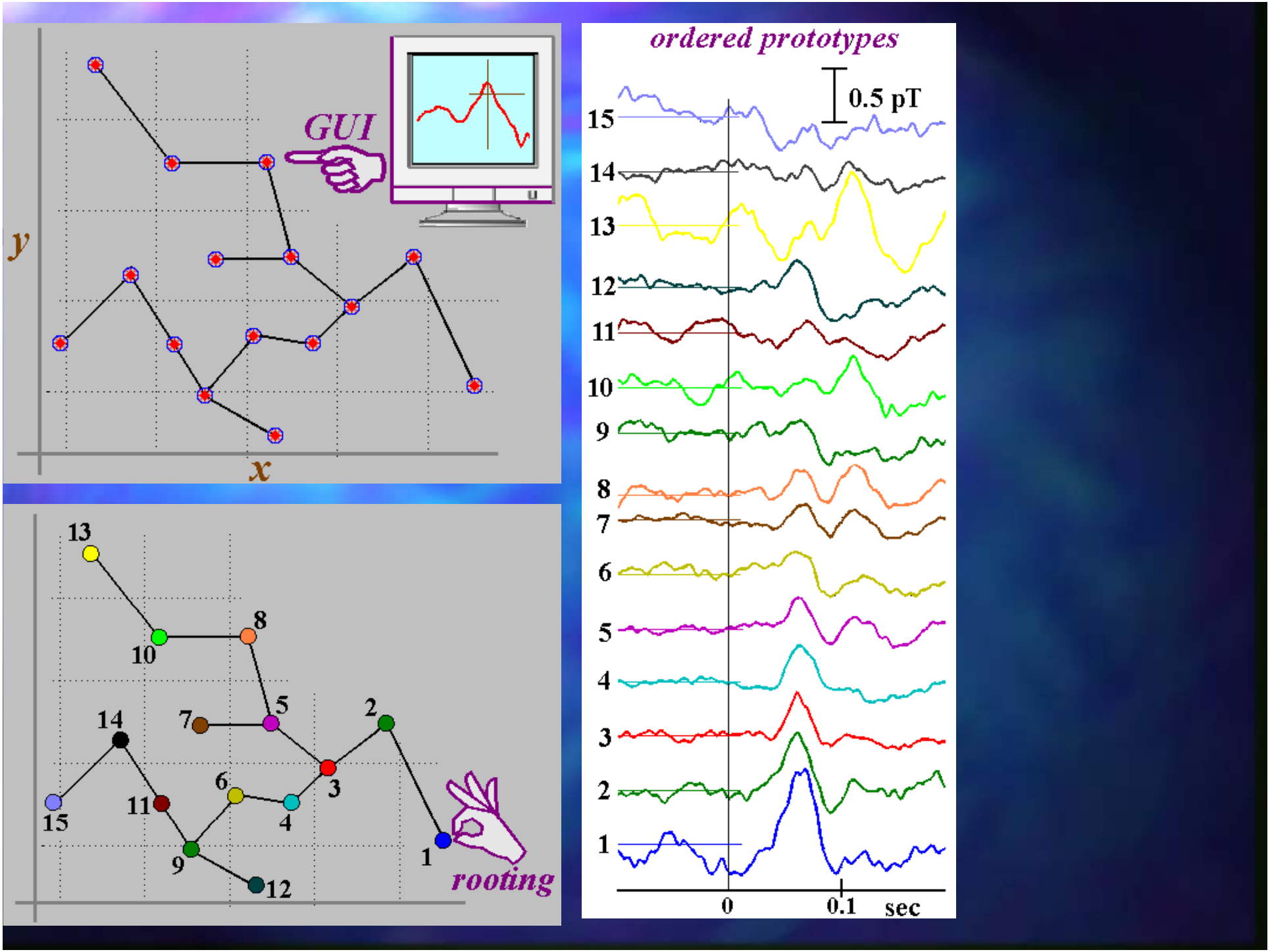



single trials
1pT
1
2
3
0.1 sec
N-2
N-1
N
average
0
x
y


pT
0.2
y
0
-0.2
0
0.2
0.4
pT
x
1
2
3


y
0.2
0
-0.2
-0.2
0
0.2
x

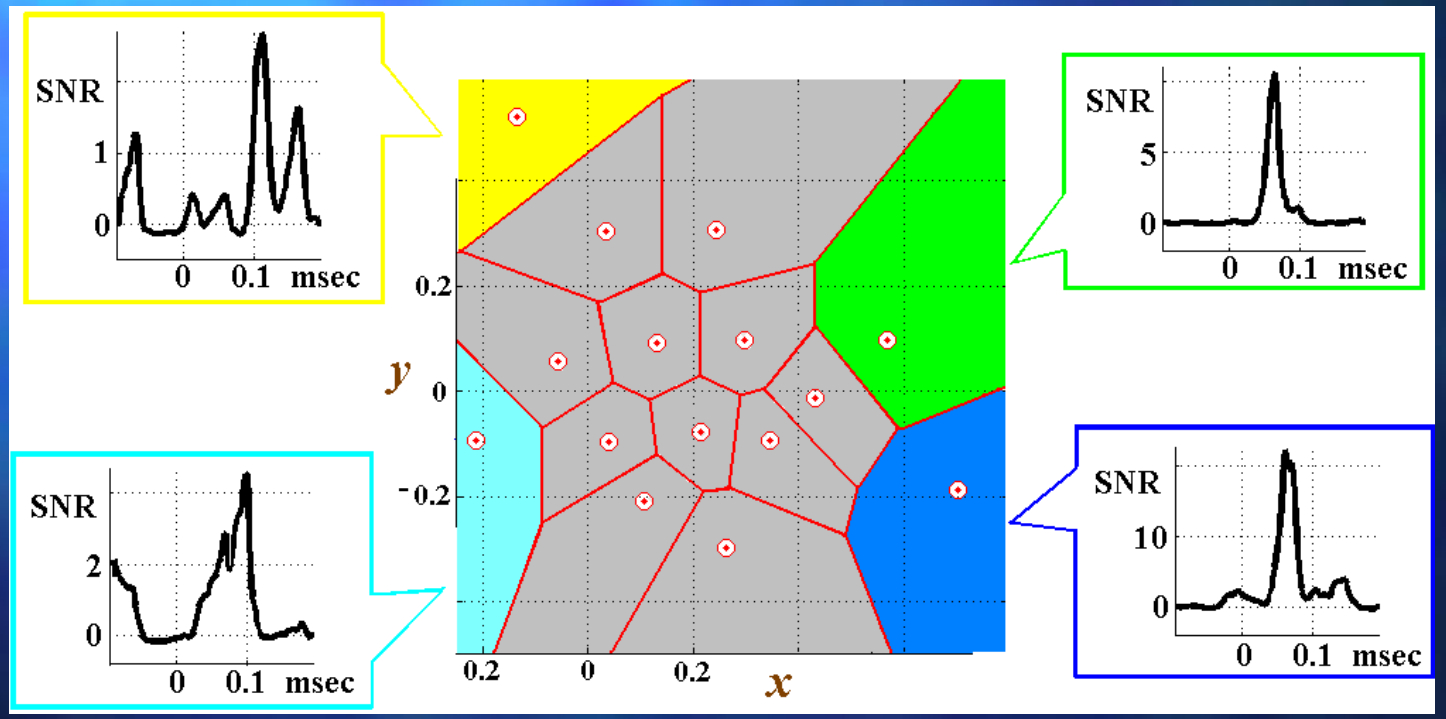

y
0.2
0
-0.2
-0.2
0
0.2
x


GUI
y
x
13
10
8
14
7
5
2
6
3
15
11
4
9
12
1
rooting
ordered prototypes
0.5 pT
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0.1
sec

Step_③

Within-group Analysis

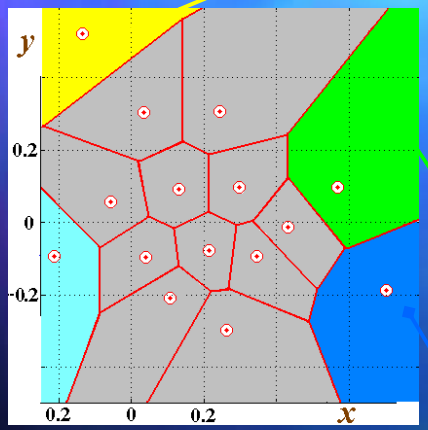
of regional response dynamics

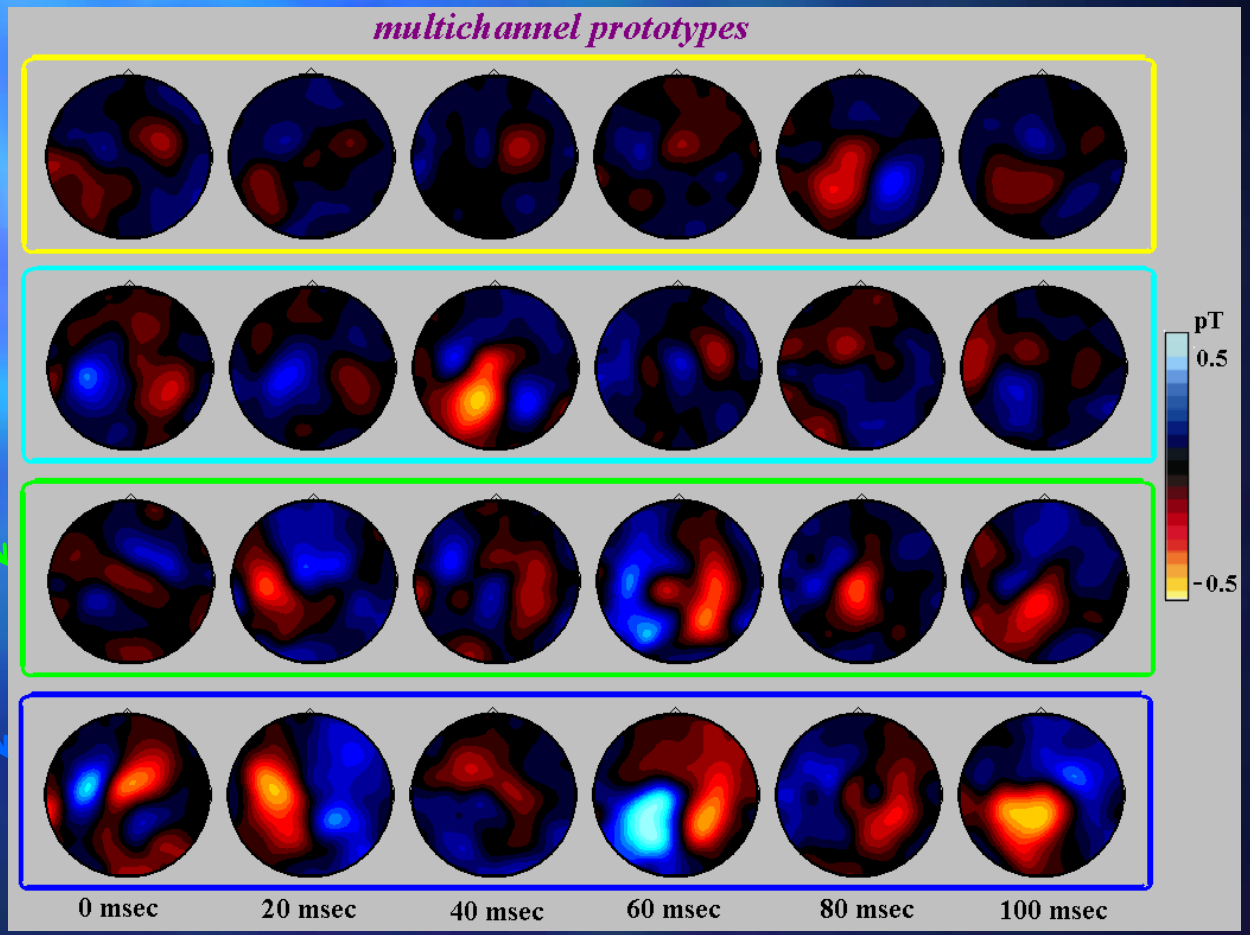


Step_❹

Within-group Analysis

of multichannel single-trial signals

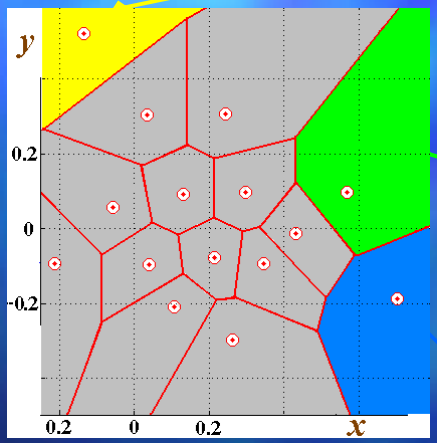


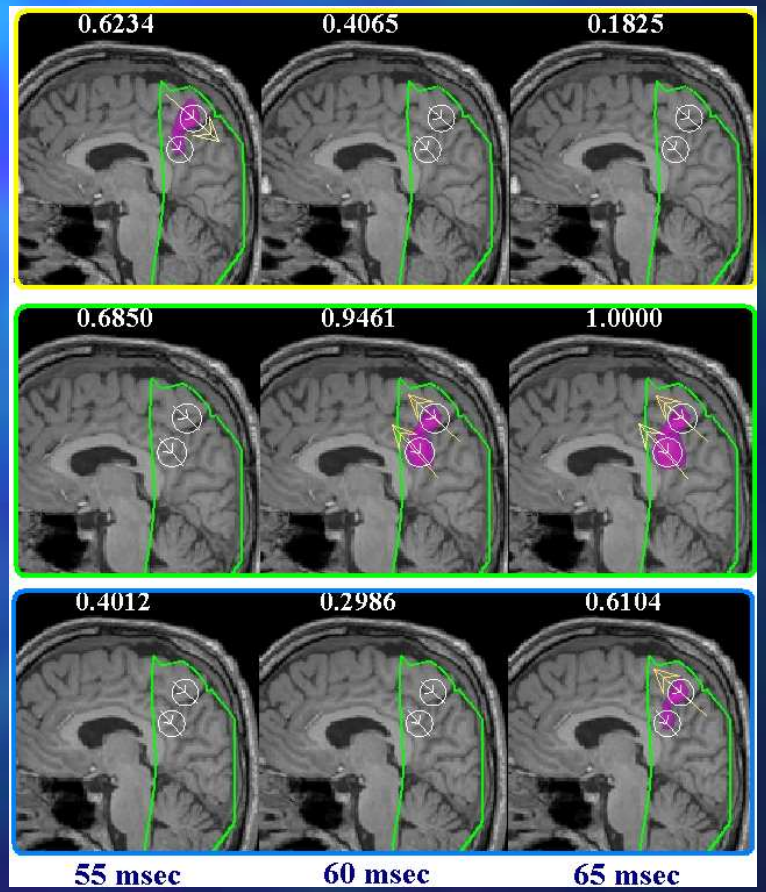


Step_⑤

Within-group Analysis

of single-trial MFT-solutions





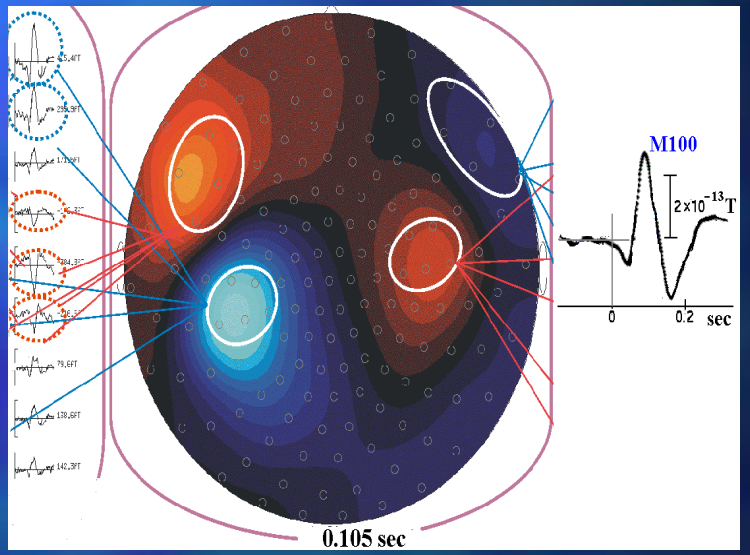
Question 7

Is there a simple example?

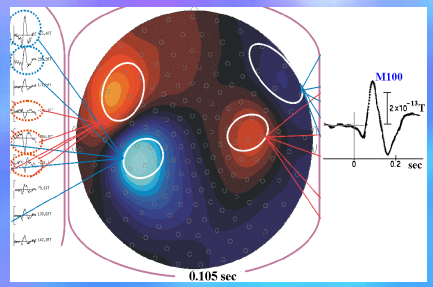
[Laskaris & Ioannides, Clin. Neurophys., 2001]

Repeated stimulation

120 trials,
binaural-stimulation
[1kHz tones, 0.2s, 45 dB],
ISI: 3sec, passive listening

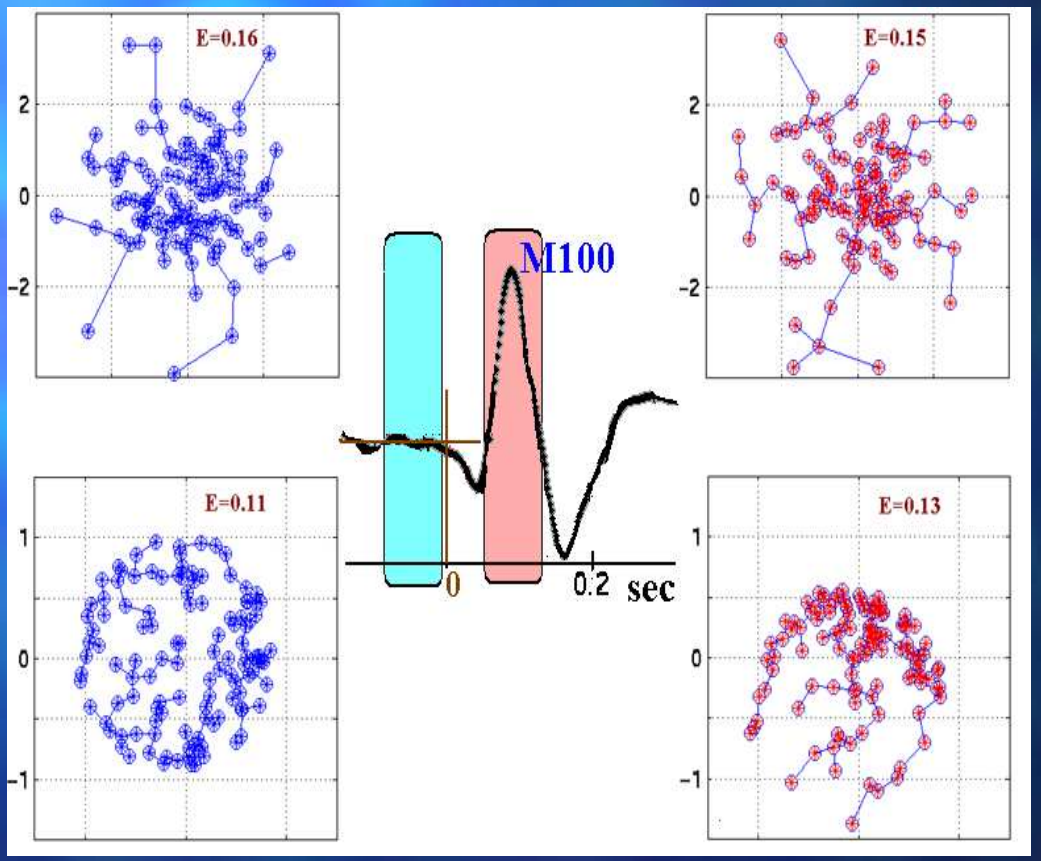


Task : to ‘‘explain’’
the averaged **M100-response**



Amplitude differences

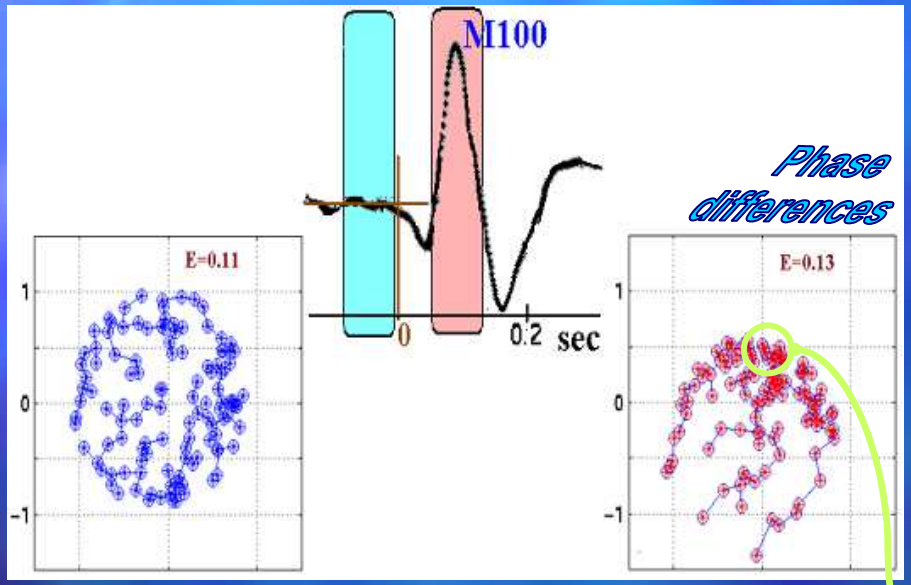
Phase differences

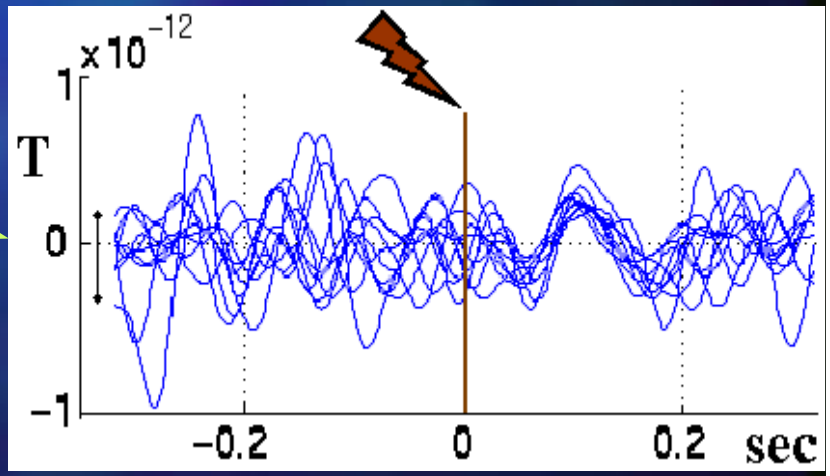


The M100-peak emerges from

the *stimulus-induced phase-resetting*

➢ *Phase reorganization*
of the **ongoing brain waves**





Is there
a more elaborate example?

[Laskaris et al., NeuroImage, 2003]

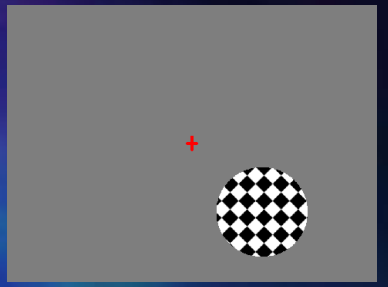
A study of global firing patterns

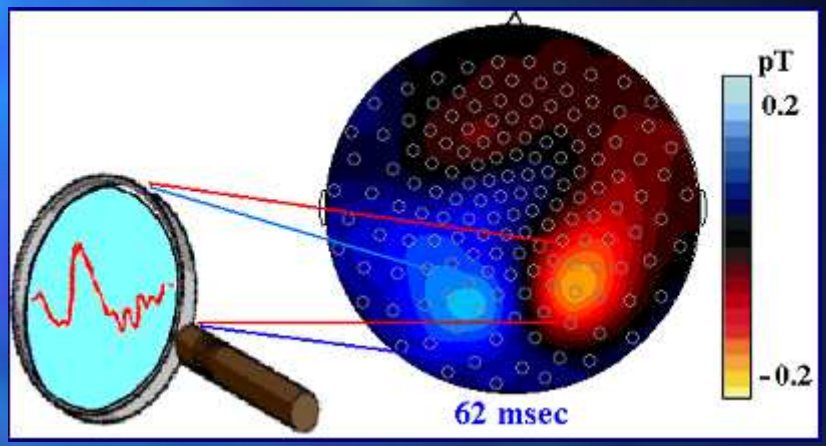
Their relation with localized sources

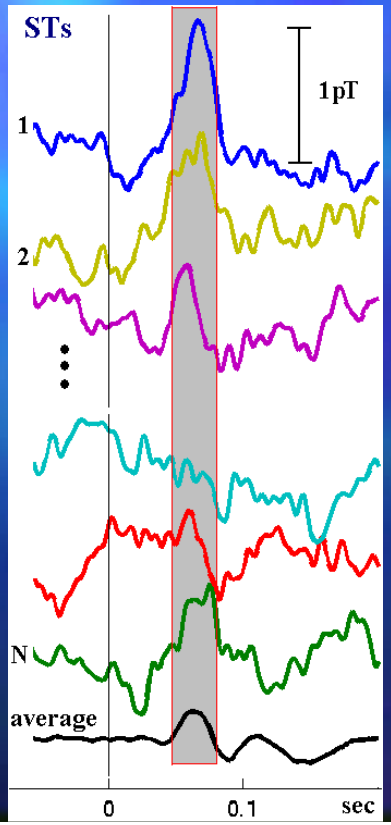
and ....

initiating events

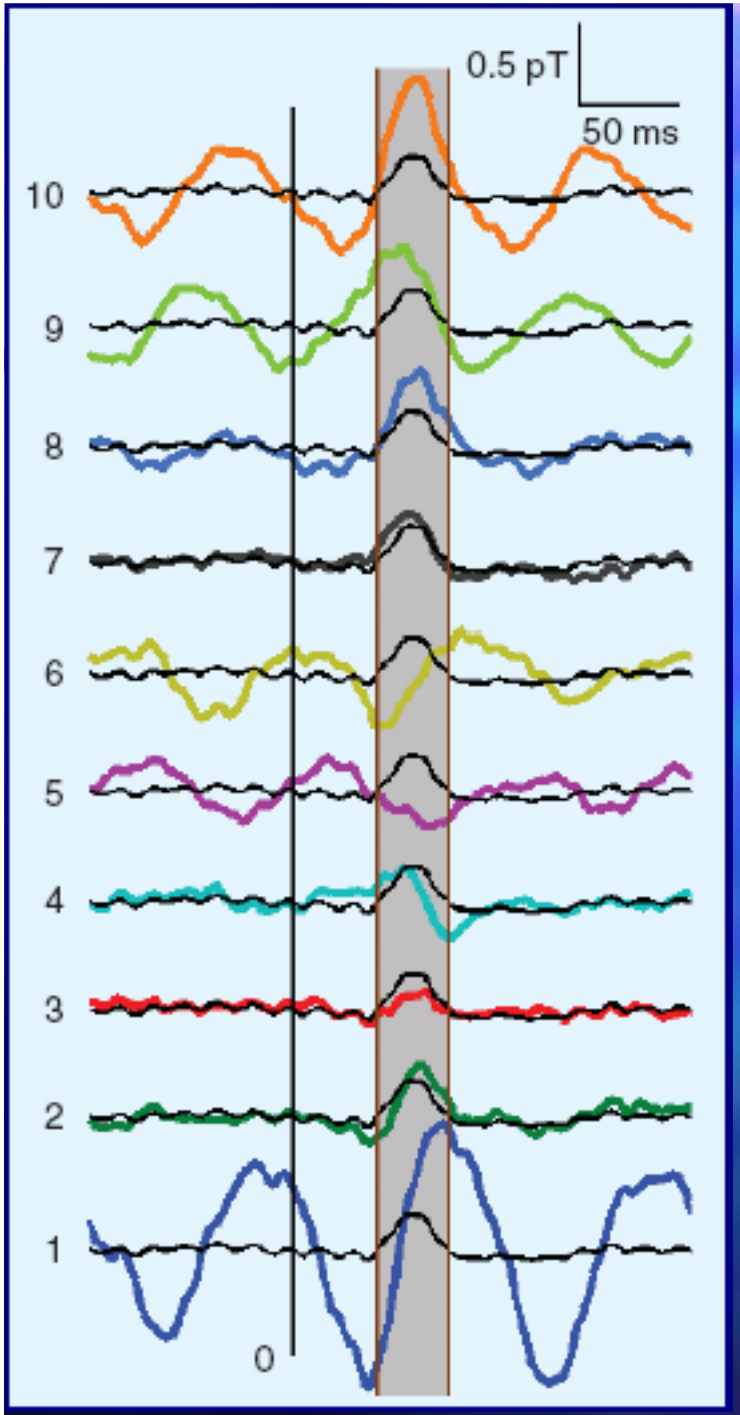
240 trials, pattern reversal,
4.5 deg , ISI: 0.7 sec,
passive viewing

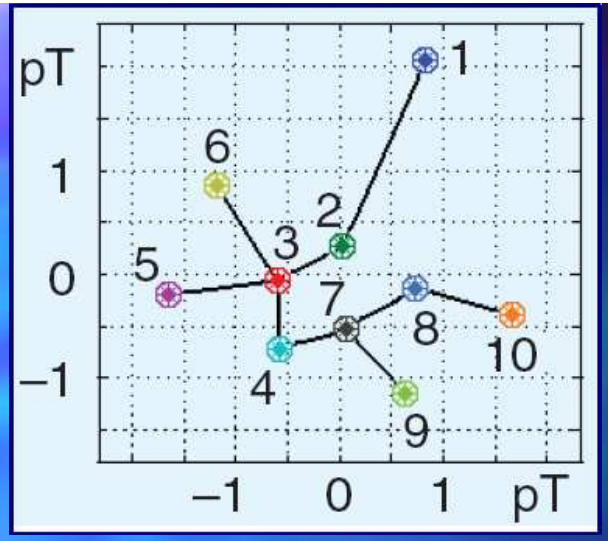




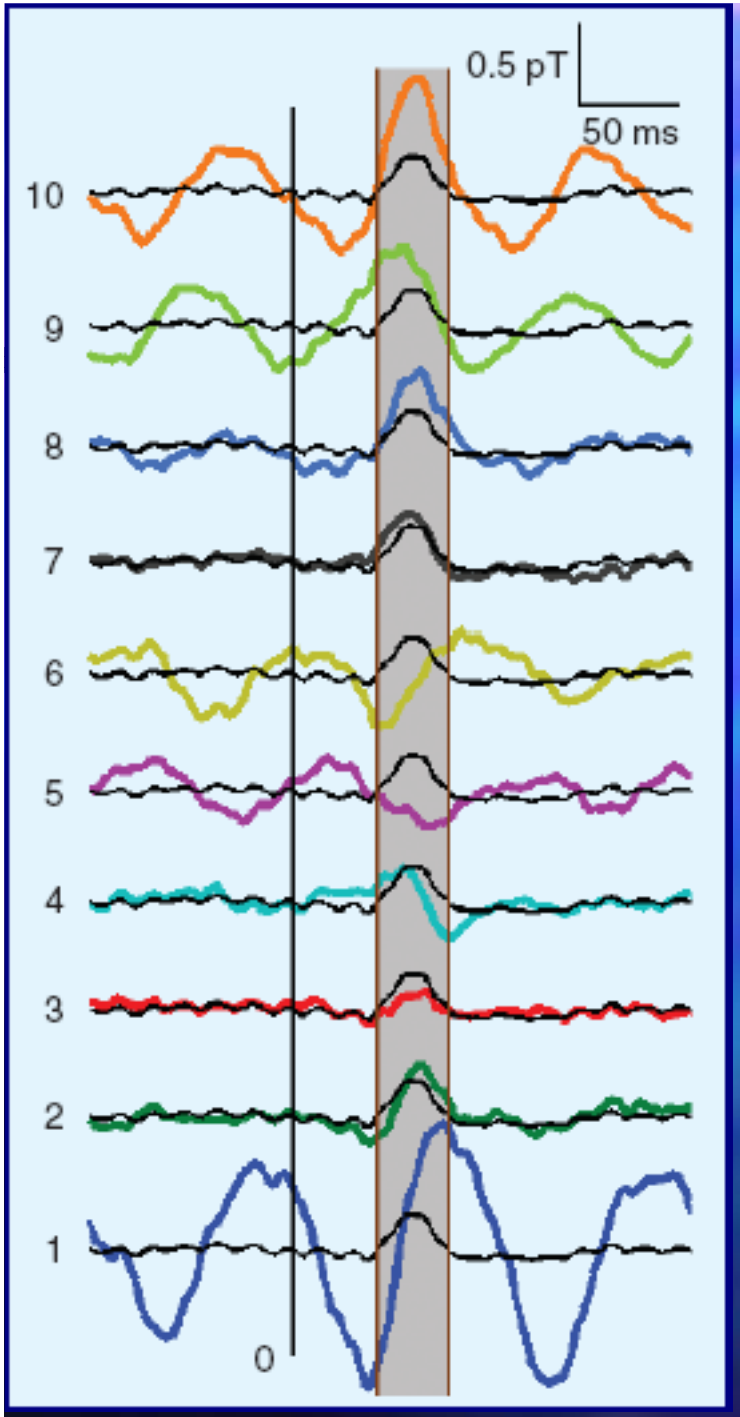


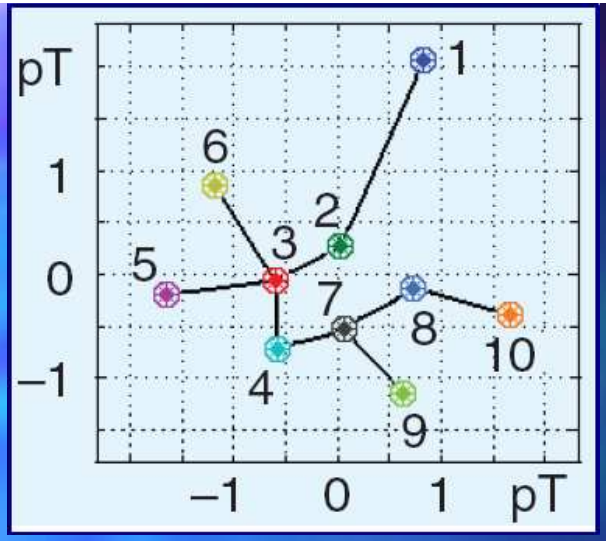
Single-Trial data in unorganized format





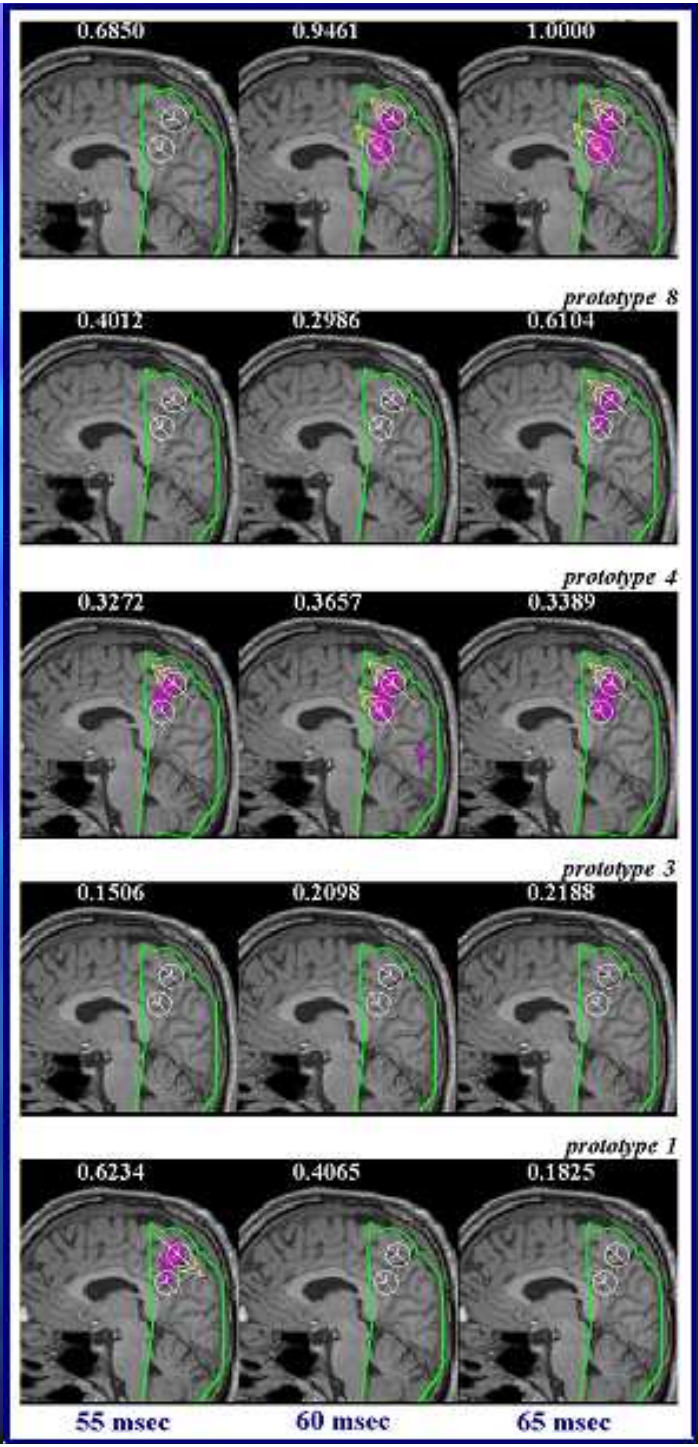
Single-Trial data summarized via ordered prototypes reflecting the variability of regional response dynamics





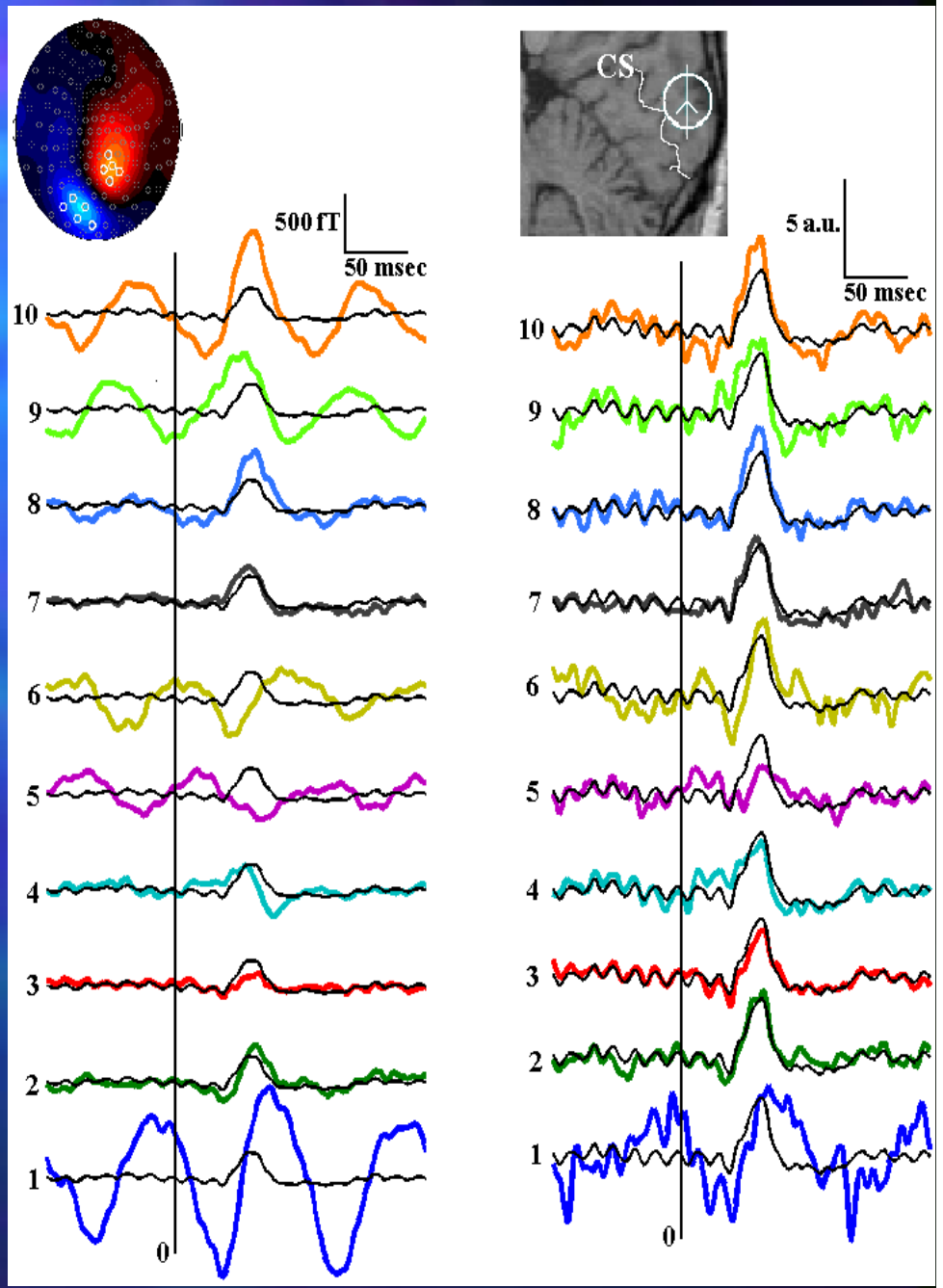
"The ongoing activity before the stimulus-onset is functionally coupled with the subsequent regional response"

Polymodal Parietal Areas BA5 & BA7 are the major sources of the observed variability



Regional vs Local response dynamics :

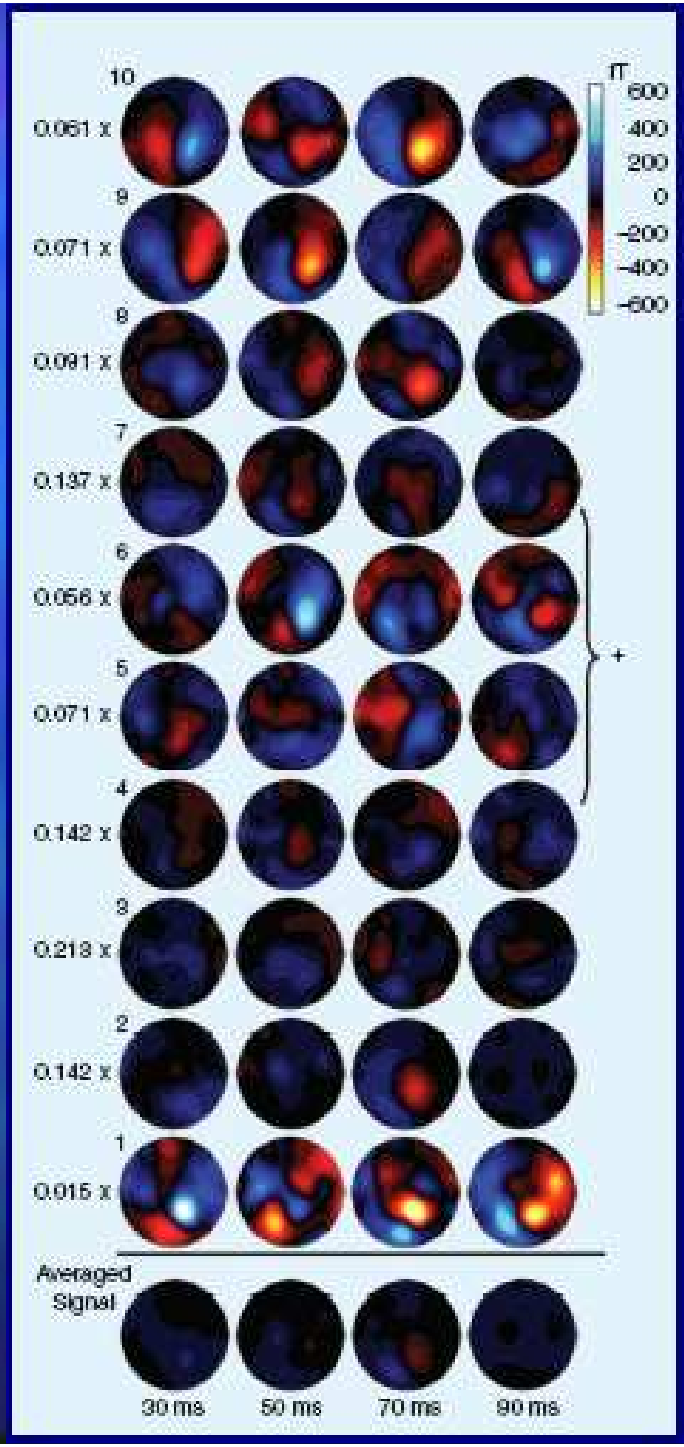
There is relationship between N70m-response variability and activity in early visual areas.



Question 9

What has been the lesson,
so far,
from the analysis
of Event-Related Dynamics ?

The "dangerous" equation




ATHENS 2004

Question 10

Where one can learn more
about ***Mining Information***
from **encephalographic recordings ?**

- **http://www.hbd.brain.riken.jp/**
- **http://www.humanbraindynamics.com**

laskaris@aiia.csd.auth.gr

thank you