

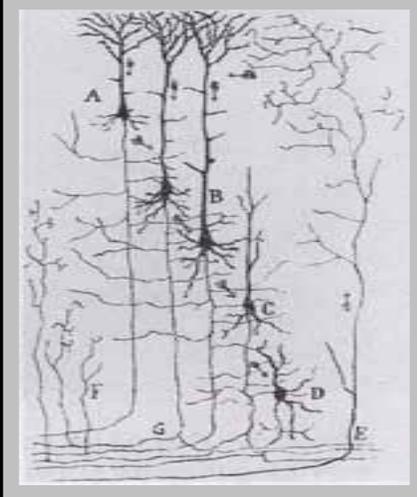
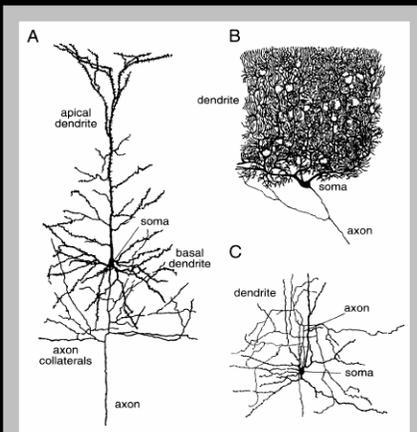
Neuroimaging and Language Processing

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台北榮總教研部整合性腦功能小組

Fundamental brain organization principles



functional specialization

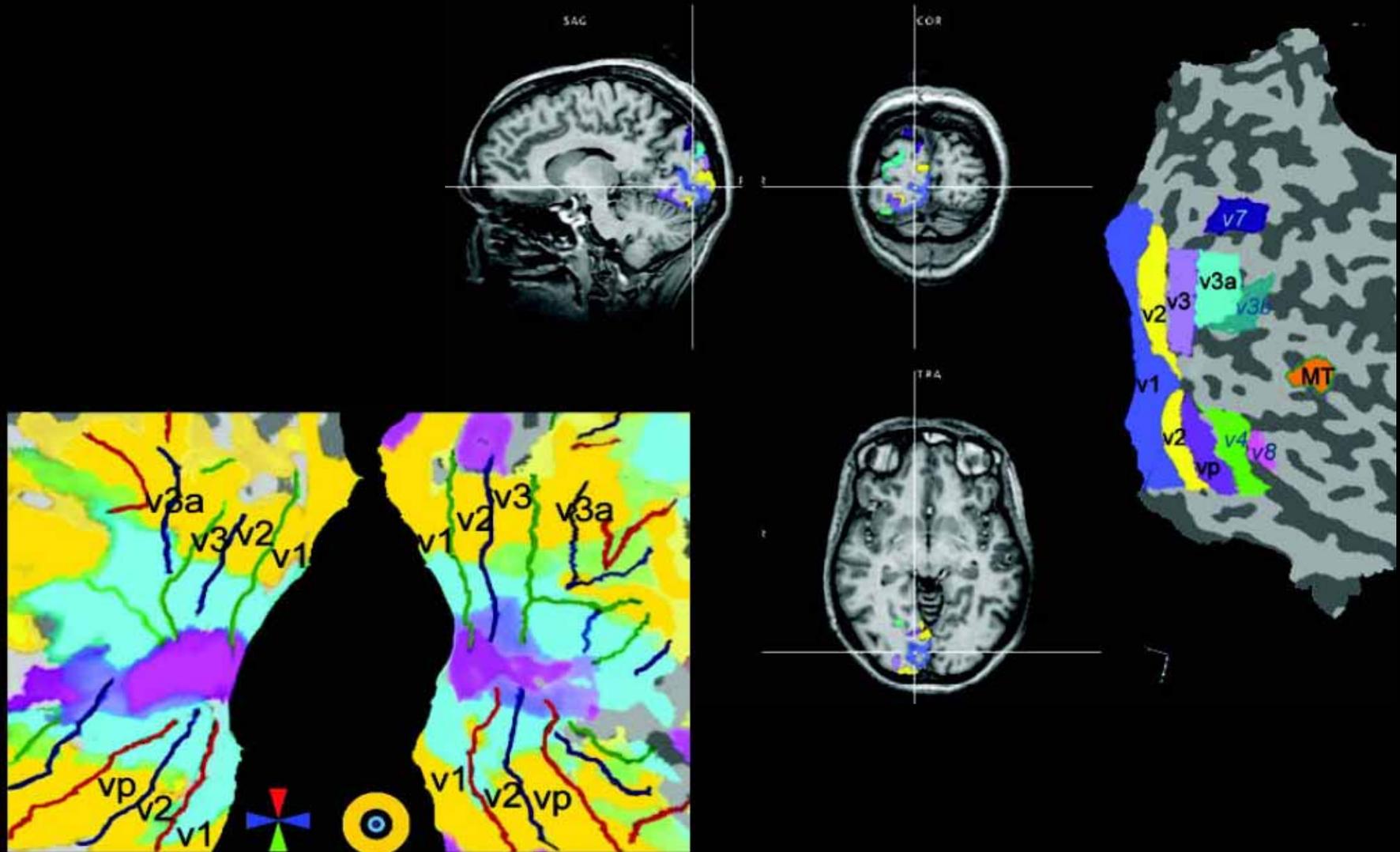
functional integration

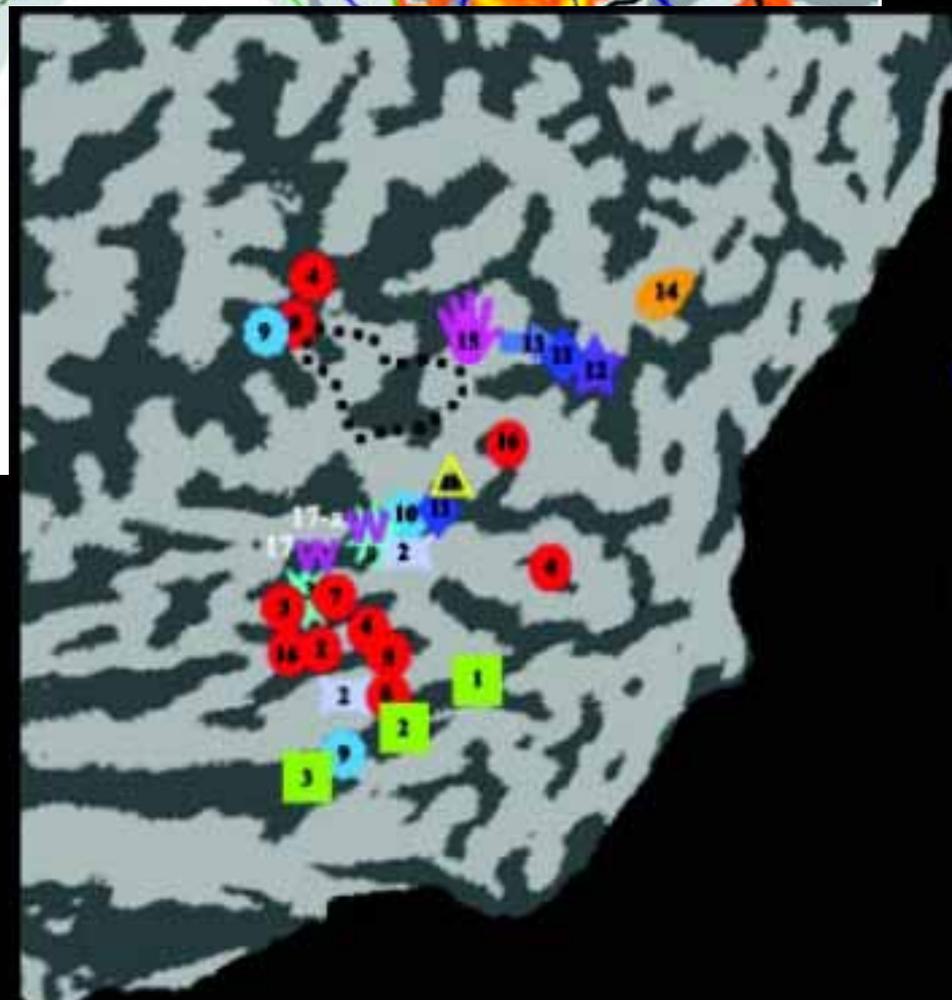
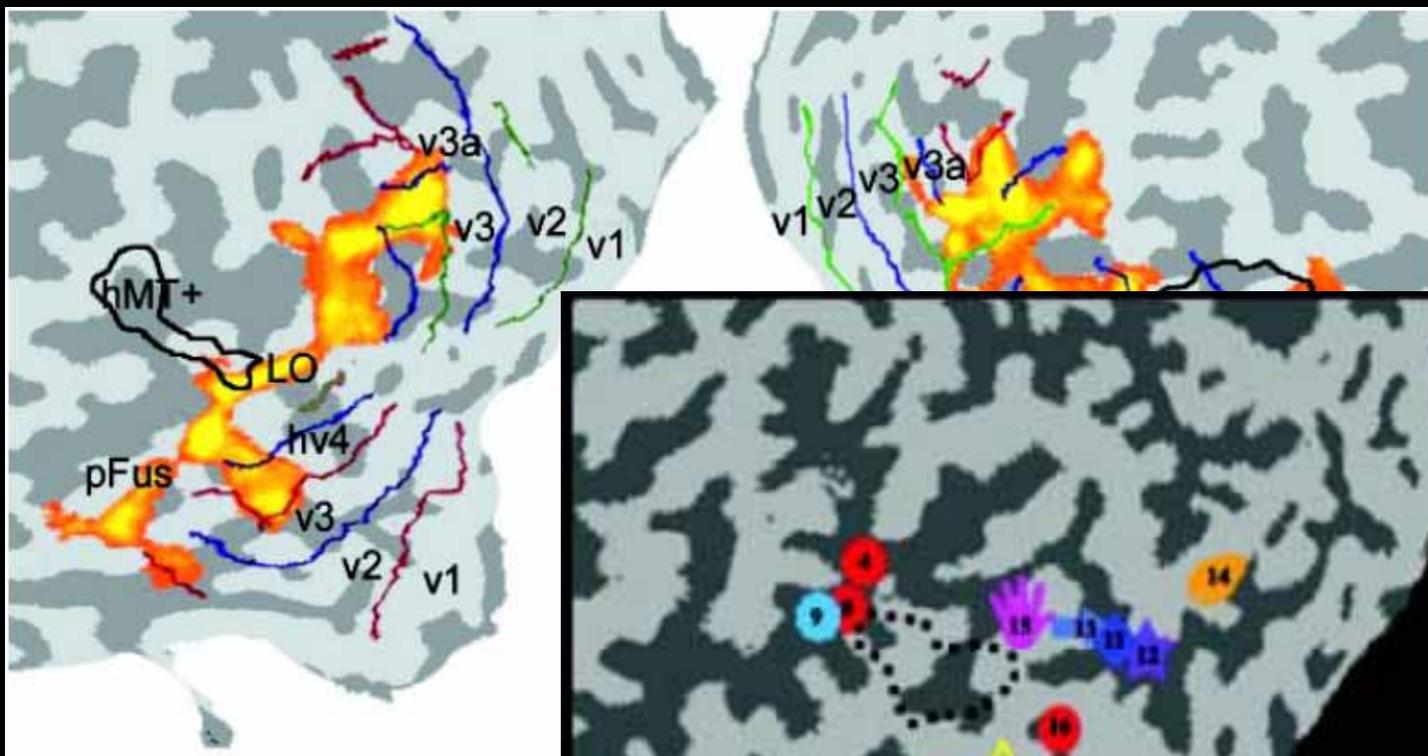
Effective connectivity

patchy connectivity

Functional Organization of the Visual Cortex

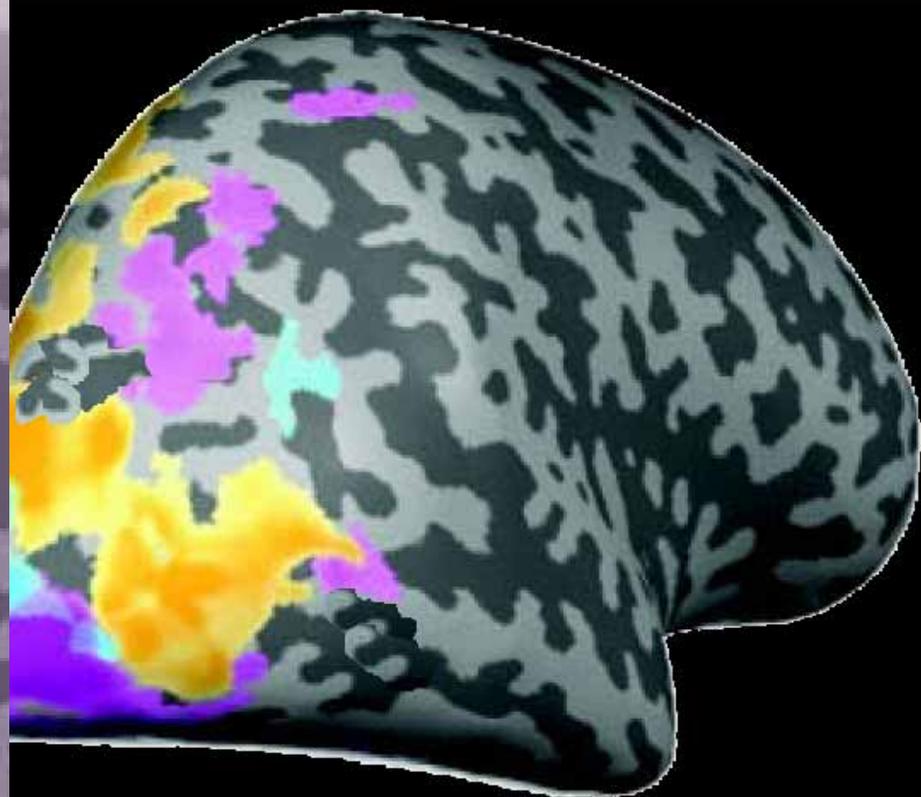
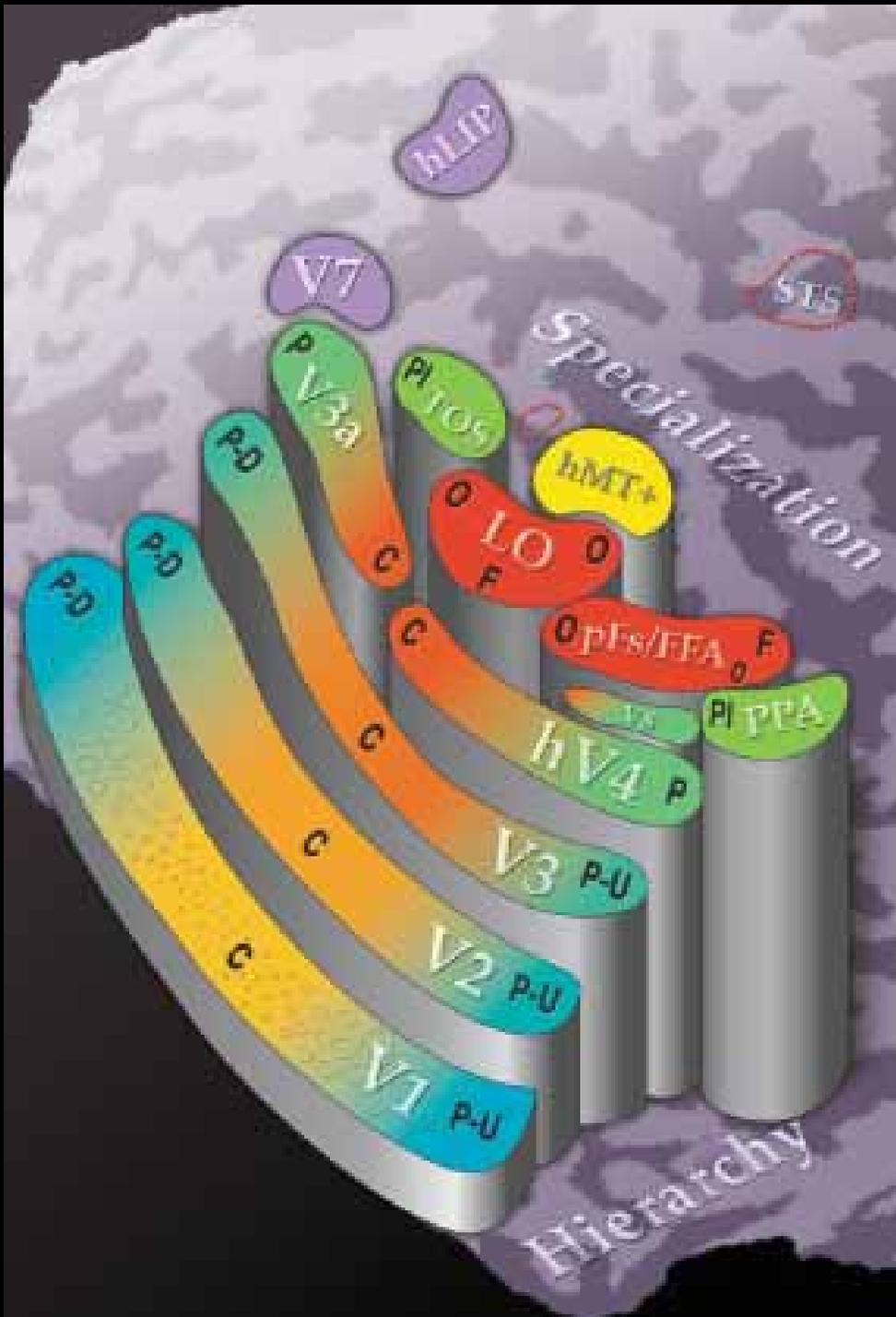
Grill-Spector and Malach,
Annu. Rev. Neurosci. 2004.



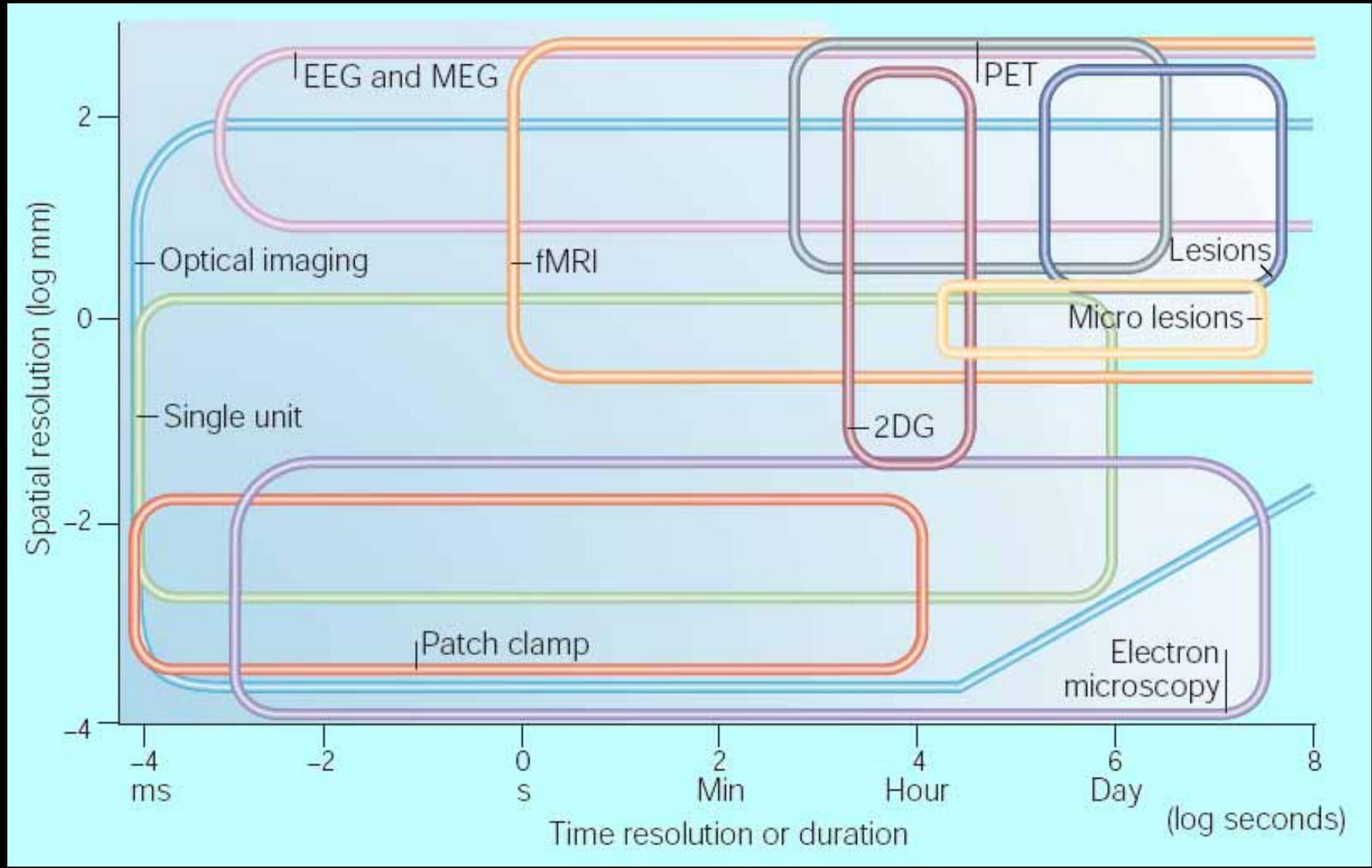


-  Somatosensory
-  Words
-  Illusory contours
-  Motion
-  Body parts
-  Kinetic
-  Animals
-  Objects
-  Chairs
-  Tools
-  Faces
-  Buildings

Anterior ← → Posterior



Modern Imaging Techniques



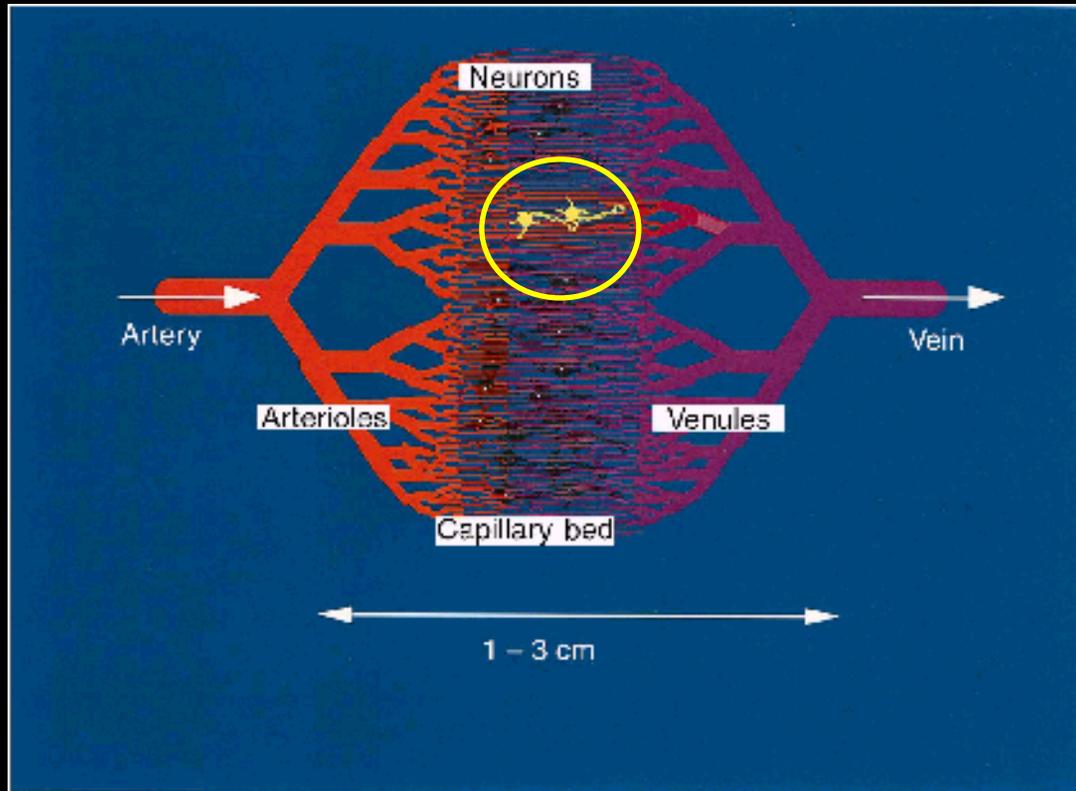
Modern Imaging Techniques

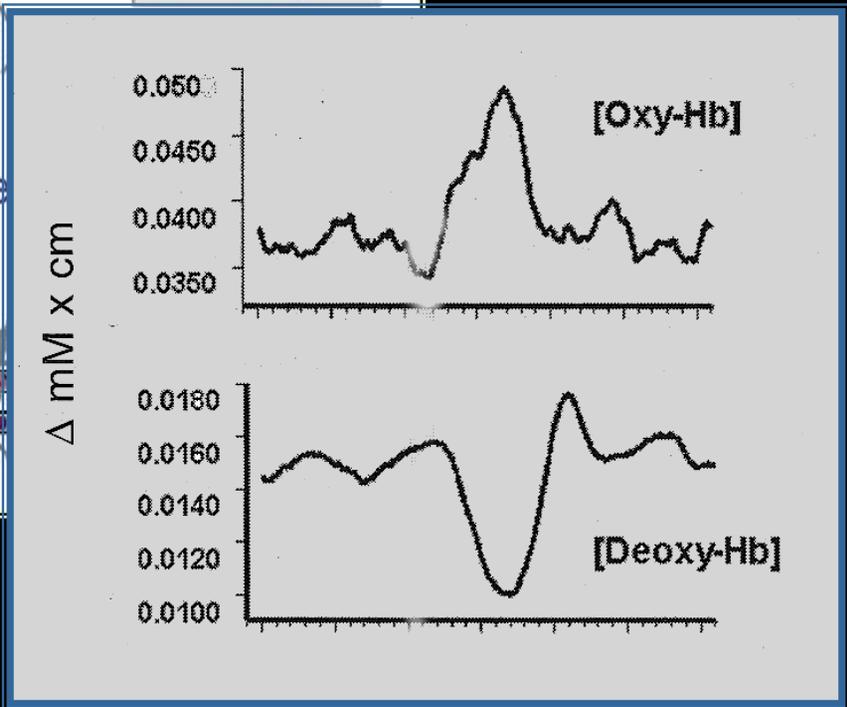
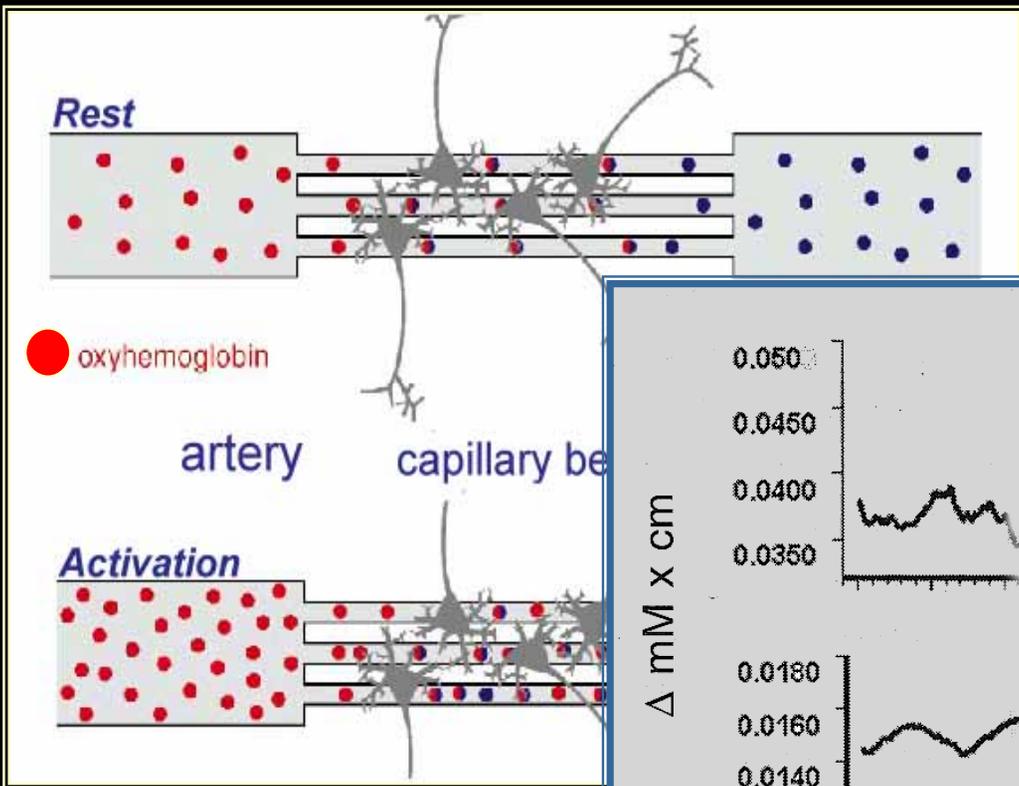
	Measuring principles	Spatial	Temporal
<i>fMRI</i>	Subject is exposed to a high static magnetic field and a small alternating radiofrequency field. Magnetic resonance signals produced by the hydrogen nuclei in different tissues are measured, either to create an image of the anatomical structures (conventional MRI) or to monitor changes related to brain metabolism and blood flow (fMRI).	<i>millimeter</i>	<i>milliseconds</i>
PET	Radioactive markers are injected into the subject's bloodstream to monitor changes in brain metabolism, blood flow or the distribution of receptors for different chemical transmitters. The radioactive substances emit positrons that hit electrons after traveling very short distances. Each collision produces two annihilation photons that are detected by cameras placed around the head.	<i>millimeters</i>	<i>seconds</i>
<i>MEG</i>	Measures tiny magnetic field produced by electrical currents in the brain via superconducting quantum interference devices (SQUIDs) placed in around the brain. The currents can be determined via mathematical modeling.	<i>millimeters</i>	<i>millisecond</i>
EEG	Electrodes placed on the scalp measure the same neuronal currents as MEG, in theory. But since the electric-potential distribution is destroyed by the skull, the scalp and other tissues that have electrical conductivities that differ from those in the brain itself, EEG is better at detecting currents that originate deep inside the brain or are radially oriented.	<i>centimeters</i>	<i>millisecond</i>

fMRI

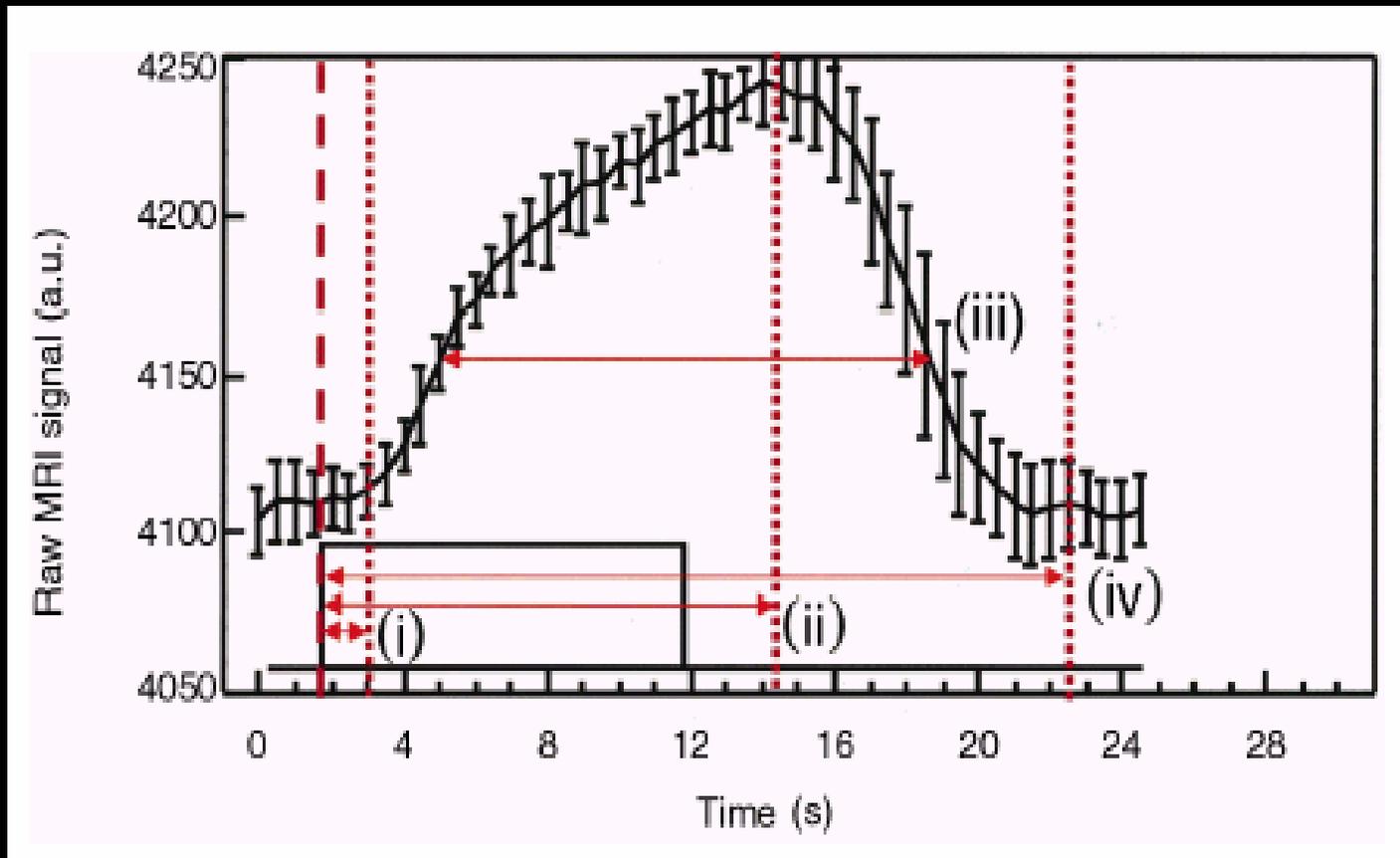


What is *fMRI* measuring ?

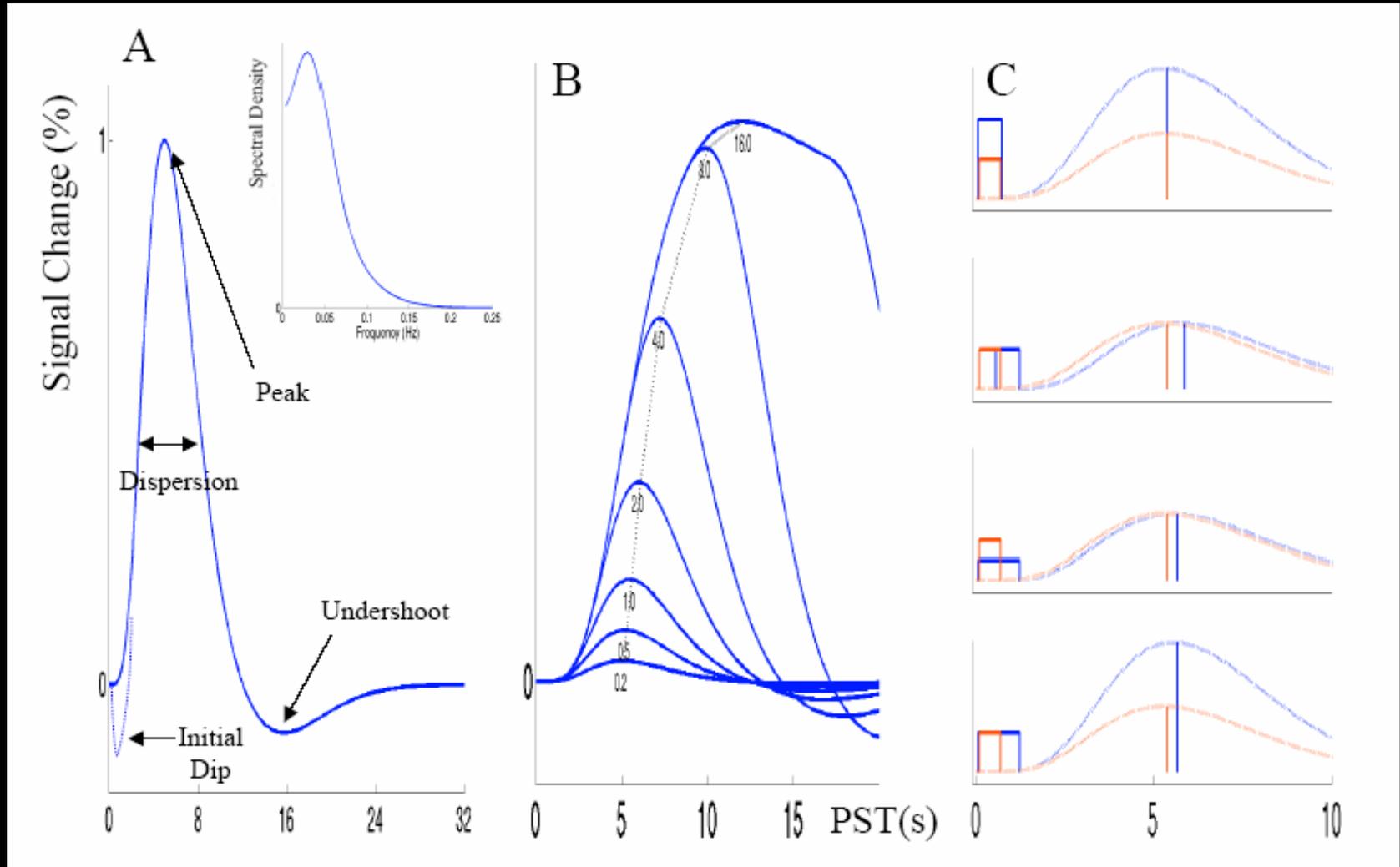




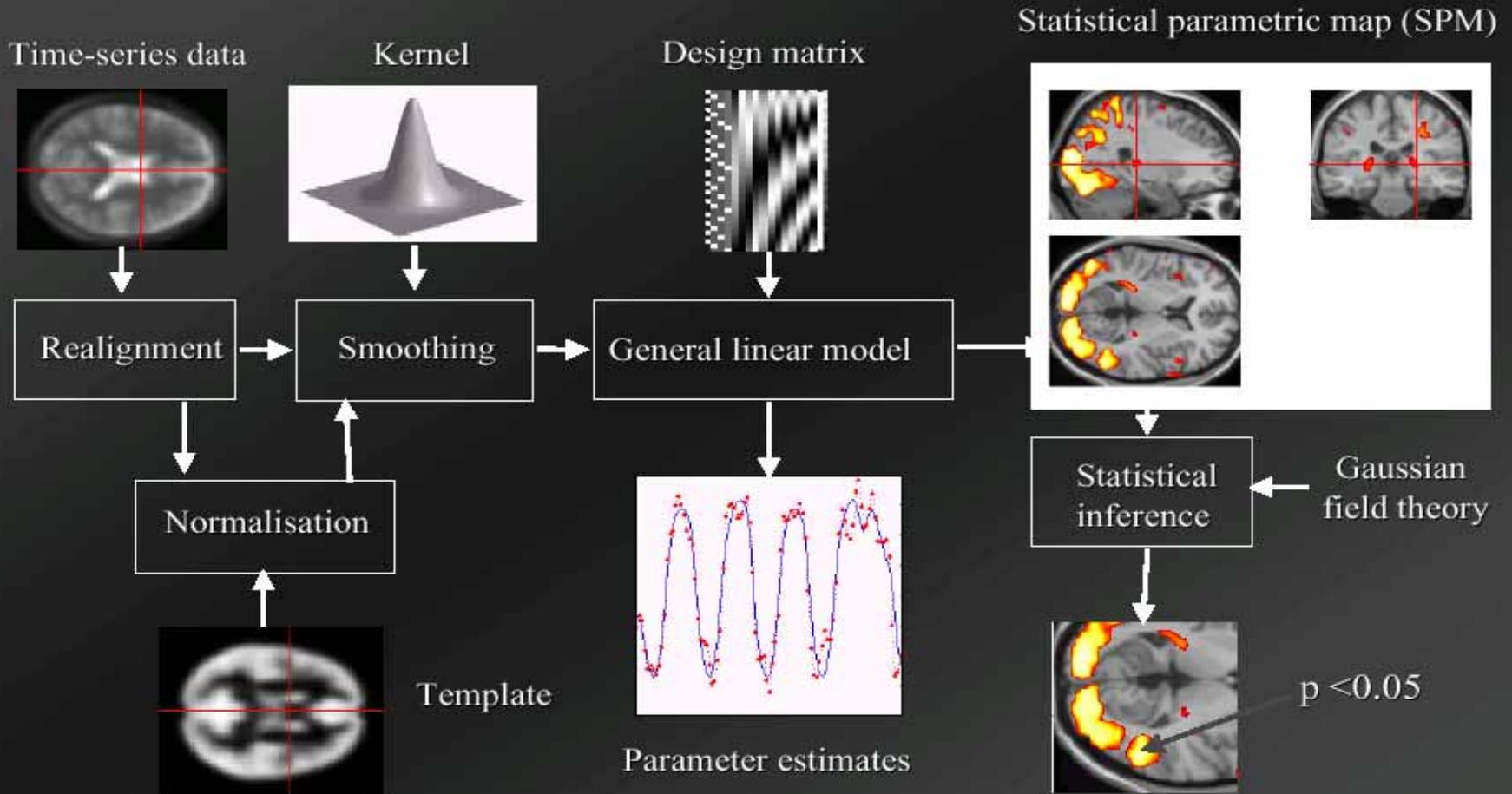
BOLD Signal of Hemodynamic Response



Parameterization of the BOLD signal



Data transformations

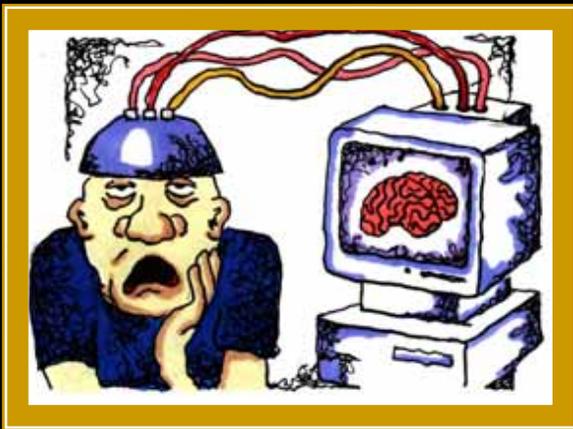


Example 1

An fMRI Study of Picture and Word Naming

Example 2

fMRI of Character, Face, and Object in the Ventral Visual Cortex



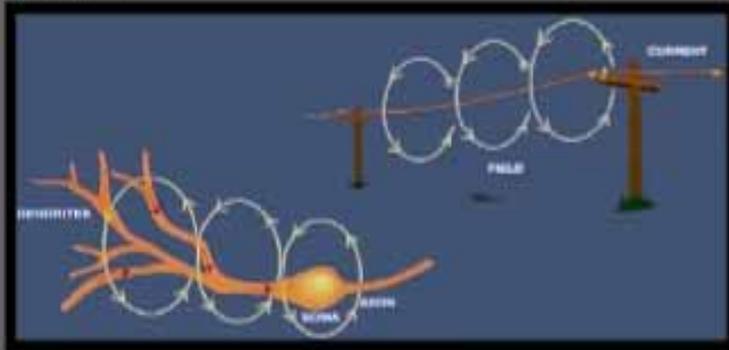
What is functional magnetic imaging (fMRI) ?

What can functional magnetic imaging (fMRI) tell us ?

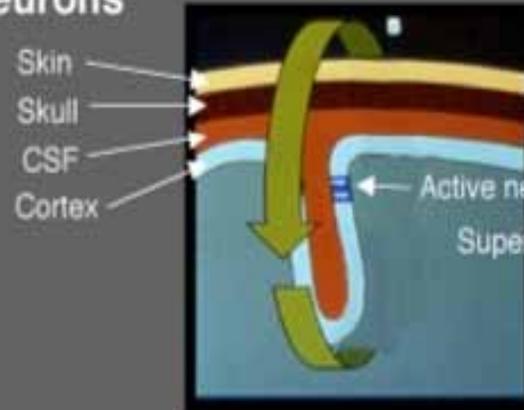
Should I use functional magnetic imaging (fMRI) ?

MEG

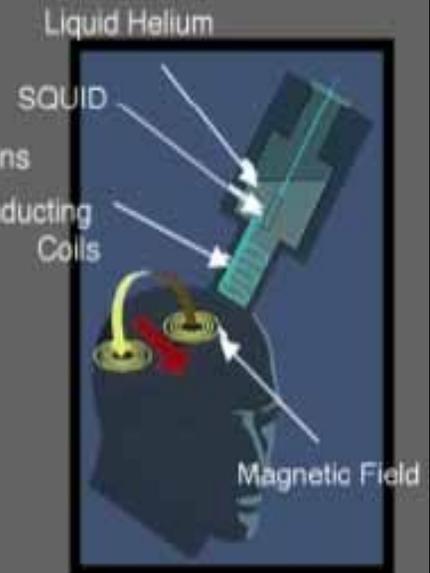
Sources of Magnetic Fields



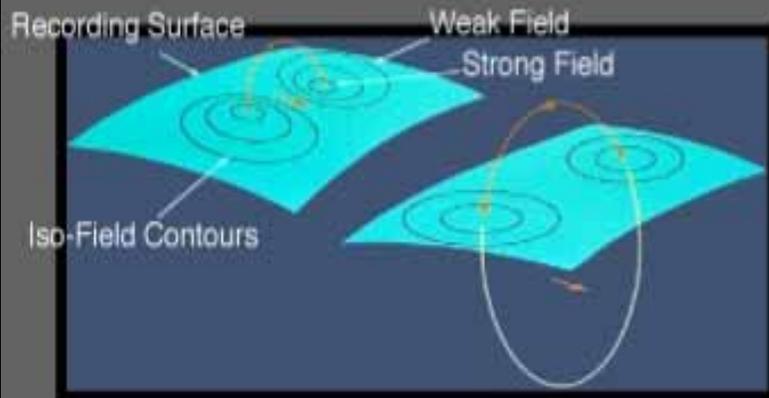
Orientation of Neurons



Detection Device



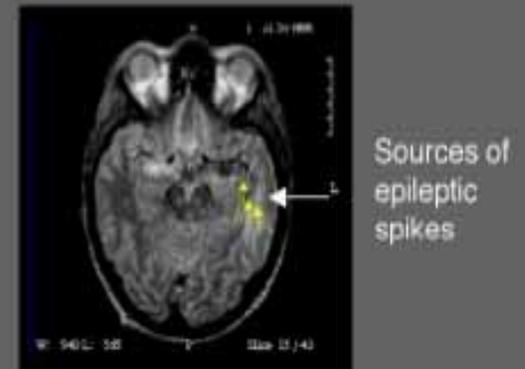
Magnetic Field Pattern



Model



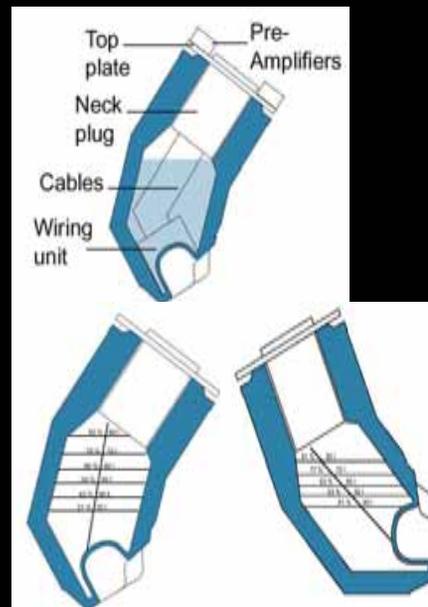
Result



Magnetic Shielding Room



Dewar



SQUID sensors



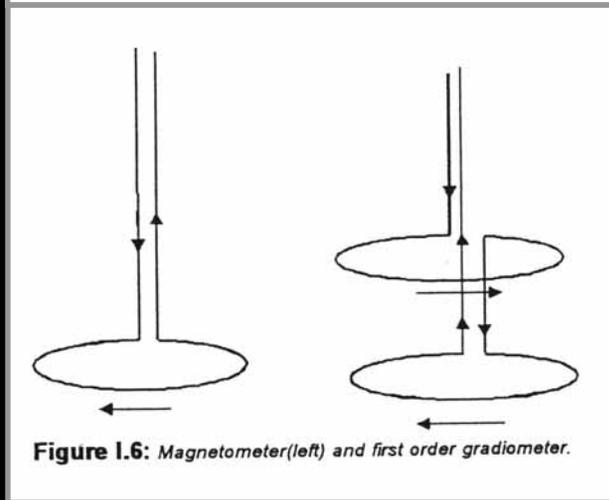
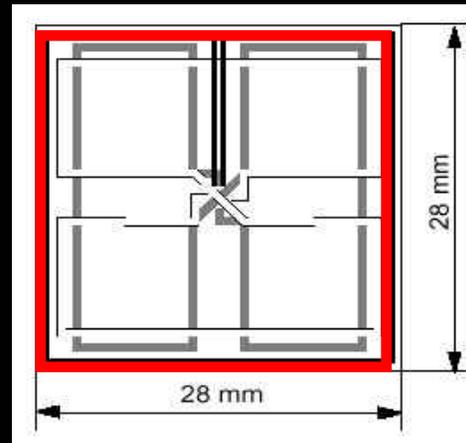
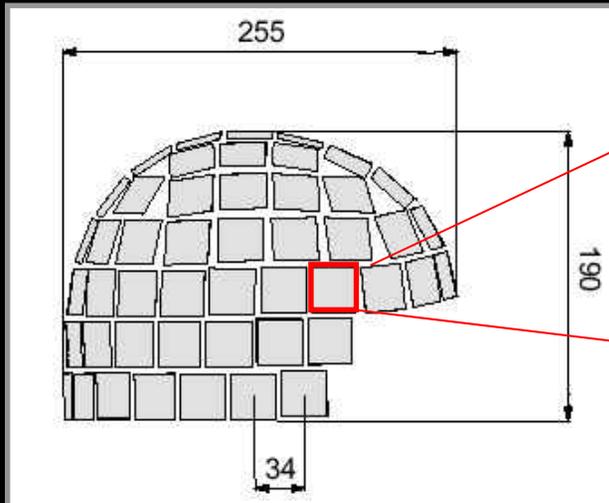
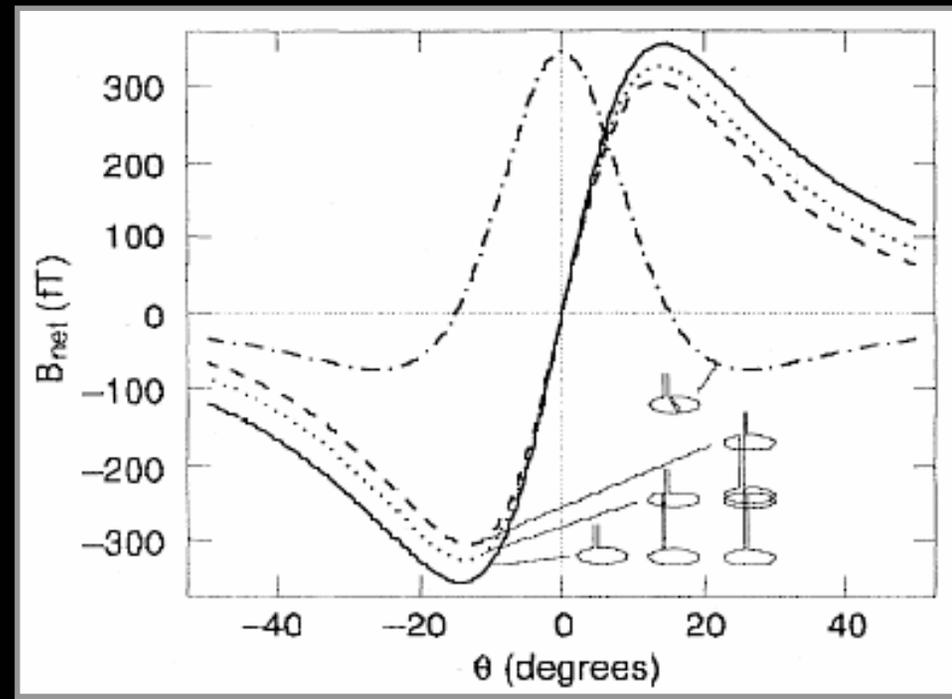


Figure I.6: Magnetometer(left) and first order gradiometer.



- ❖ Forward problem (unique solution):
 - ❖ Input: the positions, the amplitude and the orientations of the source current dipoles
 - ❖ Output: to estimate the measured data from MEG sensors
- ❖ Inverse problem (non-unique solution):
 - ❖ Input: a set of measured data
 - ❖ Output: to estimate the parameters representing the source current dipoles, including positions, the amplitude and the orientations

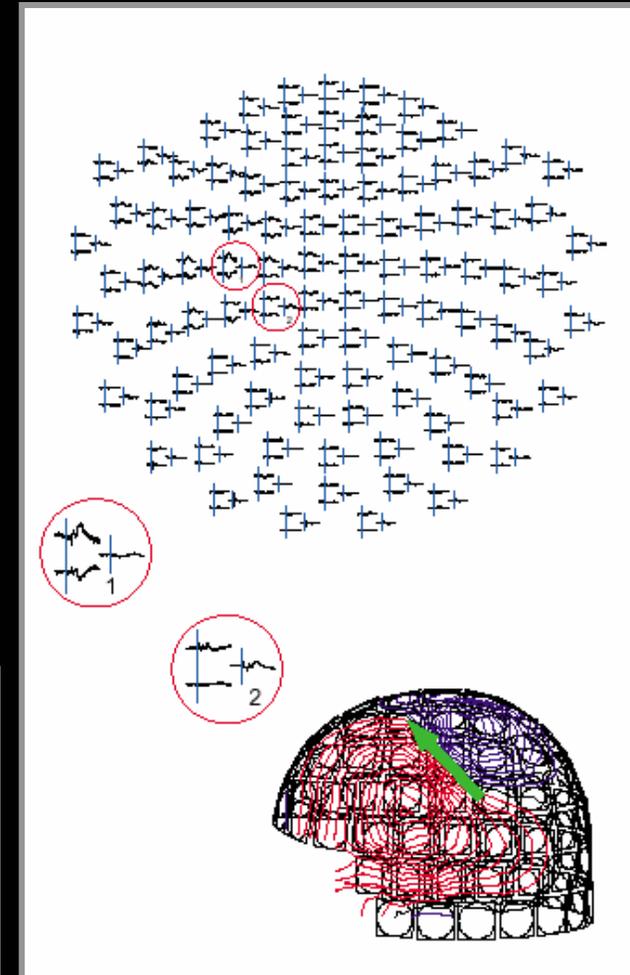
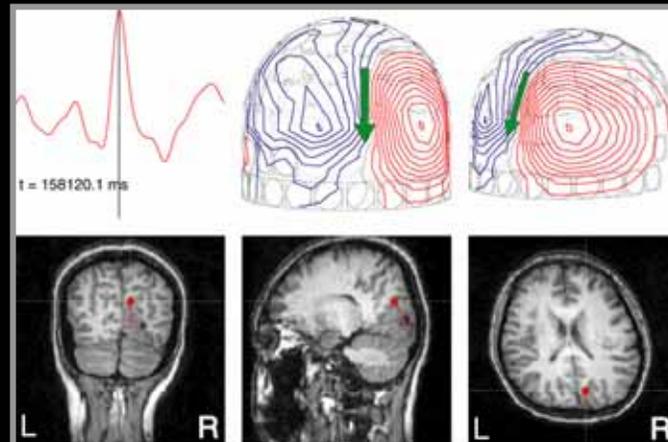
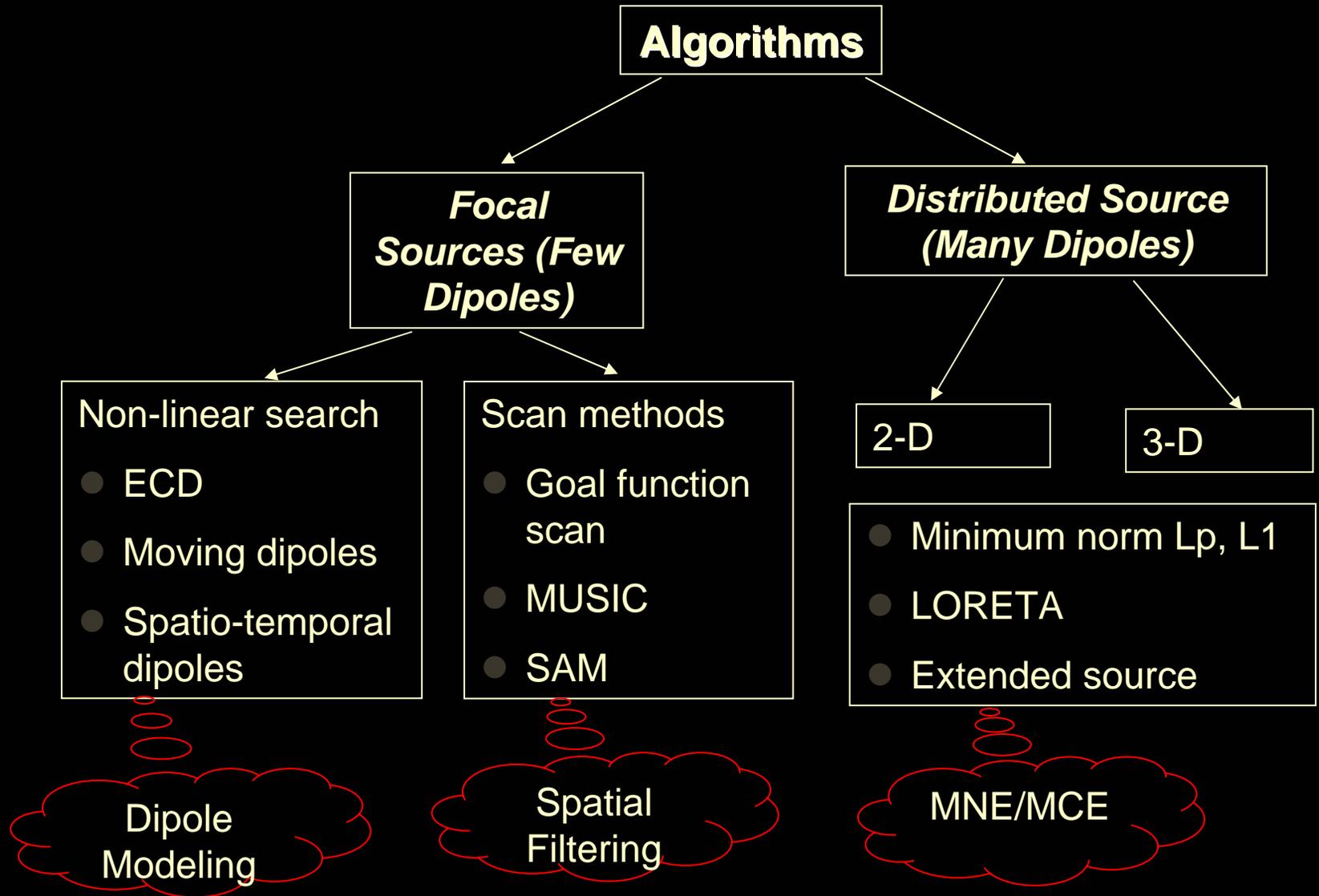


Figure 4. Somatosensory evoked field measurement. The subject was stimulated using 0.2 ms constant-current pulses. The inter stimulus interval (ISI) is 2 s, and the number of averages is 200.



Example 3

An MEG Study of Word Naming

*In Search of “**WHERE**”
and “**WHEN**” for
Chinese Language
Processing in the Brain*