

Neurociencia de Sistemas

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Francis Crick (1916-2004)

"... 'You', your joy and your sorrows, your memories and your ambitions, your sense of personal identity and free will, are in fact no more than the behaviour of a vast assembly of nerve cells and their associated molecules."

Francis Crick, *The Astonishing Hypothesis*.

Main research areas

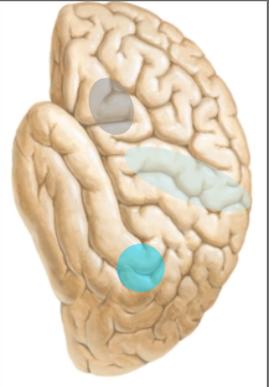
- I - Recordings in epileptic patients**
 How are concepts represented in the human brain?
 IV - Neuroprosthetics
 Can implanted devices sense cognitive devices with the brain?
- II - Advanced processing of neural data**
 How can we optimise data processing methods to add in more information from neural data?
 V - EEG & Eye tracking
 How can we link non-invasive perception and memory processing?
- III - Art & Science**
 Can we combine knowledge from arts and neuroscience?
 VI - Animal recordings
 Do animals have conscious representations of themselves?

Cracking the neural code!

Neurociencia de Sistemas

- Modelado
- Analisis de seniales
- Experimentos (Neurofisiologia)

Are functions localized?

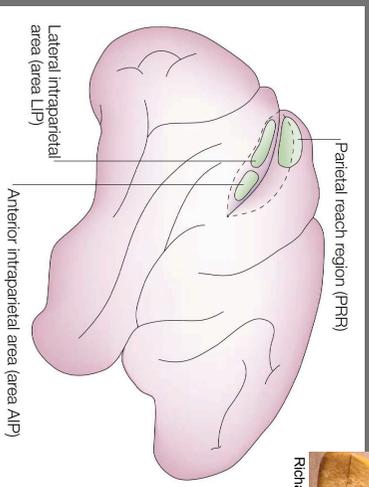


Broca's area: Speech

Wernicke's area: Language understanding

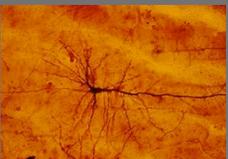
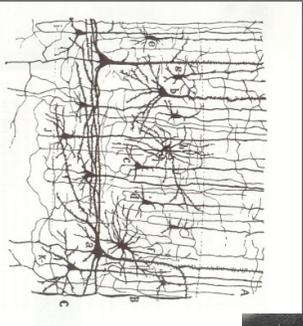
Motor areas (Jackson)

Movement planning areas

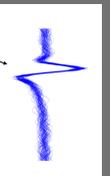


Richard Andersen

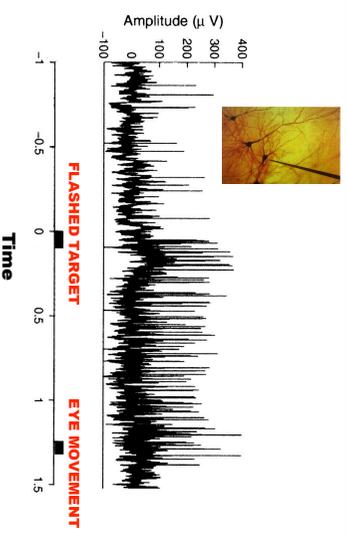
Ramon y Cajal



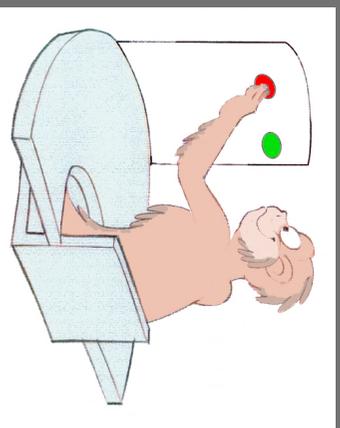
Extracellular recordings



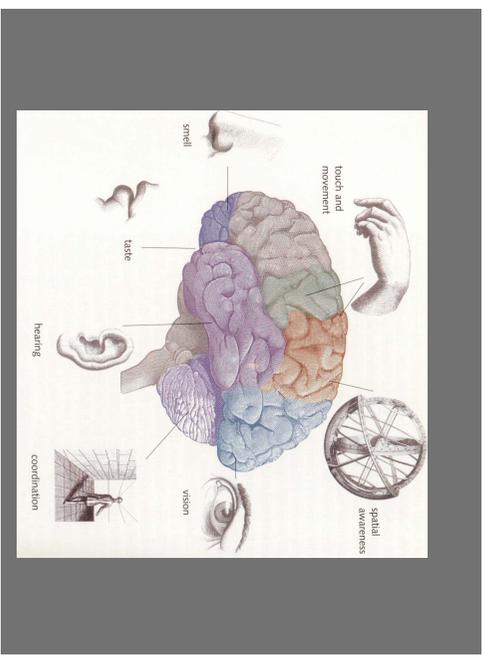
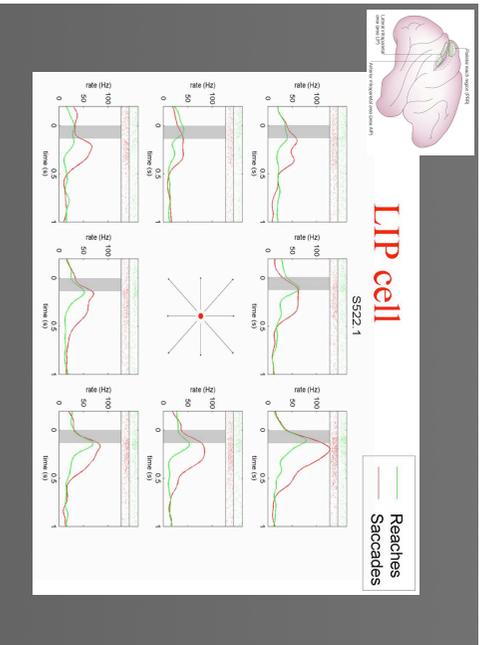
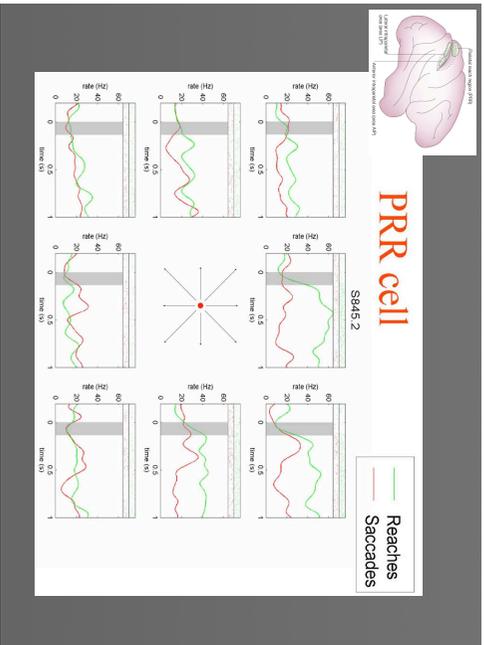
Recorded activity for an eye movement to a briefly flashed target.



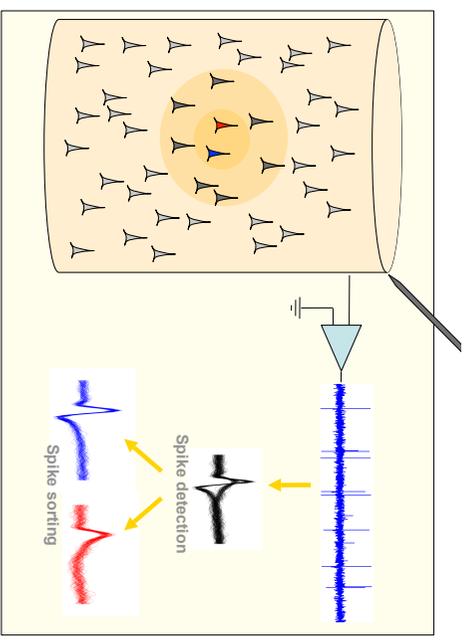
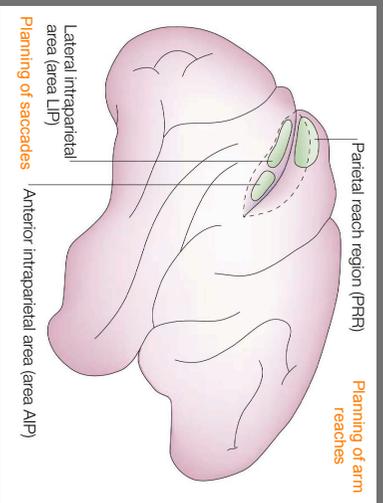
Monkey does reaches and saccades



Adapted from www.wis.caletech.edu

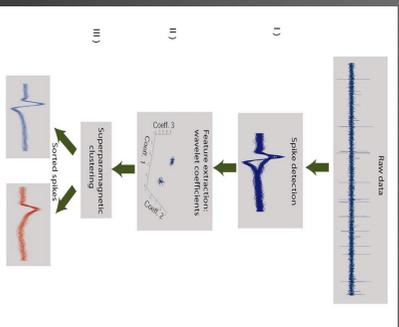


Movement planning areas



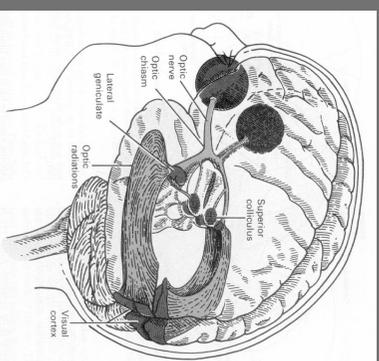
Spike sorting?

Wave_clus



Neural Computation 2004

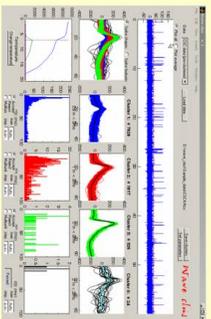
Visual pathway



Wave_clus

Unsupervised spike detection and sorting

© Rodrigo Quijano-Quesada (2004)



Introduction (click .add) Tutorial (click .add) Talk (click .add) Reference (click .add)

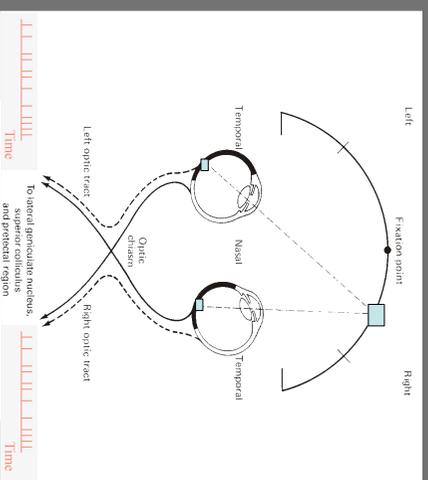
Download code (click .add)

Download data (click .add)

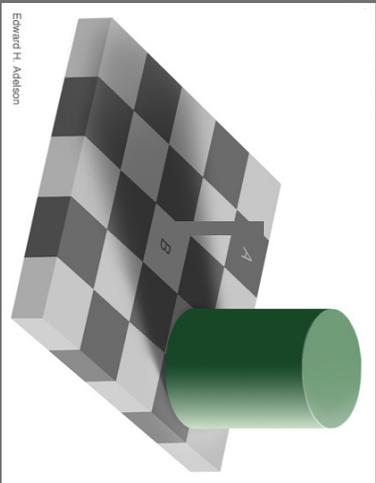
Download Matlab (function) data (click .add)

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Visual perception



Visual illusion

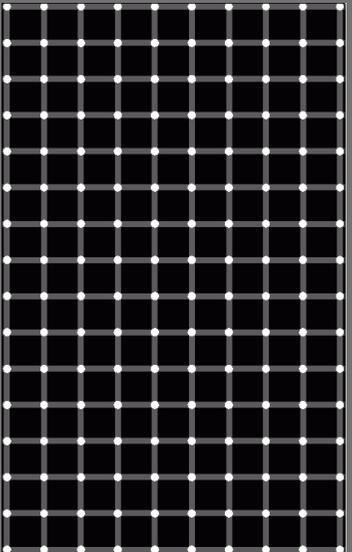


Edward H. Adelson

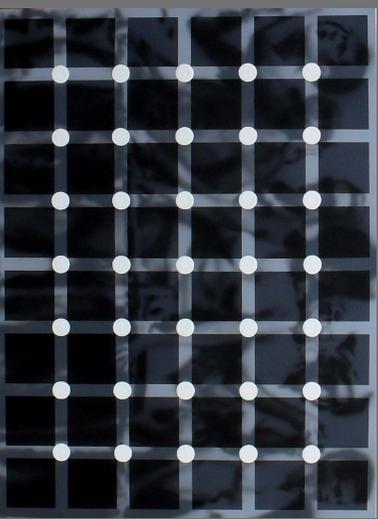
Scintillating grid illusion



Scintillating grid illusion

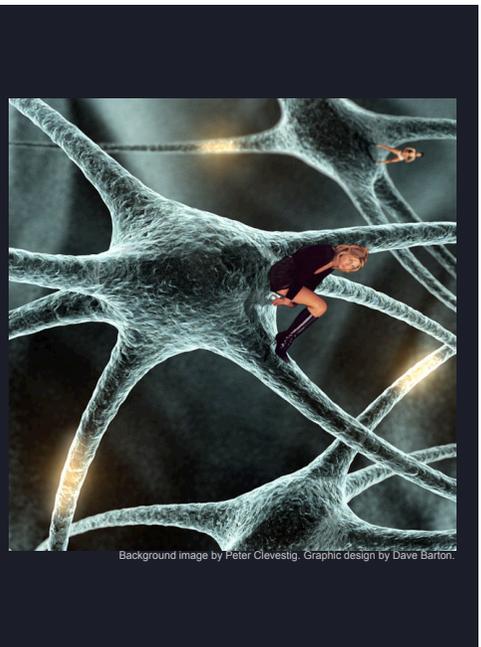
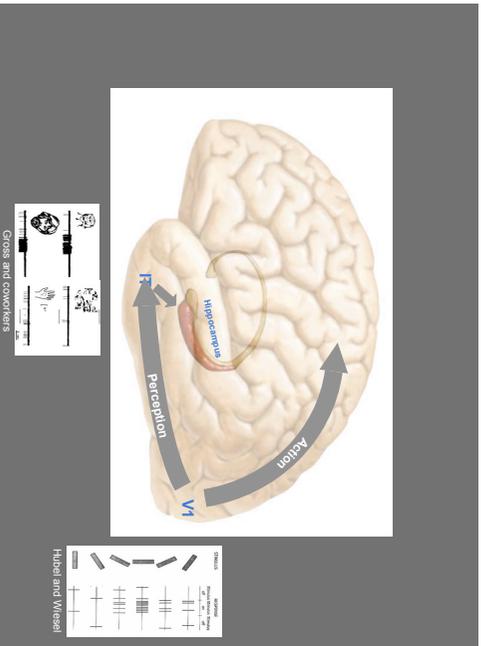


Scintillating grid illusion



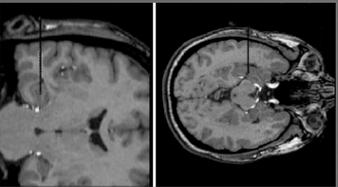
Perception



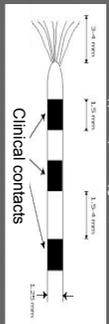


Single cell recordings in humans

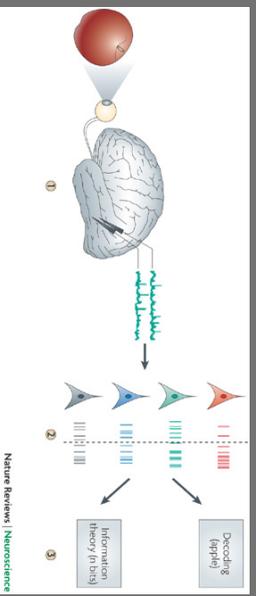
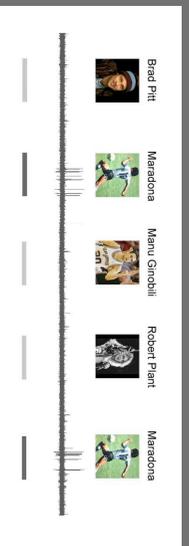
MRI

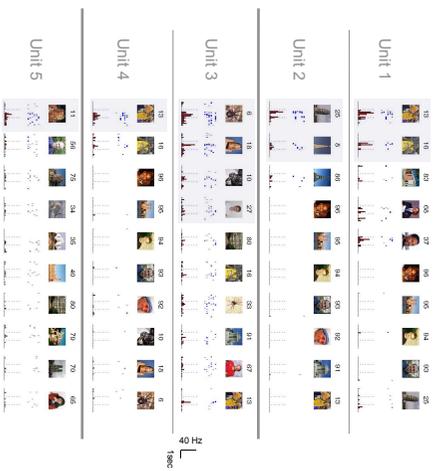


- Subjects:
 - Epileptic patients, candidates for epilepsy surgery
- Recordings:
 - 64 microwires able to record single-neurons and LFPs
 - In hippocampus, amygdala, entorhinal cortex

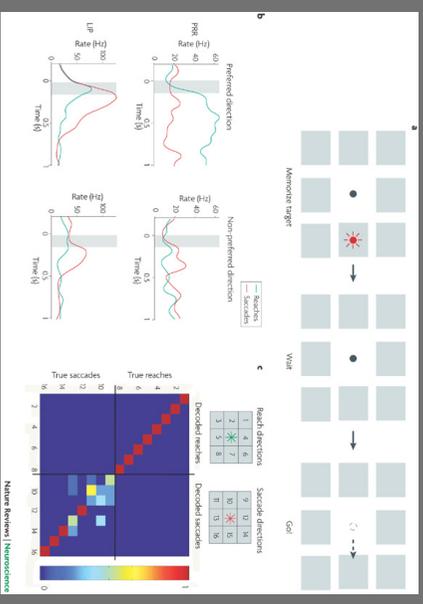
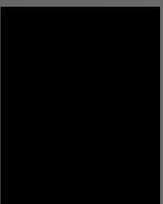
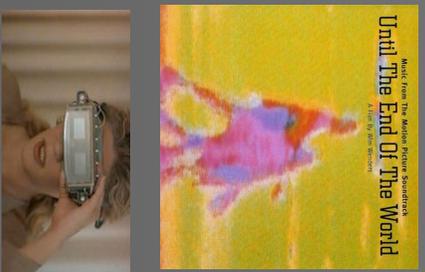


Decoding

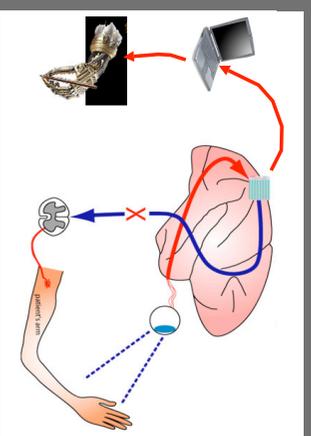




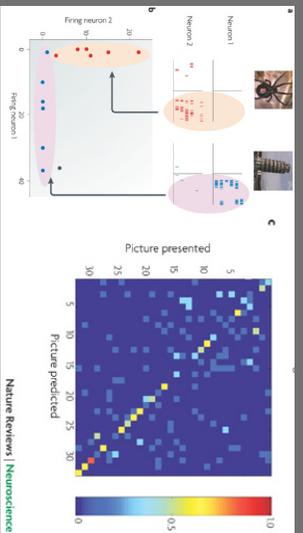
J. Neurophysiology, 2007



Neural Prosthesis



Adapted from www.its.caltech.edu



Nature Reviews | Neuroscience





From Andy Schwartz' lab

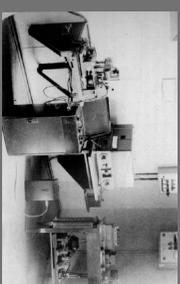
Neurociencia de Sistemas

- Clase 1. Introducción
- Clase 2. Registros extracelulares y Spike sorting.
- Clase 3. Procesado de información visual.
- Clase 4. Percepción y memoria.
- Clase 5. Decodificación - Teoría de la información.
- Clase 6. Electroencefalografía - Análisis de tiempo-frecuencia y Wavelets.
- Clase 7. Potenciales evocados - Análisis de ensayo único.

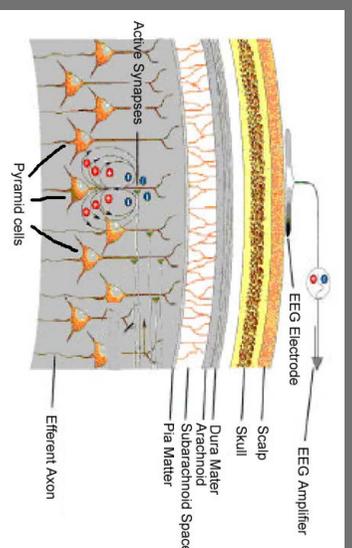
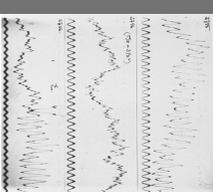
Electroencephalography (EEG)



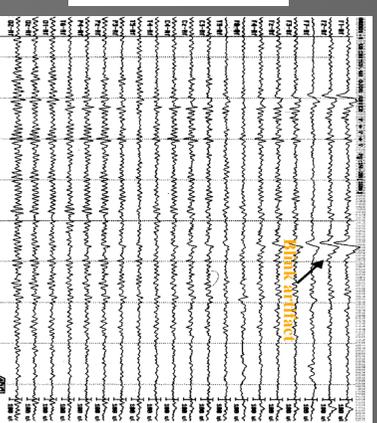
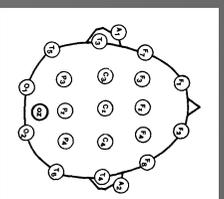
Hans Berger (1873-1941)



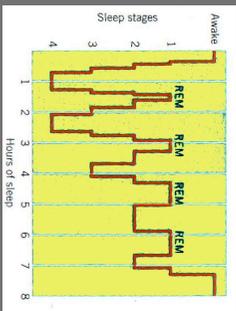
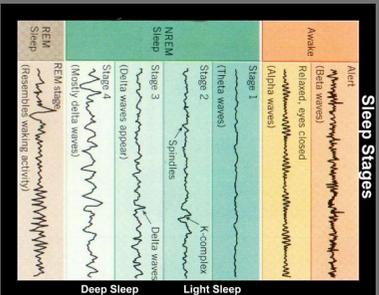
Über das Elektroenzephalogramm des Menschen.
 Von
 Professor Dr. Hans Berger, Bonn.
 (Abgebildet in der Zeitschrift
 1929, S. 203-210.)



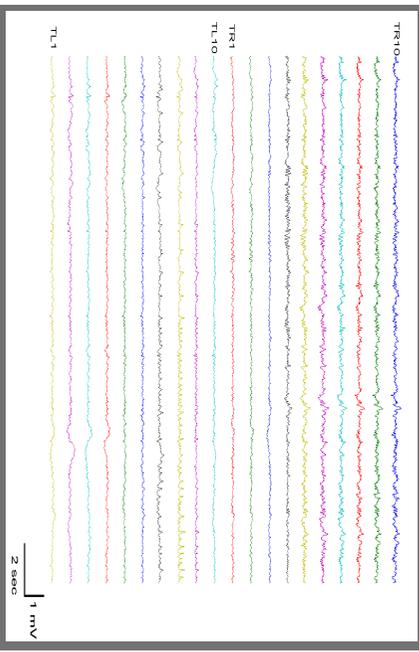
Scalp EEG



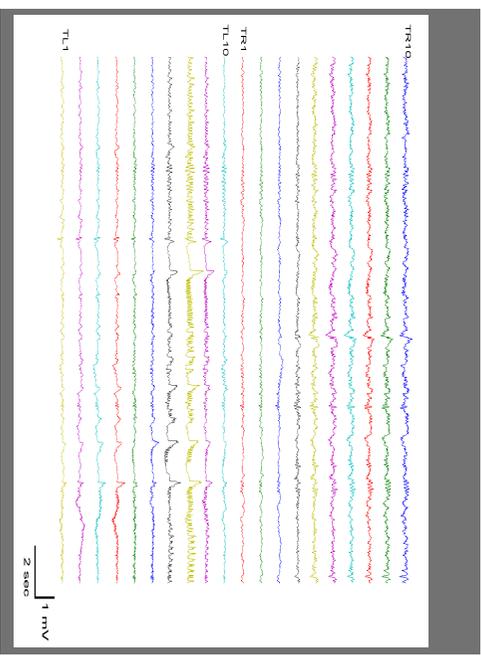
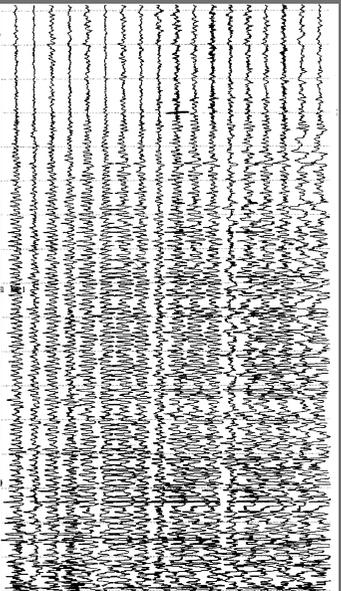
Sleep stages



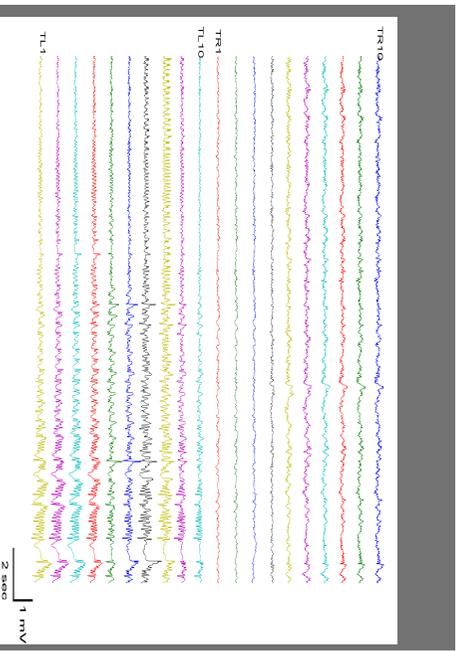
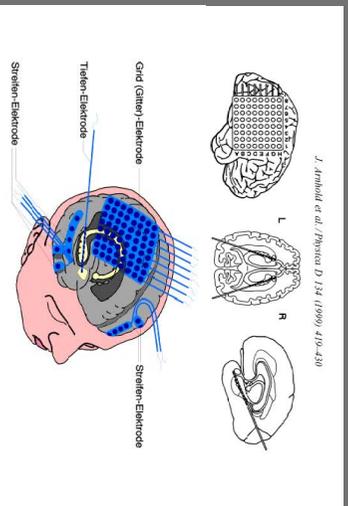
EEG of an epileptic patient

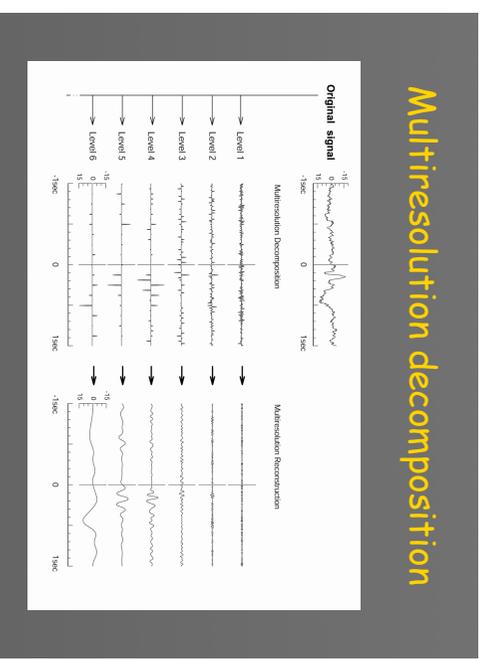
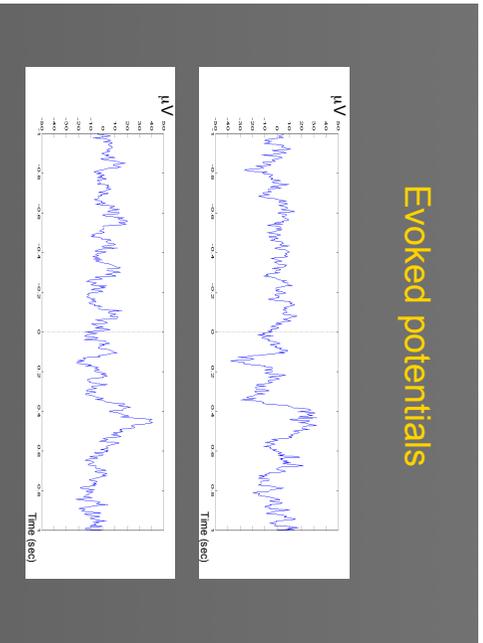
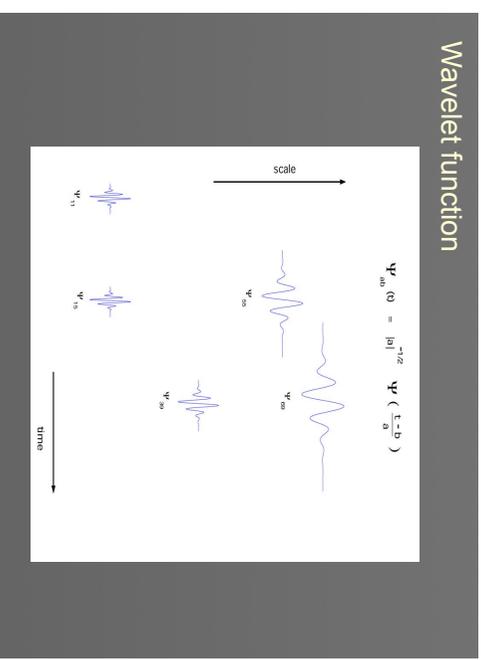
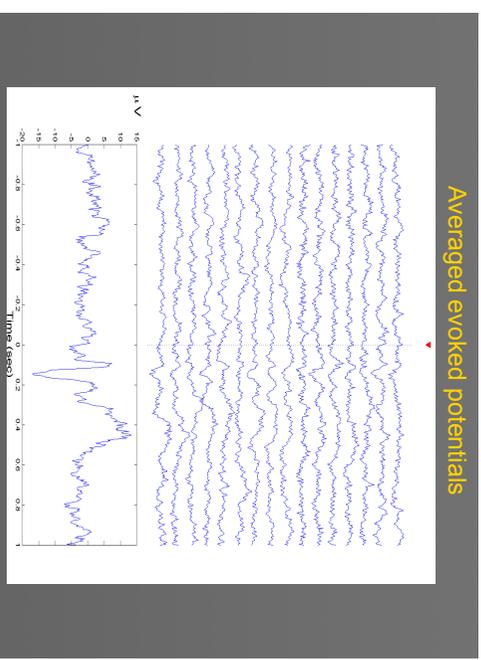
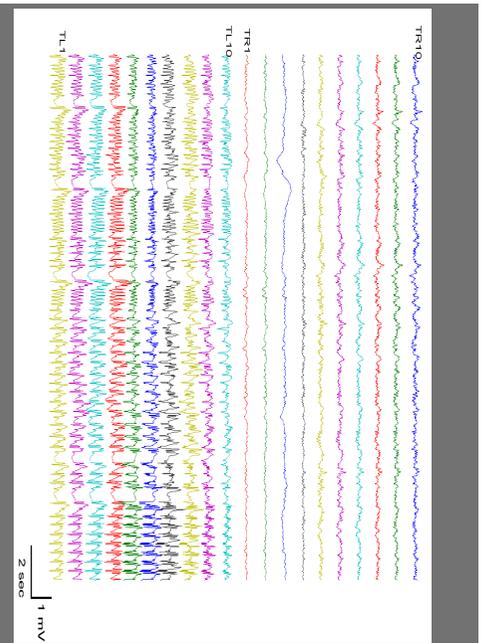


Grand Mal Seizure

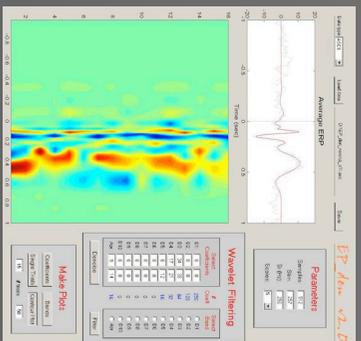


Intracranial recordings



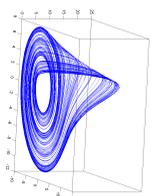


EP_den



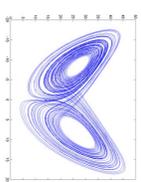
Lorenz driven by a Rossler

$$\begin{cases} \dot{x}_1 = x_2 + x_3 \\ \dot{x}_2 = x_1 + 0.2x_2 \\ \dot{x}_3 = 0.2 + x_3(x_1 - 5.7) \end{cases}$$



$$\begin{cases} \dot{y}_1 = 10(-y_1 + y_2) \\ \dot{y}_2 = 28y_1 - y_2 - y_1y_3 + Cx_2^2 \\ \dot{y}_3 = y_1y_2 - 2.6y_3 \end{cases}$$

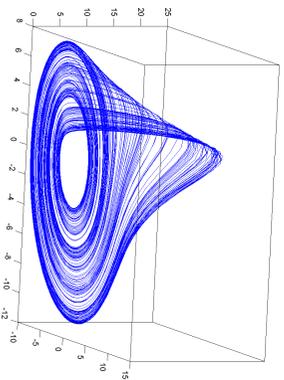
Coupling



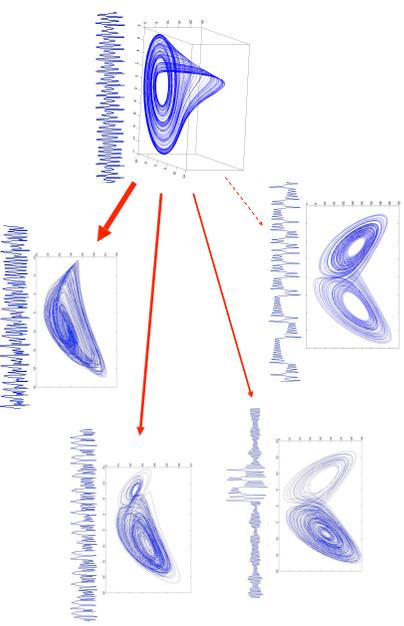
Nonlinear dynamics



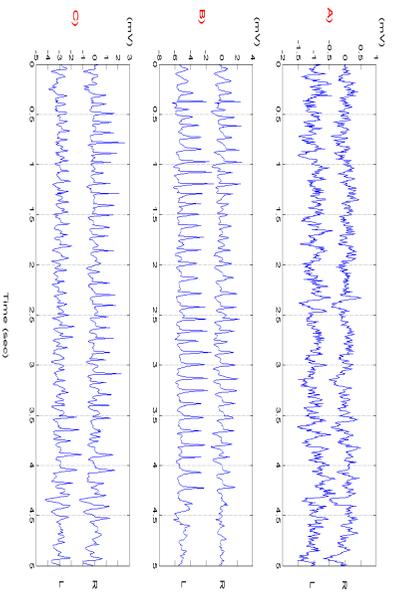
Phase space

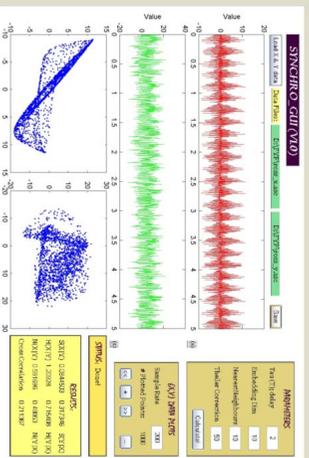


Lorenz driven by a Rossler



Synchronization





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Clase 1. Introducción a neurociencia de sistemas

The Astonishing Hypothesis, Francis Crick, 2004. *(el mejor de divulgación entre muchos...)*

Gazzaniga, Ivry and Mangun. Cognitive Neuroscience *(excelente libro de texto)*

Kandel, Schwartz and Jessell. Principles of Neural Science *(caro pero el mejor – el mas completo)*

Clase 2. La memoria

Rodrigo Quiñ Quiroga

Paidós, 2015. *(de autor controvertido, pero relativamente barato)*

Clase 3. La memoria

Rodrigo Quiñ Quiroga, Sudamericana, 2011. *(del mismo autor, que lucha con Borges...)*