Brain plasticity: spinal cord injury

An injury to the spinal cord that is caused by trauma instead of disease

Depending on where the spinal cord and nerve roots are damaged, the symptoms can vary widely, from pain to paralysis to incontinence
Cortical reorganization after \textit{spinal} lesion

De Vico Fallani et al, Hum Brain Mapp, 2007
A stroke is a rapid loss of brain function(s) due to disturbance in the blood supply to the brain.

As a result, the affected area of the brain cannot function, which might result in an inability to move one or more limbs on one side of the body.
Cortical reorganization after brain lesion

Healthy

Lesioned

Motor ability (Fugl-Meyer)

Node degree

β band

Z-value

R=0.53

De Vico Fallani et al, Neuroimage, 2013
Absence seizures are brief generalized epileptic seizures of sudden onset and termination.

The hallmark of the absence seizures is abrupt and sudden onset impairment of consciousness, interruption of ongoing activities, a blank stare, possibly a brief upward rotation of the eyes.
Modular organization in epilepsy

Healthy (resting state)

Epileptic (absence seizure)

\[ \alpha \text{ band} \]

\[ N \text{ modules} = 13,7 \]
\[ \text{Stability} = 0.47 \]

\[ N \text{ modules} = 8,3 \]
\[ \text{Stability} = 0.73 \]

Chavez et al, Phys Rev Lett, 2010
Brain-to-brain coupling

In many cases the neural processes in one brain are coupled to the neural processes in another brain via the transmission of a signal through the environment.

Brain-to-brain coupling constrains and shapes the actions of each individual in a social network, leading to complex joint behaviors that could not have emerged in isolation.

Hasson et al., Trends Cogn Sci, 2011
The “hyper-brain” network

Global Efficiency:

\[ E = \frac{1}{N(N-1)} \sum_{i \neq j=1}^{N} \frac{1}{d_{ij}} \]

Modularity:

\[ Q = \frac{1}{W} \sum_{ij} \left( w_{ij} - \frac{s_{i\text{out}} s_{j\text{in}}}{W} \right) d(C_i, C_j) \]

Divisibility:

\[ D = \frac{W}{\sum w_{ij} [1 - \delta(C_i, C_j)] + k} \]

De Vico Fallani et al., PLOS One 2010
Neural correlates of decision-making

Brain-to-brain coupling during the formulation of cooperative and non-cooperative strategies.

De Vico Fallani et al., PLOS One 2010
Hyper-brain networks in decision-making

De Vico Fallani et al, Plos ONE, 2010
Static VS Dynamic brain networks

De Vico Fallani et al, Neuroinformatics, 2008
Possible implications

Exploit cortical activity to interact with the environment/periphery

Understand cortical reorganization after spinal cord injury
Brain-computer interface

Wolpaw et al, Clin Neurophysiol, 2002
BCI applications

Control

Neuro-feedback

Domotics, external devices

Motor recovery, rehabilitation
Website

https://sites.google.com/site/fr2eborn/

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