A Complex Network Model for Mild Cognitive Impairment Subject Characterization

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Mild Cognitive Impairment (MCI) is a brain syndrome[1] that eventually could lead to Alzheimer disease. One important MCI medical issue is the classification problem between healthy and unhealthy individuals, therefore the ways to make descriptional inferences about which neurological features are involved in such a medical condition.

The aim of this work is to apply an innovative methodology[2] to build neurological networks, based on statistical analysis of brain time series, to characterize differences between MCI patients and control individuals. Brain data is collected from individuals divided into two groups: controls and patients, using magnetoencephalographic (MEG) recordings of fourteen subjects for each group. We measure the activity of 147 channels, whose record time series of brain activity during a memory task (Sternberg's test). Time series were analysed using the Synchronization Likelihood algorithm (SL) to detect the consistency (ability to respond in the same way facing same stimulus) of each brain site[3]. Consistency per channel and subject is the feature analyzed in this work.

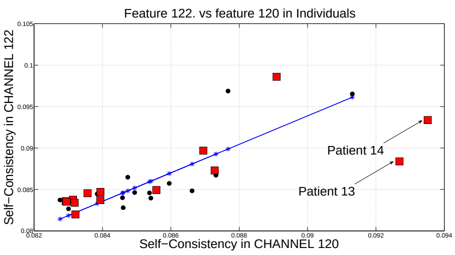

FIG. 1. Linear fit from control features related to the consistency in channels (nodes) 122 and 120, in black dots. Equivalent patient features values are plotted in red squares. Note how feature values in patient 13 and 14 are far from the equivalent information in control fit.

Controls features associated to each pair of different channels, are fitted to get standard deviations (SD). Patient features are related with controls comparing control SD and patient feature values (Fig. 1). The former method is accomplished for all combinations among 147 control and patient features. Patient features, those who have larger values (almost 3 times SD) than its respective control SD, are taken into account to build the patient network edges.

Control networks are built up in similar way avoiding self redundancy. Thence, networks obtained are weighted graphs and it is possible to use several complex network parameters[4] to find more interesting differences among the consistency networks. This methodology unveils topological differences between both groups, in fact, control networks reveal structures with more random configuration, in contrast to star-like shape in patients (Fig. 2).

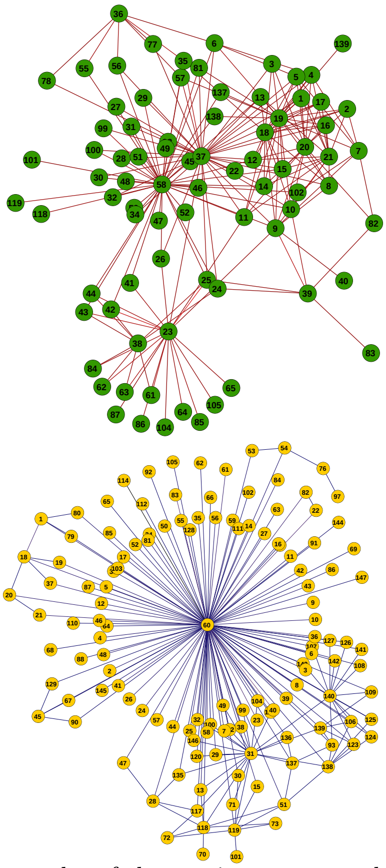

FIG. 2. Examples of the consistency network of a control (top) and MCI patient (down). Networks have different structures: MCI patients have a star-like configuration while controls have a more homogeneous structure.

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3 Buldú Javier M., et al, Reorganization of Functional Networks in Mild Cognitive Impairment, PLoS ONE. Public Library of Science, 6, 5, 2011

4 Boccaletti S., et al, Complex networks: Structure and dynamics, Physics Reports, 424, 4-5, 175-308, 2006