Modeling disorders of consciousness at the individual patient level in a low-dimensional latent-space

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Disorders of consciousness (DoC) refer to a scope of conditions that can occur after people who suffered various types of brain damage fall into a coma from which they only partially recover. The Glasgow Coma Scale[1] defines a universal protocol to classify the DoC patients into categories based on the severity of their symptoms. However, these categories contain highly heterogeneous populations in terms of pathology, behavior and cognitive ability, yielding the need for more individualized diagnosis and treatment approaches. We thus propose to develop patient-specific, biologically relevant, whole-brain models based on resting-state fMRI, to increase diagnosis and prognosis accuracy.

One of the main challenges of building such models is the need to work in very high dimensions, which leads to a prohibitive number of model parameters to fit and heavy computations. Interestingly, a growing body of works unveils the existence of a lower dimensional space, a.k.a the latent-space, that encompasses the complexity of the brain resting-state activity while remaining low-dimensional.

I will show our latest results regarding the construction of a modeling pipeline that takes DoC patients' fMRI resting state data as an input and provides automatically fitted mathematical models for each patient.

In practice, the patient's data is projected into a latent-space of *optimal* dimension that I will describe. In this latent-space, I will show an automatic parameter fitting procedure applied to two models: (1) the Hopf model[2], which provides good results for fMRI modeling but whose biological interpretation is limited. (2) The AHP model[3, 4], based on synaptic short-term plasticity and neuronal bursting afterhyperpolarization, whose biological interpretation is more straightforward but is more difficult to calibrate.

Finally, I will explore these results in the latent-space which unveil transverse groups, independent of the severity of symptoms. I shall investigate how these clusters could be related to etiology of prognosis.

References

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