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Spontaneous vs. stimulated brain activity: A statistical physics approach

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The understanding of the fundamental relation between electrophysiological activity and brain organization with respect to performing even simple tasks is a long-standing fascinating question. The ability of the brain to self-organize information processing in an efficient way is a crucial ingredient in biologically plausible models. Recent experiments have shown that the spontaneous brain activity is characterized by burst activity, i.e. avalanches showing absence of characteristic size, successfully interpreted in the context of criticality. We introduce a model inspired in self-organized criticality and reproducing the statistical properties of spontaneous activity, to study multitask learning by the implementation of adaptation mechanism inspired in neurobiology. The system is able to learn all the tested Boolean rules, as well as to recognize patterns with a good performance. Finally, the fundamental open question of the relation between spontaneous and evoked activity is addressed by means of the coarse-grained Wilson Cowan model. An approach inspired in non-equilibrium statistical physics allows to derive a fluctuation-dissipation relation, suggesting that measurements of the spontaneous fluctuations in the global brain activity alone could provide a prediction for the system response to a stimulus. Theoretical predictions are in good agreement with MEG data for healthy patients performing visual tasks.

Primary author: DE ARCANGELIS, Lucilla (SA)

Presenter: DE ARCANGELIS, Lucilla (SA)

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