The attractor states of the functional brain connectome

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Abstract

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todo

Keywords

Highglights:

- We propose a high-level computational model of "activity flow" across brain regions
- The model considers the funcional brain connectome as an already-trained Hopfield neural network
- It defines an energy level for any arbitrary brain activation patterns
- and a trajectory towards one of the finite number of stable patterns (attractor states) that minimize this energy
- The model reproduces and explains the dynamic repertoir of the brain's spontanous activity at rest
- It conceptualizes both task-induced and pathological changes in brain activity as a shift on the "attractor landscape"
- We validate our findings on healthy and clinical samples (~2000 participants)

1 Introduction

Brain function is accompanied by the activation and deactivation of anatomically distributed neuronal populations. While changes in the activity of a single brain area is often associated with various tasks or conditions, in reality, regional activation never occurs in isolation (ref). Regardless of the presence or absence of explicit stimuli, brain regions seem to work in concert, resulting in a rich and complex spatiotemporal fluctuation over time. This fluctuation shows quasi-periodic properties (**?**), with a limited number of recurring states known as "brain states" (**?**, **?**). These states are often interpreted as sporadic intervals during which information can be efficiently exchanged between a characteristic subset of brain regions (**?**, **?**, **?**). Brain state dynamics can be assessed with multiple techniques, including independent component analysis (ref), co-activation patterns (**?**) and hidden markov models (**?**).

While such efforts, by their nature, do not shed light on the driving forces of the complex spatiotemporal dance of brain acctity, they provide accumulating evidence for the neurobiological relevance of these dynamics, with promising perspectives for facilitating the clinical translation of functional neuroimaging techniques (**?**).

Why does such interregional communication manifest in co-activation? Which activiy configurations does the brain visit and which not? How do these relate to each other? How does this dyanmic repertoir of activation

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