Dynamic fluctuations coincide with periods of high and low modularity in resting-state functional brain networks

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Abstract

We investigate the relationship of resting-state fMRI functional connectivity estimated over long periods of time with time-varying functional connectivity estimated over shorter time intervals. We show that using Pearson's correlation to estimate functional connectivity implies that the range of fluctuations of functional connections over short time scales is subject to statistical constraints imposed by their connectivity strength over longer scales. We present a method for estimating time-varying functional connectivity that is designed to mitigate this issue and allows us to identify episodes where functional connections are unexpectedly strong or weak. We apply this method to data recorded from $N = 80$ participants, and show that the number of unexpectedly strong/weak connections fluctuates over time, and that these variations coincide with intermittent periods of high and low modularity in time-varying functional connectivity. We also find that during periods of relative quiescence regions associated with default mode network tend to join communities with attentional, control, and primary sensory systems. In contrast, during periods where many connections are unexpectedly strong/weak, default mode regions dissociate and form distinct modules. Finally, we go on to show that, while all functional connections can at times manifest stronger (more positively correlated) or weaker (more negatively correlated) than expected, a small number of connections, mostly within the visual and somatomotor networks, do so a disproportional number of times. Our statistical approach allows the detection of functional connections that fluctuate more or less than expected based on their long-time averages and may be of use in future studies characterizing the spatio-temporal patterns of

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