Functional connectivity

Functional connectivity is defined as the temporal dependency of neuronal activation patterns of anatomically separated brain regions and in the past years an increasing body of neuroimaging studies has started to explore functional connectivity by measuring the level of co-activation of resting-state functional magnetic resonance imaging time-series between brain regions.

Brain functional connectivity features can predict cognition and behavior at the level of the individual. Most studies measure univariate signals, correlating timecourses from the average of constituent voxels in each node. While straightforward, this approach overlooks the spatial patterns of voxel-wise signals within individual nodes. Given that multivariate spatial activity patterns across voxels can improve fMRI measures of mental representations, here we asked whether using voxel-wise timecourses can better characterize region-by-region interactions relative to univariate approaches. Using two fMRI datasets, the Human Connectome Project sample and a local test-retest sample, we measured multivariate functional connectivity with multivariate distance correlation and univariate connectivity with Pearson's correlation. We compared multivariate and univariate connectivity estimates, demonstrating that relative to univariate estimates, multivariate estimates exhibited higher reliability at both the edge-level and connectome-level, stronger prediction of individual differences, and greater sensitivity to brain states within individuals. Our findings suggest that multivariate estimates reliably provide more powerful information about an individual's functional brain organization and its relation to cognitive skills [1)].

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see Insular functional connectivity

The FC was analyzed in 10 pituitary adenoma patients under propofol anesthesia before and after tumor resection. The FC of each session (totally 20 sessions) was correlated to a reference matrix of a group of healthy subjects to evaluate the variations of the overall, interhemispheric and intrahemispheric FC between sessions.

The resting state patterns could be detected during anesthesia ($F(1,9)= 112.14$; $p<0.001$)There was a significant effect of session ($F(1,9)= 19,401$; $p=0.002$), which included a reduction in resting state from first to the second session. There was no effect of connection type ($F(2,8)=1,498$; $p=0.280$), nor was there an interaction between connection type and session ($F(2,8),=0.187$; $p=0.833$). The correlation between the observed reduction in resting state activity between the sessions, and the time span between sessions was not significant ($r=0.25;p=0.29$). The FC of the first session showed a significant correlation to the initial dose of anesthesia ($r= 0.7$, $P= 0.007$). However, there was no significant correlation between the total dose of propofol and the FC of the second session ($r=1.7$; $p=0.6$).

Significant FC could be detected under anesthesia but showed a significant decrease in the second session. To implement the FC intraoperative brain mapping, further studies are required to optimize the depth sedation in order to obtain stable FC between sessions [2)].

Resting-state networks (RSNs) show spatial patterns generally consistent with networks revealed during cognitive tasks. However, the exact degree of overlap between these networks has not been clearly quantified. Such an investigation shows promise for decoding altered functional connectivity (FC) related to abnormal language functioning in clinical populations such as temporal lobe epilepsy (TLE). In this context, we investigated the network configurations during a language task and during resting state using FC. Twenty-four healthy controls, 24 right and 24 left TLE patients completed a verb generation (VG) task and a resting-state fMRI scan. We compared the language network revealed by the VG task with three FC-based networks (seeding the left inferior frontal cortex (IFC)/Broca): two from the task (ON, OFF blocks) and one from the resting state. We found that, for both left TLE patients and controls, the RSN recruited regions bilaterally, whereas both VG-on and VG-off conditions produced more left-lateralized FC networks, matching more closely with the activated language network. TLE brings with it variability in both task-dependent and task-independent networks, reflective of atypical language organization. Overall, our findings suggest that our RSN captured bilateral activity, reflecting a set of prepotent language regions. We propose that this relationship can be best understood by the notion of pruning or winnowing down of the larger language-ready RSN to carry out specific task demands. Our data suggest that multiple types of network analyses may be needed to decode the association between language deficits and the underlying functional mechanisms altered by disease [3].

Functional connectivity is defined as the temporal dependency of neuronal activation patterns of anatomically separated brain regions and in the past years an increasing body of neuroimaging studies has started to explore functional connectivity by measuring the level of co-activation of resting-state functional magnetic resonance imaging time-series between brain regions. These studies have revealed interesting new findings about the functional connections of specific brain regions and local networks, as well as important new insights in the overall organization of functional communication in the brain network. Here we present an overview of these new methods and discuss how they have led to new insights in core aspects of the human brain, providing an overview of these novel imaging techniques and their implication to neuroscience. We discuss the use of spontaneous resting-state fMRI in determining functional connectivity, discuss suggested origins of these signals, how functional connections tend to be related to structural connections in the brain network and how functional brain communication may form a key role in cognitive performance. Furthermore, we will discuss the upcoming field of examining functional connectivity patterns using graph theory, focusing on the overall organization of the functional brain network. Specifically, we will discuss the value of these new functional connectivity tools in examining believed connectivity diseases, like Alzheimer's disease, dementia, schizophrenia and multiple sclerosis [4].

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