Dynamic reorganization of intrinsic functional networks in the mouse brain

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Abstract

Functional connectivity (FC) derived from resting-state functional magnetic resonance imaging (rs-fMRI) allows for the integrative study of neuronal processes at a macroscopic level. The majority of studies to date have assumed stationary interactions between brain regions, without considering the dynamic aspects of network organization. Only recently has the latter received increased attention, predominantly in human studies. Applying dynamic FC (dFC) analysis to mice is attractive given the relative simplicity of the mouse brain and the possibility to explore mechanisms underlying network dynamics using pharmacological, environmental or genetic interventions. Therefore, we have evaluated the feasibility and research potential of mouse dFC using the interventions of social stress or anesthesia duration as two case-study examples. By combining a sliding-window correlation approach with dictionary learning, several dynamic functional states (dFS) with a complex organization were identified, exhibiting highly dynamic inter- and intra-modular interactions. Each dFS displayed a high degree of reproducibility upon changes in analytical parameters and across datasets. They fluctuated at different degrees as a function of anesthetic depth, and were sensitive indicators of pathology as shown for the chronic psychosocial stress mouse model of depression. Dynamic functional states are proposed to make a major contribution to information integration and processing in the healthy and diseased brain.

Keywords: mouse, fMRI, functional connectivity, dynamic functional states, dictionary learning