Evolving perspectives on integrating task-based and rest-based models of brain function

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Symposium
Wednesday - Symposia AM
Driven by the discovery of task-based fMRI and the advent of resting state fMRI, our knowledge of the functional integration and segregation of brain networks has developed at an incredible speed. However, with the growth of the functional neuroimaging community and the development of increasingly complex modeling approaches several specialized subfields have emerged leading to separate rather than integrated perspectives on human brain function. Despite increasing efforts to employ multi-modal imaging by e.g. integrating structural and functional networks and indirect functional characterization of large-scale functional networks by means of meta-analytic mapping, surprisingly few studies have directly compared task-related and resting state functional MRI indices. In particular, the extent to which they are related (or different) and can provide distinct but complimentary information during pathology or following pharmacological or other modulations remains unclear.

It is time to re-integrate task and resting-state approaches for investigating neural networks and explore both how they differ and can also be combined to help provide a more holistic understanding of human brain function. We will illustrate this by considering both psychiatric disorders and particularly the effects of psychoactive substances (oxytocin, ketamine) or neurofeedback training using real time fMRI on neural networks.
Objective

(1) How we can integrate information from both resting-state and task-related neuroimaging studies (2) Encourage neuroimagers to consider innovative methods for combining resting-state and task-information in psychiatric and in response to treatments with psychoactive substances.
Target Audience

Researchers interested in effects of psychiatric disorders on both resting-state and task-responsive neural networks.

Co Organizer

Bharat Biswal, Newark College of Engineering
Organizer

Keith Kendrick, PhD, UESTC

Presentations

TASK vs REST (index.cfm?do=ev.viewEv&ev=1690)

There is a growing interest in studies of human brain networks using the resting-state functional magnetic resonance imaging (fMRI). However, it is unclear whether and how the brain networks measured during the resting-state exhibit comparable properties to the brain networks during task performance. Here, we investigated meta-analytic coactivation patterns among brain regions based upon published neuroimaging studies, and compared the coactivation network configurations with those in the resting-state network. The strength of resting-state functional connectivity between two regions were strongly correlated with the coactivation strength. However, the coactivation network showed greater global efficiency, smaller mean clustering coefficient, and lower modularity compared with the resting-state network, which suggest a more efficient global information transmission and between system integrations during task performing. Hub shifts were also observed within the thalamus and the left inferior temporal

cortex. The thalamus and the left inferior temporal cortex exhibited higher and lower degrees, respectively in the coactivation network compared with the resting-state network.

Presenter

Bharat Biswal, Newark College of Engineering

What is the role of perfusion imaging in pharmacological fMRI studies? (index.cfm?do=ev.viewEv&ev=1691)

Task-based fMRI using BOLD sensitive techniques, when used to investigate pharmacological modulation of brain function, can be influenced by neuronal and non-neuronal effects. Drugs can influence smooth muscle directly, neurovascular coupling and neuronal activity. This confound in task-based FMRI of drug effects remains unresolved. Resting-state perfusion imaging can be used to index the main effects of drugs to potentially inform on the analysis of task-based studies, but these are rarely integrated. Studies of psychoactive substances with dopaminergic activity are critically affected here as dopamine receptors are present on both the smooth muscle of the cerebrovasculature and astrocytes. Psychomotor stimulants are used with task-based and resting perfusion data, combined with multivariate analysis to show the influence of joint prediction of drug effects with both data types. A study of multiple drugs from the same class (dopamine antagonists) will be used to assess the differential influence of perfusion changes of reward processing task activations across the drugs and compare this to other measures of neurovascular effects of the drugs. Further illustration with serotonergic agents will be used to demonstrate emerging approaches to triangulate receptor distributions, resting haemodynamic and functional effects of psychoactive substances.

Presenter

Mitul Mehta, King's College London

Convergent and divergent changes of real-time fMRI Neurofeedback-associated neural regulation across task- and resting state indices. (index.cfm?do=ev.viewEv&ev=1692)

During the last years real-time fMRI-informed neurofeedback has been increasingly used as a non-invasive brain modulatory strategy to enable healthy subjects and patients with mental disorders to gain regulatory control over regional brain activity. The training-induced neural changes of successful regulatory control have been associated with both, neural indices of task-based challenges in functional domains associated with the regulated regions as well as changes in associated resting state networks. As such, real-time fMRI-neurofeedback-induced changes have been shown functional relevance for both, task-challenge and resting state neural indices and may provide a tool that allows to associate functional changes across task and resting state neural indices. The present talk will review recent findings from real-time fMRI neurofeedback studies in healthy subjects and patient populations reporting changes on the levels of behavior, task-based neural activity and intrinsic connectivity to develop a mechanistic model describing convergent and divergent changes across modalities.

Presenter

Benjamin Becker, University of Electronic Science & Technology of China

What we have learned about the effects of neuropeptides on neural networks from task and resting-state fMRI? (index.cfm?do=ev.viewEv&ev=1693)

In recent years there has been considerable interest in the behavioral and neural effects of neuropeptides administered by intranasal spray, particularly oxytocin, vasopressin and insulin. There is accumulating evidence, most notably from the oxytocin field, that while resting-state and task-related effects of neuropeptide treatments exhibit considerable overlap in terms of the involvement of specific brain regions the precise functional connections exhibiting treatment-dependent effects identified by the two approaches differ. These regions of overlap in the case of oxytocin typically involve medial frontal cortical areas, amygdala, parahippocampal gyrus, insula, striatum, precuneus and also thalamus and cerebellum. The functional connections involved are also primarily those between rather than within specific networks. While this observation is drawn mainly from independent studies using the two approaches it is also supported by the small number of studies where both resting-state and task-related measures have been included. In my talk I will review these findings from intranasal neuropeptide challenge studies in both healthy subjects and patient populations. I will also discuss the possibility that neuropeptides may produce separate but complimentary effects on synchronization in communication between rather than within different functional networks.

Presenter

Keith Kendrick, PhD, UESTC