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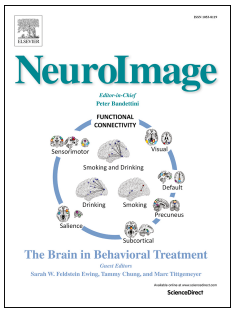

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Task-based Dynamic Functional Connectivity: recent findings and open questions

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Abstract

The temporal evolution of functional connectivity (FC) within the confines of individual scans is nowadays often explored with functional neuroimaging. This is particularly true for resting-state; yet, FC-dynamics have also been investigated as subjects engage on numerous tasks. It is these research efforts that constitute the core of this survey. First, empirical observations on how FC differs between task and rest—independent of temporal scale—are reviewed, as they underscore how, despite overall preservation of network topography, the brain's FC does reconfigure in systematic ways to accommodate task demands. Next, reports on the relationships between instantaneous FC and perception/performance in subsequent trials are discussed. Similarly, research where different aspects of task-concurrent FC-dynamics are explored or utilized to predict ongoing mental states are also examined. The manuscript finishes with an incomplete list of challenges that hopefully fuels future work in this vibrant area of neuroscientific research. Overall, this review concludes that task-concurrent FC-dynamics, when properly characterized, are relevant to behavior, and that their translational value holds considerable promise.

Keywords: dynamic functional connectivity, task-concurrent functional connectivity, functional connectivity states, connectivity dynamics, task vs. rest.

1. Introduction

In neuroscience, functional connectivity (FC) usually refers to the degree of co-variation between spatially distributed signals emanating from the brain and recorded with different functional neuroimaging techniques such as functional magnetic resonance imaging (fMRI; (Biswal et al., 1995)), electro-encephalography (EEG; (Babiloni et al., 2005)), magneto-encephalography (MEG; (Brookes et al., 2011)), functional near infrared spectroscopy (fNIRS; (Lu et al., 2010)), and electrocorticography (ECoG; (Antony et al., 2013)). FC studies are most commonly conducted under resting conditions (i.e., without any external stimulation or task demands), yet understanding how environmental stimuli and cognitive demands modulate FC is also the subject of rigorous research.

As explained elsewhere in this special issue *[REF NEEDED]*, rest-FC is known to be dynamic, with FC patterns evolving in biologically meaningful ways at temporal scales ranging from years—as it is the case with developmental FC changes (Dennis and Thompson, 2014)—to seconds (Chang and Glover, 2010). The same is true when tasks or external stimuli are present. For example, mastering motor skills over the course of weeks is accompanied by increased