Time-varying Connectivity in Resting-state fMRI: Methods, interpretations and clinical use

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The last few years have seen a flourishing literature exploring the time-varying nature of resting-state functional connectivity (FC) evaluated from resting-state fMRI time series in a wide range of applications. Many methods that were proposed to explore FC beyond the static paradigm have been presented and discussed in OHBM symposiums in the recent years. With some hindsight, we now have a better understanding of the properties, potentialities, and caveats of these methods. Therefore, we organized the first edition of this course three years ago at OHBM-Singapore. Based on the positive feedback we received for the first editions of this course, we have decided to propose a new edition with a focus on hands-on demonstrations and clinical applications. As detailed later, we also generalize the use of the OHBM Audience Response System in order to foster audience engagement. We start by providing the methodological background necessary to understand the main frameworks exploiting time-varying FC as well as the corresponding pitfalls. We then detail several applications of time-varying FC using hands-on demonstrations, and discuss how FC fluctuations might be interpreted. We conclude by summarizing the main controversies still going on in the field. Overall, we believe the different learning objectives of this course are essential to help researchers in various domains to choose the best method exploiting time-varying FC.

Recent converging evidence suggests that a static representation of FC, e.g. based on the correlation between entire fMRI time series, misses important information encoded in fMRI data. Hence, various methods have been developed in recent years to exploit the information encoded beyond such static measures. The researcher interested in exploring time-varying FC properties has to select among the multitude of proposed methods, each one having different properties and underlying assumptions. The goal of this course is to provide guidance in the choice of an adequate time-varying FC method to address a specific neuroscientific question. In the first part of the course, we will recall the definitions of the most important mathematical notions required to characterize temporal fluctuations of functional connectivity. Then, we will provide an overview of the main approaches used to explore functional connectivity beyond the classical static paradigm (e.g. brain states, co-activation patterns, autoregressive models, spatial vs temporal dynamics), including concrete examples of how these methods have been used in clinical applications. The second part of the course will be devoted to the interpretation of FC fluctuations. We will detail their links to micro-scale (i.e. neuronal) dynamics as well as their behavioral counterparts. We will conclude by summarizing the main remaining controversies and ongoing lines of inquiry in the field. In order to maximize learning outcomes for participants, we will discuss multiple-choice questions at the end of each talk, and take questions from the audience using the OHBM interactive tool.

Learning objectives for the audience:

1. Definition of various terms important to the study of time-varying connectivity including ‘stationary’, ‘dynamic’, ‘static’, ‘time-varying’
2. Step-by-step explanation of popular methods used to explore the time-varying nature of FC (including demos using popular toolboxes) and application to real datasets
3. Interpretation of the temporal fluctuations of FC in terms of (i) links to micro-scale (neuronal) dynamics and (ii) behavioral counterparts.