ORAL SESSION: Connectivity: States & Traits

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Oral Sessions

Presentations

Hierarchical Modelling of Individual- and Population-Level Resting State Networks from Big fMRI Data

It is well established that there are structured network fluctuations in fMRI when subjects are at rest. However, characterising cross-subject variability of these resting state networks (RSNs) in an interpretable manner from very large population datasets (e.g. up to 100,000 subjects in UK Biobank [1,2]) is an open problem. An accurate estimation of between-subject variability, e.g. due to anatomical differences [3], requires hierarchical group models that provide top-down and bottom-up regularisation. PROFUMO (PRObabilistic FUnctional MOdes) [4,5] provides a Bayesian framework for such hierarchical modelling of RSNs. However, its computational expense makes application to large datasets impractical. We propose an extension to PROFUMO, using stochastic variational Bayes[6,7] (sPROFUMO), in order to obtain for the first time, a hierarchical model of RSNs that can be applied to datasets like UK Biobank.

Presenter

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Topological variations in connectivity dynamics decode states of the brain

The brain's spontaneous Functional Connectivity (FC) is usually measured in terms of pairwise similarities between brain regions and interpreted as a weighted network between brain regions. Topological Data Analysis offers a multiscale and robust description of FC in terms of its topological properties, which capture mesoscopic features of brain FC space [1,2]. We hypothesize that this paradigm offers a robust foundation from which to interpret FC dynamics (dFC) [3] and to isolate similar brain configuration across experimental conditions and subjects, thus yielding a candidate for the concept of brain state.

Presenter

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Investigation of spatiotemporal functional interactivity among large-scale brain networks

The human brain is a dynamic system. In addition to the hierarchical static functional architecture, human brain activity may be decomposed into patterns of not only the spatial directed interactivity but also the temporal duration of influence, a pattern that has not been well studied. Leveraging a novel analytic approach, prediction correlation (p-corr)(Xu et al. 2017), we investigate the causal interactions between regions among the large-scale functional networks of the brain using rsfMRI. In particular, two central problems were investigated, 1) the asymmetry between the inward and outward information transfer (namely the inward-outward difference) for each brain region of interest (ROI) in both the connectivity strength and duration, and 2) the short information transfer (in duration) in brain networks and the underlying brain functions.

Presenter

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Brain Gender Spectrum

Sex, a binary value, is determined by an individual's allosome. Previous studies focused on both structural and functional sex differences in brain, but achieved small effect size. Many studies also focused on classifying sex using functional network, reaching an accuracy of approximately 75%. Those studies indicated that functional architecture is better mapped onto a gender spectrum. Furthermore, some psychiatric disorders have been proved to have different prevalence in males and females, but both sexes have the likelihood of having such psychiatric disorders. In psychology, S Bem raised the concept of sex roles and many studies have confirmed that androgynous people have better mental health. All those phenomena indicate that a continuous index of brain gender can be more informative than binary ones. The current study used rs-fMRI data obtained from 9,620 subjects. We studied sex differences and trajectory of functional networks in 2 sexes. An SVM classifier was estabilished to characterize the likelihood that a given functional brain network was collected from a male subject, which we termed as brain gender spectrum. We implemented sensitivity analysis to ensure the reliability of our model. We finally applied our gender spectrum to internalizing and externalizing symptoms.

Presenter

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Brain Network Connectivity Architecture of Ego Dissolution under LSD

Psychedelics are mind altering substances which produce altered states of consciousness. Clinical trials testing the efficacy of psychedelics in clinical populations report significant improvements to psychosocial functioning in a range of pathologies including drug addiction [1], anxiety and depression [2]. Previous psychedelic research suggests that increased functional connectivity (FC) between large-scale resting state networks correlates with ego dissolution [5] [6]. Using resting state functional MRI (fMRI) data acquired from individuals under the influence of the classic psychedelic substance lysergic acid diethylamide (LSD), we investigate the changes in effective (or directional) connectivity among three major resting state networks involved in attention using spectral dynamic causal modelling (DCM). The networks investigated are the core default network (cDN) comprising the posterior cingulate cortex (PCC. [-3 -57 21]) and medial prefrontal cortex (mPFC, [3 54 18]); the dorsal attention network (DAN) comprised of the bilateral frontal eye field (FEF, left [-24 -9 57] and right [27 -3 54]) and bilateral inferior parietal sulcus (IPS left [-42 -36 45], right [39 -42 51]); and the salience network (SN) comprised of dorsal anterior cingulate cortex (dACC, [-3 15 42]) and bilateral anterior insula (AI, left [-36 15 6], right [33 18 6]) suggested to maintain the anticorrelation between the cDN and DAN and detection of external salient stimuli [7]. Alterations to the connectivity among these networks under LSD is suspected to alter attentional boundaries subjectively experienced as increased connectedness between internal and external signals [8].

Presenter

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