Discerning signal from artifact: Current Issues in resting-state fMRI quality control

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Symposium

Numerous neuroscience studies have been based on fMRI findings, resulting in an immense amount of accumulated data. However, appropriate quality control (QC) of fMRI data has yet to be achieved, particularly as the data are used in more ways than ever. Past work has resulted in algorithms to detect unusable scans built on more (i.e. image quality metrics) or less interpretable features that are extracted from images and through visual screening following a prescribed protocol and visualization tools. However, appropriate QC depends on an accurate understanding of the potential sources of noise and artifacts, which has yet to be achieved. In this symposium, we aim to elicit insight from a group of international experts on a number of important topics, including the influence of physiological artifacts, motion artifacts and simultaneous multi-slice acquisitions on fMRI data quality, as well as potential targets for optimizing fMRI data analysis quality. We believe such knowledge is imperative in this rapidly developing field, and will be critical for avoiding false findings.

Objective

A better understanding of the artifacts associated with using parallel imaging acquisitions in rs- fMRI
An up-to-date understanding of how motion correction and physiological corrections interact, and how they can be addressed using multi-echo fMRI
An understanding of potential neuronal connections of “physiological noise” and implications for rs-fMRI

Target Audience

Anyone doing research that involves the use of resting-state fMRI.

Presentations

The influence of motion and physiological noise on fMRI: Quality control, the latest

solutions, and ongoing challenges

Motion and physiological noise continue to be the most dominant sources of noise in fMRI. These artifacts are unfortunately common in studies of patients and developmental populations, and are particularly problematic for studies of functional connectivity. This talk will discuss various quality control (QC) metrics for assessing the severity of these artifacts, compare some of the latest correction techniques, and also highlight some ongoing challenges and pitfalls with current correction techniques and QC metrics.

Presenter

Rasmus Birn, University of Wisconsin Madison, WI
United States

Multi-echo acquisition for fMRI sensitivity enhancement and data quality control

The choice of acquisition is an increasingly recognized step in minimizing noise and artifacts in large fMRI studies. My talk will begin by discussing the acquisition side of multi-echo EPI, specifically the rationale for measuring the fMRI signal at multiple echo times for sensitivity enhancement, and the considerations when navigating the spatiotemporal acquisition tradeoffs with combined “multi-echo multi-band EPI” across field strengths. The main focus will then be on how multi-echo BOLD can be exploited for (automatic) identification and separation of the true BOLD related signals of interest and artefactual signal from nuisance sources. This can be done using, for instance, multiecho ICA (ME-ICA), and the potentials and limitations of this technique will be discussed in the context of various applications including resting state fMRI and the identification of ultra-slow BOLD changes. Final considerations will be on the ability of multi-echo EPI to thus provide a strong handle on data QC, specifically in combination with proper denoising on the single-subject level, in increasingly large fMRI studies.

Presenter

Benedikt Poser, University of Maastricht Maastricht, N/A
Netherlands

Artificially induced long-range correlations in SENSE and GRAPPA accelerated fMRI

In fMRI, techniques such as SENSE and GRAPPA have made much progress accelerating the image acquisition process by measuring less k-space data. Image reconstruction is carried by estimating the missing data using other image information. However, because it is not possible to get something for nothing, there are long-range correlations induced either within-plane or through-plane from standard SENSE and GRAPPA accelerated imaging. This talk reviews the measurement and reconstruction of fully-sampled and sub-sampled k-space data in addition to their resulting statistical properties. There are important clinical implications and errors that could occur from interpreting non-biological reconstruction induced correlations.

Presenter

Daniel Rowe, Marquett University Milwaukee, WI
United States

Is physiological noise really noise? --- Evolving QC targets in resting-state fMRI

Removal of physiological noise has long been regarded as a critical target for resting-state fMRI data processing. Numerous methods are proposed to tackle respiration and cardiac pulsation, but the less understood are variations thereof, namely respiratory-volume variability (RVT) and heart-rate variability (HRV). I will provide the cognitive basis for their involvement in meaningful brain activity, and describe recent research into their neural correlates. Furthermore, fluctuations in carbon dioxide (CO_2) has been shown as being a stronger modulator of the resting-state fMRI signal than both RVT and HRV. I will discuss potential neural correlates of CO_2 and methods for addressing vascular influences of CO_2 fluctuations. For comparison, I will also present recent work on the effect of fixing (i.e. clamping) resting CO_2 on resting-state functional connectivity. This talk will highlight caveats and future directions in the QC targets for resting-state fMRI.

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