Introduction to Resting-State fMRI and Functional Connectivity

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Highlights:

- Functional MRI (fMRI) detects changes in the blood oxygen level dependent (BOLD) signal that reflect the neurovascular response to neural activity.
- Localization of function within the brain using fMRI traditionally has been performed by presenting stimuli or imposing tasks to elicit neuronal responses.
- An alternative form of fMRI analysis looks at spontaneous fluctuations of the BOLD signal in the resting state. These spontaneous fluctuations have been shown to reflect the brain functional organization.

Target Audience: This information will be beneficial to clinicians or researchers that use fMRI methods to map functional areas of in the brain.

Objectives: The audience will gain understanding of basic analysis methods of resting state fMRI (rsfMRI) and resting state networks (RSN) in the brain.

Discussion: Since the earliest days of fMRI, it has been recognized that the BOLD signal exhibits spontaneous fluctuations [1]. These fluctuations were initially regarded as noise to be averaged out over many trials or task blocks [2]. More recent studies have shown that these spontaneous fluctuations reflect the brain's functional organization. The human brain is a disproportionate consumer of metabolic energy relative to its weight: 20% of the total energy utilization but only 2% of body weight [3]. This energy appears to be largely used for signaling [4-7]. Task performance only minimally increases energy consumption in the brain [7]. Therefore, task-based experiments ignore the overwhelming preponderance of the brain's activity. That intrinsic brain activity could be utilized for functional localization was first suggested by Biswal and colleagues who demonstrated that BOLD fluctuations observed in the resting state are correlated within the somatomotor system [8]. Correlated intrinsic activity defines multiple resting state networks (RSN) in the brain that demonstrate a high correspondence with functional areas defined with task based fMRI [9]. The development of these methods has opened up many exciting possibilities for future neurocognitive research as well as clinical applications [10].

Conclusion: rsfMRI can provide useful information on the location of functional networks in the brain.

References:

[1] Purdon PL, et al. Human Brain Mapping 1998, 6(4):239-249.
[2] Triantafyllou C, et al. Neuroimage 2005, 26(1):243-250.
[3] Clark DD, et al. Circulation and Energy Metabolism of the Brain, in: Siegel GJ, Agranoff BW (eds) Basic Neurochemistry 1999, Lippincott-Raven, Philadelphia.
[4] Shulman RG, et al. Trends in Neurosciences 2004, 27(8):1133-1145.
[5] Attwell D, et al. Journal of Cerebral Blood Flow and Metabolism 2001, 21(10):840-853.
[6] Lennie P, Current Biology 2003 13(6):493-497.
[7] Raichle ME, et al. Annual Review of Neuroscience 2006, 29:449-476.
[8] Biswal B, et al. Magnetic Resonance in Medicine 1995, 34(4):537-541.
[9] Smith SM, et al. PNAS 2009, 106(31):13040-13045.
[10] Zhang D et al., Neurosurgery 2009; 65:226-236.