Interpretation of BOLD fMRI

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Synopsis

Keywords: Contrast mechanisms: fMRI, Neuro: Brain function, Neuro: Cerebrovascular

Blood- oxygen-level-dependent (BOLD) fMRI is the most-widely used technique to measure brain function non-invasively. BOLD however is a surrogate measure of brain function as the signals reflect local changes in hemodynamics. Understanding the relationship between neuronal activity and hemodynamics is therefore critical in interpreting BOLD data. This lecture will discuss neuronal and vascular contributions to BOLD in terms of spatial and temporal specificity, and address factors that affect the variability and linearity of the BOLD response. It will also discuss the importance of signal quality and data analysis methods, and the role of models, in interpreting BOLD fMRI data.

Lecture overview

Blood- oxygen-level-dependent (BOLD) fMRI is the most-widely used non-invasive neuroimaging technique to measure brain function. BOLD fMRI though is a surrogate measure of brain function, as the signals reflect local changes in blood oxygenation, flow, and volume, that are associated with neuronal activity [1]. The BOLD contrast arises from the resulting changes in the magnetic susceptibility of venous blood due to changes in the concentration of deoxy-hemoglobin associated with oxygen consumption in the tissue [2-5]. Understanding the relationship between neuronal activity and hemodynamics can aid in extracting neurophysiological information from BOLD fMRI. In addition, signal quality and the analysis methods used also affect the neurophysiological information that can be extracted from the signals measured. This lecture will address these topics as follows:

· Describe the hemodynamics underlying the BOLD response across the cortical vascular tree.
· Discuss the neuronal and vascular contributions to the BOLD response in terms of spatial and temporal specificity.
· Discuss systematic factors (such as data acquisition parameters, field strength) affecting the spatial and temporal specificity of the BOLD response to the underlying neuronal activity
· Explore the linearity and variability in the BOLD response, including baseline physiology, vascular anatomy, and the coupling between neuronal activity and cerebral blood flow (CBF), oxygenation (O2), and metabolic rate of oxygen consumption (CMRO2).
· Give examples of connecting BOLD data with mechanistic knowledge gained from invasive electrophysiological and optical imaging studies.
· Emphasize the importance of signal quality and data analysis methods in drawing reliable conclusions from BOLD fMRI studies.
· Examine the role of biophysical models in interpreting BOLD fMRI data.

In summary, this lecture will address the capabilities and limitations of interpreting BOLD fMRI data. As BOLD fMRI has evolved from primarily topographical analysis to studying cognitive processing in both normal and abnormal neural systems, it is essential to recognize the dynamic nature of the field and the ongoing advancements in both knowledge and methodologies.

Acknowledgements

No acknowledgement found.

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