

Neuro Week 1

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Even a decade after Logothetis et al. published their paper investigating the relationship between neural activation and the hemodynamic responses there remains strong distrust toward functional MRI results in the neurobiology community. Their major concern is that the hemodynamic response, although coupled to neural activity, is not necessarily a consistent measurement--for example it has considerable variability within subjects across brain regions. Logothetis et al. chose to address this issue by collecting neural activity from intracranial recordings while collecting simultaneous BOLD fMRI data. They recorded this data from anesthetized monkeys viewing a rotating checkerboard pattern, positioning their electrodes in the granular and infragranular layers of V1. Their data shows both a "typical" BOLD response as well as MUA/LFP activity. To understand whether the BOLD response was better predicted by single/multi unit activity or local field potentials the authors show in Fig. 3 a comparison across stimulus lengths (6, 12, 24s). Single and multi-unit activity quickly adapt, while the LFP activity continues throughout stimulation. The authors also report a modeling analysis which more or less amounts to a search for an estimate of the impulse-response in V1 (the hemodynamic response). They use their estimated response, convolved with the stimulation length, to estimate a BOLD response. Their LFP-based model is a close match to the actual BOLD response. The authors conclude that the BOLD signal is highly correlated with neural activation, in particular the LFP (which shows similarity to what is recorded in EEG as well). They also conclude that a linear systems analysis (i.e. convolution of an impulse response with a stimulus vector) is a good model for the hemodynamic function based on their modeling approach, which was able to link the LFP response to the BOLD response via an estimated impulse response.

A major limitation of this experiment is the choice of V1 as a model region. V1 shows little adaptation, visible in the consistent MUA signal across a stimulus presentation of up to 24s. What would have happened if this experiment were done in other parts of the brain? Even in the visual cortex we might expect changes in the MUA/BOLD correlation as we ascend the visual hierarchy.