

TEMPORAL DYNAMICS OF THE BOLD SIGNAL

J.H.Duyn; P.Kellman; P.van Gelderen; J.A.de Zwart; M.Jansma; M.Fukunaga; R.Chu

BOLD fMRI allows the measurement of neuronal activation through tissue perfusion changes. Spatial and temporal resolution are limited by a number of factors that are inherent to signal generation, including neurovascular control mechanisms and the hemodynamic properties of the cerebral vasculature. The BOLD fMRI temporal impulse response has been estimated to have a time-to-peak and width of 4-7 seconds (Friston 2002, Dale 1997, Boynton 1996), significantly blurring the neuronal temporal information. Despite this temporal blurring, a number of reports show that in properly controlled fMRI of the visual system, BOLD does not introduce significant non-linearities (Boynton 1996, Dale 1997, Kellman 2003).

By performing fMRI at high spatial resolution and high temporal resolution, we set out to investigate to what extent temporal blurring is caused by hemodynamic effects rather than neurovascular control mechanisms. We used SENSE MRI (Pruessman) and a 16-channel brain array (de Zwart 2003) at 3.0 Tesla to allow (EPI) imaging with a spatial resolution of 1x1x3 millimeter and allow separation of contributions from intracortical regions and the pial vasculature. Visual stimuli were presented using a binary m-sequence (Kellman 2003) to obtain linear and non-linear kernel estimates of the impulse response function at high temporal (130-1000 ms) resolution and adequate sensitivity.

The results ($n > 10$) show a large spread in response timing within and across subjects, with a correlation between time-to-peak and width. Response widths as short as 2.0 s FWHM were found. Furthermore, only weak (<20%) second-order kernel amplitudes were found. These findings suggest that neurovascular control is faster than 2.0 s FWHM, and that hemodynamics have a dispersive but largely linear character that adds several seconds to the delay and width of the BOLD impulse response.

Citation:

J.H. Duyn, P. Kellman, P. van Gelderen, J.A. de Zwart, M. Jansma, M. Fukunaga, R. Chu. TEMPORAL DYNAMICS OF THE BOLD SIGNAL. Program No. 863.18. 2003; Society for Neuroscience, 2003.