Empirical question: what is the shape of the BOLD HRF response across different cortical areas? We applied transcranial magnetic stimulation (TMS) during fMRI over several brain regions to directly evoke responses.

Methods: Concurrent TMS-fMRI

- "Button press runs"  
- Visual cue = right thumb button press (20x per run)  
- To evoke HRFs in somatosensory cortex  
- Two separate runs to show variability of responses across time i.e. test-retest approach  
- "TMS runs"  
- 20 single TMS pulses per run  
- 110% of rMT intensity, scalp-cortex distance corrected

FIR-based constrained principal component analysis (cPCA)

- Multivariate approach to statistical analysis of fMRI data  
- Singular value decomposition of fMRI time series to derive eigenimages  
- 10 FIR basis functions specified for the average number time points across trials  
- Averaged, correlated BOLD signal for each time point revealed for extracted components  
- "Thresholded" eigenimages to show top 5% most extreme eigenvalues  
- Average response extracted from voxels under stimulating coil  
- Compared 4 parameters (time to onset, time to peak, response height, full width at half maximum (FWHM)) of TMS-evoked responses to button press evoked, and to responses evoked in primary auditory cortex (A1)

Results: HRF variability

Parameters from responses extracted under TMS coil  
Parameters from responses extracted under TMS coil and from primary auditory cortex

* No significant differences detected between any parameters for any conditions

Results: "Ping"

- A single TMS pulse propagates producing activation in multiple, anatomically distinct brain areas

Example Subject:

Non-specific activation evoked by TMS (regardless of stimulation target)

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