

Effects of Stimulus Repetition on Latency of the BOLD Impulse Response

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It is informative to consider not only the magnitude of the BOLD response to brief stimulation, but also its onset and peak latency. Using nonlinear fitting of a canonical haemodynamic response function (HRF) parameterised by peak height, onset latency and peak latency, we show that repetition of famous faces produces not only a decrease in peak height of the right midfusiform response, but also a decrease in peak latency (but not onset latency). The most parsimonious account of this pattern is that repeated stimuli elicit neural activity of shorter duration.

Initial Analysis

Twelve subjects made fame judgments on famous and nonfamous faces, each of which was presented twice in a randomly intermixed fashion. Faces were presented for 500ms against a baseline oval chequerboard, with a stochastic distribution of SOAs determined by a minimal SOA of 4.5s and 1/3 probability of null events. T2*-weighted transverse echoplanar images (3x3mm² pixels, TE=40ms, TR=2s) were acquired with blood oxygenation level dependent (BOLD) contrast. Images were realigned spatially and temporally, normalised, and smoothed by 8mm in SPM99. The data were highpass filtered to 1/120Hz and scaled to a grand mean over voxels and scans of 100. Data for correct responses to first (F1) and second (F2) presentations of famous faces were extracted from a right midfusiform voxel (45 -57 -24), adjusted for other events (nonfamous faces and incorrect responses), plus residual movement effects, within a General Linear Model.

Nonlinear Fitting

The adjusted data for each subject were binned every 0.5s for peristimulus times 0-32s. These data were fit by a 3-parameter function using the Nelder-Mead nonlinear minimisation of the root mean square error. The fitted function was based on a canonical HRF, which is the difference of two gamma functions representing the peak and undershoot of the BOLD impulse response (initial values: response onset = 0s, peak delay = 6s, peak dispersion = 1s, undershoot delay = 16s, undershoot dispersion = 1s; ratio of peak to undershoot = 6). The onset and peak delay were allowed to vary, in addition to the overall scaling (peak height). This scaling was applied after the reparameterised HRF had been normalised to its peak height; peak latency was calculated from the best-fitting response.

Results

Nonparametric comparisons were made using Wilcoxon's T-statistic. Median peak heights for F1 and F2 were 1.37 and 1.03 respectively, median onset latencies were -0.04 and 0.26, and median peak latencies were 4.62 and 4.38. The peak heights and peak latencies differed significantly (T=5 and T=14, df=11, p<.05), but onset latencies did not (T=35).

Conclusion

Repetition effects have been interpreted as decreases in instantaneous neural firing rates ("repetition suppression"). Because the BOLD response effectively integrates neural activity over short periods (seconds), decreasing the duration of neural activity decreases both the height and peak latency of the BOLD impulse response. The present BOLD repetition effects must therefore reflect a decrease in the time-constants of the evoked neural transient, with or without classical repetition suppression.

