COMPARISONS OF SIGNAL CHANGE FROM *INVIVO* SMARTPHANTOM AND HUMAN BOLD FMRI OF LANGUAGE AND MOTOR SYSTEMS

Tim Conway (VA Brain Rehabilitation Research Center), Jian-Bo Gao (UF, Electrical/Computer Engineering), Keith White (UF, Psychology), Qun Zhao (Univ. of Georgia, Dept. of Physics & Astronomy and Bio-Imaging Research Center)

Introduction

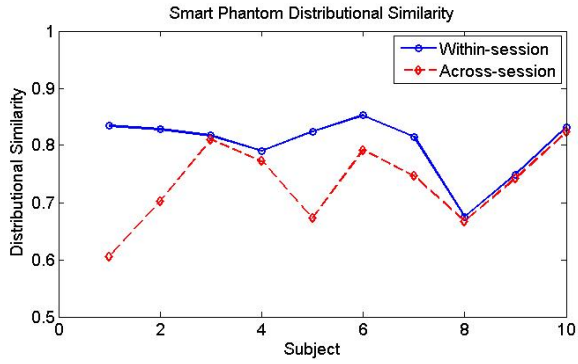
Reliability of functional magnetic resonance imaging (fMRI) using blood oxygenation-level dependent (BOLD) contrast is hard to estimate. Smart Phantom (Invivo Corp.) is a device that eliminates human variability from fMRI reliability tests by generating simulated-BOLD signals electronically in a $NiCl_2$ in H_2O phantom. A second device (non-NHMFL funding), Smart Coil, generates simulated BOLD signals in living human brain. In both devices, direct current flowing in the coils during phase encode or readout locally distorts the B_0 field, inducing dephasing effects analogous to those produced by oxy-/deoxy-hemoglobin. This simulates the basis of BOLD contrast in a controllable manner. We used simulated-BOLD signals to study instrument reliability, and compared it to reliability of actual BOLD signals from human participants [1,2,3].

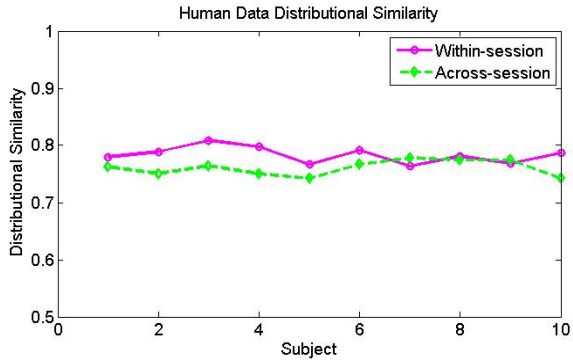
Experimental

Time series of computer-controlled current flows were generated to roughly approximate the temporal frequency contents of hemodynamic responses. Gradient-echo EPI scans of the SmartPhantom were performed on a Siemens 3T Allegra (TR =1700 msec; TE = 25 msec; FA = 70° ; matrix 64x64; 25 interleaved slices covering the phantom with no gap).Humans were imaged with the same parameters save that 32 slices were collected to cover the whole brain.

Results and Discussion

Test-retest reliability of simulated-(or of actual) BOLD statistical parametric spatial maps, based on cross-correlation of voxel time courses with ideal waveforms, was evaluated with a distributional similarity index, mutual-information-based integrated squared error divergence. Reliability was measured comparing two runs (a) within a scan session or (b) across sessions separated by one or twelve weeks.





Conclusions

Test-retest reliability of spatial maps was somewhat variable for Smart Phantom. Positioning the SmartPhantom in the scanner with a jig rather than by hand may reduce these unwanted variations. Simulated BOLD generated in human brain by Smart Coils (data not shown) are promising to determine fMRI sensitivity and specificity, as well as reliability [4].

References

[1] Zhao, Q, *et al*., 14th ISMRM, Seattle, WA (2006).
[2] Lee, J., *et al*., 14th ISMRM, Seattle, WA (2006).
[3] Li, Y.., *et al*., 14th ISMRM, Seattle, WA (2006).
[4] US Patent Application 60/793,210, "Device for Calibrating Human Functional Magnetic Resonance Imaging" (2006)