# Calibration of fMRI Activation for the FIRST BIRN Project

M. E. Thomason[1], L. Foland[2], F. BIRN[3], G. H. Glover[1,2]

[1]Neurosciences, Stanford University, Stanford, CA, United States, [2]Radiology, Stanford University, Stanford, CA, United States, [3]Biomedical Informatics Research Network, NIH NCRR, Bethesda, United States

Introduction The FIRST (Functional Imaging Research Schizophrenia Testbed) Biomedical Informatics Research Network (fBIRN) program is the first-ever large scale, multi-center fMRI study of schizophrenia (http://www.nbirn.net). The fBIRN goal is to scan 60 subjects at each of the 11 participating sites to enable the acquisition of a large and diverse study population in a modest time period. To be able to pool fMRI scan data across sites, a calibration series was performed utilizing a protocol in which 5 normal volunteers were scanned at each of the 11 sites. The concept was to examine whether activation from a sensorimotor and/or hypoxic challenge could be used to eventually normalize data from the cognitive tasks associated with the schizophrenia evaluation across sites. This abstract presents initial results for comparison of sensorimotor and breath-holding activation from scans conducted at Stanford University, one of the 11 sites.

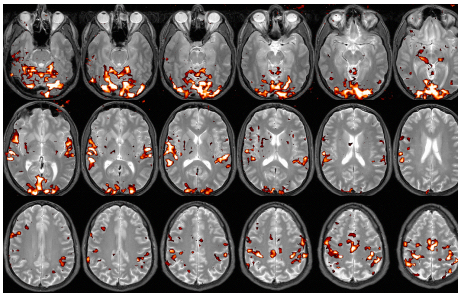
Methods The calibration protocol comprised 2D and 3D anatomic scans and 8 fMRI scans that were performed in one session for each subject and repeated the next day. Three of the five subjects began the fBIRN study at Stanford University and returned approximately 1.5 months later for repeat scans. The other two subjects were scanned during one 2-day visit. Thus, a total of 16 scan sessions was utilized in the analysis presented here. The functional portion of the calibration scan protocol included 4 sensorimotor (SM) tasks, 2 breath-holding (BH) tasks and 2 resting state (R) scans. During the 15s experimental condition of the SM task, the subject viewed a contrast-reversing checkerboard pattern while performing bilateral finger tapping on button boxes and hearing frequency modulated auditory tones, all synchronized at 3Hz. The control condition was a 15s fixation cross; 8 on-off blocks were collected. The BH task consisted of 15s of normal breathing and 15s of breath-holding after inspiration, visually cued and repeated for 8 cycles. This caused systemic hypoxia and resulted in global BOLD signal modulation not dependent on cognition. The signal significantly decreased during breath-holding epochs, as has been demonstrated previously (1). The resting state scans are not discussed here.

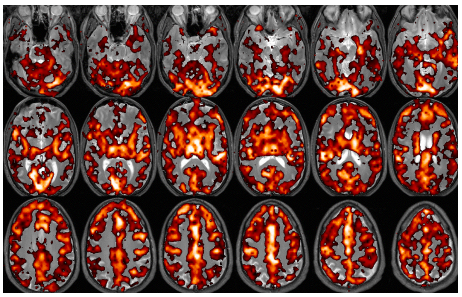
After giving informed consent, the volunteers were scanned at 3T (GE Signa, Cv/Nv gradients) using a spiral-in/out sequence (2). The fBIRN acquisition parameters were 35 axial 4 mm contiguous slices, 22 cm FOV, 64x64 matrix, TE 30ms, TR 3000ms, 87 time frames (2 discards). After 2 cognitive tasks (Sternberg and mismatched negativity),functional calibration scans were obtained in the following order: SM1, R1, SM2, BH1, SM3, BH2, R2, SM4. The image timeseries were analyzed with ROIs in visual, auditory and motor cortices defined using activation maps from SM4. Percent BOLD signal in the SM and BH scans was obtained with Fourier analysis of the timeseries signal by averaging over all activated voxels. These values were averaged over the session (4 SM and 2 BH scans), to give one (SM-BH) data pair for that session and ROI. These results were plotted to determine degree of correlation between SM and BH.

Results The figures show typical activation maps for SM and BH as well as quantitative BOLD signal comparisons for auditory cortex. The latter resulted in a grouped linear regression $R^2$ value of 0.50 and slope of 0.42 for SM vs. BH (Fig. 3). Similar results were obtained in motor and visual cortices with $R^2$ values of 0.62 and 0.47, respectively, suggesting a good correlation between the non-cognitive BH task and the sensorimotor task. Global variations in the BH BOLD signal during repeated scans in the same and subsequent days were observed. These variations may result from differences in inspiration level.

Conclusion The observed correlation between BOLD signal in the BH task and SM task suggests that BH is an effective calibration metric, because it is a measure of vascular reactivity (i.e. is a systemically caused $O_2$ state change) intrinsically devoid of neuronal processes and is therefore not modulated by attentional variations. In addition, while SM provides activation only in sensory regions, BH results in global BOLD modulation in gray matter (Fig. 2), so that all active voxels in the brain can be characterized. This is an important consideration for calibrating between-group or in multicenter studies of higher cognitive function. For greatest reliability it may be important to control the level of inspiration during BH.

Supported by the NIH NCRR FIRST Biomedical Informatics Network (RR00827-28), RR09784, MH63576, Lucas Foundation and GEMS.





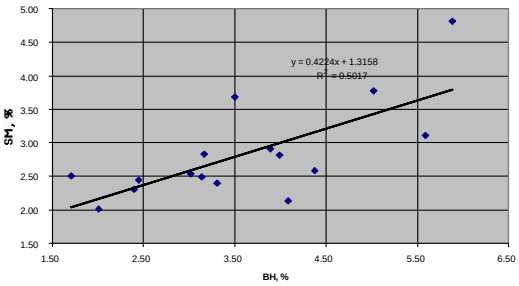



Fig. 1 (Left): Activation maps for SM task; Fig. 2 (Center): activation maps for BH task; Fig. 3 (Right): BOLD signal for SM vs. BH.