# Effect of Different Frequency Bands on Functional Connectivity in the Motor Cortex Network

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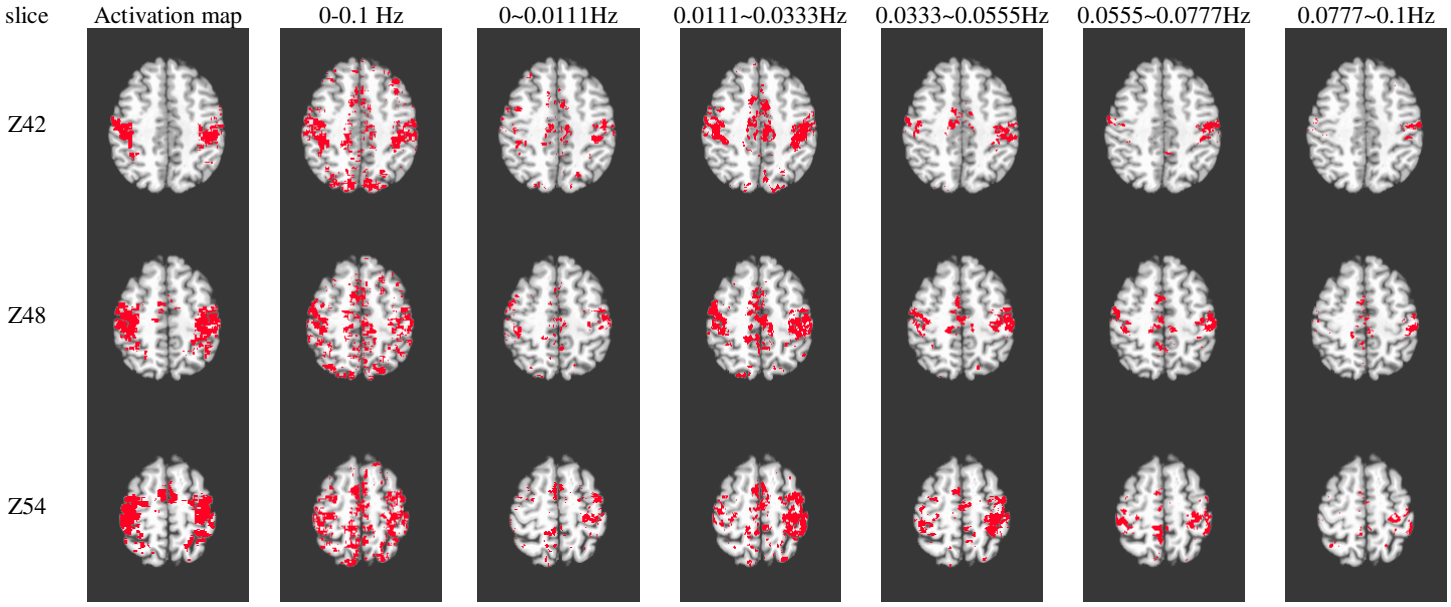
**Introduction:** Spontaneous low-frequency fluctuations (SLF) detected by functional MRI (fMRI) techniques have been utilized to investigate functional connectivity in human brain networks. SLF has been demonstrated as T2* dependant, hence, a hemodynamic phenomenon. Its effective frequency band is usually defined as 0~0.1Hz [1]. However, few studies have investigated SLF signal on different narrower frequency bands. In the present study, we investigate the functional connectivity of SLF in the primary motor model and determine the effect of different frequency bands of the SLF signal on functional connectivity maps by using a series of carefully designed band-pass filters to extract different narrow band-limited SLF signals.

**Materials and Methods**: The fMRI experiments were conducted on a GE 3T Signa scanner. Nine healthy young subjects were recruited for the experiments, and informed consent was obtained from all the subjects for this IRB-approved study. The fMRI parameters were: single-shot gradient echo EPI sequence, axial images, TE/TR=30/2000 ms, slice thickness of 4mm, matrix size of 64×64, FOV of 24 cm. For each subject, two fMRI scans were acquired: resting-state scan acquired 180 repeated images and block-designed finger-tapping tasks with 180 repeated images (30s on, 30s off, 6 blocks). Three activated regions were determined in the motor cortex network with the block-designed scan ($P$<0.05 with Bonferroni correction): left primary motor cortex (LM), right primary motor cortex (RM), and supplementary motor cortex (SM). In this study, the LM was selected as the seed region for functional connectivity processing. Cardiac and respiration cycle data were also recorded by using a pulse-oximeter and pneumatic belt. For preprocessing, all the brain voxel time courses of the resting-state scan were processed by RETROICOR method [2] to regress out unwanted cardiac and respiration noise. **Filters:** The effective frequency range of the resting-state voxel time course was 0~0.25Hz due to TR of 2 seconds. A series of finite impulse response (FIR) filters were designed by using Parks-McClellan method (REMEZ algorithm) [4] to divide this frequency range into 7 sub-bands: 0-0.1 Hz, 0~0.0111Hz, 0.0111~0.0333Hz, 0.0333~0.0555Hz, 0.0555~0.777Hz, 0.0777~0.1Hz, and 0.1~0.25Hz. FIR filters preserve the phase shift between the voxel time courses on each frequency component. Thus, for each sub-band, the functional connectivity map was obtained by correlating the sub-band signal of the averaged voxel time course in the LM region with the same sub-band of the brain voxel time courses in the whole brain. The obtained cc map of the sub-band signal then was transformed to Talairach space. For group analysis, each sub-band maps was transformed to Z-score map with the nine-subject-pool. Finally, the maps were presented as normalized Z-score maps (divide Z-score to 4). For comparison, the activation map from the block-design scan was also generated as the normalized Z-score map.

**Results and Discussion**: The functional-connectivity maps of each sub-band are presented and compared with the activation map on three slices at Z42, Z48 and Z54, shown in Figure 1. It is demonstrated that among all the sub-bands, the functional connectivity map of 0.0111~0.0333Hz sub-band resembles the finger-tapping activation map most, suggesting that the effective SLF components are concentrated within this band, i.e., centered around 0.02Hz. Although other sub-bands showed a self-connected map within the LM region, there is little connectivity between the left and right sides of the motor cortex. These results demonstrate that the SLF signal that determines the functional connectivity within the range of 0-0.1 Hz can be further narrowed to the frequency range of 0.0111-0.0333 Hz, providing a significant advantage in the SNR for cross-correlation analysis.




**References**: 1. Biswal B et al. MRM 1995;34:537-541. 2. Glover GH et al. MRM 2000;44:162-167.
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