Introduction

Adult animal brains adjust to damage by recruiting areas not previously used to perform an activity, primarily through engaging in the activity impaired by damage[1]. Thus, design of maximally effective rehabilitation for brain damage entails understanding neuroplastic responses to rehabilitation. The Locomotor Initiative of the VA RR&D Brain Rehabilitation Research Center (BRRC) seeks to understand neuroplastic substrates of locomotor treatments for stroke. The BRRC Locomotor Initiative and Neuroimaging Core are developing ways to measure brain activity responsible for lower extremity movement using functional MRI (fMRI). As a beginning step, an fMRI isometric ankle dorsiflexion paradigm [2] was modified and implemented during fMRI with normal and stroke subjects. One challenge in implementing this paradigm has been head motion coincident with ankle movements that obscures brain activity. Methods focused on minimizing head motion during fMRI and removing motion-related signal artifacts during data analysis.

Experimental

Five healthy and six stroke subjects completed one or more of the following paradigms fMRI: a single-event “hold” paradigm where subjects performed isometric dorsiflexion at 20% of maximal effort and held the at that effort for 5.1 s, a block paradigm in which subjects performed 3 consecutive “hold” trials with 3.4 s between them, and a single-event “release” paradigm where subjects initiated isometric dorsiflexion and released once 20% of maximal effort was reached. Functional (TR= 1700ms, TE=30ms, FA=70, voxel size=4.0 x 3.75 x 3.75 mm, slices=36, orientation=sagittal, no gap) and structural (TR= 8.1ms, TE=3.7ms, FA=8, voxel size=1 x 1 x 1 mm, slices=160, orientation=sagittal, no gap) images were acquired on the Philips 3 Tesla instrument at the Advanced Magnetic Resonance Imaging and Spectroscopy facility (AMRIS) at the McKnight Brain Institute (MBI) of the University of Florida. Data were analyzed with the 3dDeconvolution program of Analysis of Functional Neuroimages (AFNI) software from NIH and locally developed programs.

Results and Discussion

Motion was prevalent during the block paradigm, and motion-related artifacts were difficult to mitigate while maintaining sensitivity because they were comingled with signal from hemodynamic responses. Motion also was prevalent during the single-event “hold” paradigm, but the different time courses of artifacts (rapid) and hemodynamic responses (slow) allowed for mitigation of motion-related artifacts. Motion was less prevalent in the single-event “release” paradigm than in the other paradigms, but the signal intensity was also of lower amplitude than in the other paradigms. The best results for analysis of single-event paradigms were achieved with a combination of selective detrending for motion-related artifacts and low-pass filtering.

Conclusions

The single-event “hold” paradigm seems best for applications where sensitivity is paramount, but the single-event “release” paradigm is more suitable when specificity is at issue.

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References