Reliability comparison of spontaneous brain activities between BOLD and CBF contrasts in eyes-open and eyes-closed resting states

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Abstract: Blood oxygenation level dependent (BOLD) and arterial spin labeling (ASL) are two predominant resting-state fMRI techniques in mapping spontaneous brain activities. At single voxel level, cerebral blood flow (CBF) measured by ASL and amplitude of low frequency fluctuations (ALFF) of BOLD have been recognized as useful indices to characterize brain function in health and disease. However, no study has directly compared the test-retest reliability between BOLD and CBF contrasts on the same group of subjects at single voxel level. Moreover, both eyes-open and eyes-closed conditions have been employed as resting states, but it is still not clear which state is more reliable. Here we collected BOLD and ASL data during eyes-open and eyes-closed states across three scanning visits on twenty-two healthy young subjects. CBF-mean, BOLD- and CBF-ALFF were computed to characterize corresponding brain activities at single voxel level. Seed-based functional
connectivity (FC) with the posterior cingulate cortex (PCC) was further calculated for both BOLD and CBF data. Intra-Class Correlation was used as the index of long-term reliability between visits 1 and 2 (two months apart) and short-term reliability between visits 2 and 3 (on the same day). Both short- and long-term reliabilities for CBF-mean and BOLD-ALFF were high, but were lower for CBF-ALFF, BOLD- and CBF-FC in both eyes-open and eyes-closed states. Direct comparisons showed that brain regions with the highest reliability of CBF-mean were mainly in the gray matter. The reliability of CBF-ALFF and BOLD-FC was lower than that of BOLD-ALFF, and the reliability of CBF-FC was lower than those of both CBF-ALFF and BOLD-FC. Furthermore, we observed that reliabilities of the eyes-open state were higher than those of the eyes-closed state for both imaging contrasts, though the effect size was small. Voxel-wise comparisons demonstrated that the long-term reliability of BOLD-ALFF was significantly higher with eyes open in the visual system, and both the short- and long-term reliability of BOLD-FC was slightly higher with eyes open in the default mode network. Moreover, we showed that denoising decreased the reliability of both ALFF and FC of both BOLD and ASL contrasts. In conclusion, our results indicated that CBF-mean and BOLD-ALFF could both be used as reliable indices for characterizing resting-state brain activities at single voxel level and recommended the eyes-open state for resting-state studies, especially for those targeting the visual system and default mode network.

**Key words:** oscillation, cerebral blood flow, resting state, eyes open, eyes closed