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Exploring the high-resolution EPI fMRI protocol to reduce susceptibility-related BOLD signal dropout

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RESEARCH BACKGROUND

Signal Dropout

- Signal dropout caused by air, is especially severe in the orbitofrontal area and temporal area
- Blood Oxygen Level Dependent (BOLD) signal decays too fast to detect

High resolution EPI sequence

- The conventional fMRI studies have used low resolution EPI sequence whose voxel size is bigger than 3mm
- Images with voxel size smaller than 3mm can be acquired using the multiband EPI sequence
- The high resolution functional images can be used for more sophisticated functional connectivity study

METHODS

SCAN PROTOCOLS

- Philips 3T Ingenia CX, 32 channel head coil

Functional Image

- EPI sequence; TR = 2000ms, TE = 30ms, 80 axial slices, Multiband factor = 4, SENSE factor = 1.4, voxel size = 2 * 2 * 2mm^3, FOV = 216 * 216mm^2, FA = 71°
- Total 18 time points were acquired and first 8 time points were discarded to ensure magnetization equilibrium
- Except slice tilt and polarity, parameters were same
- 3 Slice tilt; 30 ° slice tilt, parallel to Anterior Commissure and Posterior Commissure (ACPC) line, -45 ° slice tilt[4]
- 2 polarities; Anterior to Posterior (AP) and Posterior to Anterior (PA)
- Acquisition order was counter balanced

Field Image[1]

- Two spin echo EPI field images; TR = 9031.50ms, TE = 70ms, Multiband factor = 4, 80 axial slices, voxel size = 2 * 2 * 2mm^3

Structural Image

- T1 weighted image; TR = 8.04ms, TE = 3.68ms, 170 sagittal slices, voxel size = 1 * 1 * 1mm^3,FOV = 240 * 240mm^2, FA = 8°

DATA ANALYSIS

Participants

- 18 healthy right handed subjects (8 females; mean age = 24.07)

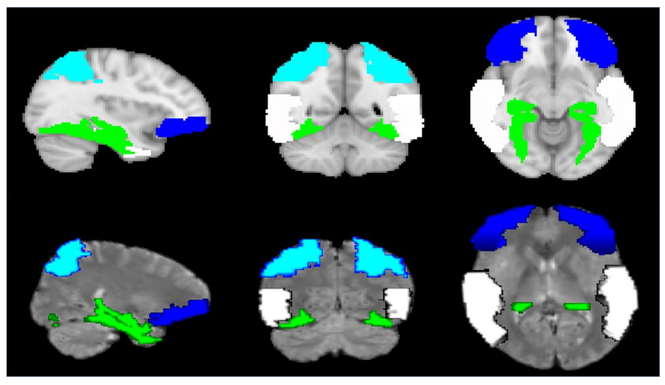
Preprocessing

- FSL 5.0 command line tool and SPM 12
- Fieldmap correction (TOPUP) – motion correction (MCFLIRT) – co-register (FLIRT) – average image (FSLMATHS) – reverse normalization (FLIRT)

*Automatic Anatomical Labeling (AAL) template to individual space

AAL Template[2][3]

- The orbitofrontal lobe, temporal lobe; inferior, middle, superior
- The parietal lobe; inferior, superior
- The hippocampus, parahippocampus, fusiform face area (FFA)



Upper
AAL template in MNI space

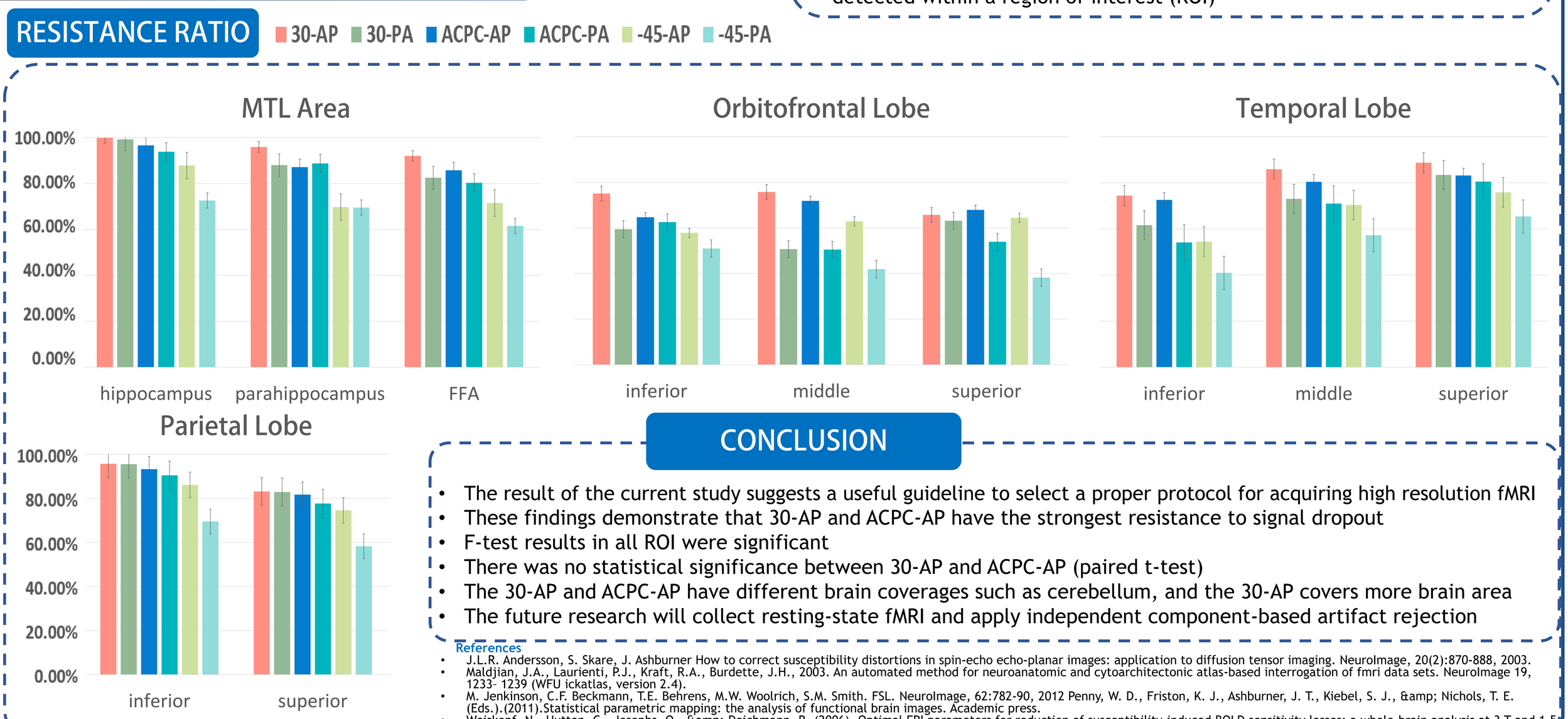
Lower
AAL template in individual space

Resistance Ratio of Signal Dropout

- Resistance ratio was defined as the percentage of voxels where signals were detected within a region of interest (ROI)

RESULTS / CONCLUSION

RESISTANCE RATIO



CONCLUSION

- The result of the current study suggests a useful guideline to select a proper protocol for acquiring high resolution fMRI
- These findings demonstrate that 30-AP and ACPC-AP have the strongest resistance to signal dropout
- F-test results in all ROI were significant
- There was no statistical significance between 30-AP and ACPC-AP (paired t-test)
- The 30-AP and ACPC-AP have different brain coverages such as cerebellum, and the 30-AP covers more brain area
- The future research will collect resting-state fMRI and apply independent component-based artifact rejection

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