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Introduction

- It is often beneficial to determine language lateralization prior to neurosurgical intervention in children with epilepsy.
- Currently, the most commonly used method for lateralizing language via fMRI is threshold based qualitative assessment of statistical parametric color maps.
- There is no current gold standard for fMRI based quantitative determination of language lateralization.

Objectives

- We compared three methods of lateralizing language via task-based fMRI:
 1. Threshold dependent qualitative analysis
 2. Threshold independent quantitative hemispheric laterality index (AveLI-H)
 3. Threshold independent quantitative language center regions of interest (ROI) laterality index (AveLI-L)
- Methods 2 and 3 were compared to Method 1. We hypothesized that Method 3 will produce results more similar to that of Method 1.

Methods

- 10 patients with epilepsy who underwent presurgical planning fMRI were retrospectively included.
- BOLD imaging data from both auditory decision making (ADT) and verbal phonemic fluency (VPF) tasks were obtained in all 10 patients.
- Statistical parametric maps obtained from fMRI data were processed via three methods.

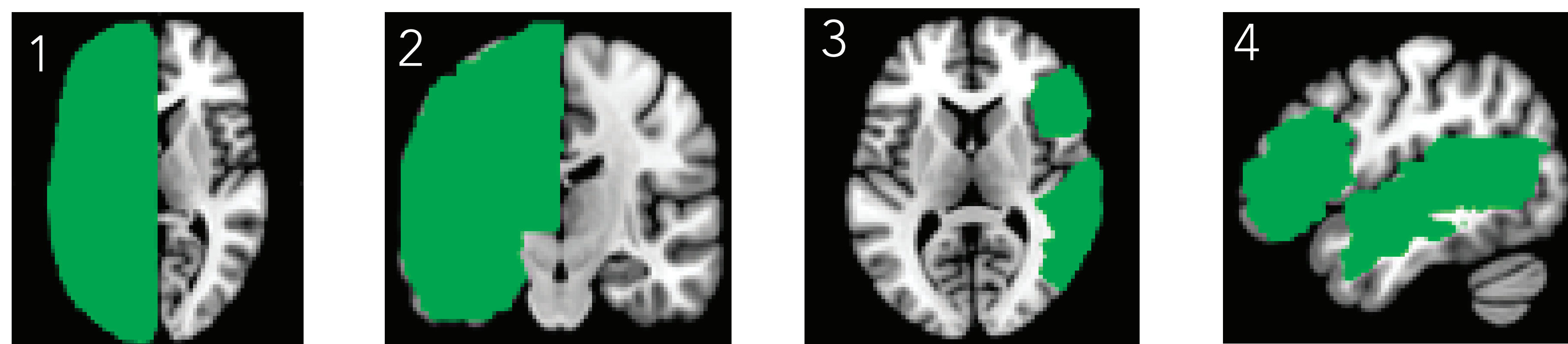
Method 1

MRIs were processed by a pediatric neuroradiologist using Syngovia¹ or Dynasuite².

Thresholds were applied to data from each language paradigm based on visual inspection by the neuroradiologist to qualitatively determine hemispheric dominance for language.

Methods 2 and 3

MRIs were pre-processed with SPM12³. Masks were then applied to include BOLD signal from the entire cerebral hemisphere (Method 2) or from language center ROI (Method 3). Masks were created in WFU_PickAtlas⁴. Language ROI masks included the inferior frontal gyrus, middle temporal gyrus, and superior temporal gyrus. Separate masks were created for left and right hemispheres. fMRI data was analyzed in Matlab⁵ using the AveLI^{6,7} method described below. Sample masks of the entire right cerebral hemisphere (Figures 1, 2) and left hemisphere language centers (Figures 3, 4) are shown.

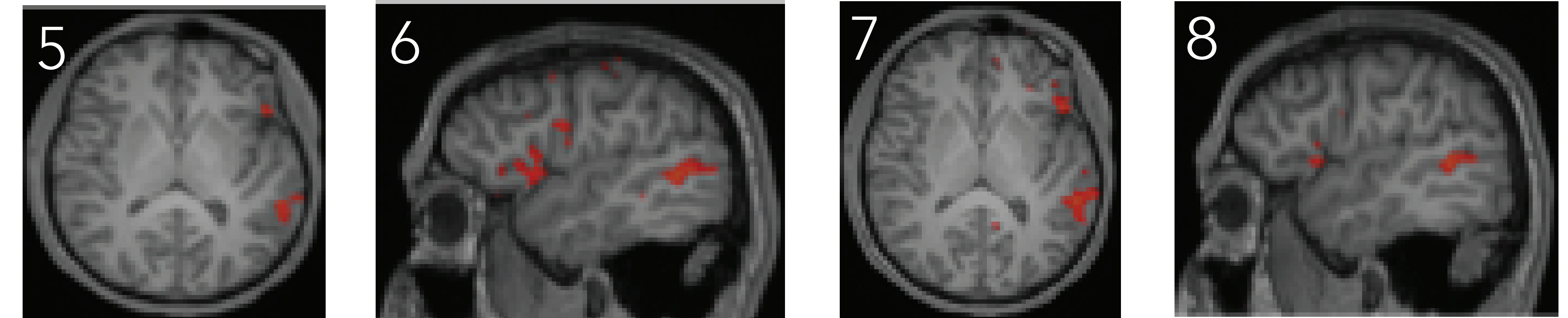


Laterality Index (LI)

- LIs of BOLD signal were calculated using the formula: $(L-R)/(L+R)$
- LIs were calculated at every possible threshold and averaged to create a threshold independent average LI (AveLI).
- $LI < -0.2$ = right dominant; $-0.2 < LI < 0.2$ = bilateral language dominance; $LI > 0.2$ = left dominant

Results

Threshold dependent qualitative analysis by the pediatric neuroradiologist most closely matched the threshold independent quantitative language ROI based technique for language lateralization. Additionally, the threshold independent quantitative language ROI technique determined language dominance in 3 ADT tasks and 2 VPF tasks when the pediatric neuroradiologist could not.



Activation clusters for ADT task in the left frontal operculum and along the left superior temporal sulcus posteriorly at $t = 4.0$ (Figures 5 and 6) and $t = 6.0$ (Figures 7 and 8) using Method 1.

N=10	Method 1 (Clinical)	Method 2 (AveLI-H)	Method 3 (AveLI-L)
Task 1 (ADT)	Left = 6 Right = 0 Bilateral = 1 Inconclusive = 3	Left = 5 Right = 1 Bilateral = 4	Left = 7 Right = 1 Bilateral = 2
Task 2 (VPF)	Left = 7 Right = 0 Bilateral = 1 Inconclusive = 2	Left = 6 Right = 0 Bilateral = 4	Left = 9 Right = 0 Bilateral = 1

Conclusions

- Threshold independent language ROI quantitative fMRI analysis can determine language dominance, and may do so in cases when a radiologist using conventional threshold dependent methods cannot.
- Further studies including correlation with WADA testing and postsurgical outcomes are needed to determine what method is best for accurately determining language dominance.
- Improved signal to noise ratio with technological advances in MRI hardware and software may allow for more targeted, smaller ROI for analyzing language dominance.

References

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