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Initial validation of a novel method of presurgical language localization through functional connectivity (fcMRI)

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Presenter/Creator Information
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Initial validation of a novel method of presurgical fMRI language localization through functional connectivity

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Introduction

Neurosurgery is potentially curative in chronic epilepsy but can only be offered to patients if the surgical risk to language is known. Clinical functional magnetic resonance imaging (fMRI) is a potentially ideal, noninvasive method for localizing language cortex yet remains to be validated for this purpose. Connectivity analyses presented here provide preliminary validation for this method by demonstrating that such maps are likely to be functionally-cohesive.

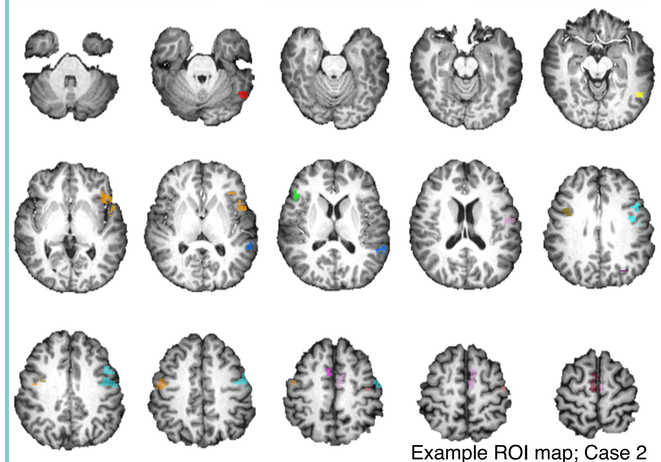
Subjects and Methods

- 16 temporal lobe epilepsy (TLE) patients
  - undergoing evaluation for surgery
  - mean age 38.9, sd 11.4
  - 14 left language-dominant, 1 right, 1 mixed (Wada)
- 4 min runs of language and motor tasks
  - language tasks: auditory responsive naming, object naming, visual responsive naming
  - motor tasks: foot-tapping, finger-tapping, tongue motor

Analysis

Network Definition

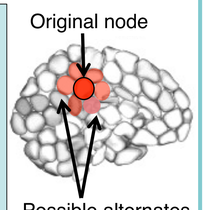
Clinician-defined map (variable z-threshold, selection of language tasks) → Mask clinician-defined maps with language BA mask → Define ROIs as contiguous clusters of voxels (>155 mm^3)



Example ROI map; Case 2

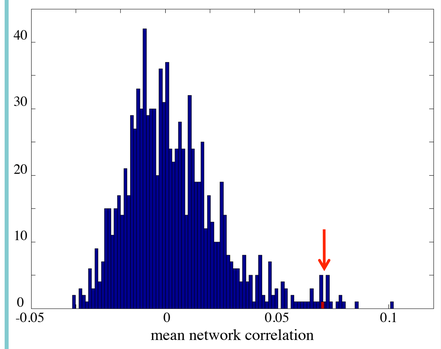
Significance Testing

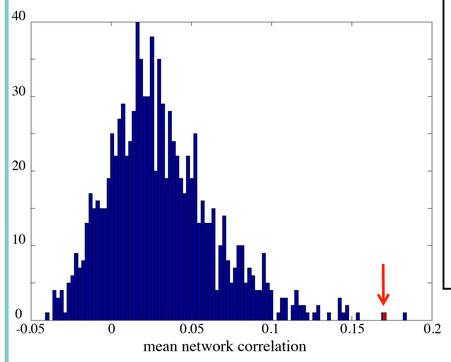
Mean network connectivity during motor tasks → Permutation test of proximal random networks
- 1000 iterations
- center of mass allowed to vary -9mm, 0mm, or +9mm each direction
- Selection process: drop if >50% outside grey matter; 10% allowed to drop



Results

Distribution of Alternate Network Mean Correlations





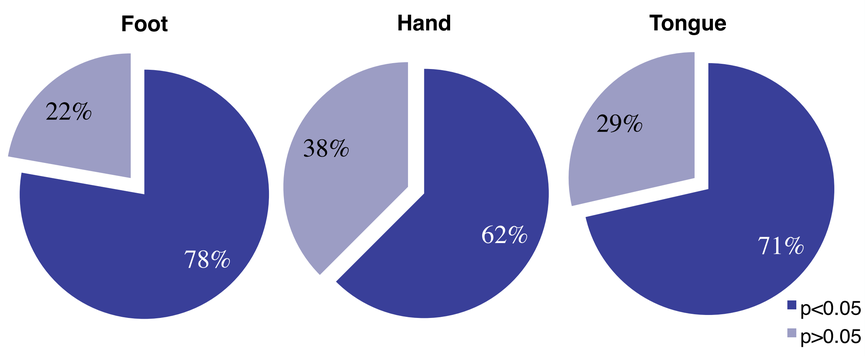
Example distributions for case 5 - tongue (top) and case 8 - tongue (bottom)

Mean Network Correlation

Case	Foot	Hand	Tongue
1 (R)	0.14*	0.10*	0.19**
2 (R)	0.20*	0.08	0.15*
3 (L)	-	0.08**	0.06*
4 (R)	-	0.13*	0.08
5 (L)	0.07*	0.11**	0.07*
6 (R)[1]	0.03*	0.03*	0.02
7 (L)	-	0.01	0.05
8 (R)	-	0.07	0.17**
9 (R)	0.06*	0.07*	0.10**
10 (R)	-	0.18*	-
11 (R)	0.04	0.02	0.13*
12 (R)	0.19*	0.06	0.31**
13 (R)	-	0.13*	-
14 (R)	-	0.08	0.21**
15 (R)	0.29**	0.18**	0.11*
16 (L)	0.06	0.14*	0.10

* p < 0.05
** p < 0.01
r < 0.1 with p < 0.05
[1]40% dropout threshold

Percent scans validated via permutation test



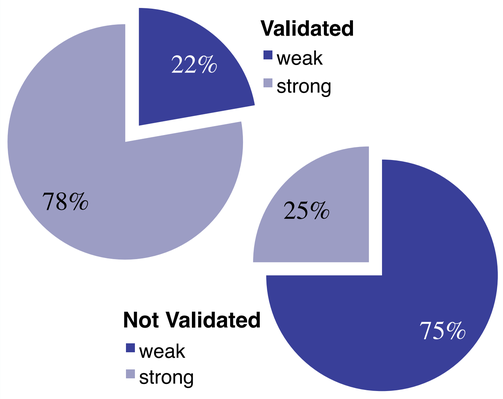
Composition of Network: Weak Nodes

Case	Foot	Hand	Tongue
1 (R)	5/14	3/14	2/14
2 (R)	2/9	3/9	2/9
3 (L)	-	11/28	14/28
4 (R)	-	4/14	6/14
5 (L)	11/18	9/18	7/18
6 (R)	24/30	23/30	28/30
7 (L)	-	15/16	11/16
8 (R)	-	9/14	4/15
9 (R	9/18	8/18	7/18
10 (R)	-	3/17	-
11 (R)	9/12	6/12	3/12
12 (R)	3/15	8/15	1/15
13 (R)	-	7/23	-
14 (R)	-	8/14	3/14
15 (R)	2/20	4/20	9/20
16 (L)	7/13	4/13	5/13

Majority weak (MW): >50% nodes weakly correlated (r<0.1) with network

Validated + no MW	Validated + MW
Not validated + no MW	Not validated + MW

Percent scans with MW



Summary

- 69% of clinician-derived language maps exhibited mean connectivity greater than proximal random networks (p<0.05)
- 77% of clinician-derived language maps exhibited mean connectivity greater than fully random networks (p<0.05)
- 75% of networks not passing the proximal permutation test contained a majority of weak nodes. In contrast, only 22% of networks passing the test contained a majority of weak nodes

Discussion

- The majority of clinician-derived language maps demonstrated significant functional connectivity, indicating that these regions are functionally related
- The networks that do not pass the permutation test may contain many nodes that are not part of the network
- Next steps include: relating these results to surgical outcomes, and comparing fMRI language maps using this technique with the results of direct stimulation mapping

Conclusion

- This study provides preliminary validity for a novel, clinician-based approach to presurgical language localization
- This complements our recent work showing this method is reliable, and supports future work validating this method

Acknowledgement

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