The role of the left and right inferior frontal gyrus in language recovery in aphasia

Peter Glynn, Swathi Kiran, & Chaleece Sandberg

Aphasia Research Laboratory, Boston University, Boston, MA

INTRODUCTION

The mechanisms of the involvement of the left and right inferior frontal gyrus (IFG) in the process of post-stroke language recovery are not well understood.

- Some studies have underlined the role of LIFG in recovery mechanisms (Sebastian & Kiran, 2011; Saur et al., 2006; Fridriksson, 2010).
- Other studies have implicated the RIFG in compensatory functions (Abo et al., 2004; Fridriksson & Morrow, 2005).

Main Hypothesis: LIFG is very important in language recovery to the extent that LIFG tissue is spared post stroke.

Research Question: What is the relationship between % spared tissue and % signal change

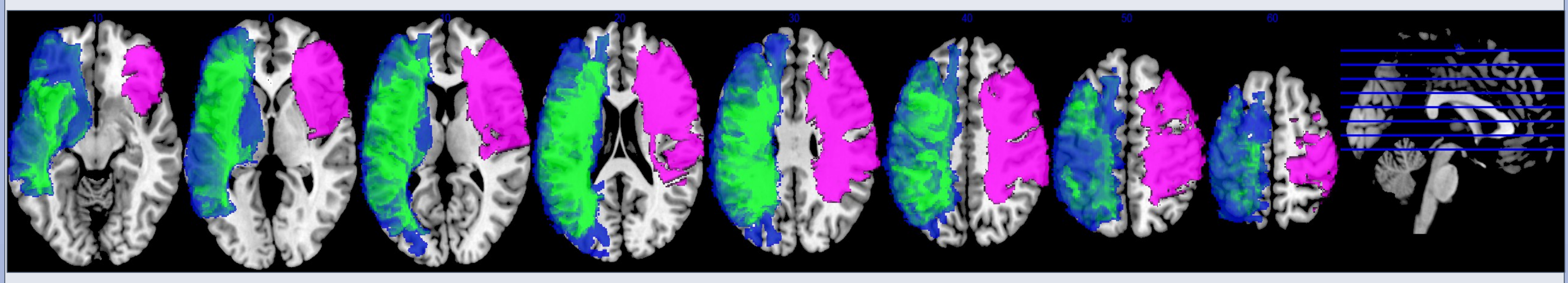
1) in the IFG and ipsilesional tissue?
2) in the IFG and corresponding contralesional tissue?
3) in the IFG and all other regions?

PARTICIPANTS

Table 1. Participant Profiles

	P1	P2	P3	P4	P5	P6	P7
Age	56	66	55	54	59	59	49
Gender	Female	Female	Male	Male	Male	Male	Male
Months Post Stroke	38	15	76	108	144	23	168
Lesion Region	Left MCA	Left ICA	Left MCA	Right MCA	Left MCA	Left MCA	Left MCA
Lesion Size (volume of cortex)	85cc	112cc	133cc	180cc	180cc	228cc	314 cc

Lesion overlap in left hemisphere (n=6) and right hemisphere (n=1)



METHODS

Participants were scanned once while performing a semantic language task in English.

Data Acquisition Parameters:

- T1: 140 sagittal slices, $1mm^3$ voxels, 240 x 240 matrix, FOV = 240 mm, flip angle = 8, fold-over direction = AP, TR = 8.2ms, TE = 3.8ms
- BOLD:31 axial slices (3mm thick, 0.3 interslice gap), $3mm^3$ voxels, 80 x 78 matrix, FOV = 240, flip angle = 90, fold-over direction = AP, TR = 2000ms, TE = 35ms

Preprocessing in SPM8
- Lesion Masking (MRIcron)
- Slice Timing
- Realignment
- Coregistration
- Segmentation (lesion masked as Brett et al., 2001)
- Normalization
- ART Repair (Mazaika et al., 2009)

Statistical Modeling in SPM8
- Fixed Effects Analysis using GLM
- Canonical HRF and its Temporal Derivative
- High Pass Filter of 128 s

Bilateral ROIs
- IFG opercularis
- IFG orbitalis
- IFG triangularis
- Middle Frontal Gyrus
- Superior Frontal Gyrus
- Angular + Suprmarginal Gyri
- Middle Temporal Gyrus
- Anterior Cingulate

ROI and Correlation Analysis
- Subtracted normalized lesion maps from ROI maps (AAL atlas)
- Calculated ROI volumes using MRIcron
- Calculated % of spared tissue as (Anatomical ROI Volume –Lesion Volume)/(Anatomical ROI Volume)
- Calculated % signal change in ROIs using Marsbar (Brett et al., 2002)
- Non-parametric Spearman correlation determined for the % spared tissue in each ipsilesional ROI and % signal change within each ROI

REFERENCES

Abo, M. C., Senoo, A., Watanabe, S., Miyano, S., Doseki, K., Sasaki, N., Kobayashi, K.,Kikuchi, Y., & Yonemoto, K. (2004). 'Language-related brain function during word repetition in post-stroke aphasics', Neuroreport, vol. 15, pp. 1891-1894.

Brett, M., Anton, J. L., Valabregue, R., & Poline, J. B. (2002). 'Region of interest analysis using an SPM toolbox', Paper presented at the Human Brain Mapping.

Brett, M., Leff, A. P., Rorden, C., & Ashburner, J. (2001). 'Spatial normalization of brain images with focal lesions using cost function masking', Neuroimage, vol. 14, pp. 486 - 500.

Fridriksson J, Bonilha L, Baker JM, Moser D, Rorden C (2010). 'Activity in preserved left hemisphere regions predicts anomia severity in aphasia', Cerebral Cortex, vol. 20, pp. 1013-1019.

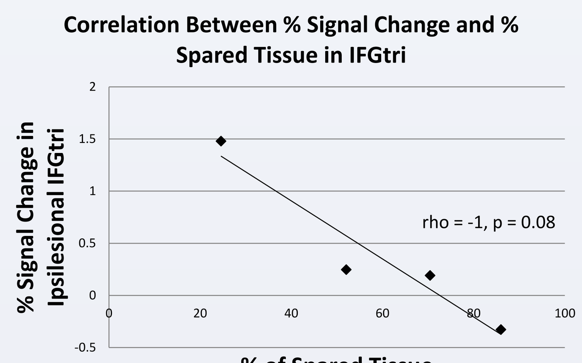
Fridriksson, J., & Morrow, L. (2005). 'Cortical activation associated with language task difficulty in aphasia', Aphasiology, vol. 19, pp. 239-250.

Saur D, Lange R, Baumgaertner A, Schraknepper, V., Willmes, K., Rijntjes, M., & Weiller, C. (2006). 'Dynamics of language reorganization after stroke', Brain, vol. 129, pp. 1371-1384.

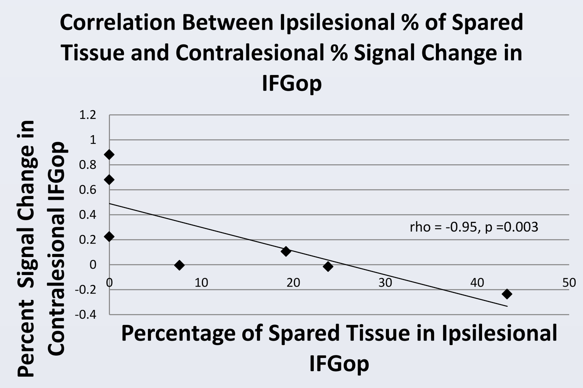
Sebastian, R. & Kiran, S. (2011). Task Modulated activation patterns in chronic stroke patients with aphasia. Aphasiology.25 (8), 927-951

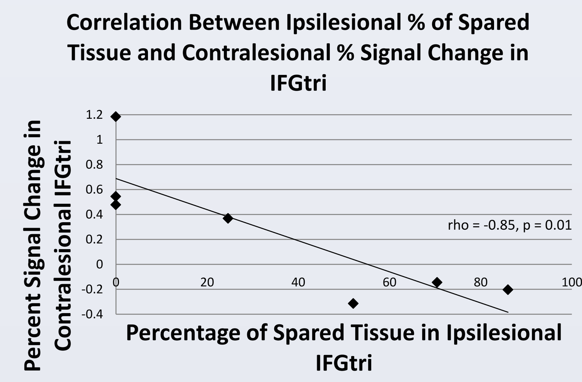
RESULTS

1. Research Question 1: Correlations between % spared tissue and ipsilesional % signal change
   - Only one region, the IFG triangularis, showed a correlation that approached significance (rho = -1, p = .08).

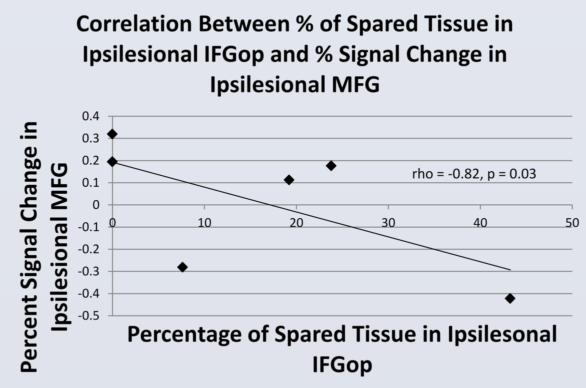


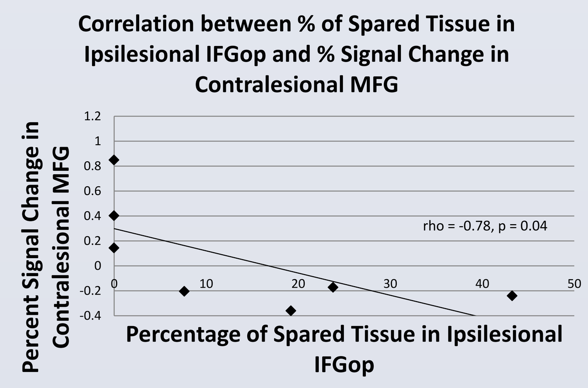
2. Research Question 2: Correlations between % spared tissue and contralesional % signal change
   - Two regions showed a significant negative correlation between ipsilesional spared tissue and contraslesional signal changes.
     i. IFG opercularis (rho = -0.93, p = 0.003)
     ii. IFG triangularis (rho = -0.85, p = 0.01)

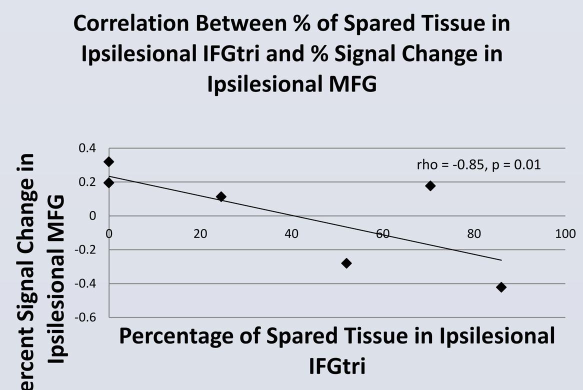




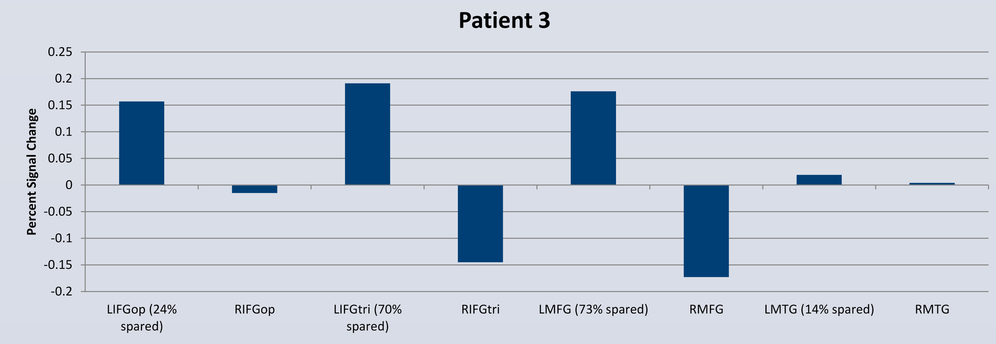
3. Research Question 3: Correlations between % spared tissue in IFG and % signal change in other brain regions
   - Three regions showed a significant negative correlation between ipsilesional spared tissue in the IFG and signal changes within the MFG, two approached significance.
     i. IFG opercularis to ipsilesional MFG (rho = -0.82, p = 0.03)
     ii. IFG triangularis to ipsilesional MFG (rho = -0.85, p = 0.01)
     iii. IFG orbitalis to ipsilesional MFG *(rho = -0.75, p = 0.07)*
     iv. IFG opercularis to contralesional MFG (rho = -0.78, p = 0.04)
     v. IFG triangularis to contralesional MFG *(rho = -0.70, p = 0.08)*

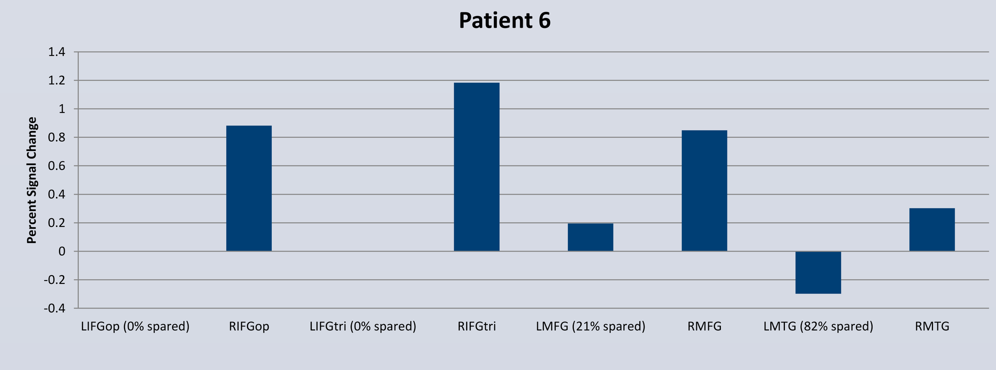


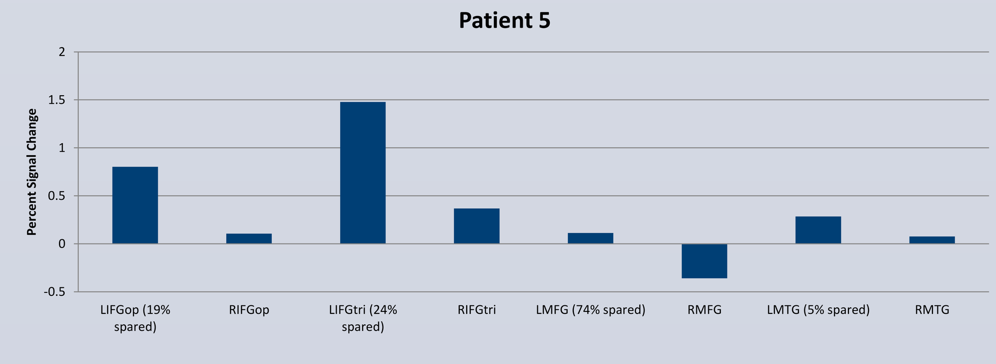




4. How does the extent of damage determine engagement?







CONCLUSIONS

- Despite extensive damage, spared LIFG tissue shows consistent activation in a semantic task.
- In the IFGop and IFGtri, increased damage is also associated with significantly increased signal change in the contralesional IFG and MFG and the ipsilesional MFG.
- When the IFG is not spared, contralesional IFG is engaged. When some IFG is spared, ipsilesional structures (IFG, MFG) are engaged.
- These data therefore highlight the importance of the preservation and consequent activation of left IFG in language recovery in aphasia.