THE IMPORTANCE OF IPSI AND CONTRALESIONAL FRONTAL AND TEMPORAL REGIONS IN LANGUAGE RECOVERY IN APHASIA

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INTRODUCTION

The relationship between spared tissue and ipsi and contralesional activation within language areas of the brain 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).
- In a systematic review, Turkeltaub et al. (2011), found that participants recruit a normal network that includes LIFG, LMTG, and new regions such as MFG and anterior insula and regions in the right hemisphere such as RIFG.
- In patients with large left hemisphere lesions, however the engagement of the contralateral right hemisphere homologues, particularly the RIFG is crucial to successful recovery of language.

Research Questions: What is the relationship between % spared tissue and % signal change in ipsilesional and contralesional regions? We hypothesize that: (1) left hemisphere language regions, even if slightly spared, will be engaged in language recovery, and (2) right hemisphere homologues will be active depending on the degree of damage to the left hemisphere.

METHODS

16 participations were scanned while performing a semantic processing language task in English. Data from two participants was dropped.

Participant Information

	Age	Gender	Months Post Stroke	Lesion Size (volume of cortex)
Averages	59.9 years	11 males 3 females	58 months	114.7 cc
Ranges	47 years to 74 years		6 months to 162 months	67 cc to 165 cc
Aphasia Types Present	Broca's (n=3), Wernicke's (n=1), Anomic (n=4), Conduction (n=2), Transcortical Motor (n=3), not categorized (n=1)			

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 = 35 ms

Preprocessing in SPM8
- Lesion drawn and then masked (MRICron)
- Slice timing
- Realignment
- Coregistration
- Segmetation (lesion masked as in Brett et al., 2001)
- Normalization

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Statistical Modeling in SPM8
- Fixed effects analysis using GLM
- Canonical HRF and its temporal derivative
- High pass filter of 128 s
- Semantic processing relative to baseline

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Bilateral functional ROIs selected
- IFG opercularis (IFGop)
- IFG orbitalis (IFGorb)
- IFG triangularis (IFGtri)
- Middle Frontal Gyrus (MFG)
- Superior Frontal Gyrus (SFG)
- Angular + Supramarginal Gyri (Ang/SMG)
- Middle Temporal Gyrus (MTG)
- Anterior Cingulate (ACC)

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ROI Analysis
- Subtracted normalized lesion maps from ROI maps
- Calculated ROI volumes using MRICron
- Calculated % spared tissue as (Anatomical ROI Volume – Lesion Volume)/(Anatomical ROI Volume)
- Calculated % signal change in ROIs using Marsbar (Brett, et al., 2002)

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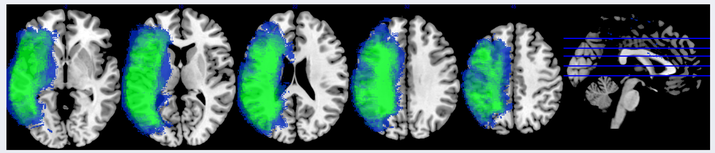
Correlation Analysis
- Pearson correlation determined for % signal change and task accuracy
- Pearson correlation determined for % spared tissue in each ipsilesional ROI and % signal change within each ROI
- Pearson correlation determined for % signal change across regions

LESION INFORMATION

Percent spared tissue in ROIs in the left hemisphere for each patient

Regions \ Patients	1	2	3	4	5	6	7	8	9	10	11	12	13	14
LIFGop	21	3	46	51	6	94	4	18	6	100	74	21	56	38
LIFGorb	46	93	85	85	52	81	31	96	88	100	100	90	97	34
LIFGtri	28	10	85	73	15	99	13	48	48	100	72	42	70	68
LMFG	78	55	62	99	35	100	66	40	90	100	93	57	99	99
LSFG	99	98	99	100	72	100	85	83	100	100	95	57	100	100
LMTG	5	72	13	86	31	1	5	91	96	99	92	93	87	1
LAng/SMG	14	31	75	78	24	58	1	41	59	88	91	84	73	4
LAntCing	96	100	100	100	100	100	99	94	100	100	100	80	100	100

Lesion overlap in left hemisphere (n=14)

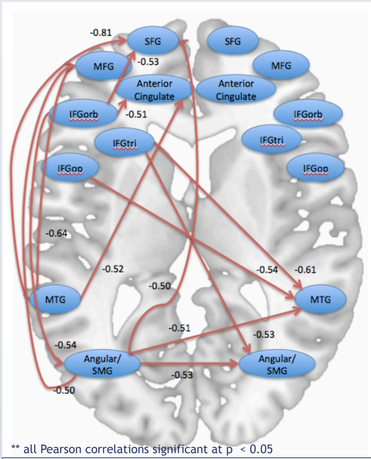


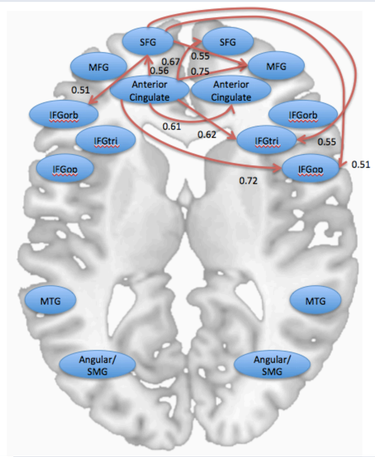
RESULTS

1. CORRELATIONS BETWEEN TASK ACCURACY AND PERCENT SIGNAL CHANGE

- Task accuracy is significantly correlated ($p < 0.05$) with signal in Ipsi IFGop (r=0.54) and Ipsi IFGtri (r=0.54), suggesting that the more accurate patients were on a task, the stronger the signal in LIFGop and LIFGtri.

2. CORRELATIONS BETWEEN PERCENT SPARED TISSUE AND PERCENT SIGNAL CHANGE





** all Pearson correlations significant at $p < 0.05$

Negative Correlations

Greater % spared, less activation

More spared tissue in LIFGtri and LIFGop is associated with decreased % signal in RMTG and RAng/SMG; More spared tissue in LMTG and LAng/SMG is associated with less activation in LSFG and LMFG as well as RMTG and RAng/SMG

Positive Correlations

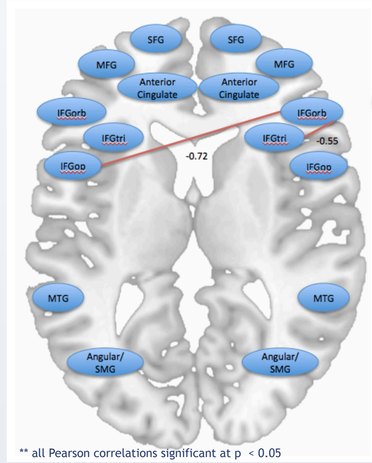
Greater % spared, more activation

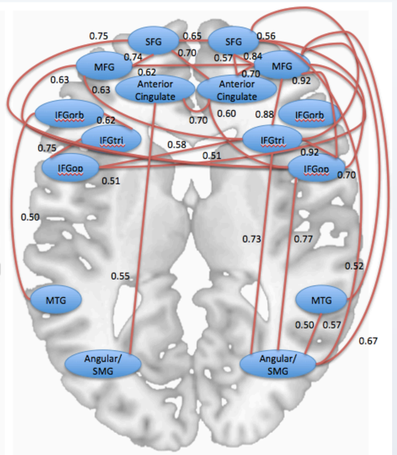
More spared tissue in LSFG is associated with increased % signal in LIFGorb, RIFGtri, RIFGop, and RMFG

More spared tissue in the LACC is associated with more activation in bilateral SFG

RESULTS (cont)

3. CORRELATIONS BETWEEN PERCENT SIGNAL CHANGE ACROSS REGIONS





** all Pearson correlations significant at $p < 0.05$

Negative Correlations
- RIFGorb is the only region showing negative correlations; it is on its own
- RIFGorb displays no positive correlations with any other region
- RIFGorb displays negative correlations with RIFGtri and LIFGop

Positive Correlations
- LIFGorb and LMTG appear to work as one unit; not correlated with other regions
- RSFG, RMFG, RIFG, RMTG and RAng/SMG appear to work as a unit; are correlated with each other
- RMFG is a hub of correlations

CONCLUSIONS

1. **LIFGop is the most lesioned tissue (Lesion core; 12/14 patients show damage in LIFGop and 11/14 patients show damage in LIFGtri).**
2. **Increased accuracy is positively correlated with activation in LIFGop and LIFG tri.**
3. **The more the spared tissue in LIFG (op,tri,orb), LMTG and LAng/SMG, the less activation in ipsilesional regions (LMFG, LSFG) and contralesional regions (RMTG, RAng/SMG).**
4. **The more the spared tissue in LSFG and LACC, the more the activation in R frontal regions (RIFG) – these regions appear to work in tandem.**
5. **RH regions show positive correlations with each other, and a general upregulation of RH homologues to lesioned regions.**
6. **RIFGorb does not appear to have any relationship with percent spared tissue, and it has a negative correlation with other regions in terms of BOLD signal activation.**

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