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Changes in Functional Connectivity Associated with Treatment Gains in Aphasia

Changes in Functional Connectivity Associated with Treatment Gains in Aphasia

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Introduction

- Persons with aphasia who are trained to generate abstract words (e.g., justice) in a specific context-category (e.g., courthouse) have been shown to improve not only on the trained items, but also on concrete words (e.g., lawyer) in the same context-category (Kiran, Sandberg, & Abbott, 2009).
- However, the underlying neural mechanism of this generalization effect is unknown.
- The current study examined the neural activation and functional connectivity patterns of abstract and concrete word processing in persons with aphasia before and after training abstract word retrieval to shed some light on this phenomenon.

Methods

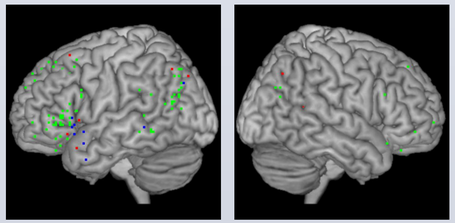
- Participants
  - Five right-handed persons with aphasia secondary to left hemisphere stroke (1 F, mean age: 53).
  - All participants were scanned using fMRI before and after a theory-based treatment.
- Treatment
  - Based on the Complexity Account of Treatment Efficacy (Thompson, Shapiro, Kiran, & Sobecks, 2003)
  - Consisted of training abstract words in a specific context-category for up to 10 weeks
  - Criterion for stopping treatment before 10 weeks = 80% accuracy for 2 weeks in a row
- fMRI Task
  - Word Judgment

Experimental Condition

Control Condition

- Data Analysis
  - GLM in SPM8
    - Contrasts
      - Post-treatment Abstract > Pre-treatment Abstract
      - Post-treatment Concrete > Pre-treatment Concrete
  - Task-related functional connectivity
    - CONN toolbox for SPM8
    - Functional ROIs = 5 mm sphere around peak activation voxels elicited during general word processing (i.e., abstract + concrete > control)
      - Used meta-analyses of abstract and concrete word processing (Binder, Desai, Graves, & Conant, 2009 [RED]; Wang, Conder, Blitzer, & Shinkareva, 2010 [BLUE]) and our own work in healthy older adults [GREEN] as a guide.

Anterior:	Posterior:
SupMed	PostMTG
SFG	AG
MFG	SMG
IFGorb	MOG
IFGtri	Precuneus
IFGop	PCC
TempPole	Fusiform

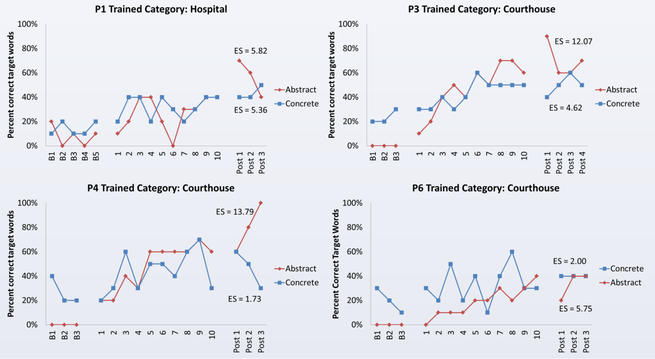


- Conducted semipartial ROI-ROI correlations individually for each patient to create 4 networks:

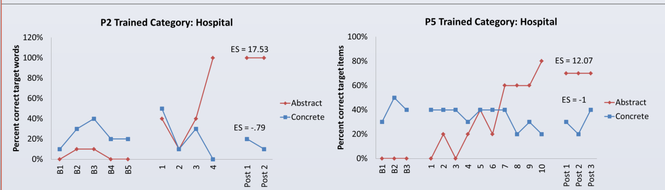
Pre-treatment	Post-treatment
1. Abstract	3. Abstract
2. Concrete	4. Concrete

- Pre-treatment matrix subtracted from post-treatment matrix to obtain increases in connectivity (decreases ignored for now).
  - Used confidence intervals to determine significance of each value
  - Focused on increases that resulted in positive correlations post-treatment

Treatment Results



Four patients showed improvement in both the trained and untrained items



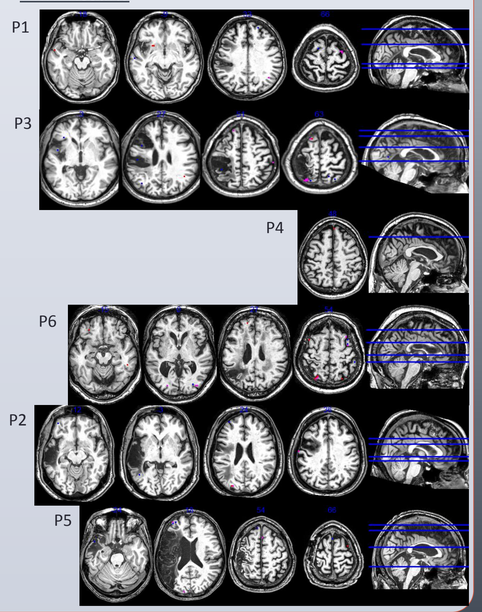
Two patients only showed improvement in the trained items

All six patients showed increases in activation from pre to post-treatment (FWE $p < .05$).

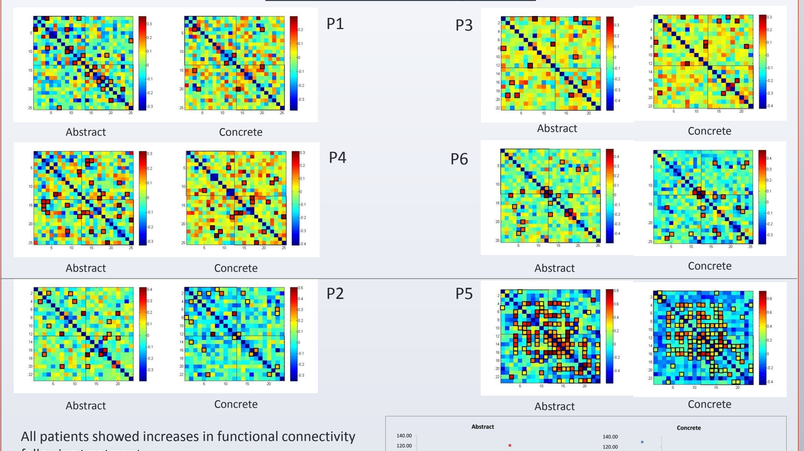
All but one patient showed changes in both abstract (trained) and concrete (untrained) word processing.

Regions included perilesional areas, ipsilesional areas, and right hemisphere homologues.

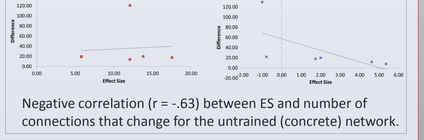
fMRI Results



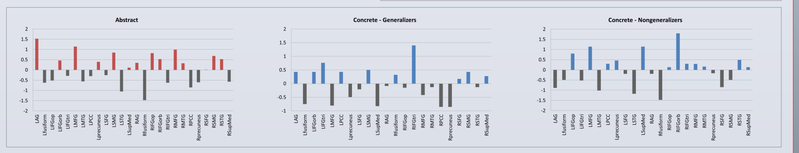
Functional Connectivity Results



All patients showed increases in functional connectivity following treatment.
More changes in L-L and R-R than in L-R and R-L connections. Abstract average bias = -.20; concrete average bias = -.17.
Nongeneralizers tended to have more changes in connectivity overall.



Negative correlation ($r = -.63$) between ES and number of connections that change for the untrained (concrete) network.



Conclusions

- Overall, behavioral gains in treatment are measurable as specific neural changes in fMRI and task-related functional connectivity in persons with aphasia.
- All patients show more changes in intra- (L-L or R-R) than inter-hemispheric connections for both abstract and concrete networks. Furthermore, the laterality of these connections is changing from left-biased before treatment to right-biased after treatment ($p<.05$) for both abstract and concrete networks. This may indicate compensation rather than restoration of function.
- For the trained items, there is no correlation between increases in connectivity and effect sizes; however, there is a negative correlation between number of connections that change in the concrete network and the effect size for generalization to concrete words. This may indicate increased effort.
- There appear to be certain nodes in the abstract network whose connections increase as a function of training. In the concrete network, the nodes are different depending on whether or not generalization occurred. This difference is interesting and may be important for understanding training vs. generalization effects.

References

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