Introduction

- Persons with aphasia (PWA) 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 item, but also on concrete words (e.g., lawyer) in the same context-category (Kiran, Sandberg, & Abbott, 2009).
- However, the underlying neural mechanisms of this generalization effect are unknown.
- The current study examined the neural activation and functional connectivity patterns of abstract and concrete word processing in PWA before and after training abstract word retrieval to shed some light on this phenomenon.

Methods

Participants
- Eight right-handed persons with chronic aphasia (> 6 mos post) secondary to left hemisphere stroke (3 F, mean age: 58)
- All participants were scanned using fMRI before and after a theory-based treatment

Treatment
- Based on the Complexity Account of Treatment Efficiency (Thompson, Shapiro, Kiran, & Soble, 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

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 SPM
    - Functional ROIs = 5 mm sphere around peak activation voxel elicited during general word processing (i.e., abstract + concrete + control)
- Used meta-analyses of abstract and concrete word processing (Binder, Desai, Graves, & Conant, 2009; Wang, Conder, Blitzer, & Shinkareva, 2010), our own work in healthy older adults (Sandberg & Kiran, 2013), and patients' own activations as a guide

Findings
- Conducted semipartial ROI-ROI correlations individually for each patient to create 4 networks:
  - Pre-treatment Abstract
  - Pre-treatment Concrete
  - Post-treatment Abstract
  - Post-treatment Concrete
- Pre-treatment matrix subtracted from post-treatment matrix to obtain increases in connectivity
- Thresholded changes at 1.0 SD away from the mean

Treatment Results
- All eight patients showed increases in activation from pre to post
- Areas included those normally activated for abstract and concrete word processing
  - The highest agreement among PWA was 1:8
  - There is a high level of overlap for increases in activation for abstract and concrete words

fMRI Results

Across patients, there appear to be more intra- than inter-hemispheric connections changing as a function of training.

When changes that cross threshold (1.0 SD) are tallied and averaged across patients,
- LFGtri appears to be an important node for positive changes, especially in the trained abstract network
- Differences between generalized and non-generalized networks surface

When connectivity change magnitude is calculated and averaged across patients,
- LFGtri appears to be important for changes related to direct training, or changes related to functional connectivity in the left hemisphere and a shift to a higher magnitude of change in the right to left hemisphere connections for both the trained abstract and generalized concrete networks
- Generalizers and non-generalizers appear to show different patterns of change in the untrained concrete network (Figures 3 and 4).

Conclusions
- Overall, behavioral gains in treatment are measurable as specific neural changes in fMRI and task-related functional connectivity in PWA (Figures 1 and 2).
- Furthermore, specific nodes in each network show changes in connectivity after treatment
- LFGtri appears to be important changes related direct training, or abstract word training, for which all patients improved (Figure 3).
- Additionally, there is a higher magnitude of change in within-hemisphere connections in the left hemisphere and a shift to a higher magnitude of change in the right to left hemisphere connections for both the trained abstract and generalized concrete networks (Figure 4).
- Generalizers and non-generalizers appear to show different patterns of change in the untrained concrete network (Figures 3 and 4).

Acknowledgments
- This work was supported by an NINDS F31 NS076503 and the Dudley Allen Sargent Research Fund

References