



Aphasia Severity and Response to Semantic Feature Analysis Not Predicted by Network Connectivity Estimates

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Introduction

- Naming impairments persist in 30-40% of persons with post-stroke aphasia (PWA; [1]).
- Semantic Feature Analysis (SFA; [2])**, one of the most well-documented impairment-focused aphasia treatments, can improve both naming and overall aphasia severity [3]–[5].
- However**, it remains unknown how the residual neural networks of stroke survivors support response to this SFA.
- Recent work from our lab suggests that the integrity of the left-hemisphere ventral pathways may account for the relationship between baseline aphasia severity and change in response to SFA [6].
- Prior studies have found that organization of language-related neural networks shares a relationship with both aphasia severity and treatment response.

- Marebwa and colleagues [7] identified a relationship between increased network modularity and more severe aphasia.
- Normalized Small Worldness (NSW) and average temporal-lobe betweenness centrality (BC) predicted patient response to phonological/semantic cueing treatments [8].

Purpose:

- The goals of this study were to:
- Cross-validate the finding that neural network integration is related to aphasia severity
- Extend the findings from Bonilha and colleagues [8] by investigating whether temporal-lobe network organization is predictive of response to SFA.

Hypotheses:

- When controlling for age, months post onset, lesion size, and aphasia severity:
- NSW will predict patient response to treatment as measured by both proportional maximal gain (PMG) on treated items and improvement on the Comprehensive Aphasia Test.
- Temporal Lobe BC will predict patient response to treatment while also controlling for frontal and parietal BC.

Method

Participants

- Eighteen participants with aphasia secondary to left-hemisphere stroke > 6 MPO participated.
- Inclusion criteria: Left hemisphere stroke ≥ 6 months post-onset, diagnosis of aphasia based on the Comprehensive Aphasia Test.

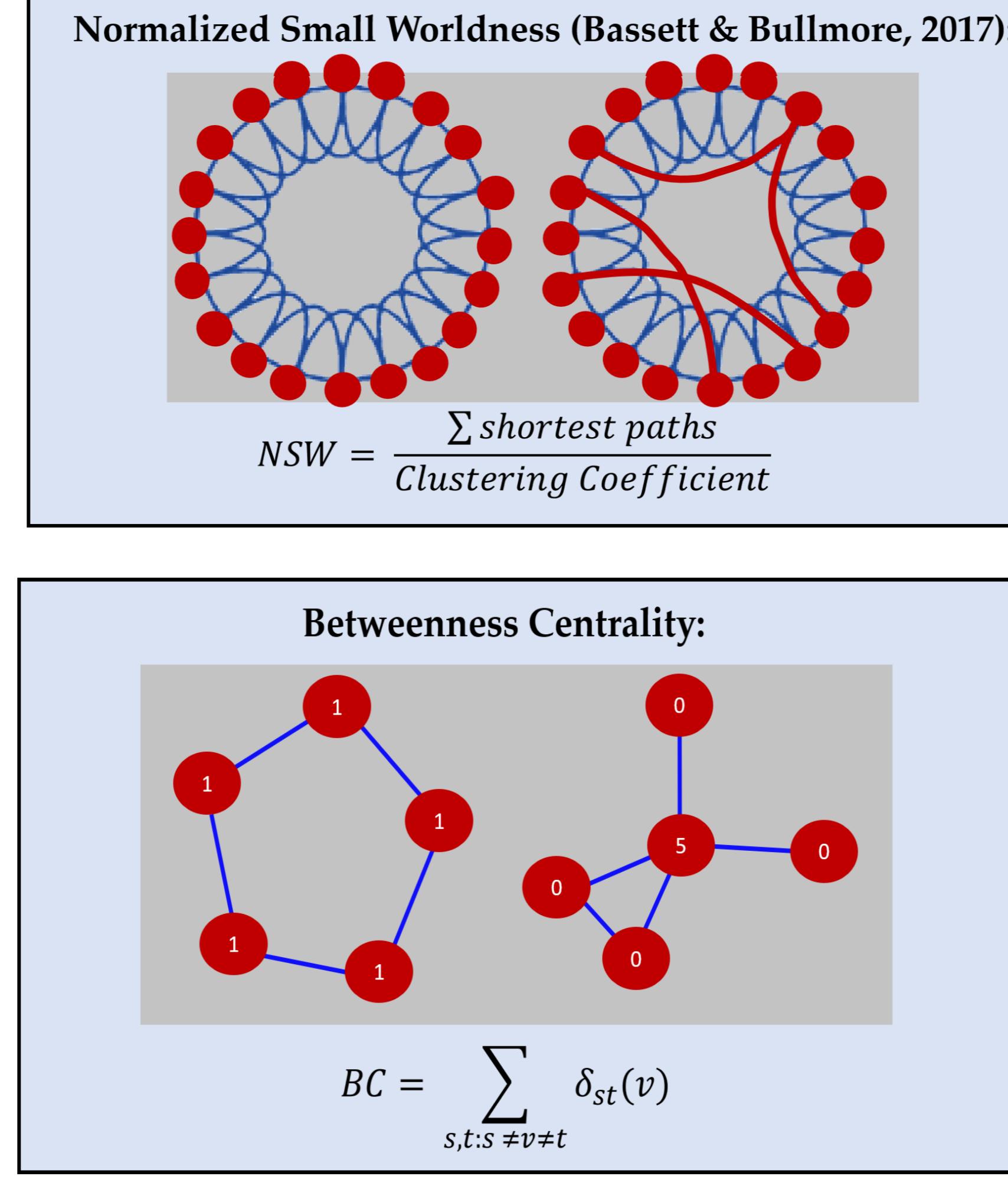
Table 1. Demographic and Clinical Characteristics

Gender	3 females, 15 males
Education, Years	Mean (SD) 14.27 (2.39)
Age, Years	Mean (SD) 57.2 (11.23)
Months Post-Onset	Mean (SD) 70.3 (66.71)
CAT Modality Mean T-score	Mean (SD) 52.41 (4.21) Min - Max 45.16–59.15
Lesion Volume (mm ³)	Mean (SD) 123765.30 (75522.34)

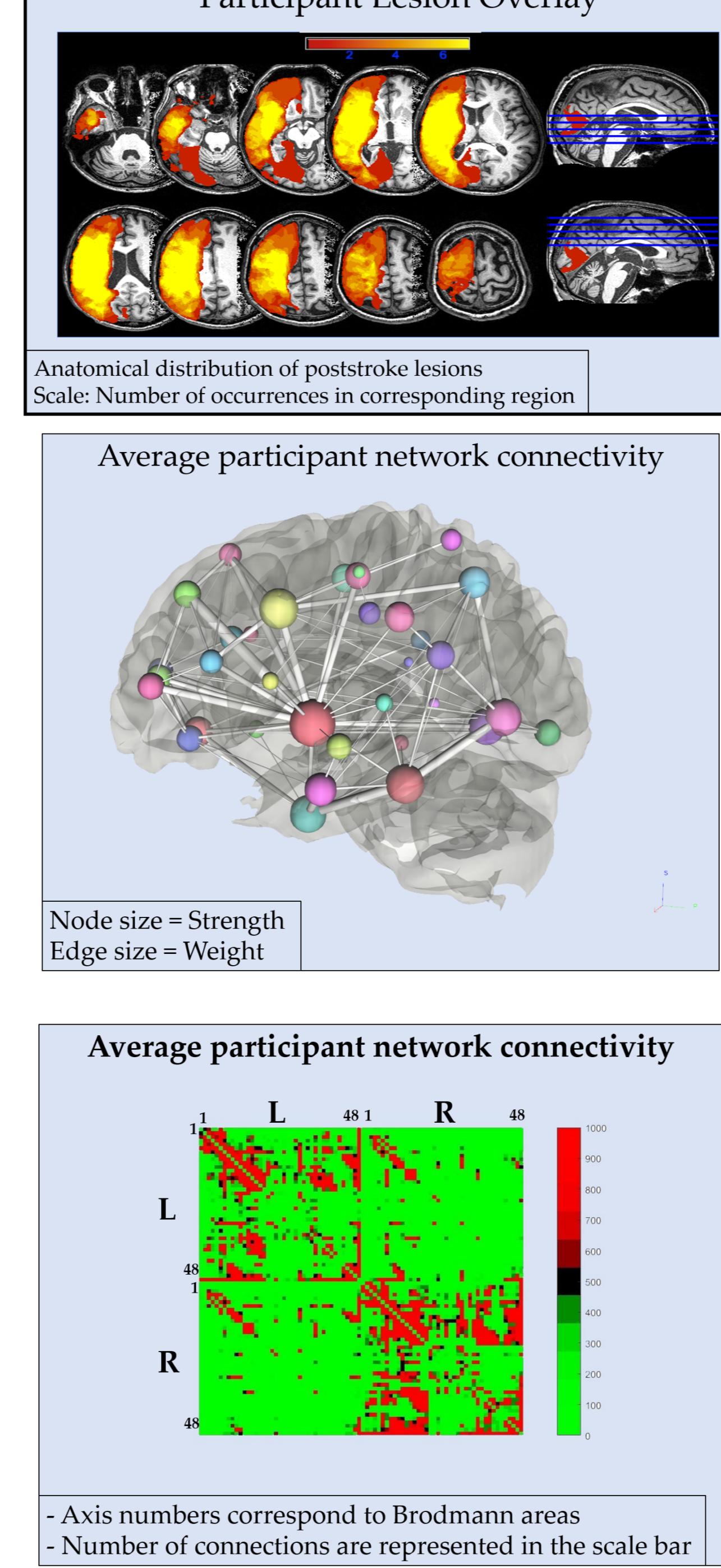
Treatment

- Participants received intensive SFA treatment (4 hours/day, 4-5 days/week, for 4 weeks) as part of a clinical trial at the VA Pittsburgh Healthcare System.

Graph Measures:

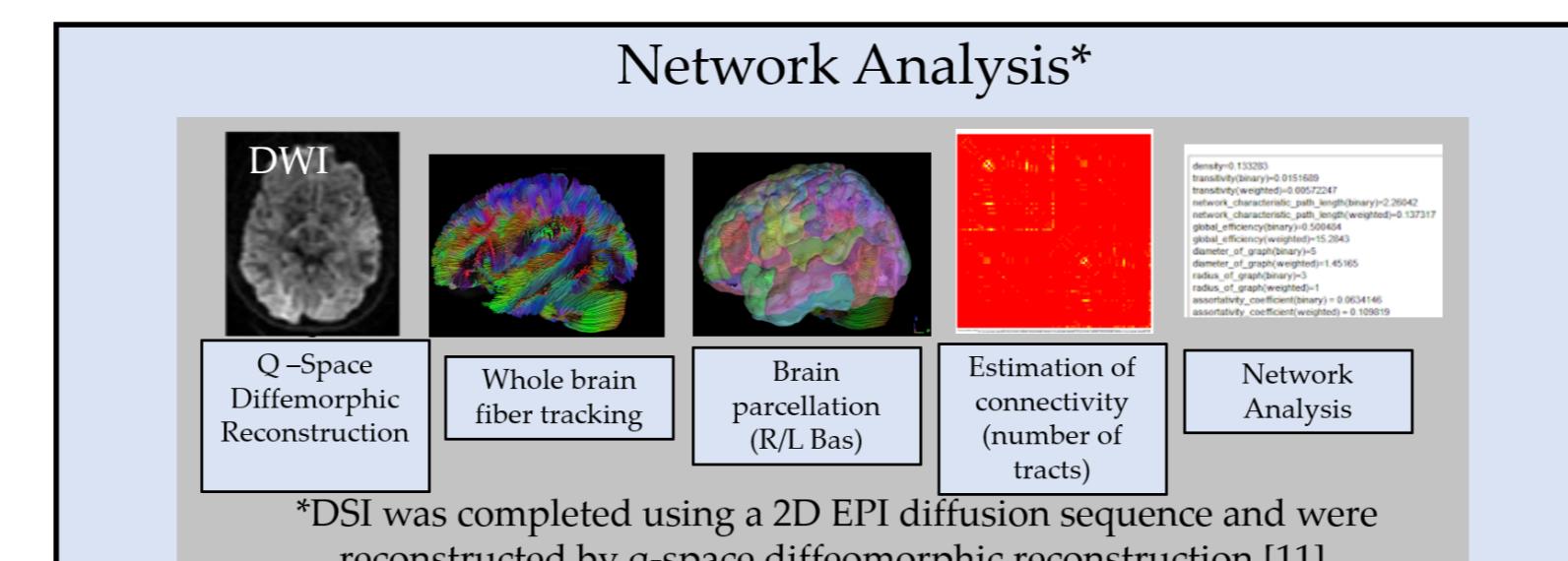


Results



Baseline MRI Scanning

- All imaging was conducted on a Siemens 3T Tim Trio Scanner.
- T1 and T2-weighted images were obtained and lesion masks were drawn in ITK-SNAP



Primary analyses

- All Analyses were conducted in a Bayesian Framework with Rstan [9].
- 4 MCMC chains were run with each model
- Predictor variables were standardized and Normal(0,5) priors were utilized for each estimated parameter.
- Convergence of MCMC chains and posterior predictive checking was affirmed prior to interpretation of each model.
- Leave one out cross validation utilized to assess model performance (see: [10] and [11]).
- Bayes Factors were used to compare predictor models and control variable only models.

Outcome variables:

- Naming improvement: PMG on treated SFA stimuli.
- Aphasia Severity: CAT Modality Mean T-score [12].

Results (cont)

ROI	Frontal BC	ROI	Parietal BC	ROI	Temporal BC
	46.67 (62.52)	BA 7 (291.286)	349.14 (68.21)	BA 20 (73.59)	237.72 (159.47)
BA 45	98.56 (94.75)	BA 39 (121.07)	57.89 (81.28)	BA 22 (33.17)	51.33 (330.58)
	75.56 (121.07)	BA 40 (109.20)	81.28 (73.56)	BA 37 (68.30)	(252.19) (69.69)
	Average (SD)	73.9 (51.17)	140.50 (72.88)		154 (68.30)

Table 2: Means (SDs) of weighted betweenness centrality for each Brodmann ROI:

*All variables were standardized
**Bayes Factor

Table 3: Regression of PMG on NSW*

Predictors	DV					
	NSW	Age	MPO	Lesion Volume	CAT-T Score	BF**
PMG full model	0.08 [-0.37, 0.50]	-0.31 [-0.74, 0.010]	-0.54 [-1.06, -0.03]	-0.09 [-0.55, 0.37]	-0.09 [-0.36, 0.64]	0.53
PMG covariates-only	-	-0.31 [-0.71, 0.08]	-0.52 [-1.00, -0.03]	-0.11 [-0.52, 0.30]	0.16 [-0.31, 0.63]	1.87

Table 4: Regression of Mean CAT Modality T-Score and ΔCAT on NSW*

Predictors	DV					
	NSW	Age	MPO	Lesion Volume	BF**	
CAT T-Score Full model	0.10 [-0.45, 0.63]	-0.03 [-0.54, 0.50]	-0.50 [-1.05, 0.07]	-0.20 [-0.67, 0.48]	-0.10 [-0.13, -0.03]	0.60
CAT T-Score Covariates only	-	-0.32 [-0.71, 0.08]	-0.60 [-1.01, -0.19]	-0.13 [-0.52, 0.38]	-0.13 [-0.13, -0.03]	1.64
ACAT T-Score Full model	0.09 [-0.52, 0.67]	-0.07 [-0.62, 0.49]	0.41 [-0.21, 0.61]	-0.22 [-0.84, 0.39]	-0.22 [-0.24, 0.24]	0.75
ACAT T-Score Covariates only	-	-0.07 [-0.62, 0.47]	0.42 [-0.15, 0.99]	-0.24 [-0.79, 0.33]	-0.24 [-0.61, 0.25]	1.34

*All variables were standardized

**Bayes Factor

Table 5: Regression of PMG on Betweenness Centrality*

Predictors	DV					
	Temporal BC	Frontal BC	Parietal BC	Age	MPO	Lesion Volume
PMG Full model	0.13 [-0.32, 0.57]	-0.50 [-1.07, 0.07]	-0.11 [-0.56, 0.03]	-0.22 [-0.66, 0.22]	-0.67 [-1.17, 0.16]	-0.20 [-0.65, -0.25]
PMG Covariates only	0.12 [-0.31, 0.55]	-0.46 [-0.99, 0.08]	-0.24 [-0.67, 0.17]	-0.64 [-1.12, .17]	-0.11 [-0.52, 0.30]	0.35 [-0.17, 0.86]

*All variables were standardized

**Bayes Factor

Table 6: PMG Multiple Regression CAT Modality T-score and ΔCAT on Betweenness Centrality*

Predictors	DV					
	Temporal BC	Frontal BC	Parietal BC	Age	MPO	Lesion Volume
CAT-T Score Full model	0.15 [-0.42, 0.71]	-0.02 [-0.58, 0.55]	0.51 [-0.13, 1.13]	-0.08 [-0.64, 0.49]	-0.23 [-0.85, 0.39]	0.01 [0.59]
CAT-T Score Covariates only	0.12 [-0.31, 0.53]	-0.29 [-0.78, 0.22]	-0.26 [-0.70, 0.18]	-0.73 [-1.21, -0.18]	-0.26 [-0.61, 0.25]	0.57 [1.74]
ΔCAT T-Score	-0.53 [-0.07, 0.72]	0.10 [-0.71, 0.52]	-0.16 [-0.77, 0.43]	0.53 [-0.14, 1.17]	-0.07 [-0.70, 0.13]	4.25
ΔCAT T-Score	-0.06 [-0.74, 0.61]	-0.08 [0.85, 0.66]	-0.09 [-0.75, 0.56]	0.36 [-0.33, 1.11]	-0.27 [-0.92, 0.38]	0.25

*All variables were standardized

**Bayes Factor

Discussion

- Network structure did not predict aphasia severity or response to treatment in this sample.
- Bayes factors preferred the covariate-only models relative to models with network measures included as predictors.
- These findings are not consistent with previous findings that global and peri-Sylvian network architecture correlate with patient response to naming treatment.
- Potential causes for the discrepant findings may include variability in:
 - Imaging and connectomic pipelines
 - DTI vs DSI imaging sequences
 - Parcellation schemes
 - Tractography algorithms