Language Networks in English-Spanish bilinguals with and without aphasia

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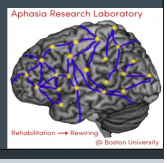


INTRODUCTION

Recent functional neuroimaging studies in bi- and multi-lingualism converge on the observation that the same core set of brain regions subserve all languages, irrespective of proficiency and age of aquisition (Indefrey, 2006; Sebastian, Laird, & Kiran, 2011) but that language proficiency is a critical variable (Abutalebi, 2008; Hernandez & Li, 2007).

The nature of language networks in individuals with bilingual aphasia has been less studied (Abutalebi, et al., 2009;Sebastian, Sandberg, & Kiran, 2012) but has high potential for clinical impact.

OBJECTIVES

In this study, using fMRI and DCM, we examine language networks in normal Spanish-English bilinguals and in individuals with bilingual aphasia.

First, we examined patterns of activation on a word synonym task in English and in Spanish in both patients and controls.

- We hypothesized overlapping activation in language regions for both English and Spanish but also language specific activation foci.

Next, we examined effective connectivity (using DCM) in the two language networks.

- We hypothesized that patterns of connectivity will reflect BOLD signal changes, and differences in network connectivity will emerge for the two languages.

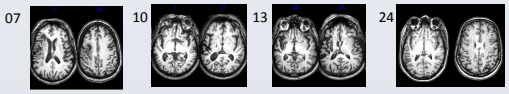
METHODS

Participants

- Four Spanish-English speaking non-brain damaged bilinguals (NBB) and four chronic bilingual adults with aphasia (BAA)

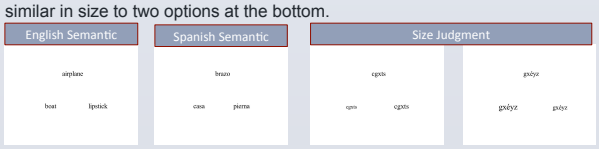
	Overall Dominance	Lifetime Exposure		Confidence		Current Exposure	
Patients		English	Spanish	English	Spanish	English	Spanish
BAA07	Spanish	0.098	0.90	0.045	1	0.018	0.981
BAA10	Spanish	0.040	0.959	0.151	1	0	1
BAA13	Spanish	0.159	0.840	1	1	0.031	0.968
BAA24	Balanced	0.550	0.449	0.459	1	0.5	0.5
Controls							
NBB85	Balanced	0.539	0.460	0.684	0.633	0.844	0.155
NBB86	Spanish	0.141	0.858	0.476	0.970	0.445	0.554
NBB87	Balanced	0.416	0.583	0.476	0.970	0.76	0.234
NBB89	Spanish/Balanced	0.387	0.612	0.192	1	0.707	0.292

- Patients experienced a single, unilateral ischemic stroke in the distribution of the left middle cerebral artery.



Stimuli/Task

- Word Triplet Judgment: 60 items in each language balanced for frequency, non-cognateness and word-association in each language. Participants were required to match the target on the top to the word most similar in meaning from the bottom.
- Size Judgment: 60 stimulus triplets consisting of consonant letter strings were presented, and participants were required to match the target on the top most similar in size to two options at the bottom.



fMRI design

- MR images were acquired at Boston University's Center for Biomedical Imaging on a 3T Phillips scanner.
- T1 images were acquired with the following parameters: 140 sagittal slices, 1mm^3 voxels, TR=8.2ms. BOLD images were collected using the following parameters: 31 axial slices, 3mm^3 voxels, TR=2s.
- MR data was analyzed in SPM8. Structural images were coregistered to pre-processed functional images and both were normalized to the MNI template.
- Lesion masks were drawn in MRIcron on each patient's T1 image and were used in normalization to minimize deformities during warping (Brett et al.,
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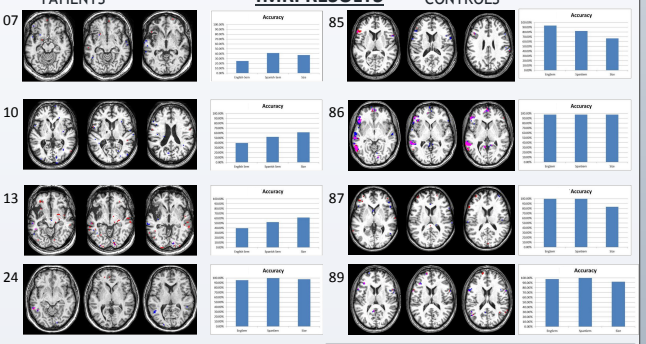
English semantic-Spanish Semantic	Spanish semantic-English Semantic
Spanish semantic – Spanish size	English semantic –English size

fMRI RESULTS



Summary of fMRI results:

Several regions of common overlap in activation for patients and controls (>75% overlap)

Equal # of participants show activation for English and Spanish

- LMTG

More # of participants show activation for Spanish relative to English

- LIFGtri, Left PCG, Left SMA, LITG, RSTG, RMTG

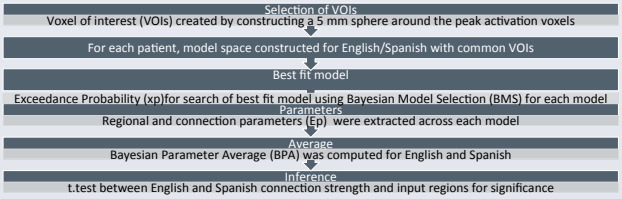
More # of participants show activation for English relative to Spanish

- None

Table: Percent of participations showing a significant above threshold (T>3.5) activation in the regions below

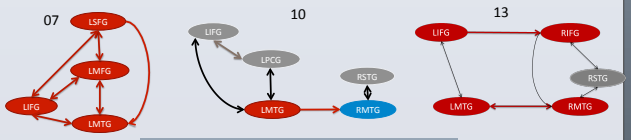
	#Subjects	Activation in English	Activation in Spanish
Anterior Language and Speech Processing			
Left Inferior Frontal Gyrus (p. Orbitalis)	8	50.00%	50.00%
Left Inferior Frontal Gyrus (p. Triangularis)	8	62.50%	87.50%
Left Inferior Frontal Gyrus (p. Opercularis)	8	25.00%	62.50%
Right Inferior Frontal Gyrus (p. Orbitalis)	8	12.50%	50.00%
Right Inferior Frontal Gyrus (p. Triangularis)	8	25.00%	62.50%
Right Inferior Frontal Gyrus (p. Opercularis)	8	25.00%	62.50%
Left Middle Frontal Gyrus	8	62.50%	50.00%
Right Middle Frontal Gyrus	8	25.00%	62.50%
Left Precentral Gyrus	8	50.00%	87.50%
Left SMA	8	37.50%	87.50%
Right SMA	8	25.00%	50.00%
Anterior and Basal Temporal			
Left Temporal Pole	8	0.00%	50.00%
Left Inferior Temporal Gyrus	8	50.00%	75.00%
Posterior Language			
Left Superior Temporal Gyrus	8	25.00%	50.00%
Right Superior Temporal Gyrus	8	62.50%	75.00%
Left Middle Temporal Gyrus	8	75.00%	75.00%
Right Middle Temporal Gyrus	8	50.00%	75.00%
Left SupraMarginal Gyrus	8	12.50%	62.50%
Right SupraMarginal Gyrus	8	62.50%	25.00%
Attention and Working Memory			
Left Superior Frontal Gyrus	8	50.00%	62.50%
Right Superior Frontal Gyrus	8	12.50%	62.50%

EFFECTIVE CONNECTIVITY METHODS (DCM)



EFFECTIVE CONNECTIVITY RESULTS FOR PATIENTS

Red: English (xp) is significantly stronger than Spanish (xp),Blue: Spanish (xp) is significant stronger than English (xp), gray is non-significant



No significant differences in connection for 24

CONCLUSIONS

1. Patients and controls both show overlapping activation for English and Spanish in LMTG only. More regions are activated for Spanish relative to English.
2. With regards to patients, 3 of the 4 patients were more proficient in Spanish pre and post-stroke. These patients show DCM results show stronger connections and input region parameters for English relative to Spanish.
3. The more diffuse BOLD signal activation in Spanish relative to English, but more modulation of networks for English relative to Spanish is an interesting paradox.
4. It raises the question of whether stronger connections are an indication of less efficiency.

REFERENCES

Sebastian, R., Kiran, S., & Sandberg, C. (2012). Semantic processing in Spanish-English bilinguals with aphasia. *Journal of Neurolinguistics*, 25(4), 240-262. doi: 10.1016/j.jneuroling.2012.01.003.

Sebastian, R., Laird, A. & Kiran, S. (2011). Meta-analyses of the neural representation of first language and second language. *Applied Psycholinguistics*. DOI:10.1017/S0142716411000075.