Right Hemisphere Loading as an Experimental Treatment for Chronic Non-Fluent Aphasia

Theresa Yao[1], Sarah Millar[1], Regina Monteiro[1], Kendall Finch[1], Brian Gonsalves, PhD[2], and Pradeep Ramanathan, PhD, CCC-SLP[1]

[1]California State University East Bay, Department of Speech, Language, and Hearing Sciences
[2]California State University East Bay, Department of Psychology

Background

Evidence regarding the role of the right hemisphere (RH) in language recovery after a left hemisphere (LH) stroke has been inconsistent. Various hypotheses suggest: reactivation of core LH language regions, recruitment of new LH regions, recruitment of RH homologues, and recruitment of domain general (e.g., executive & attentional) networks which may contribute to improved language performance (Cocquyt et al., 2017; Heiss & Theil, 2006; Sebastian & Kiran, 2011; Saur et al., 2006; Turkeltaub et al., 2011).

Some attempts have been made to deliberately engage the RH (Crosson et al., 2005, 2009), with some evidence supporting RH involvement in language recovery.

What has been missing is the use of dichotic and split visual field stimulus presentation and instructions to selectively ignore LH stimuli and attend to RH stimuli, thereby stimulating the RH language network.

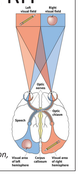


Image adapted from Psychology, 10th edition, David G. Myers, Worth Publishing

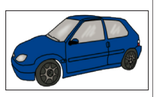
Objective

To investigate changes in hemispheric activation for object naming before and after training with dichotic auditory and split visual field stimuli, to determine its potential utility as a therapeutic intervention for chronic aphasia. We will refer to this technique as "Constrained Hemisphere Aphasia Therapy (CHAT)."

Procedures

Pilot Subjects: Four healthy volunteers, ages 29 to 55.

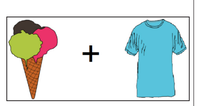
Procedures: A visual object naming task, completed pre- and post-treatment, used event-related potential to measure hemispheric activation.



Eye gaze training on non-nameable objects, prior to treatment, ensured maintenance of gaze at central fixation.

Treatment tasks:
NOTE: Throughout 4 phases of RH training participants continuously maintained eye-gaze at the central fixation.

Tx phase 1 - Participants received different images and corresponding auditory names to L & R. They maintained central gaze fixation, ignored stimuli at the R visual field and ear, and attended to stimuli on the L. Then a two-item field was presented in vertical arrangement; participants used the L hand to select the item previously presented on the L (x20 stimuli).



Tx phase 2 - This phase replicates phase 1,except using written stimuli instead of images (x20 stimuli).

DOOR + FEET

Tx phase 3 - This phase replicates phase 1, except the participant named the stimuli presented to the left (x20 stimuli).

Tx phase 4 - The participant was presented with left and right visual stimuli, then named the left-presented stimuli (x60 stimuli - Phase 1-3 stimuli combined).

Results

Behavioral results showed response accuracy at ceiling in our healthy pilot subjects, with no response time data due to fixed delays to enhance ERP signal.

Neuroimaging results compared brain activity between the pre- and post- treatment picture-naming task. The EEG signal was recorded continuously during task participation. Pilot data presented below.

Pilot Subject 1
Strong laterality shift from left to right

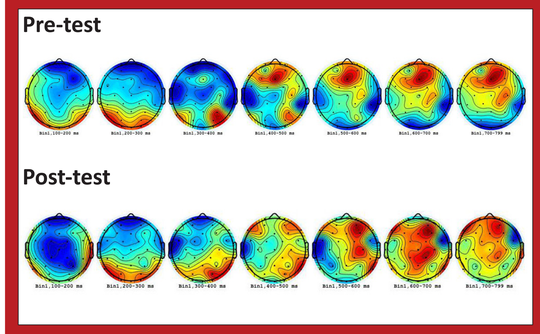


Figure 1. Topographic maps for naming tasks before and after treatment in 100ms increments.

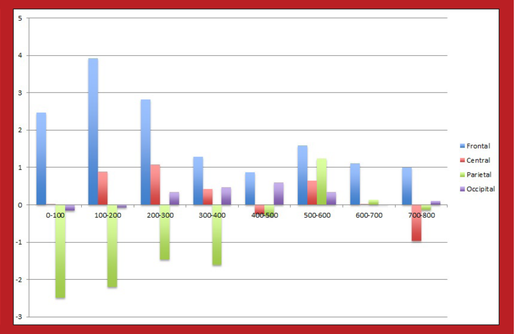
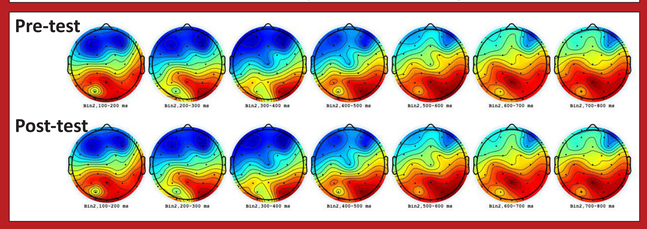
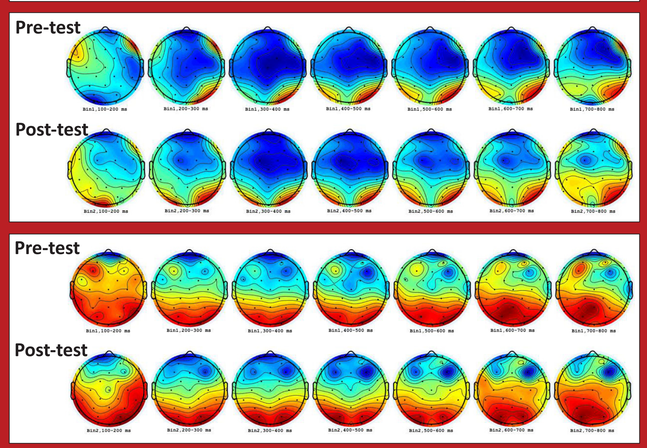


Figure 2. Pre/Post Laterality Index (Post-treatment value; Pre-treatment value)

Pilot Subject 2
Weak laterality shift left to right



Pilot Subjects 3 & 4
No Pre-/Post-Treatment change



Conclusions

- Preliminary pilot results are mixed, with a clear rightward shift of ERP activation post-treatment in one subject, a weak rightward shift in a second, and no shift in the remaining two subjects.
- A complete set of data for the planned 24 participants is expected to provide sufficient evidence for/against the hypothesis that the RH semantic network can be stimulated by dichotic and split visual field presentation.
- An additional 4 subjects' data were lost due to excessive eye-blink artifact and other procedural issues.

Future Directions

- Recruiting and running 24 healthy participants, ages 18 to 65.
- Planned near-replication of Crosson et al. (2008), with 24 participants matched for age, sex, education level, and handedness with CHAT participants.
- If CHAT results demonstrate increased RH activation, then provide 30 hours CHAT training protocol to individuals with severe chronic non-fluent aphasia post LH stroke.

Acknowledgements

Department of Speech, Language, and Hearing Sciences, CSUEB
Department of Psychology, CSUEB
Center for Student Research, CSUEB

Correspondence about this research may be sent to:
Theresa Yao (theresa921@hotmail.com)
Sarah Millar (smillar@horizon.csueastbay.edu)

References

Anglade, C., Thiel, A., & Ansaldo, A. I. (2014). The complementary role of the cerebral hemispheres in recovery from aphasia after stroke: A critical review of literature. *Brain Injury, 28*(2), 138-145.

Cocquyt, E., et al. (2017). The role of the right hemisphere in the recovery of stroke-related aphasia: A systematic review. *Journal of Neurolinguistics, 44*, 68-90.

Corballis, M. C. (2014). Left Brain, Right Brain: Facts and Fantasies. *PLoS Biology, 12*(1).

Crosson, B., et al. (2005). Role of the Right and Left Hemispheres in Recovery of Function during Treatment of Intention in Aphasia. *Journal of Cognitive Neuroscience, 17*(3), 392-406.

Crosson, B., et al. (2009). Regional changes in word-production laterality after a naming treatment designed to produce a rightward shift in frontal activity. *Brain and Language, 111*(2), 73-85.

Heiss, W., & Thiel, A. (2006). A proposed regional hierarchy in recovery of post-stroke aphasia. *Brain and Language, 98*(1), 118-123.

Knecht, S. (2000). Handedness and hemispheric language dominance in healthy humans. *Brain, 123*(12), 2512-2518.

Saur, D., et al. (2006). Dynamics of language reorganization after stroke. *Brain, 129*(6), 1371-1384.

Sebastian, R., & Kiran, S. (2011). Task-modulated neural activation patterns in chronic stroke patients with aphasia. *Aphasiology, 25*(8), 927-951.

Turkeltaub, P. E. (2011). Are networks for residual language function and recovery consistent across aphasic patients? *Neurology, 76*(20), 1726-1734.