

# Increased Connectivity with Right Hemisphere Language Areas in a Melody-based Intervention for Aphasia

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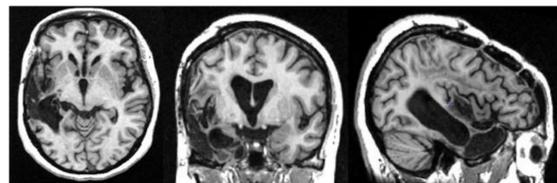
## Introduction

- **Melody-based treatments** for patients with aphasia, rely on the notion of preserved musical abilities in the right hemisphere (RH), following left hemisphere (LH) damage.
- Despite evidence for the effectiveness of therapy the role of the RH in improvement is an open question.
- Previous studies examined changes in local activation or in structural connectivity following therapy (e.g. Schlaug, et al. 2008; Hurkmans, et al. 2012; van der Meulen, et al. 2012; Al-Janabi, et al. 2014; Orellana, et al. 2014).
- The current study examined changes in **resting state connectivity** following melody-based treatment.
  - Interpretation of connectivity changes is less ambiguous than changes in local activation.
  - Resting state measures are not confounded by the patient's level of language performance

## Methods

### 2 Patients

- **JV (Treated)** – female, 48 at injury, **chronic moderate-severe non-fluent aphasia**
  - Suffered 2 moderate-severe TBI's 39 & 36 months before treatment.
  - 5-6 weeks of coma;
  - Extensive lesion to left temporal and frontal lobes.
  - L1- Tagalog, L2 – English
- **GB (Control)** – female, 54 at injury. No persistent language deficit.
  - Suffered moderate-severe TBI.
  - 1 week of coma;
  - Left temporal subarachnoid and intraventricular damage.
  - L1- English

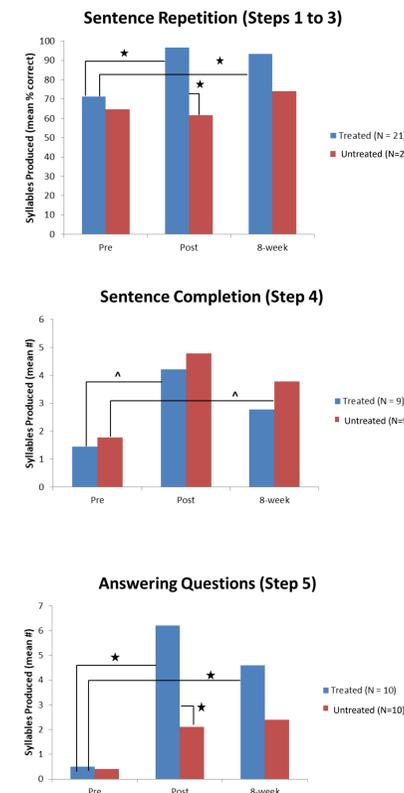


### Treatment

- Modified version of Melodic Intonation Therapy (Norton, Zipse et al. 2009).
  - By accredited music therapist (CJ)
  - 36 months post injury, 48 sessions of 30 min. in 16 weeks
  - Steps 1-3: sentence repetition (7 per step), with increasing length. E.g. "I drink coffee every morning"
    - Each phrase has a unique melody
    - Phrases sung in unison with therapist, accompanied by an electric keyboard, and tapping on patient's left hand; until phrase can be sung independently.
  - Step 4: sentence completion (9). E.g. "for dinner I will make \_\_\_\_\_".
  - Step 5: question probes (10). E.g. "what did you do yesterday?"

## Effects of Treatment on Sentence Production

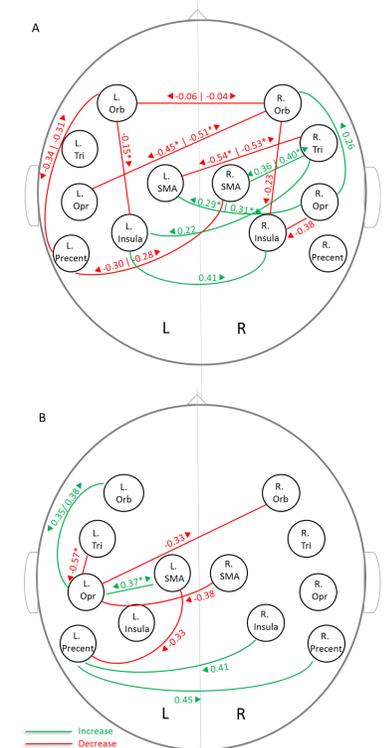
- **Sentence Repetition** (steps 1-3): Treated sentences improved significantly from pre- to post-treatment, and were maintained after 8 week, with no generalization to untreated sentences.
- **Sentence Completion** (step 4): both treated and untreated sentences showed a marginally significant trend for improvement, with no significant difference between them post treatment, indicating generalization.
- **Answering Questions** (step 5): Treated questions showed a significant improvement from pre- to post- treatment which was maintained at 8 weeks follow-up.



\* - significance at Wilcoxon signed ranks test of  $P < 0.05$  after correction for multiple comparisons  
 ^ - significance at Wilcoxon signed ranks test of  $P < 0.05$  uncorrected.

## Effects of Treatment on Resting State Connectivity

- **JV (treated patient):** Connections between **RH language areas and speech motor control areas** (R. Tri.-R. SMA; R. Tri.-L. Insula; R. Operc.-L. SMA), and among RH language areas (R.Orb-R.Operc) were strengthened during the treatment interval significantly more than during the baseline interval.
- No increase in connectivity for LH language areas
- **GB (control patient):** No increase in connectivity for RH language areas
- Connections between LH language areas and speech motor control areas (L. SMA-L. Operc) and among LH language areas (L. Orb-L. Operc) strengthened during the no-treatment interval significantly more than during the baseline interval.



**Changes in resting state connectivity during the treatment interval in the treated patient JV (A) and control patient GB (B).** Values represent differences (t3-t2) in semi-partial correlation. Arrows point to the target region in the calculation of semi-partial correlations. Only changes in t3-t2 which were significantly greater than changes during the baseline period (t2-t1) are shown. Significance is determined with FDR correction for 66 correlations with  $p < 0.05$  or  $p < 0.01$  (marked by\*). L-Left; R-Right; Orb-IFG Orbitalis; Tri-IFG uTriangularis; Operc- IFG Opercularis; SMA-Supplementary motor area; Precent – Precentral gyrus.

## Resting state connectivity methods

### Data collection

- **JV (time post 2<sup>nd</sup> injury):**
  - T1: 25 months
  - T2: 35 months
  - T3: 39 months
- **GB (time post injury):**
  - T1: 28 months
  - T2: 32 months
  - T3: 36 months

### Data analysis

- Bilateral ROIs
  - Frontal language areas and their homologues:
    - Inferior frontal gyrus (IFG): pars opercularis (Operc), pars triangularis (Tri), and pars orbitalis (Orb).
  - Speech motor control areas:
    - Precentral gyrus (PreC), Insula and Supplementary motor area (SMA).
- Semipartial correlations between ROIs were computed in CONN functional connectivity toolbox (Whitfield-Gabrieli & Nieto-Castanon, 2012).
- Changes in semipartial correlations in the treatment interval were compared to changes in the baseline interval.

## Conclusions

- Melody based treatment was **effective** in improving the patient's production of familiar sentences even when spoken without a melody. This ability was maintained 8 weeks after treatment, and was generalized to the completion of unfamiliar sentences.
- The treatment was associated with **stable** changes to the language and motor speech **networks** which were evident even during rest.
- This treatment was associated with right lateralized changes, suggesting that a targeted intervention can recruit **compensatory** mechanisms in the healthy hemisphere.
- The results converge with a previous study showing an effects of intonation based therapy on white matter volume in the **R. Opercularis** (Wan et al. 2014).
- Melody based treatment may affect **the interface between language retrieval and speech motor control** mechanisms.