Individually-Targeted tDCS Enhances Language Recovery in Patients with Chronic Non-Fluent Aphasia

Catherine Norise
Post-stroke aphasia: An unspoken epidemic

Stroke
- Affects 4.6 million Americans
- 500,000 new cases/year
- #3 cause of mortality
- #1 cause of morbidity

Post-Stroke Aphasia
- ~20% of stroke patients
- Left perisylvian circuit
- Deficits often persist
- Current treatments are limited

Outline

• Transcranial magnetic stimulation (TMS)
• Mechanisms of aphasia recovery
• Transcranial direct current stimulation (tDCS)
• Study overview
• Results
  – Experiment I
    • Montage
  – Experiment II
    • Western Aphasia Battery
    • Fluency
Finding the right words: Transcranial magnetic stimulation improves discourse productivity in non-fluent aphasia after stroke

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Discourse Productivity  Sentence Productivity  Lexical Content  Grammatical Accuracy

<table>
<thead>
<tr>
<th>Percentage Change from baseline – 2Month</th>
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</thead>
<tbody>
<tr>
<td>CIU**</td>
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<tr>
<td>Narrative Words*</td>
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<tr>
<td>Speech Rate</td>
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<td>Sentences</td>
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<tr>
<td>Utterance Length</td>
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<td>Unique Words</td>
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<tr>
<td>Nouns</td>
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<td>Verbs**</td>
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<tr>
<td>Auxiliary Score</td>
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<tr>
<td>Sentence Complexity: Closed Class Words in Sentence**</td>
</tr>
</tbody>
</table>

P < 0.05 **
P < .10*
Multiple mechanisms of aphasia recovery after stroke

Desirable properties of a novel therapy:
- Left hemisphere perisylvian recruitment (B)
- Right hemisphere homolog recruitment (C)
- Interhemispheric inhibition (D)
- Inefficient compensatory right hemisphere (E)

- Would facilitate activity of the distributed networks involved in language recovery
- Could be tailored to accentuate different mechanisms of recovery
Transcranial Direct Current Stimulation (tDCS)

- Subthreshold stimulation
- Alters neuronal firing rates
- Anodal vs. cathodal stimulation
- Inexpensive, portable, easy to pair with other therapies
Poor spatial resolution in tDCS: Drawback or Advantage?

Datta et al. *Brain Stimul*, 2009
Poor spatial resolution in tDCS: Drawback or Advantage?
Study Overview

**Subjects:** Chronic nonfluent aphasia

**Experiment 1**
- Baseline testing
- Identify Montage

**Experiment 2**
- Sham tDCS
- 2 Month follow-up
- Crossover
- tDCS
- 2 Month follow-up
- 6 Month follow-up
Experiment 1: Identify Optimal Montage

Events within each session

Possible Montages: LA, LC, RA, RC, Sham
Real Stimulation: 20 min; 2 mA
Experiment 1: Comparison of Montages

N=7

ANOVA: Main effect of montage (F[4,34]=3.59; p=0.17)
Experiment 1: Comparison of Montages

N=7

- Left cathodal: consistently positive but not uniformly optimal response.
- Consistent with some prior evidence (Monti et al., 2008)
Study Overview

Subjects: Chronic nonfluent aphasia
(M-F x 2 weeks)

Duration: 20 Minutes
Intensity: 2.0 mA

Language Tasks
- Western Aphasia Battery
- Pyramids and Palmtrees
- Sentence Comprehension
- Philadelphia Repetition Test
- Philadelphia Naming Test

Baseline testing

Experiment 1
Real Stimulation:
10 sessions over 2 weeks
(Duration: 20 Minutes, Intensity: 2.0 mA)

Experiment 2
Crossover

Sham tDCS
2 Month follow-up

2 Month follow-up
6 Month follow-up
Experiment 2: tDCS treatment & follow-up

WAB Aphasia Quotient Scoring
- 0-25 = very severe
- 26-50 = severe
- 51-75 = moderate
- 76 and above = mild

*p < .05, one-tailed
Experiment 2: tDCS treatment & follow-up

WAB: Aphasia Quotient

% Change From Baseline

Real (n=5)  Sham (n=3)

2 Week 2 Month

% Change WAB AQ (Baseline to 2 mo)

R=-0.988; p = .002

Baseline WAB AQ
Which language abilities drive tDCS response?

![Chart showing % Change in WAB Subscale (from Baseline) for REAL and SHAM conditions. The chart indicates a significant increase in Spontaneous Speech for the REAL condition compared to the SHAM condition.*]
Quantitative Production Analysis: Fluency

**Sentence Productivity**
- Mean sentence length
- Median utterance length
- Sentence elaboration index
- Embedding index

**Discourse Productivity**
- CIU
- Diff nouns
- Diff verbs
- Unique words
- # Narrative Words
- # Open Class Words
- # Nouns
- # Verbs
- # Closed Class Words

**Lexical Selection**
- % closed-class words
- Proportion of pronouns

* p ≤ 0.05

* indicates significance from baseline.
Conclusions

• tDCS may facilitate recovery in chronic nonfluent aphasic patients

• Patients may respond preferentially to different montages.
  • Responders show consistent benefit after left cathodal stimulation

• Consistent with prior studies patients demonstrate an improvement in naming following tDCS stimulation
Conclusions

• Subjects demonstrate an improvement in spontaneous speech
  • Present in categories of:
    • Discourse Productivity
    • Sentence Productivity
    • Lexical Selection
  • Pronounced improvement at 2 month follow-up
• Future Directions:
  • Larger sample
  • Relevance of montage differences
  • Determinants of response
    • Aphasia severity
    • Lesion size, location
    • Plasticity
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tDCS stimulation segregates words in the brain: evidence from aphasia

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