Inducing and Measuring Brain Plasticity Associated with Aphasia Treatment

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Background

• Aphasia – language impairment typically caused by stroke in the left hemisphere

• Typical aphasia treatment
  – Behavioral treatment
  – Administered by a Speech-language pathologist
    • One-on-one setting
  – Targets:
    • Language and/or functional communication

• RESEARCH FOCUS: Brain plasticity associated with aphasia treatment
Purpose:
- To examine functional brain changes associated with aphasia treatment outcome
- To examine structural brain damage as a predictor of treatment outcome

Treatment target:
- Anomia – Impaired ability to name common objects
  - Common in left hemisphere stroke
  - Varies greatly among patients
  - Commonly targeted in speech-language therapy of aphasia

(Fridriksson, 2010; J of Neuroscience)
Participants & Aphasia Treatment

- N = 26 – left hemisphere, chronic stroke
- Single event stroke
- Time post-stroke: At least 8 months

• Behavioral aphasia treatment
  - Administered by a speech pathologist
• 3 consecutive hours/day
• 5 sessions per week for two weeks
• Total time in treatment: 30 hours

(Fridriksson, 2010; J of Neuroscience)
• 4 fMRI sessions
  – 2 before treatment started
  – 2 when treatment was completed
• Treatment outcome: Naming common objects (pictures) during fMRI scanning
• Naming attempts recorded with non-ferrous microphone – scored off-line by a SLP

(Fridriksson, 2010; J of Neuroscience)
Results: Aphasia treatment success – Change in correct naming

(Fridriksson, 2010; J of Neuroscience)
Results: Aphasia treatment success – Functional brain changes

(Fridriksson, 2010; J of Neuroscience)
Studies 2 and 3: Transcranial direct current stimulation (tDCS) to treat aphasia

• Study 2: Does brain stimulation improve aphasia treatment outcome?
• Study 3: Follow-up study with “tighter” experimental control

tDCS: Induces a weak electrical current (1-2 mA) between two electrodes (anode – positive charge; cathode – negative charge) placed on the scalp
ABSTRACT

Objective: Motor recovery after stroke depends on the integrity of ipsilesional motor circuits and interactions between the ipsilesional and contralesional hemispheres. In this sham-controlled randomized trial, we investigated whether noninvasive modulation of regional excitability of bilateral motor cortices in combination with physical and occupational therapy improves motor outcome after stroke.
Study 2: tDCS accompanied by aphasia treatment

- 10 participants
  - Chronic aphasia
  - Various aphasia types/severities

- Treatment
  - Visual-speech perception to treat anomia (Fridriksson et al., 2009, *Stroke*)
    - Computerized treatment based on speech perception (picture – word matching)
  - 2 weeks of treatment
    - 5 sessions/week
    - Session length = 20 min

(Baker, Rorden, & Fridriksson, 2010; *Stroke*)
tDCS

- Design – double blinded
  - 1 week of anodal stimulation (A-tDCS)
  - 1 week of placebo (sham tDCS; S-tDCS)

- Electrode placement
  - Anode - Left frontal lobe
  - Cathode – Right shoulder
  - Targeted with fMRI

- Outcome measure
  - Naming
    - Trained items
    - Generalization

(Baker, Rorden, & Fridriksson, 2010; Stroke)
More treated items were named correctly following A-tDCS compared to S-tDCS ($p = 0.04$) (Baker, Rorden, & Fridriksson, 2010; Stroke)
More untreated items were named correctly following A-tDCS compared to S-tDCS ($p = 0.07$)

(Baker, Rorden, & Fridriksson, 2010; *Stroke*)
Study 3: tDCS to treat naming in fluent aphasia

- 8 Participants
  - Mild-moderate aphasia severity
  - Posterior damage
- Aphasia treatment & tDCS
  - Picture-word matching task
  - tDCS:
    - 5 sessions A-tDCS
    - 5 sessions S-tDCS
    - Electrode placement fMRI guided
- Treatment type blinded
  - Participants
  - Clinicians administering treatment
  - Clinicians scoring outcome tests

(Fridriksson et al., in press; Stroke)
Results – Change in RT during naming

• Immediately post treatment
  – A-tDCS > S-tDCS ($p=0.025$)

• 3 Weeks post treatment
  – A-tDCS > S-tDCS ($p=0.004$)

(Fridriksson et al., in press; Stroke)
• Collaborators
  – Post-docs
    • Jessica Richardson, Paul Fillmore, Dana Moser, Julie Baker
  – Graduate Students
    • David Eoute, Leigh Morrow, Tracy Toothman, Katie Kramp, Sarah Grace Hudspeth, Barry Floyd
  – Other collaborators
    • Chris Rorden – GA Tech
    • Leonardo Bonilha – Medical University of South Carolina
    • Marom Bikson – City College of New York

• Research support
  – NIDCD
    • DC008355
    • DC009571
Thank You