Manipulating sensory-motor coupling during speech production

Jason W. Bohland
Monique C. Tardif

- Department of Communication Science & Disorders, School of Health & Rehabilitation Sciences
- Center for the Neural Basis of Cognition

Motivation

- Speaking fluently requires coordinating the brain areas that allow us to produce movements and perceive speech sounds
- Coordination between these brain areas may be atypical in communication disorders such as persistent stuttering
- Here we will **establish the ability to non-invasively manipulate these brain systems while people speak**

Project Description

- We will use transcranial alternating current stimulation (**tACS**)[1] to alter brain activity during speech
- Participants will perform two tasks:
  - Producing syllables with a specific rhythm
  - Producing speech under delayed auditory feedback (DAF)
- We will measure how tACS changes the N100, a brain response to the sound inputs produced while speaking
- We will measure how tACS changes speech production under DAF

Context

- tACS uses weak electrical currents to non-invasively modulate brain activity
- tACS has become a powerful tool in neuroscience but has not had impact in speech production research
- Our lab has studied the effects of delayed auditory feedback on speech using a rhythmic speaking task[2], which will be used with tACS to establish the behavioral effects of stimulation

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Can **non-invasive brain stimulation** be used to modulate how the **auditory system** responds when individuals produce **speech?**

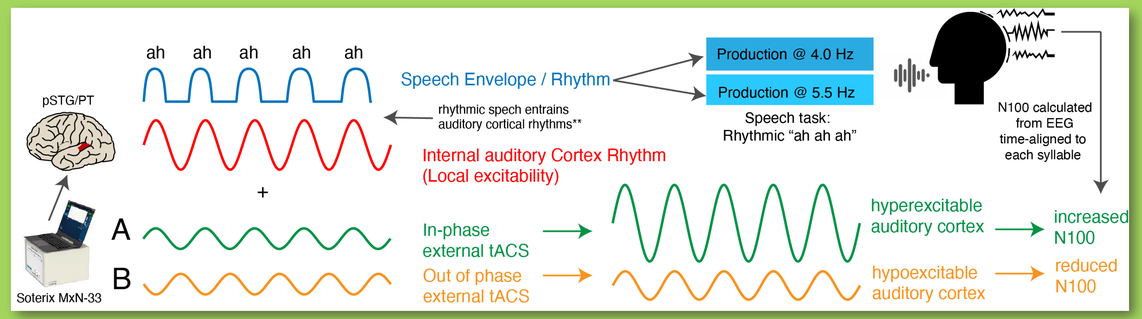

Figure 1: Schematic of approach to establishing tACS protocol for self-produced speech

Project Deliverables

- We will develop and publish a protocol for using tACS in speech production experiments
- We will first demonstrate the ability to change the neural response to rhythmically produced syllables
- We will then demonstrate the ability to modify speech output under DAF
- Successful completion of this work will provide critical feasibility data necessary for obtaining external funding to use tACS in basic and clinical research

Potential Impact

- The work here will establish, for the first time, the ability to non-invasively modify rhythmic brain activity and speech output during speaking tasks
- Results will help inform computational models of speech production[3]
- This will set the stage for using tACS as a tool for basic research in speech neuroscience
- This work may lead to new treatment approaches for communication disorders such as stuttering

References

1. Herrmann, C. S., Rach, S., Neuling, T., & Strüber, D. (2013). Transcranial alternating current stimulation: a review of the underlying mechanisms and modulation of cognitive processes. *Frontiers in Human Neuroscience*, 7, 279.
2. Malloy JR, Nistal DA, Heyne M, Tardif MC, Bohland JW (in press). Delayed auditory feedback elicits specific patterns of serial order errors in a paced syllable sequence production task. *Journal of Speech, Language, and Hearing Research*.
3. Bohland JW, Bullock D, and Guenther FH (2010). Neural representations and mechanisms for the performance of simple speech sequences. *Journal of Cognitive Neuroscience*, 22, 1504–29.

speech neural systems lab