The Effects of Transcranial Direct Current Stimulation on Overt Reading of Words in Skilled Readers

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BACKGROUND

- The *Directions into Velocities of Articulators* (DIVA) model maps events for components of articulation and connects them to corresponding brain regions [2],[5]. (Figure 1.)
- The Superior Temporal Gyrus (Figure 2) is involved in motor learning and monitoring speech production [5]
- The present study used transcranial direct-current stimulation (tDCS) to explore the contribution of the superior temporal gyrus to speech output including:
  - Vocal reaction time
  - Word Accuracy
  - Word Duration
  - Intermuscular coherence of right and left orbicularis oris and masseter muscles
- Pre-post simulation outcomes were examined for individuals who responded to tDCS and those who did not. [1],[4]

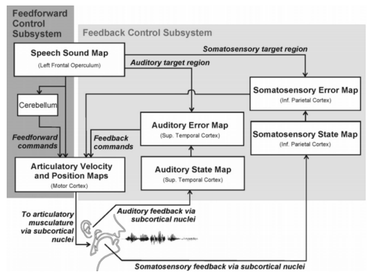


Figure 1. The Directions into Articulators Model [1]

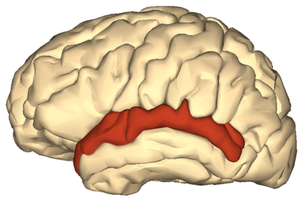


Figure 2. The Superior Temporal Gyrus (Wikipedia Commons)

METHODS

- 10 adult participants (18 - 40 years old)
- Acoustic recordings yielded vocal reaction time, accuracy and word duration outcomes
- 12 surface EMG electrodes over the right and left orbicularis oris and masseter muscles yielded peak intermuscular coherence outcomes
- Participants read matched sets of single words presented one at a time as quickly and accurately a possible, pre- and post-stimulation
- 13 minutes of anodal (1mA), cathodal (1mA) or sham stimulation was delivered
  - Participants were blinded to their stimulation condition.

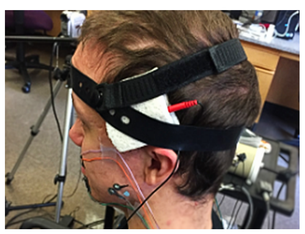
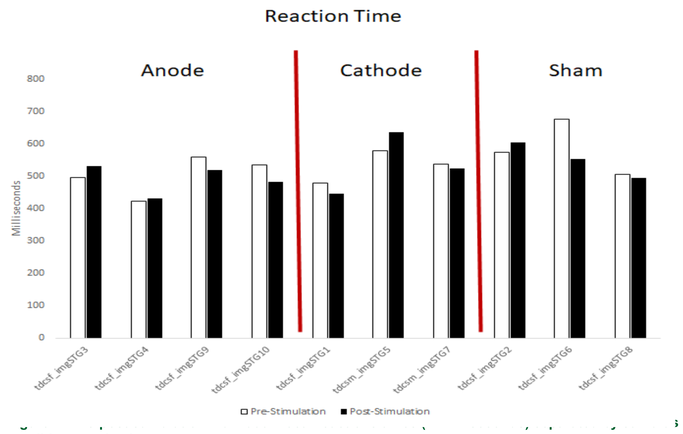


Figure 3. Placement of tDCS device and EMG electrodes.

EXPECTED OUTCOMES

- Anodal (excitatory): decrease response time, shorten word duration and increase coherence
- Cathodal (inhibitory): increase response time, lower accuracy, lengthen word duration and decrease coherence
- Sham is expected to have no impact on performance
- Individual differences in patterns of response may emerge

RESULTS



condition received.

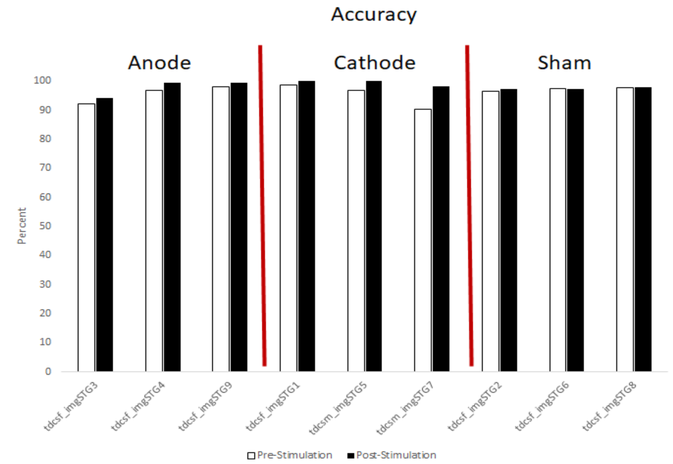
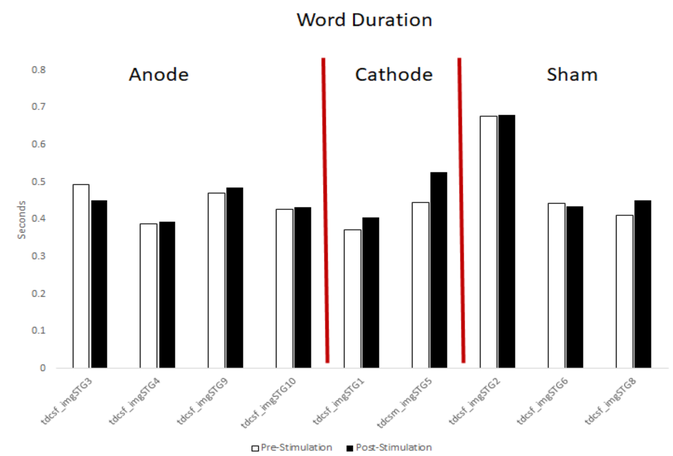


Figure 9. Pre-post stimulation individual reading accuracy scores (in percent) separated by stimulus condition received.



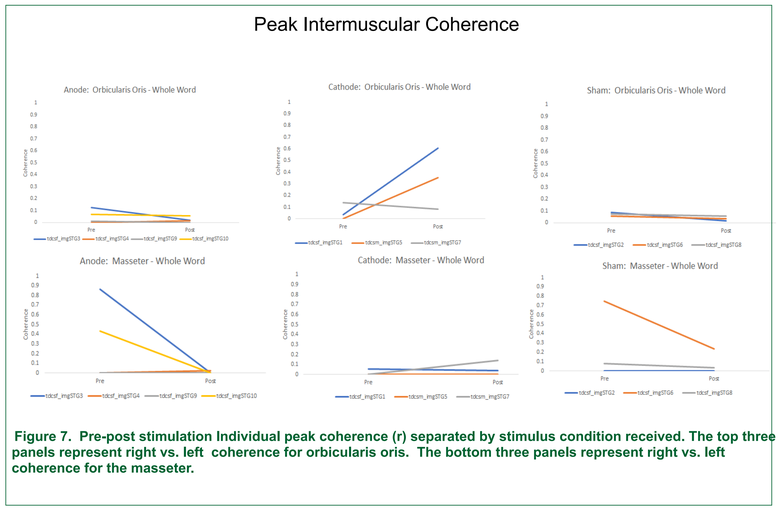


Figure 7. Pre-post stimulation Individual peak coherence (r) separated by stimulus condition received. The top three panels represent right vs. left coherence for orbicularis oris. The bottom three panels represent right vs. left coherence for the masseter.

CONCLUSIONS

- Based on the sample tested, there appears to be variability in performance regardless of stimulation condition
- Accuracy may have improved slightly following both anode and cathode stimulation but not for sham
- Word duration may have increased following cathodal stimulation in the two individuals measured
- Cathode stimulation may have had an effect on peak coherence for orbicularis oris in the participants measured
- Presence of responders and non-responders to tDCS found in previous research [1], [4] is consistent with some of the outcomes in present study
- Limited statistical power prevented the use of group statistics

IMPLICATIONS

- Reinforces the need for large sample sizes in tDCS research
- Individual variability between participants likely to play a factor in future study design

FUTURE RESEARCH

- Larger sample sizes in future research would allow for stronger comparison between conditions
- Role of intermuscular coherence may be important for understanding features of speech motor control

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NSERC CRSNG