Introduction

**Question:** Does High-Definition transcranial Direct Current Stimulation (HD-tDCS) of speech motor areas in the brain improve a participant’s ability to control their vocal pitch in response to a change in auditory feedback?

**Purpose:** To use EEG to record and obtain changes in neural activity prior to and after neural stimulation from HD-tDCS, while human subjects control their voice pitch in response to auditory feedback alterations.

**Goal:** To investigate whether pitch control is affected by neural stimulation, with the long-term goal of facilitating future diagnosis and treatment of neurological diseases resulting in speech motor disorders (e.g. Parkinson’s disease).

**Background:**
- Alterations in the pitch of auditory feedback have been shown to cause involuntary vocal pitch shifts in the opposite direction to compensate for the perceived change (Behroozmand et al., 2012; Chen et al., 2007; Larson, 1998).
- This shift is associated with changes to timing and amplitude of the N100 ERP component, a negative wave in scalp potential measured around 100 ms after the stimulus pitch modulation (Liu et al., 2011).
- Findings in previous studies suggest that HD-tDCS affects functional behavior and neural plasticity (Kuo et al., 2013; Monti et al., 2013; Malutina & Den Ouden, 2014).
- Ventral motor cortex is known to be involved in controlling the movement of speech production muscles (Parkinson et al., 2012).
- The combination of EEG and HD-tDCS has not been utilized in previous studies and therefore is novel to this Magellan Scholar project.

Methods

**Participants:** Our goal is to recruit 30 right-handed speakers of English with no language, hearing, or other cognitive impairments. This presentation shows the results of our preliminary analysis on the first three participants.

**Behavioral Task:**
- participants directed to produce a steady vowel sound for 2.3 seconds while receiving pitch shift stimuli in the auditory feedback of their own voice
  - Pitch shift magnitude: +/- 100 cents
  - Pitch shift duration: 200 ms
  - Trials: ~200 (~100 shifted up, ~100 shifted down)
- magnitude and speed of compensatory vocal response recorded for analysis

**Procedure:**
- Session 1: participants’ brain signals recorded with EEG during behavioral task
- Session 2
  - participants received 20 minutes of HD-tDCS brain stimulation to ventral motor cortex
  - 3 conditions: anodal, cathodal, and sham (control), between subjects
  - behavioral task performed for ~10 minutes during stimulation
  - brain signals then recorded with EEG while performing full-length behavioral task

**HD-tDCS**

- a low-current form of brain stimulation, in which a mild electrical current (e.g. 2 mA) is passed through the cortex in order to increase or decrease the excitability of the neurons

**Anodal:** Increases excitability

**Cathodal:** Decreases excitability

**Sham:** Control group; stimulation does not penetrate deeply into cortex, but produces an identical scalp sensation

**Analysis:**
- comparison of behavioral and EEG data
  - between upward and downward pitch shifts
  - before and after stimulation
  - between conditions (anodal, cathodal, sham)

Results

<table>
<thead>
<tr>
<th>Subject</th>
<th>Pre-Stimulation</th>
<th>Post-Stimulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pitch Shift</td>
<td>Up</td>
<td>Down</td>
</tr>
<tr>
<td>Subject 1:</td>
<td></td>
<td></td>
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</tbody>
</table>
- Anodal |
| Subject 2: |  |  |  |  |
- Cathodal |
| Subject 3: |  |  |  |  |
- Sham |

**Further Study:**
- Collect data from remaining participants (7 out of 30 complete)
- Analyze behavioral data
- Finish analysis of EEG data

References


