Effects of Cortical Stimulation on Covert Speech Monitoring in People Who Stutter
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Introduction

• Research shows structural and functional neurological differences between people who stutter (PWS) and controls (Ingham, 2001).
• Psycholinguistic theories (e.g. Postma & Kolk, 1993; Vasic & Wijnen, 2005) account for stuttering by a deficit in the phonological-encoding stage of speech planning.
• Our research replicated findings by Sasisekaran et al. (2006) that PWS have increased reaction times during phoneme monitoring of the internal speech plan (Garnett & Den Ouden, submitted). PWS in our study also made significantly more errors.
• Functional imaging studies show that LH posterior superior temporal gyrus (pSTG) supports phonological encoding (Indefrey, 2011) and is involved in monitoring internal speech (Den Ouden et al., 2013).
• Neuroimaging methods alone cannot conclude if specific brain regions are crucial for a task.
• High Definition Transcranial Direct Current Stimulation (HD-DCS) is a non-invasive, focal method of brain stimulation which provides better information about neural involvement (Dmochowski et al., 2011).
• This study had two purposes: First, can we disrupt or enhance task performance in healthy control participants on a covert phoneme detection task? This will tell us about the relation between the targeted areas and silent-speech monitoring. Second, can we ‘normalize’ the performance of PWS on the same task? This would suggest a potential therapeutic application, subject to further study.

Method

Participants

• Presently 4 PWS (2 females, 2 males, mean age 23 years) and 5 controls (all females, mean age 22.8 years), all right-handed.

Stimulation Location, Materials, and Task

• Target location was based on activation found in a cluster of 0.278 cl., with peak in left pSTG (Den Ouden et al., 2013; Figure 1).
• Electrode montages were configured using Soterix software (HD-Targets™ and HD-Explorer™; Figure 2).
• Two stimulation conditions (field orientations of left posterior and right anterior) were modeled for max fociality using 4 active electrodes and a sham location was modeled separately to ensure adequate blinding (Figures 1 and 2).
• Impedance was measured before and after stimulation.
• After 20 min of stimulation participants completed the monitoring task.
• Order of stimulation and stimuli was counterbalanced.
• Participants monitored for the presence of a target phoneme (e.g. /pa/) during silent picture naming.
• 28 bislavlicic words were used, with the target phoneme occurring in one of four positions, C1VCCV/C1V (e.g. pig/planet).
• Targets: /p/, /t/, /k/, /b/, /d/, /g/, /m/, /n/, /s/, /ʃ/, /r/, /l/, /f/, /v/.

Results

• Exploratory analyses on 4 PWS and 5 control participants are presented.
• No significant Main Effects of Condition for RT or Accuracy for either group.
• Generally, with left posterior field orientation (FO), PWS’s RTs decrease to Controls’ shams RTs, and with right anterior FO, Controls’ RTs increase to that of the PWS’s baseline.
• No significant differences for accuracy, although stimulation tends to increase accuracy in PWS and decrease accuracy in controls.
• Individual subject analyses show that 2 PWS exhibited main effects of Condition in RT, driven by left posterior FO stimulation compared to baseline.
• 3 of 5 control participants exhibited a main effect of Condition for RT, with varying driving forces behind the effects – all 3 include significant differences between sham and left posterior FO stimulation.

Discussion and Conclusions

• The present study is the first to investigate direct cortical stimulation effects on monitoring/phonological encoding in PWS.
• Data collection is ongoing.
• Method appears effective in that it affects RT and accuracy, and changes seem to be different in PWS and controls.
• If preliminary results hold, they suggest that stimulation of left pSTG using a left posterior FO may speed up the phonological encoding/procesing in PWS.
• Additionally, right anterior FO stimulation of this same area appears to slow down this process in control participants.
• Effects on accuracy data tend to show that stimulation increases accuracy in PWS, but decreases it in controls.
• Results continue to support previous findings that suggest a phonological encoding/internal speech monitoring deficit in PWS (Postma & Kolk, 1993; Vasic & Wijnen, 2005; Sasisekaran et al., 2006) as PWS tend to be slower and more error-prone on a monitoring task designed to tap into this level of speech production.
• Additionally, results tentatively support previous research indicating involvement of left pSTG in phonological encoding and/or monitoring of the internal speech plan.

References