Motivation

- Lingual cancer affects 54,000 Americans each year.
- Lingual cancer is typically treated via radiation, chemotherapy, glossectomy, and then reconstruction.
- Glossectomy is more detrimental to speech intelligibility than the tumor itself.
- Tongue alterations often cause significant speech intelligibility and swallowing difficulties.
- Tongue volume and mobility are affected, leading to impaired functionality.
- Speech therapy post-operatively is often necessary to improve intelligibility.
- Patients have been observed to produce compensatory behaviors post-operatively.
- They develop to aid with patient's speech intelligibility.
- Real-time MRI provides visualization of speakers' full vocal tract.
- Allows for new insight into compensatory behaviors.
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- Patient may exhibit compensation for consonant segments requiring oral and base of tongue which correlate to patient's resection.
- Dental segments /d/ and /t/.
- Alveolar segments /n/, /l/, /r/, /l/, /r/, /l/, /t/, /t/, and /t/.
- Velar segments /k/, /g/, and /g/.
- Palatal segments /t/, /l/, /l/, and /l/.
- Patient's production of consonant segments that require incomplete closure may exhibit less frequent compensation than consonant segments requiring full occlusion of the vocal tract.
- Bilabial and labial segments will not be compensated for, as they do not involve lingual articulation.

Hypotheses

- Patient will exhibit compensation for consonant segments requiring oral and base of tongue which correlate to patient's resection:
  - Dental segments /d/ and /t/.
  - Alveolar segments /n/, /l/, /r/, /l/, /r/, /l/, /t/, /t/, and /t/.
  - Velar segments /k/, /g/, and /g/.
  - Palatal segments /t/, /l/, /l/, and /l/.
- Patient's production of consonant segments that require incomplete closure may exhibit less frequent compensation than consonant segments requiring full occlusion of the vocal tract.
- Bilabial and labial segments will not be compensated for, as they do not involve lingual articulation.

Methods

- Participant: Adult female who underwent oral and base of tongue glossectomy and reconstructive surgery for lingual cancer.
- Stimuli: Excerpts from TIMIT corpus and the Rainbow Passage.
- Data Acquisition: Image data recorded in midsagittal plane (12.8 fps).
- Audio and imaging data collected simultaneously.
- Data Analysis: Target phrases transcribed using IPA.
- Image data visualized in MATLAB.
- Token trees produced against typical articulation to identify possible compensatory mechanisms.

Results

- Patient exhibited compensation for consonant segments that required full oral or base of tongue constriction.
  - Compensated for constriction of the tongue tip against the alveolar ridge /alveolar stop segments: /n/ (Compensated 86% ) and /l/ (Compensated 100%), and alveolar nasal stop: /n/ (Compensated 100%).
  - Compensated for velar segments that required full constriction by the tongue dorsum against velum /velar stop sounds /n/ (Compensated 100%) and /g/ (Compensated 100%), and velar nasal stop /n/ (Compensated 100%).
- Consonant segments requiring partial constriction of the tongue tip against the alveolar ridge /alveolar fricatives /s/ (Compensated 0%), /t/ (Compensated 10%) and approximants /l/ (Compensated 0%), /l/ (Compensated 0%) were mostly produced according to target.
- Consonant segments requiring full constriction in the oral cavity /k/ (Coproduced 81.8%), /g/ (Coproduced 100%), /r/ (Coproduced 94%), /n/ (Coproduced 91%), /n/ (Coproduced 100%), /l/ (Coproduced 80%) were coproduced via labial constriction.
- Coproduction of the Alveolar segments /n/ /l/, /l/, and /l/ involved either full or partial target tongue tip constriction against the alveolar ridge and a full labial constriction.
- Patient frequently produced these segments by co-producing a partial constriction in the target position and a full or partial labial constriction.
- No compensation exhibited for labio-velar segment /w/, since full constriction is unnecessary.
- Dental segments were produced according to target despite prediction.

Significance

- rtMRI reveals that target alveolar and velar consonants are compensated for by producing partial target constrictions and full labial constrictions.
- Improves understanding of compensatory mechanisms and allows therapists to refine intervention methods for improving speech intelligibility.

Future Directions

- Increase sample size of participants for more in-depth study:
  - Investigate patients with various areas and sizes of lingual resection.
  - Investigate discovered compensatory mechanisms' applicability to improving speech therapy strategies for this population.

References