Characterizing Post-Glossectomy Speech Using Real-time MRI
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Motivation
When a glossectomy procedure affects a patient’s ability to form vocal tract constrictions as typical individuals do, is vowel and consonant articulation completely reworked, or are some aspects of articulation preserved even when others cannot be? Specifically, is range of vertical lingual displacement preserved, even if range of horizontal displacement is limited?

Background
Real-time MRI
• Provides dynamic information about all components of the vocal tract
• Analyses performed directly on time functions of pixel intensities, not segmented regions [1]

Glossectomy Procedure for Advanced Tongue Cancer
• Surgical resection with/without reconstruction and radiation therapy
• Disfigurement, viscous saliva, trismus, dysphagia
• Mobility (not volume) of residual tongue is critical in maintaining speech intelligibility [2] [3]

Articulatory and Acoustic Analysis

Articulatory Analysis
Time series illustrating articulatory activity in regions of interest generated by calculating mean intensity of pixels in each region (labial, alveolar, velar)

Acoustic Analysis
Formant frequency values at acoustic midpoint of vowel extracted using Praat

Hypotheses
Consonants
Patients may rearticulate consonants such that constrictions are made with alternate articulators [4]

Vowels
Patients may preserve range of tongue height (and F1) despite restriction on tongue backness (and F2) due to resection of tissue and limited mobility of residual tongue

Patient Type Prediction
Base of Tongue Back vowels fronted
Oral Tongue Front vowels backed
Base of Tongue and Oral Tongue Vowel space compressed centrally

Experimental Method
Participants
• 7 advanced tongue cancer patients (6 male, 1 female)
• 5 base of tongue
• 1 oral tongue
• 1 base of tongue and partial oral tongue
• Data collected more than 6 mos. after treatment except for base of tongue patient M3
• No speech therapy between treatment and MRI scan

Stimuli
Short phrases and single words 2-3 times in random order
• ‘The Rainbow Passage’ phrases
• MOCHA-TIMIT corpus phrases
• Monosyllabic, labial stop-initial words containing /l, t, r, e, æ, o, a, u, o, ɔ/ as syllable nuclei

Results

Oral tongue cancer patient

Base of tongue cancer patient

Glossectomy patients
• Create compensatory constrictions for consonants
• Preserve vowel articulations as best they can

Due to posterior/base of tongue resection with respect to normal male vowel space [5] (red overlay)

Tongue backness (and resulting F2 values) predicted by region of missing tissue. No apparent compensation.

Selected References

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