

EFFECTS OF COSMETIC TONGUE BIFURCATION ON ENGLISH FRICATIVE PRODUCTION

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ABSTRACT

Differences in the speech of individuals with cosmetically bifurcated tongues have yet to be extensively investigated. The aim of this study was to collect acoustic and ultrasound data so as to provide preliminary descriptive analysis of the production of fricative consonants by several speakers of this population. Results indicate that the fricatives of bifurcants were judged as atypical by a trained listener between 13 - 53% of the time, with the voiceless interdental fricative [θ] being the most consistently affected and the voiced alveolar fricative [ʒ] being the least affected.

Keywords: phonetics, speech sciences, cosmetic surgery, tongue bifurcation, speech pathology.

1. INTRODUCTION

In the body modification community, there is a cosmetic procedure of midline tongue bifurcation (also called “splitting” or “forking”), typically performed with either scalpel-and-sutures, or over several weeks by attrition using an increasingly tightened loop of fishing line or dental floss anchored in an existing tongue piercing. Individuals who undertake this procedure are motivated by a variety of reasons, and some have the procedure done multiple times as it is purportedly not uncommon for the split to heal back together up to 50% of the original incision. The extent of the bifurcation depends on each individual’s anatomy; with the split usually extending from the tongue tip back to as far as the sub-lingual frenulum (i.e., ~1.5 – 2.5 cm). One body modification practitioner consulted¹ described the bifurcation procedure, specifying that he would first perform a frenotomy in cases of ankyloglossia (excessive lingual frenula tethering the inferior tongue to the floor of the mouth) to allow space for bifurcation.

The aim of the present study was to discover what, if any, implications tongue bifurcation may have for speech sound production. The topic of tongue bifurcation has been only very rarely investigated in the speech, dental, and medical literature — a surprising observation considering the procedure’s widespread application and its

considerable functional impact on a major body structure. One individual instance of bifurcation is addressed in a 1999 case study by Benecke [2]; an accidental bifurcation caused by complications from tongue piercing is described in [5]; and a single case of bifurcation gone awry is described in [1].

Only one study addresses the impact of bifurcation on speech: a 2004 case report by Bressmann [4] considers bifurcation descriptively, rating one individual’s speech intelligibility and giving an anatomical account of the tongue (using sagittal, coronal, as well as 3D, ultrasound). The study found that the speech was rated as completely intelligible, although qualitative distortions in the coronal fricatives [s] and [z] were noted. The individual was found to have typical tongue motility and no independent control of both tongue halves.

Given this scant treatment in the literature, we sought to better understand whether and to what extent the speech sound production of this population is affected, particularly with regard to fricative consonants.

2. METHODS

2.1. Participants

7 participants in total (4 bifurcated, 3 control) took part in the present study. No participants reported any speech disorder, congenital malformation or dysfunction. All participants were native monolingual speakers of Canadian English from various regions in Canada.

2.1.1 Bifurcated Participants

This study included 4 bifurcated speakers: 101: f, 40, bifurcated 10 y; 102: m, 35, bifurcated 10 y; 103: genderqueer, 28, bifurcated 6 y; 104: f, 26 bifurcated 4 y. Participants were recruited from the body modification community through word of mouth and Internet message boards. Participants were compensated \$20 for their visit. Bifurcation depth varied by participant. 101, 102 and 103 had the procedure performed by scalpel and suture; 104 used the attrition method. Bifurcants were asked if they were able to perform tongue “tricks”, including independent movement of each tongue tip; all

participants were able to do so to different extents, including "clapping" or "wagging" the tongue tips together or sliding the tips against each other (see Figs 1 and 2). Bifurcants were able to produce alveolar clicks and trills when asked.

2.1.2 Control Participants

To compare the bifurcant speech to typical speech, controls participants reported for the study: 201, m, 28; 202, m, 44; 203, f, 28.

2.2. Stimuli

Artificial English disyllables were used to elicit the speech sounds of interest. The present study focused on fricative consonant sounds that make use of the tongue tip and blade. Under analysis are 6 fricative sounds: [ð], [θ] interdental fricatives, [z], [s] alveolar fricatives, and [ʒ], [ʃ] palatoalveolar fricatives.

Along with the target tokens ([asa], [aza], [aʃa], [iʃi], [aʒa], [aθa], [oθo], [aða], additional tokens were collected but not analyzed for the present study ([ala], [aɹa], [oɹo], [ata], [ada], [idi], [atʃa], [ipi]). The 16 tokens were randomized over 6 trials of 40 tokens, to get a minimum of 15 unique iterations for each token. 101 produced fewer tokens than 15 for [s] and [z]. The tokens appeared on a screen in English orthography (e.g. "asha", "atha").

Although participants were instructed to pronounce the tokens with initial stress, every participant produced some tokens of both initial and secondary stress. All participants needed prompting to produce distinct adequate tokens of each voiced and voiceless interdental fricative (e.g. "like author" or "like other").

2.3. Procedure

2.3.1 Data Collection

Data were collected in the Interdisciplinary Speech Research Laboratory at the University of British Columbia. Participants sat in a modified ophthalmic examination chair (American Optical Co. model 507-A) with a UST-9118 EV ultrasound 180-degree transducer under the chin and the head against a headrest to constrain movement (see [6]). A Shure SM63LB dynamic omnidirectional microphone was 18 cm from the participant's mouth, recording speech into a computer and analyzed using Praat [3]. The present study focuses strictly on acoustic and perception-based analysis of the speech stream; ultrasound data were collected for future analysis. The study lasted approximately 30 minutes.

2.3.2 Data Analysis

The target fricative segments were isolated in Praat by hand. Fricatives produced by bifurcants and controls were compared. Centre of Gravity (CoG) and Standard Deviation (SD) were measured by fricative, by participant and across groups (Tables 1 and 2). Carrying out an across-participants statistical analysis will be the next step once our sample is larger. Phonetically trained listeners evaluated fricatives in the speech of the bifurcated participants as being either typical or atypical (Tables 3 and 4).

Table 1: Bifurcant CoG and SD.

Fric	101 CoG	102 CoG	103 CoG
[θ]	4011.83(SD=2017.03)	4541.45(SD=642.52)	5006.39(SD=1280.56)
[ð]	1126.28(SD=441.87)	1453.29(SD=878.88)	2696.48(SD=848.17)
[s]	-	6421.50(SD=687.83)	4906.45(SD=864.48)
[z]	1979.72(SD=1278.16)	2412.22(SD=997.54)	3676.44(SD=1346.67)
[ʃ]	3444.12(SD=322.85)	3836.62(SD=225.42)	3597.03(SD=377.18)
[ʒ]	1917.59(SD=526.36)	2319.35(SD=656.97)	2328.30(SD=693.01)
Fric	104 CoG	Grouped CoG	
[θ]	9258.70(SD=688.60)	5520.92(SD=2412.32)	
[ð]	9028.68(SD=941.69)	3107.35(SD=3050.58)	
[s]	9150.45(SD=465.41)	7092.34(SD=1862.85)	
[z]	8449.99(SD=1452.10)	4189.30(SD=2663.16)	
[ʃ]	7039.27(SD=1154.11)	4253.12(SD=1462.88)	
[ʒ]	6249.55(SD=728.57)	3155.01(SD=1869.22)	

Table 2: Control CoG and SD.

Fric	201 CoG	202 CoG
[θ]	10253.69(SD=1310.11)	6090.74(SD=1601.87)
[ð]	5820.88(SD=1722.01)	1193.76(SD=1202.70)
[s]	9730.93(SD=553.32)	8877.83(SD=1235.02)
[z]	6772.81(SD=1386.14)	1544.02(SD=499.01)
[ʃ]	5096.85(SD=893.87)	3111.59(SD=350.75)
[ʒ]	4427.03(SD=631.63)	1463.46(SD=418.93)
Fric	203 CoG	Grouped CoG
[θ]	11708.32(SD=1301.00)	9747.47(SD=2700.20)
[ð]	7312.37(SD=2188.20)	5303.33(SD=2932.01)
[s]	9522.12(SD=369.10)	9383.39(SD=871.34)
[z]	7741.77(SD=809.02)	5298.25(SD=2937.72)
[ʃ]	6233.08(SD=622.89)	4724.25(SD=1467.02)
[ʒ]	5103.79(SD=413.60)	3704.07(SD=1655.66)

3. RESULTS

The proportion of fricatives affected varied by participant. Several tokens demonstrated anomalous "pops" in [ð] and [θ], and noticeable "slushiness" in [s] (sounding rather like a lateral fricative). Data on CoG and SD are reported in Tables 1 and 2.

Figure 1: 101 demonstrates independent movement of his tongue tips.



Figure 2: 103 demonstrates independent movement of their tongue tips.



Figure 3: an anomalous fricative [ð] of participant 1.

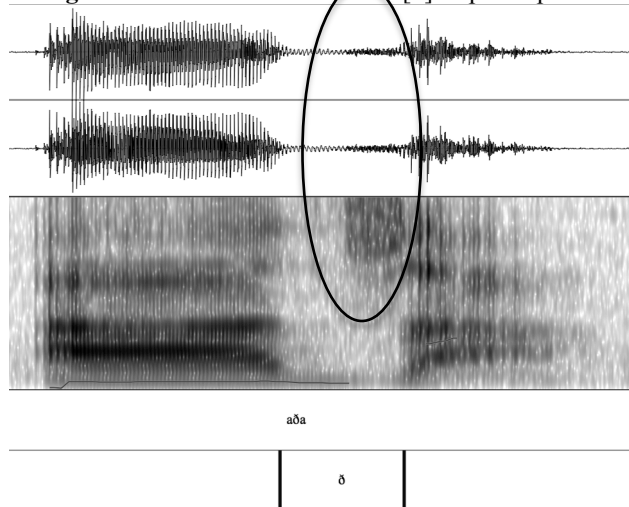


Figure 4: an anomalous fricative [θ] of participant 4.

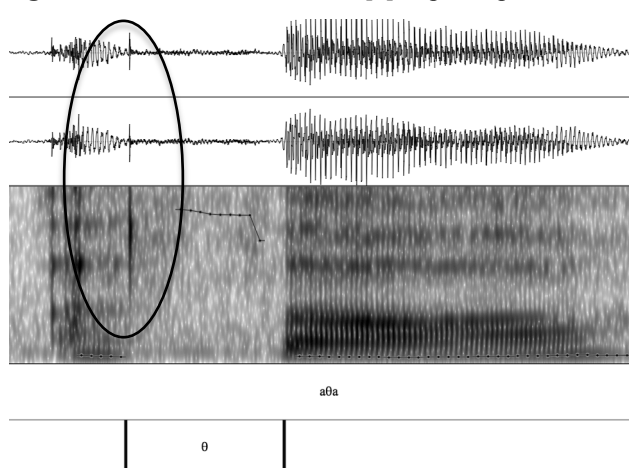


Figure 5: an anomalous fricative [θ] of participant 1.

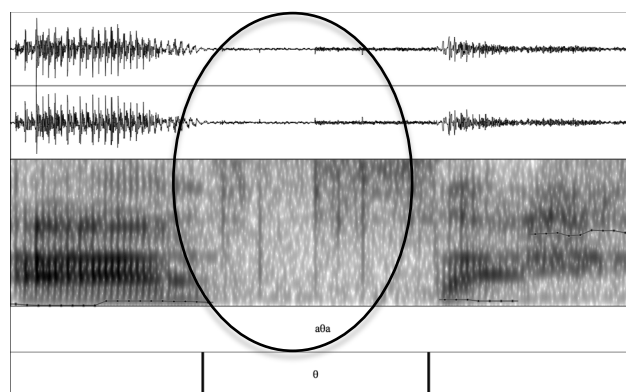


Table 3: percentage of atypical fricatives by participant for each fricative.

Fricative	% Atypical by participant				Mean % Atypical
	1	2	3	4	
[θ]	56	59	54	46	53.75
[ð]	76	20	72	20	47.0
[s]	-*	26	15	5	15.33
[z]	80**	4	28	63	33.75
[ʃ]	3	21	28	63	28.75
[ʒ]	11	5	0	37	13.0

* [s] and [z] were added to the stimuli after 101's visit.

**The [z] collected were incidental errors of pronunciation of [ʒ].

Table 4: percentage of total averaged atypical fricatives by bifurcant.

Bifurcant	Grouped % Atypical
101	38
102	22
103	33
104	32

4. DISCUSSION

The speech of bifurcants does not differ from controls in terms of intelligibility. Ostensibly, the atypical-sounding fricatives observed here could be caused by turbulent airflow around or through the tongue split, or possibly by oral air pressure blowing the split apart, creating an opening where additional surface area and saliva on the tongue interact with airflow to generate sporadic acoustic effects, visible both in the waveform and spectrogram (see Fig. 3-5). Although the quality of each fricative fell along a continuum of typicality, the listeners categorized each as either typical or atypical.

Notice that the fricative of the spectrogram for Fig. 3 contains a change in frequency density in the latter half. In Fig. 4, a spike in the waveform and a dark band in the spectrogram can be seen in the initial part of the fricative [θ]. In Fig. 5, a visibly near-periodic spectrographic representation captures the “popping” sound of the anomalous fricative.

The percentages of atypical sounding fricatives are tallied by type (Table 3) and by participant (Table 4). The controls produced atypical-sounding interdental fricatives about 10-15% of the time with interdentals being the most frequently atypical. This may be owing to the interaction of the rapidly moving tongue tip, the teeth, and saliva. Bifurcant 101 had the most atypical fricatives and 102 had the fewest. Impressionistically, the consequences of bifurcation on speech are comparable to a lisp.

According to qualitative self-reporting of the bifurcant participants, their speech requires more precision and effort to avoid mispronouncing certain sounds. They said this was especially noticeable during the initial healing of and adaptation to the bifurcation, which took place over the weeks following the procedure. Additionally, all bifurcants volunteered the information that when tired or inebriated, their speech was especially subject to noticeable variation (that is, the fricatives produced were non-canonical). Bifurcants characterized their speech as sounding “lispy” or “messy” under these particular circumstances.

The trained listeners also noted that these anomalies were accentuated in the participants’ running speech. One plausible explanation for these effects is that the two tongue tips must be held together using medial compression, which requires more effort and precision than non-bifurcated speech. During higher-load tasks, such as natural connected speech or under the influence of fatigue or inebriation, compression as a strategy may be less available to the bifurcated speakers, due to the conscious effort required.

Generally, the noticeable differences were minor, inconsistent and variable, though not negligible. Individual differences in tongue anatomy or bifurcation length might account for the variation.

We hope that, given more information about how bifurcation may affect speech, those considering the procedure can make a decision informed by impartial evidence. In particular, it would behoove individuals in fields relying on their speech (e.g., education, broadcasting, etc.) to understand the consequences of this procedure on the acoustic quality of their speech. The bifurcated tongue is also of interest to clinicians in speech pathology and dentistry, as the motility and agility of the tongue can affect speech performance and potentially swallowing or lavage by the tongue of the teeth and gums after eating. Future work should focus more thoroughly on these functions with regard to tongue bifurcation.

Conversely, the general maintenance of intelligibility and the presence of independent tongue tip movement suggest that there may be a potential use of tongue bifurcation as a medical treatment for survivors of stroke with hemiparesis of the tongue. Bifurcation could offer more tongue motility if the tip of the tongue is freed from the tether of the affected half of the tongue.

The present paper only begins to touch on possible implications of bifurcation on tongue function, warranting further study. Larger sample sizes and longitudinal before-and-after testing on individual participants undergoing bifurcation are logical next steps with this research. These would enable us to determine which effects are due to the bifurcation and which can be attributed to individual differences.

We hope that in future work analysis of the additional data collected as part of the present study (ultrasound imaging, longer speech passages) will provide further insight into the quantitative differences in the speech of this population. Also in future work, we anticipate that biomechanical simulations using ArtiSynth (www.artisynth.com) will elucidate the function of the bifurcated tongue.

7. REFERENCES

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