Voicing Contrast in Fijian: a descriptive ultrasound study

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1 Introduction

The purpose of this squib is to describe the voicing contrast in Fijian, an Austronesian language spoken by 350,000 to 450,000 people in the Republic of Fiji. The description presented here is based on one session of ultrasound recording of one speaker from Korovou, a village located in the eastern side of Viti Levu, where Standard Fijian is spoken.

According to previous reports (Milner, 1972; Schütz, 2014), the vowel system of Fijian is comprised by 5 phonemes, however, there is not the same consensus regarding consonants. For example, Milner (1972) states that there are 14 consonants, and Schütz (2014) 19 phonemes (considering *traditional* and *indigenous consonants*). Although there is not consensus regarding the number of consonants, the previous descriptions agree on the existence of a voicing contrast between alveolar and velar stops. There is also a labial voiced stop, but it does not contrast with a labial voiceless. The present study seeks to describe the voicing contrast between alveolar and velar stops, considering supralaryngeal gestures, in particular, the tongue root advancement related with voiced consonants (Westbury, 1983; Ahn, 2015). Voiced consonants have been described as prenasalized /ⁿd/, /ᵑg/, while voiceless consonants mostly as unaspirated (Milner, 1972), but also it has been reported a slightly aspiration (Scott, 1948) and a relative aspiration (Schütz, 2014).

1.1 *Two-way contrast in Fijian* *When languages have two-way contrast, they can distinguish between voiced and voiceless unaspirated, like Russian; or between unaspirated (voiced or voiceless) and voiceless aspirated like Mandarin. In this context, according to the previous descriptions, Fijian would be a voicing language, because even when it has been established a slightly level of aspiration, they are classified as unaspirated; thus, they have a short VOT lag.*

A voiced consonant is prenasalized when the nasal passage is open in the onset of the stop. According to Henton et al. (1992) when these consonants do not contrast with the plain voiced ones, the prenasalization can be understood as a mechanism to maintain the voicing. As it is pointed out by Solé (2018), despite of the difficult of initiate and maintain voicing during the closure, many languages contrast voiced with voiceless consonants.

In order to favor the phonation, speakers do articulatory adjustments, and prenasalization is one of them (Rothenberg, 1968). Solé (2011) claims that the principal adjustment used by speakers of French, Portuguese and Spanish is prenasalization. Others adjustments involve the enlargement of the oral cavity, which can be produced passive or actively (Kent & Moll, 1969; Westbury, 1983). When the enlargement is produced actively, there are different mechanisms like raising the soft palate, lowering the larynx, advancing the tongue root, between others (Ahn, 2018).

According to Westbury (1983), in English, the tongue root advancement is the most reliable maneuver of enlarging the oral cavity actively in voiced consonants in all environments. Also, the author claims that the prenasalization is not used as a mechanism to favor voicing in American English. Ahn (2015) points out that the tongue root advancement or tongue body lowering is what differentiate phonologically the voiced (without phonation) and voiceless stops in English at the beginning of the utterance. In relation to other languages, Ahn (2018) also provide the same evidence of a phonological laryngeal contrast in German, thought with some variation. In addition, she states that in Portuguese, a true voicing language, there is a consistent tongue root advancement in voiced consonants comparing with voiceless ones.

If the prenasalization in Fijian is a mechanism to favor phonation, it would be interesting to know if there is also tongue root advancement or not in voicing consonants. As it was pointed out previously, in Portuguese, in addition to the prenasalization (Solé, 2011) the tongue root advancement is consistent in voiced consonants (Ahn, 2018). However, Portuguese voiced consonants do not exhibit the same level of prenasalization as Fijian does, actually, they are described as prenasalized (Milner, 1972; Schütz, 2014). Crosslinguistically, it is important to determine if the tongue root advancement is a typical gesture that accompanied voiced consonant in order to favor phonation, even though when there are others adjustment like prenasalization.

The descriptive analysis shows that in Fijian there is tongue root advancement in voiced alveolar and velar consonants word-initially. This suggest that, in addition to prenasalization, Fijian uses the enlargement of the oral cavity by fronting the tongue in order to facilitate the voicing at the beginning of the word.

2 Data collection

Data was collected from a male Fijian native speaker in his forties. The consultant also speak English fluently since childhood. The articulatory and acoustic data was obtained simultaneously with the AAA software from the Articulate Instruments Limited. The participant wore an Ultrafit Stabilisation Headset, with which a 64 element convex ultrasound transducer was connected and placed under the chin. The transducer captured images in a 20 mm 69 radius range with 92 degree of maximum field of view. A pre-amp microphone was connected to 70micro ultrasound system for speech research, which captured the audio signal. The AAA software was run on a 64-bit Windows computer with USB ports.

The consultant was requested to read four Fijian words per each alveolar and velar plosive consonant in word-initially and word medial position, in total, 224 tokens. According to Westbury (1983), in English there is tongue root advancement in all environments, however, Ahn (2015) only explores word-initially, in order to know if the advancement of the tongue root is a phonological gesture. A set of three words per time was shown on the screen of the AAA software. The stimuli were the following:

(1) Voiced consonants:

/d/ word-onset	/d/ word-medial	/g/ word-onset	/g/ word-medial
daliga [dali ga] ‘ear’	danda [ⁿdaⁿda] ‘soft, pulpy, of wet things only’	qalo [galo] ‘swim’	qaqa [ga ga] ‘win’
daku [ⁿdaku] ‘back’	dadara [ⁿdaⁿdaɻa] ‘slippery, smooth’	qai [gai] ‘now’	saqa [sa ga] ‘cook’
damudamu [ⁿdamuⁿdamu] ‘red’	mamada [mamaⁿda] ‘light, not heavy’	qara [gaɻa] ‘hole’	vaqali [βa gali] ‘polish’
davo [ⁿdaβo] ‘lie’	taumada [taumaⁿda] ‘beforehand, first, before, of time, early’	qase [gase] ‘adult’	waqa [wa ga] ‘burn’

(2) Voiceless consonants:

/t/ word-onset	/t/ word-medial	/k/ word-onset	/k/ word-medial
tasea [tasea] ‘split’	gagata [ga gata] ‘sharp’	kana [kana] ‘eat’	yaloka [jaloka] ‘egg’
tani [tani] ‘other’	matau [matau] ‘right’	kalokalo [kalokalo] ‘star’	waka [waka] ‘root’
taura [tauɻa] ‘hold’	mata [mata] ‘eye’	kau [kau] ‘stick’	vakasama [βakasama] ‘think’
tamata [tamata] ‘man’	vuata [βuata] ‘fruit’	kabu [kaβu] ‘fog’	vakamatea [βakamatea] ‘kill’

Despite of the fact that the entire list was elicited, in order to have a preliminary description of the voicing contrast in Fijian, only the best ultrasound frames were selected. For this reason, seven words per each sound word-initially and word-medially were analyzed.

3 Analysis

The annotation of the recordings of the target words were conducted using the AAA software. First, the last frame before the release was selected per each consonant in order to obtain an image of the tongue position with the highest oral pressure (Ahn, 2018). Then, the software semi-automatically tracked the trace of the tongue and it was corrected manually when it was necessary. Figure 1 shows the screen with the annotation of the last frame before the release of /t/ and the trace of the tongue in that frame in the word *taura* 'hold'.

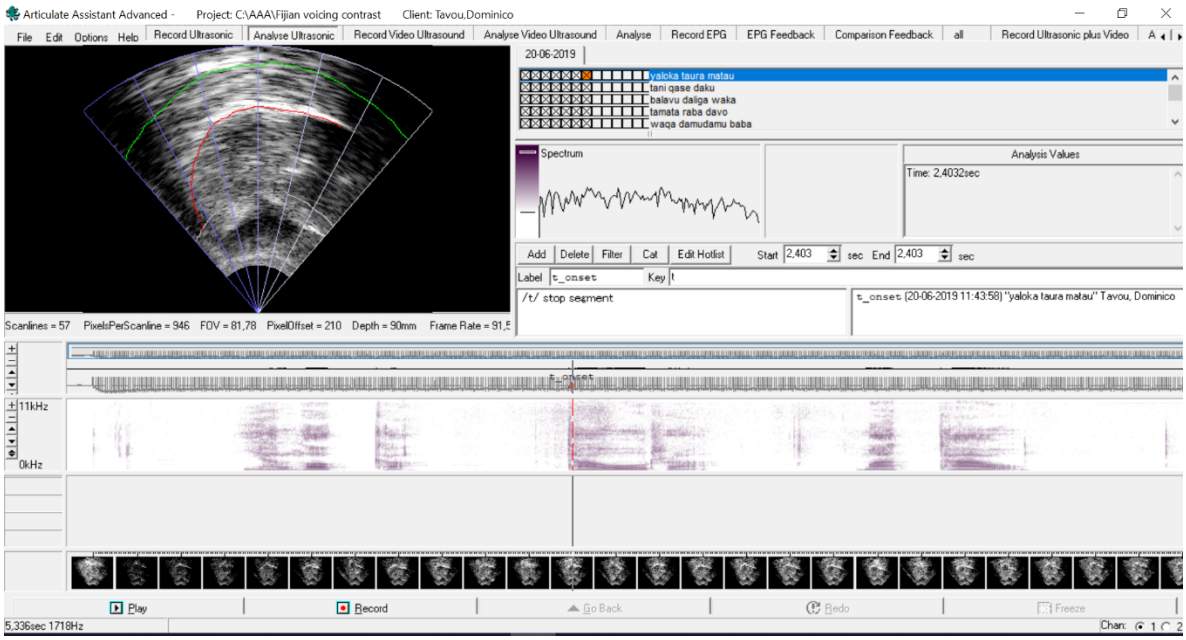

Figure 1: Annotation of the last frame before the release of /t/.

In order to find evidence to support the tongue root advancement, the Spline Workspace of the AAA Software was used to obtain an image with the last frame before the release of the contrast between /t/ and /d/ word-initially and word-medially, and the same for /g/ and /k/. In Figures 2, 3, 4 and 5 there is a comparison of the body of the tongue between the last frame before the release of voiced and voiceless consonants. On the left, the tongue root and, on the right the tongue tip.

3.1 *Alveolar voicing contrast* Seven words containing /t/ and seven words with /d/ in word-initial position were selected and copied into the Spline Workspace in the AAA Software. In this manner, it is possible to observe the difference of the tongue shape between voiced and voiceless consonants. Figure 2 shows in red the realizations of /t/ and in blue the realizations of /d/.

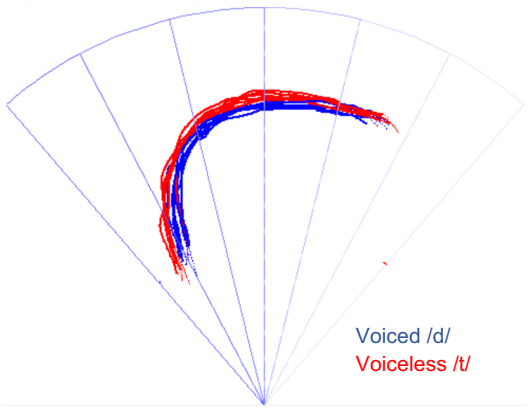

Figure 2: Shape of the tongue of /d/ and /t/ word-initially.

Word-initially, according to Figure 2 there are differences in the shape of the tongue between the voiced and the voiceless alveolar. The voiced consonant seems to have the tongue root more fronted than the voiceless ones. In addition, it is observed that the body of the tongue is lower in voiced consonants than in voiceless.

According to Westbury (1983), in American English, the tongue root advancement occurs in all environments. For that reason, Figure 3 shows the difference between voiced and voiceless alveolar in word medial position:

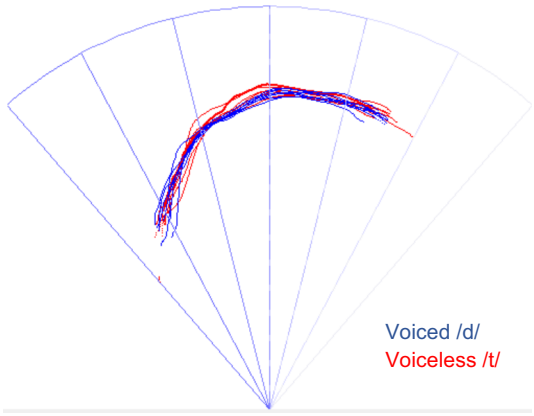

Figure 3: Shape of the tongue of /d/ and /t/ in word medial position.

In this case, the shape of the tongue of voiced and voiceless alveolar consonants is similar. In fact, there is overlap between them.

3.2 *Velar voicing contrast* In order to compare the velar sounds, seven words of each consonant were selected and the splines were copied into the Spline workspace of the AAA Software. Figure 4 shows the shape of the tongue of both voiced and voiceless velars:

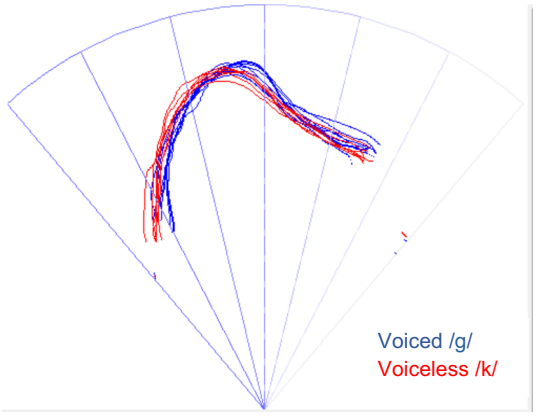

Figure 4: Shape of the tongue of /g/ and /k/ word-initially.

There is a slightly difference in the shape of the tongue between velar consonants. It seems that voiced consonants are more fronted that voiceless ones. However, comparing with the alveolar contrast, it is less evident. Figure 5 shows the difference between the same sounds, but in word medial position:

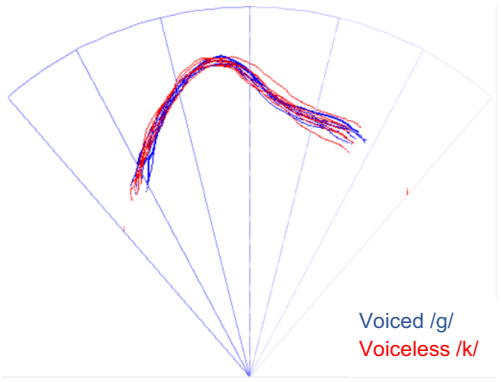

Figure 5: Shape of the tongue of /g/ and /k/ in word medial position.

In this context, there is also overlap between velar consonants as in the alveolar contrast.

4 Discussion

From a descriptive approach there is evidence of differences in the shape of the tongue between alveolar sounds /t/ and /d/ word-initially in Fijian. In the voiced consonants not only the tongue root is more advanced, but also the body tongue is lower than in voiceless. Ahn (2018) found tongue body/front lowering in the contrast between labials /b/ and /p/ word-initially in American English, but not tongue root advancement at the same time.

In the case of the velar consonants, there is a small difference in the shape of the tongue word-initially. It seems that the tongue root is more advanced, but also there is overlap between voiced and voiceless, thus, the comparison between them is not clear as in the alveolar consonants in the same context.

Word-medially, there is overlap between voiced and voiceless consonants in alveolar and velar consonants. Apparently, in Fijian there are differences in the shape of the tongue between voiced and voiceless consonants word-initially, but not in word medial position. Thus, in addition to prenasalization, the tongue root advancement is used at the beginning of the word as a mechanism to enlarge the oral cavity. As Solé (2018) pointed out, speakers can use more than one mechanism in order to reach the voicing. In this context, it would not be necessary to enlarge the oral cavity word-medially, because the vocal folds are vibrating before and after the voiced stop.

As it was pointed out before, this study is based on only one speaker. For this reason, it is not possible to generalize this description to a whole Fijian language. It would be interesting to extend the sample, in order to determine if there is evidence of tongue root advancement as a supralaryngeal gesture in Fijian, and also to analyze acoustic data related to voiceless consonants to have a complete panorama of the voicing contrast.

5 References

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