

# DENTALS ARE GRAVE

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## 1. INTRODUCTION

Phonetic features require either an articulatory or an acoustic basis. Defining a feature in an optimal fashion can lead to improved explanatory force concerning, for example, phonetically motivated sound change. This article highlights the increased explanation of certain auditorily based sound changes and assimilations, obtained by correcting the definition of the old-school feature [grave], and concomitant adjustments to the classification of segments. In particular, non-sibilant dentals must be [grave]. Like all coronals, dentals are considered [acute] in Jakobsonian taxonomy [1] et seq. However, their noise energy and their involvement in [flat] enhancement and assimilation suggest instead that they are [grave], like labials and velars.

## 2. CLASSIFICATION

With noise measurements alone, it is notoriously difficult to discriminate reliably between non-sibilant dental and labial consonants, as both present generally level spectra with no significant peaks.

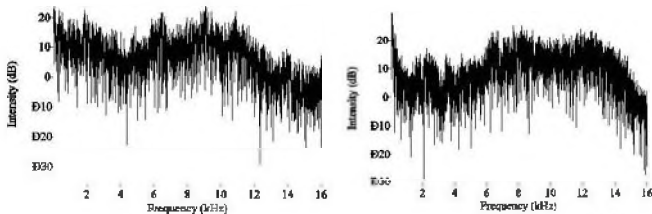


Fig. 1. Simple Fourier power spectra of [θ] in Slavey [tʰah] 'carrot' and [f] in English 'fan' (rendered in Praat)

Indeed their noise energies are so similar that labials commonly substitute for dentals across languages. Table 1 showcases such substitution in the Slavey (Athabaskan) dialect centered in Tulita, NT; cf. dentals in South Slavey (NT, AB).

Table 1. Dentals > labials in North Slavey, Tulita, NT [2]

| Slavey   | Tulita    |            | Sl.  | Tul. |         |
|----------|-----------|------------|------|------|---------|
| ʔeh̄tʰaa | ehpa:     | 'dryfish'  | θé   | fēʔ  | 'star'  |
| -(tʰ)ʰiʔ | -pʰiʔ     | 'head'     | θa   | fa   | 'sand'  |
| tʰih     | p'ih/p'ie | 'mosquito' | -ðáʔ | -va  | 'mouth' |
| -(tʰ)éhé | p'é/p'éh  | 'sinew'    | -ðeʔ | -ve  | 'liver' |

Since labials are always considered [grave], we can find no support at all for the claim that (inter)dentals are not [grave], let alone [acute]. Rather it seems clear that (inter)dentals can only be given the same value of [grave] as the labials from which they are so hard to distinguish. To quote Ladefoged and Maddieson: "It seems that in the case of the pairs [f, θ], and [v, ð] in English, the inconsistencies between speakers are so great that it may be profitless to try to characterize the acoustic spectra of the fricatives themselves." [3]

Moreover, given their rather level spectrum, labials (and dentals) cannot be [grave] in the sense of "having predominantly low frequency energy" [1]. Rather, given that an acoustic feature must really be an *auditory* feature, we propose to redefine [grave] as the *audible* presence of significant low frequency noise in a sound. In particular this means that the low frequency noise (< 2.5 kHz) must not be overshadowed by predominant high frequency noise (as in sibilants).

On this definition, [grave] applies equally to labials and dentals as it does to velars, which present a preponderance of noise in lower frequencies. This allows us to rationalize shifts not only between velars and labiodentals as in Table 2, but also between velars and dentals as in Table 3.

Table 2. [f] ~ [x] in Hare Slavey, Fort Good Hope, NT [2]

|                 |           |                       |             |
|-----------------|-----------|-----------------------|-------------|
| fori ~ xori     | 'quickly' | lifufé ~ lixufé       | 'fork'      |
| lifótō ~ lixótō | 'nine'    | fawéhgewe ~ xawéhgewe | 'Old Baldy' |

Table 3. [θ, ð] > [x, ɣ] in South Slavey, Wrigley, NT [2]

| Standard | Wrigley |        | St.  | Wrg. |         |
|----------|---------|--------|------|------|---------|
| θe-      | xe-     | PERF.  | -ðáʔ | -ɣáʔ | 'mouth' |
| θé       | xéʔ     | 'star' | -ðéh | -ɣéʔ | 'skin'  |

## 3. ENHANCEMENT

According to Jakobson et al. [1] [grave] is *enhanced* (cf. [4]) by another "low tonality" feature of vocoids, [flat], characterized by a downward shift of formants—particularly F<sub>2</sub>. (Similarly, consonantal [acute] is enhanced by vocalic [sharp], an upward shift of formants.) Indeed, across languages, F<sub>2</sub> transitions tend to be lower or equal in dentals vs. alveolars [5]. This pattern is shown for American English in Table 4.

Table 4. Starting F2 values (Hz) for alveolars vs. dentals [6]

|    |      |    |      |    |      |    |      |    |      |
|----|------|----|------|----|------|----|------|----|------|
| si | 2050 | zi | 1950 | di | 2000 | ði | 1950 | ði | 1950 |
| sæ | 1700 | zæ | 1700 | dæ | 1750 | ðæ | 1650 | ðæ | 1650 |
| sɔ | 1150 | zɔ | 1200 | dɔ | 1350 | ðɔ | 1050 | ðɔ | 1150 |
| su | 1600 | zu | 1550 | du | 1700 | ðu | 1600 | ðu | 1500 |

Like its consonantal counterpart [grave], [flat] has diverse articulatory exponents in speech: labialization, velarization, pharyngealization, and retroflexion. We present diachronic evidence that dentals—as [grave]—are enhanced acoustically by all such incongruent articulations.

### 3.1 Labialization and velarization

Table 5 illustrates that dental consonants, which remain in South Slavey, have evolved into labiovelars in the North Slavey dialect centered in Deline, NT. This sound change also occurred in Hare, another Slavey dialect of NT, in Tlicho (also NT), and word-finally in Gwich'in (YK). As predicted, the [grave] feature of dentals was enhanced by the [flat] feature of labialization and velarization (and the dental gesture was eventually lost).

**Table 5. Dentals > labiovelars in North Slavey, Deline, NT [2]**

|                     |                    |        |                    |                   |         |
|---------------------|--------------------|--------|--------------------|-------------------|---------|
| Slavey              | Deline             |        | Slavey             | Del.              |         |
| ᶕ <sup>h</sup> e    | k <sup>wh</sup> e  | ‘rock’ | ᶕ <sup>h</sup> éhé | -k <sup>w</sup> é | ‘sinew’ |
| ᶕ <sup>h</sup> ione | k <sup>w</sup> ené | ‘bone’ | -ðé                | -wé?              | ‘liver’ |

### 3.2 Pharyngealization

Table 6 illustrates that the dentalized sibilants of Proto-Athabaskan which survive in some speakers of South Dakelh (BC) have all become pharyngealized (“emphatics”) in adjacent Tsilhqot’in. In the sibilants, the decidedly weak [grave] tonality of the dental gesture was enhanced and eventually replaced by the [flat] tonality of tongue root retraction.

**Table 6. Sibilants in Dakelh vs. Tsilhqot’in, BC [2]**

|   |  |        |        |         |        |
|---|--|--------|--------|---------|--------|
| Dakelh  | Tsilhq.  |        | Dakelh | Tsilhq. |        |
| ᶕ <sup>h</sup> ᶕ <sup>h</sup> ᶕ <sup>h</sup> el | ᶕ <sup>h</sup> ᶕ <sup>h</sup> ᶕ <sup>h</sup> l | ‘axe’  | jaᶕ    | jəᶕ     | ‘snow’ |
| ᶕ <sup>h</sup> i                                | -ᶕ <sup>h</sup> i                              | ‘head’ | -jiᶕ   | -neᶕ    | ‘long’ |

Interestingly, Tsilhqot’in’s own neighbor St’at’imcets Salish has pharyngealized coronal approximants /z, z’/ which are phonetically dental or interdental. (Arabic has a similar voiced continuant, called ḍa:ʔ.)

### 3.3 Retroflexion

Retroflexion cannot enhance dentalization, as these gestures are incompatible. Revealingly, however, an interdental approximant /ð/ which occurs in disparate Philippine languages has evolved into a retroflex lateral /l/ in Southern Kalinga, and a retroflex rhotic /ɭ/ in Madukayang Kalinga, Balangao, Mansaka and Upper Tanudan Kalinga. We assume that retroflexion came to substitute for interdentalization on the basis of a shared “low tonality”: [flat] in /l, ɭ/ and [grave] in /ð/. (An acoustic study of Kagayanen /ð/ confirms that it is not [flat]; its F<sub>2</sub> and F<sub>3</sub> are similar to those of an alveolar liquid [7].)

## 4. ASSIMILATION

That dentals are [grave] predicts that coronal consonants may become dental when released into a [flat] vowel or approximant. This is because “low tonality” in an approximant or vowel, viz. [flat], can be mistaken for “low tonality” in a preceding consonant, viz. [grave]—a kind of acoustic assimilation. This prediction is confirmed in the subsections below.

### 4.1 Back vowels

Table 7 illustrates that in the Australian language Lardil /t/ is realized as dental before /u, a/ (and as laminal-postalveolar before /i/). On our interpretation, the “low tonality” of [flat] in /u, a/ is assimilated into /t/ as [grave]/dental (and the “high tonality” of [sharp] in /i/ is assimilated into /t/ as [acute]/laminal-postalveolar).

**Table 7. Coronal allophony in Lardil [4]**

|        |           |           |           |               |
|--------|-----------|-----------|-----------|---------------|
| nom.   | fut.      | nonfut.   | Acc.      |               |
| kaltit | kaltit-ut | kaltit-at | kaltit-in | ‘urine’       |
| jarput | jarput-ut | jarput-at | jarput-in | ‘snake, bird’ |

### 4.2 Retracted vowels

A palatographic study of Kamwe (Afro-Asiatic) reveals that coronal consonants are alveolar or postalveolar when

adjacent to advanced tongue root vowels, but dental when adjacent to retracted tongue root vowels [8]. A similar pattern occurs in Kalenjin (Nilo-Saharan) [9]. In our view, the “low tonality” of [flat] in retracted vowels, which may be considered pharyngealized, is assimilated into coronal consonants as [grave]/dental.

### 4.3 /ɬ, ʂ/

In Irish English, alveolar consonants can be realized as dental before /ɬ, ʂ/, which are retroflexed (and perhaps rounded) [10]. For instance, /t, d, n, l/ are dental in e.g. *train, spider, manner, pillar*. Again, on our interpretation, the “low tonality” of [flat] in retroflex/rounded /ɬ, ʂ/ is assimilated into coronal consonants as [grave]/dental (cf. [10]).

## 5. CONCLUSION

We have argued that the Jakobsonian feature [grave] does not require a predominance of low-frequency noise, but rather requires that the noise below 2.5 kHz is “sufficiently audible” owing to a lack of predominance of high-frequency noise. This effectively extends the reach of the feature, since all the noisy sounds which were classed as [grave] under the original definition still are—notably labials and velars. We have argued that non-sibilant dentals, too, are [grave]. On the one hand, their noise energy is very similar to that of labials. On the other hand, their interaction with the vocalic feature [flat] across languages strongly suggests that they bear the consonantal counterpart [grave].

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