Guide to Features

based on Bruce Hayes's Guide to Features, with modifications, additions and omissions

Format: feature, *acoustic and/or articulatory definition*, list of sounds having the feature value given. The feature values that is easier to define is listed first.

[+syllabic] *forms peak of syllable.*   y, ʏ, u, ʊ, æ, ɵ, ɨ, o, ø, ɞ, ɜ, i, ɪ, ɤ, e, ɛ, ʌ, ɑ, a, ɯ, ʉ, ə, œ, ɶ, ɔ, ɒ, and all syllabic consonants (transcribed like [r̩])

[-syllabic]: ʍ, w, ɥ, ʋ, ɹ, ɰ, ɥ, ɰ, j, ɦ, h, p͡t, b͡d, k͡p, g͡b, ɓ, p, m, b, ɱ, p͡f, b͡v, p͡ɸ, b͡β, ɲ, ɟ, c, d͡ʑ , t͡ɕ, c͡ç, ʈ, ɳ, ɗ, ɖ, t, n, d, d͡ʒ, d͡z, d͡ʐ, d͡ʑ, t͡ʃ, t͡ɬ, ts, t͡ɬ, t͡s, t͡ɬ, d͡z, d͡ʑ, t͡s, d͡z, t͡s, d͡z, t͡θ, d͡ð, ɴ, q, ɢ, k, g, ŋ, k͡x, g͡ɣ, q͡χ, ɢ͡ʁ, ʔ , ʙ, ɸ, v, f, β, ɬ, ɕ , ʎ, ç, ʑ, l̩, ɭ, ɭ̩, ɮ, z�, ʂ, ɻ, ʒ, z, ʃ, s, r, l, θ, ɾ, ʐ, ð, ʕ, ʁ, χ, ʀ, ɟ̃, ɣ, x,

[+stress] *greater articulatory effort*: always marked with [ˈ] diacritic before the stress syllable, as in: [ˈsɪləbəl]

[+long] *greater duration*: marked with [ˑ] or doubling of symbol, as in [nipˑoŋ] or [nippoŋ]

[-consonantal] *oral constriction degree of glide or less*: vowels and glides (ʍ, w, ɥ, ʋ, ɹ, ɰ, j, h, ɒ, ɶ, ɔ, o, œ, ɵ, ø, u, ʊ, ʉ, y, ʏ, ɑ, a, æ, ʌ, ɤ, ɜ, ə, e, ɛ, ɯ, ɨ, i, ɪ) and

[+consonantal]: p͡t, b͡d, k͡p, g͡b, ɓ, p, m, b, ɱ, p͡f, b͡v, p͡ɸ, b͡β, ɲ, c, d͡ʑ , t͡ɕ, c͡ç, ʈ, ɳ, ɗ, ɖ, t, n, d, d͡ʒ, d͡z, d͡ʐ, d͡ʑ, t͡ʃ, t͡ɬ, ts, t͡ɬ, t͡s, t͡ɬ, d͡z, d͡ʑ, t͡s, d͡z, t͡s, d͡z, t͡θ, d͡ð, ɴ, q, ɢ, k, g, ŋ, k͡x, g͡ɣ, q͡χ, ɢ͡ʁ, ʙ, ɸ, v, f, β, ɬ, ɕ , ʎ, ç, ʑ, l̩, ɭ, ɭ̩, ɮ, z̯, ʂ, ɻ, ʒ, z, ʃ, s, r, l, θ, ɾ, ʐ, ð, ɦ, ʕ, ʁ, χ, ʀ, ɟ̃, ɣ, x

[+approximant] *oral constriction degree of liquid or less:* vowels, glide, liquids: ɒ, ɑ, ɶ, a, æ, ʌ, ɔ, o, ɤ, ɜ, œ, ə, e, ɵ, ø, ɛ, ɯ, u, ʊ, ɨ, ʉ, y, i, ʏ, ɪ, ɥ, ɰ, w, ɥ, j, ɹ, ʋ, ɬ, ʀ, ʎ, ʙ, l̩, ɭ, ɭ̩, ɾ̩, r, l, ɾ, h, ʔ

 [-approximant]: ʍ, ɦ, h, ɴ, ɲ, ŋ, ŋ̍, ŋ, ɳ, n, m, ɱ, ʁ, q, χ, ɢ, ɕ , ɟ, c, ç, d͡ʑ , t͡ɕ, ɣ, ɣ, ɣ, x, x̣, x̠, k, ḳ, k̠, g, g, g, ʑ, ʈ, ɗ, ɬ, z̯, ɸ, ʂ, ʒ, z, v, t, ʃ, s, p, f, d, b, θ, ʐ, ð, β, d͡ʒ, d͡z, d͡ʐ, d͡ʑ, t͡ʃ, t͡ɬ, ts, t͡ɬ, t͡s, t͡ɬ, d͡z, d͡ʑ, t͡s, d͡z, p͡f, b͡v, p͡ɸ, b͡β, t͡θ, d͡ð, c͡ç, ɟ̃, k͡x, g͡ɣ, q͡χ, ɢ͡ʁ, ɦ, k͡p, g͡b, p͡t, b͡d

[+sonorant] *no oral pressure buildup* vowels, glides, liquids, nasals: w, ɥ, ʋ, ɹ, ɰ, ɥ, ɰ, j, ɒ, ɶ, ɔ, o, œ, ɵ, ø, u, ʊ, ʉ, y, ʏ, ɑ, a, æ, ʌ, ɤ, ɜ, ə, e, ɛ, ɯ, ɨ, i, ɪ, m, ɱ, ɲ, ɳ, n, ɴ, ŋ, ŋ̍, ŋ, ʙ, ɬ, ʎ, l̩, ɭ, ɭ̩, ɾ̩, r, l, ɾ, ʀ, ʔ, h

[-sonorant]: ʍ, ɦ, h, p͡t, b͡d, ⊙, k͡p, g͡b, ɓ, p, b, p͡f, b͡v, p͡ɸ, b͡β, ɟ, ǂ, c, d͡ʑ , t͡ɕ, ‖, ǀ, ǃ, c͡ç, ɟ̃, ʈ, ɳ, ɗ, ɖ, t, d, d͡ʒ, d͡z, d͡ʐ, d͡ʑ, t͡ʃ, t͡ɬ, ts, t͡ɬ, t͡s, t͡ɬ, d͡z, d͡ʑ, t͡s, d͡z, t͡s, d͡z, t͡θ, d͡ð, q, ɢ, k, g, k͡x, g͡ɣ, q͡χ, ɢ͡ʁ, , ɸ, v, f, β, ɕ , ç, ɦ, ʑ, ɬ, z̯, ʂ, ʒ, z, ʃ, s, θ, ʐ, ð, ʁ, χ, ɟ̃, ɣ, x,

[-contin-artic] *complete closure in oral cavity* stops, affricates, and nasals: p͡t, b͡d, k͡p, g͡b, ɓ, p, m, b, ɱ, p͡f, b͡v, p͡ɸ, b͡β, ɲ, ɟ, c, d͡ʑ , t͡ɕ, c͡ç, ɟ̃, ʈ, ɳ, ɗ, ɖ, t, n, d, d͡ʒ, d͡z, d͡ʐ, d͡ʑ, t͡ʃ, t͡ɬ, ts, t͡ɬ, t͡s, t͡ɬ, d͡z, d͡ʑ, t͡s, d͡z, t͡s, d͡z, t͡θ, d͡ð, ɴ, q, ɢ, ʃ, ɟ, ɟ, ɟ, k, g, ŋ, ŋ̍, ŋ, k͡x, g͡ɣ, q͡χ, ɢ͡ʁ,

 [+contin-artic] vowels, glides, liquids, fricatives: ʍ, w, ɥ, ʋ, ɹ, ɰ, ɥ, ɰ, j, ɦ, h, ɒ, ɶ, ɔ, o, œ, ɵ, ø, u, ʊ, ʉ, y, ʏ, ɑ, a, æ, ʌ, ɤ, ɜ, ə, e, ɛ, ɯ, ɨ, i, ɪ, ʙ, ɸ, v, f, β, ɬ, ɕ , ʎ, ç, ɦ, ʑ, l̩, ɭ, ɭ̩, ɮ, z̯, ʂ, ɻ, ʒ, z, ʃ, s, r, l, θ, ɾ, ʐ, ð, z ʕ, ɦ, ʁ, χ, ʀ, ɟ̃, ɣ, ɣ, ɣ, x, x̣, x̠, ʟ, ʟ̥, ʟ̠

[-contin-acous] *complete absence of acoustic energy at all but lowest frequencies*[1] stops and affricates: p͡t, b͡d, ʘ, k͡p,
g͡b, ɓ, p, b, p͡f, b͡v, p͡ɸ, b͡β, ɟ, ɟ, c, d͡ʑ , t͡ɕ, ‖, ǀ, ǃ, c͡ç, ɟ͡ʝ, ʈ, ɗ, ɖ, t, d, d͡ʒ, d͡z, d͡ʐ, d͡ʑ, t͡ʃ, t͡ɬ, ts, t͡ɬ, t͡ʂ, t͡ɬ, d͡z, d͡ʐ, t͡ʂ, d͡ʑ,
t͡s, d͡z, t͡θ, d͡ð, ʔ, ɢ, q, ɢ, ʄ, ɠ, ʄ, ɠ, k, ḵ, ḵ, g, ɡ, ɡ, k͡x, k͡x, k͡x, g͡ɣ, g͡ɣ, g͡ɣ, q͡χ, ɢ͡ʁ, ʔ͡ʜ, ʔ͡ʕ, ʔ , ʕ

[+contin-acous]: vowels, glides, liquids, nasals, fricatives: ʍ, w, ɥ, ʋ, ɹ, ɰ, ɰ, ɰ, j, ɦ, ɒ, Œ, ɔ, o, œ, ɵ, ø, ɘ, u, ʊ, ʉ,
y, ʏ, ɑ, a, æ, ʌ, ɤ, ɜ, ə, e, ɛ, ɯ, ɨ, i, ɪ, m, ɱ, ɲ, ŋ, n, ɴ, ŋ, ŋ, ŋ, ʙ, ɸ, v, f, β, ɬ, ç , ʎ, ç, ʑ, ɭ, ɫ, ɭ, ɫ, z, ʂ, ɽ, ʒ, z, ʃ, s, r,
l, θ, ɾ, ɻ, ð, ʁ, χ, ʀ, ɟ, ɣ, x,

[-delayed release] *complete oral closure followed by abrupt release* non-affricated stops, including nasal stops:[2] p͡t,
b͡d, k͡p, g͡b, ɓ, p, m, b, ɱ, ɲ, ɟ, c, ʈ, ŋ, ɗ, ɖ, t, n, d, ɴ, q, ɢ, ɠ, k, ɡ, ŋ,

[+delayed release]: p͡f, b͡v, p͡ɸ, b͡β, d͡ʑ , t͡ɕ, ǀ, c͡ç, ɟ͡ʝ, d͡ʒ, d͡z, d͡ʐ, d͡ʑ, t͡ʃ, t͡ɬ, ts, t͡ɬ, t͡ʂ, t͡ɬ, d͡z, d͡ʐ, t͡ʂ, d͡ʑ, t͡s, d͡z, t͡θ, d͡ð, k͡x,
g͡ɣ, q͡χ, ɢ͡ʁ,

[+flap]: *articulated with rapid, ballistic motion; no period of controlled closure* ɺ (lateral), ɽ (retroflex), ɾ (alveolar)
[-flap]: all others

[+trill]: ʙ (bilabial], r (alveolar), ʀ (uvular)
[-trill]: all others

[+nasal]: *lowered velum* The nasal stops: m, ɱ, ɲ, ŋ, n, ɴ, ŋ, ŋ, ŋ, plus all nasalized vowels, glides, etc. (e.g. [a], j)])
[-nasal]: all others

[+voice]: *vocal cord vibration* w, ɥ, ʋ, ɹ, ɰ, ɰ, ɰ, j, ɦ, ɒ, Œ, ɔ, o, œ, ɵ, ø, ɘ, u, ʊ, ʉ, y, ʏ, ɑ, a, æ, ʌ, ɤ, ɜ, ə, e, ɛ, ɯ, ɨ,
i, ɪ, b͡d, g͡b, ɓ, m, b, ɱ, b͡v, b͡β, ɲ, ɟ, d͡ʑ , ɟ͡ʝ, ŋ, ɗ, ɖ, n, d, d͡ʒ, d͡z, d͡ʐ, d͡ʑ, d͡z, d͡ʐ, d͡ʑ, d͡z, d͡ð, ɴ, ɢ, ɠ, ɡ, ɠ, ɡ, ŋ, ŋ, ŋ,
g͡ɣ, g͡ɣ, g͡ɣ, ɢ͡ʁ, ʙ, v, β, ɬ, ʎ, z, ɭ, ɫ, ɭ, z, ɽ, ʒ, z, r, l, ɾ, ɻ, ð, ʁ, ʀ, ɟ, ɣ,
[-voice]: ʍ, h, p͡t, k͡p, p, p͡f, p͡ɸ, c, t͡ɕ, c͡ç, ʈ, t, t͡ʃ, t͡ɬ, ts, t͡ɬ, t͡ʂ, t͡ɬ, t͡ʂ, t͡s, t͡θ, q, k, k͡x, q͡χ, ʔ , ɸ, f, ç , ç, ɬ, ʂ, ʃ, s, θ, χ, x,
[+implosive]: *oral pressure reduced by larynx lowering* ɓ, ɗ, ɠ, ʄ, ɠ, ʄ, ɠ
[-implosive]: all others

[+spread gl]: *vocal folds abducted* ʍ, ɦ, h, plus all aspirated sounds (e.g. [pH]); status of s, f, x is in doubt.
[-spread gl]: all others

[+constr gl]: *vocal folds closely adducted.* ʔ, ejectives (e.g. [p', t', k']), Korean "tense" stops
[-constr gl]: all others

[+LABIAL]: *articulated with lips.* ʍ, w, ɥ, ʋ, ɒ, Œ, ɔ, o, œ, ɵ, ø, ɘ, u, ʊ, ʉ, y, ʏ, p͡t, b͡d, ʘ, k͡p, g͡b, ɓ, p, m, b, ɱ, p͡f,
b͡v, p͡ɸ, b͡β, ʙ, ɸ, v, f, β, and all labialized consonants (e.g. [tʷ]).
[-LABIAL]: all others

[+round]: *articulated with rounded lips.* ʍ, w, ɥ, ɒ, Œ, ɔ, o, œ, ɵ, ø, u, ʊ, ʉ, y, ʏ, and all labialized consonants (e.g.
[tʷ]).
[-round]: all others

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[1] The "all but lowest frequencies" is needed for voiced stops and affricates. Voiceless stops and affricates
include periods of complete silence.

[2] This assumes an articulatory definition of [delayed release]. For the issue of articulatory vs. acoustic features,
see the text, section 3.1.6.

[+labiodental]: *articulated with lower lip touching upper teeth.* ʋ, ɱ, p͡f, b͡v, v, f

[-labiodental]: all others

[+CORONAL]: *articulated with tongue tip/blade.* dentals, alveolars, retroflexes, palato-alveolars, alveolo-palatals, and palatals[3]. ɹ, p͡t, b͡d, ɲ, ɟ, ǂ, c, d͡ʑ , t͡ɕ, ‖, ǀ, !, c͡ç, ɟ͡ʝ, t̪, n̪, ɗ, d̪, t, n, d, d͡ʒ, d͡z, d͡ʐ, d͡ʑ, t͡ʃ, t͡ɬ, ts, t͡ɬ, t͡s, t͡ɬ, d͡z, d͡ʐ, t͡s, d͡z, t͡s, d͡z, t͡θ, d͡ð, ɬ, ɕ , ʎ, ç, ɦ, ʑ, ļ, ɭ, ɺ, ɫ, ʐ, ʂ, ɻ, ʒ, z, ʃ, s, r, l, θ, ɾ, ʐ, ð, and retroflex vowels like [ʼ].

[-CORONAL]: all others

[+anterior]: *articulated forward of alveolar ridge.* dentals and alveolars. p͡t, b͡d, d͡ʑ , t͡ɕ, ɗ, t, n, d, d͡z, d͡ʐ, ts, t͡ɬ, t͡s, t͡ɬ, d͡z, d͡ʐ, t͡s, d͡z, t͡θ, d͡ð, ɬ, ɕ , ʑ, ɭ, ɫ, z, s, r, l, θ, ɾ, ʐ, ð

[-anterior]: ɹ, ɲ, ɟ, c, c͡ç, ɟ͡ʝ, t̪, n̪, ɗ, d͡ʒ, d͡ʐ, t͡ʃ, t͡ɬ, t͡s, d͡ʐ, ʎ, ç, ļ, ɺ, ʑ, ʂ, ʒ, ʃ

[0 anterior]: all [-CORONAL] sounds. Anteriority is not definable in a non-coronal.

[+distributed]: *articulated with tongue blade.* dentals, palato-alveolars, alveolo-palatals, and palatals. ɹ, ɲ, ɟ, c, d͡ʑ , t͡ɕ, c͡ç, ɟ͡ʝ, d͡ʒ, d͡ʐ, t͡ʃ, t͡ɬ, t͡s, t͡ɬ, d͡z, d͡ʐ, t͡θ, d͡ð, ɕ , ʎ, ç, ɦ, ʑ, ʒ, ʃ, θ, ð

[-distributed]: *articulated with tongue tip.* alveolars, retroflexes. p͡t, b͡d, t̪, n̪, ɗ, d̪, t, n, d, d͡z, d͡ʐ, ts, t͡ɬ, t͡s, d͡z, t͡s, d͡z, ɬ, ļ, ɭ, ɺ, ɫ, ʑ, ʂ, ɻ, z, s, r, l, ɾ, ʐ

[0 distributed]: all [-CORONAL] sounds. Distributedness is not definable in a non-coronal.

[+strident]: *loud hissing noise, normally produced by air channeled through central tongue groove at teeth.* d͡ʑ , t͡ɕ, d͡ʒ, d͡z, t͡ʃ, ts, t͡s, d͡z, t͡s, d͡z, ɕ , ʑ, z, ʂ, ʒ, z, ʃ, s

[-strident]: all others including f, x, ç, c͡ç, ɟ͡ʝ, d͡ʐ, d͡ʐ, t͡ɬ, t͡ɬ, t͡ɬ, d͡ʐ, t͡s, d͡z, t͡θ, d͡ð, ɬ, ʎ, ç, θ, ɾ, ð

[+lateral] *sides of tongue body, blade low, contact at center*: d͡ʐ, d͡ʐ, t͡ɬ, t͡ɬ, t͡ɬ, d͡ʐ, ɬ, ʎ, ļ, ɭ, ɫ, l, ʐ,

[-lateral]: all others

[+DORSAL]: *articulated with tongue body.* vowels, palatals,[4] velars (including fronted and backed velars), uvulars, pharyngeals. ʍ, w, ɥ, ɯ, ɰ, ɰ, j, ɒ, Œ, ɔ, o, œ, ɵ, ø, ɞ, u, ʊ, ʉ, y, ʏ, ɑ, a, æ, ʌ, ɤ, ɜ, ə, e, ɛ, ɯ, ɨ, i, ɪ, k͡p, g͡b, ɲ, ɟ, c, d͡ʑ , t͡ɕ, c͡ç, ɟ͡ʝ, ɴ, q, ɢ, ʄ, ɠ, ɠ, ɠ, k, g, ŋ, ŋ, ŋ, k͡x, g͡ɣ, q͡χ, ɢ͡ʁ, ɬ, ɕ , ʎ, ç, ʁ, χ, ʀ, j, ɣ, ɣ, ɣ, x,

[-DORSAL]: all others

[+high]: *tongue body raised.* high vowels and glides, palatals, velars. ʍ, w, ɥ, ɯ, ɰ, ɰ, j, u, ʊ, ʉ, y, ʏ, ɯ, ɨ, i, ɪ, k͡p, g͡b, ɲ, ɟ, c, d͡ʑ , t͡ɕ, c͡ç, ɟ͡ʝ, ʄ, k, k̟, k̠, g, g̟, g̠, ŋ, ŋ, ŋ, k͡x, k͡x, k͡x, g͡ɣ, ɕ , ʎ, ç, ʑ, j, ɣ, x,

[-high]: non-high vowels, uvulars, pharyngeals. ɒ, Œ, ɔ, o, œ, ɵ, ø, ɞ, ɑ, a, æ, ʌ, ɤ, ɜ, ə, e, ɛ, ɠ, ɴ, q, ɢ, q͡χ, ɢ͡ʁ, ɬ, ʁ, χ, ʀ

[0 high]: all [-DORSAL] sounds. Height is not definable in a non-dorsal.[5]

[+low]: *tongue body lowered.* low vowels ɒ, Œ, ɑ, a, æ,

[-low]: ʍ, w, ɥ, ɯ, ɰ, ɰ, j, ɔ, o, œ, ɵ, ø, ɞ, u, ʊ, ʉ, y, ʏ, ʌ, ɤ, ɜ, ə, e, ɛ, ɯ, ɨ, i, ɪ, k͡p, g͡b, ɲ, ɟ, c, d͡ʑ , t͡ɕ, c͡ç, ɟ͡ʝ, ɠ, ɴ, q, ɢ, ʄ, ɠ, ɠ, ɠ, k, k̟, k̠, g, g̟, g̠, ŋ, ŋ, ŋ, k͡x, g͡ɣ, q͡χ, ɢ͡ʁ, ɬ, ɕ , ʎ, ç, ʑ, ʁ, χ, ʀ, j, ɣ, x, ʟ,

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[3] Palatals are generally considered to be both coronal and dorsal.

[4] Palatals are generally considered to be both coronal and dorsal.

[5] Of course, the tongue body is always located *somewhere*! But in non-dorsals, it is usually located somewhere along a smooth trajectory between the closest preceding, and the closest following [+DORSAL] sound. That is, a non-dorsal segment does not itself specify a tongue body position.

This remark holds good as well for [low], [front] and [back].

[0 low]: all [-DORSAL] sounds. Lowness is not definable in a non-dorsal.

[+front]: *tongue body fronted.* front vowels and glides, palatals, fronted velars. ɥ, ɥ̃, j, Œ, œ, ø, y, ʏ, æ, e, ɛ, i, ɪ, ɲ, ɟ,
    c, d͡ʑ , t͡ɕ, c͡ç, ɟ͡ʝ, ʃ, ʝ, k̟, ɡ, ŋ, k͡x, ɡ͡ɣ, ç , ʎ, ç, ʑ, j, ɣ, x̟, ʟ̟

[-front]: ʍ, w, ɰ̃, ɒ, ɔ, o, θ, ɵ, u, ʊ, ʉ, ɑ, a, ʌ, ɤ, ɜ, ə, ɯ, ɨ, ʔ, ɢ, ɴ, q, ɢ, ʛ, k̠, ɡ, ŋ, k͡x, ɡ͡ɣ, q͡χ, ɢ͡ʁ, ɫ, ʁ, χ, ʀ, ɣ, x̠, ʟ̠

[0 front]: all [-DORSAL] sounds. Frontness is not definable in a non-dorsal.

[+back]: *tongue body backed.* backed velars, uvulars, pharyngeals, back vowels and glides. ʍ, w, ɰ̃, ɒ, ɔ, o, u, ʊ, ɑ,
    ʌ, ɤ, ɯ, ʔ, ɢ, ɴ, q, ɢ, ʛ, k̠, ɡ, ŋ, k͡x, ɡ͡ɣ, q͡χ, ɢ͡ʁ, χ, ʀ, ɣ, x̠,

[-back]: ɥ, ɥ̃, j, Œ, œ, θ, ø, ɵ, ʉ, y, ʏ, a, æ, ɜ, ə, e, ɛ, ɨ, i, ɪ, ɲ, ɟ, c, d͡ʑ , t͡ɕ, c͡ç, ɟ͡ʝ, ʃ, ʝ, k̟, ɡ, ŋ, k͡x, ɡ͡ɣ, ç , ʎ, ç, ʑ, j, ɣ, x̟, ʟ̟

[0 back]: all [-DORSAL] sounds. Backness is not definable in a non-dorsal. Plain velars, which accommodate in
    backness to neighboring sounds, are also listed as [0 back].

[+tense]: *tongue body relatively high for a given specification of [high] and [low]* ʍ, w, ɥ, ɥ̃, ɰ̃, ɰ̃, j, o, ø, u, ʉ, y, ɤ,
    ɜ, e, ɯ, ɨ, i

[-tense]: ɔ, œ, θ, ʊ, ʏ, ʌ, ə, ɛ, ɪ

[0 tense]: (1) All [-DORSAL] sounds are [0 tense]. Tenseness is not definable in a non-dorsal. (2) [+consonantal
    sounds, even if dorsal, are assumed to be [0 tense]. (3) It is unusual for low vowels to contrast for [tense]; and
    symbol usage is not consistent. For this reason, this text assumes [0 tense] for all low vowels.