The phonological consequences of geminate phonetics

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The apparently obvious phonetic description of a geminate is that its articulation is held for longer, perhaps in much the same way that the articulation of a long vowel is held for longer than that of a short vowel (but cf. Summers, 1987; Beckman & Edwards, 1994). The phonological representations of geminates and long vowels appear equally obvious, a geminate or long vowel occupies two timing slots compared to a singleton's or short vowel's one or one more mora than a singleton or short vowel. Yet even a cursory look at geminates' phonetics reveals considerable complexity, which has a variety of phonological consequences. Three examples suffice to illustrate it:

1. The geminate stops in Tamil are voiceless, while the corresponding singletons are instead voiced and often spirantize. These differences follow from well-known interactions between the duration of a stop closure, the aerodynamics of voicing, and the likelihood of articulatory undershoot. These interactions form the basis of explanations for the relative rarity of voiced as compared to voiceless geminate stops in the world's languages (Jaeger, 1978) and alternations or sound changes that eliminate them (Nihilani, 1974; Kawahara, 2011). Voiceless stop closures are also longer than voiced stop closures, even in singletons (Lisker, 1986). Is this difference simply a scaled-down variant of the voiceless geminate versus voiced singleton contrast seen in Tamil?

2. While languages such as Arabic and to a more limited extent Japanese allow a geminate consonant to follow a long vowel, many others instead permit geminates only after short vowels and only singletons after long vowels, as in Norwegian and Italian (Fintoft, 1961; Esposito & Di Benedetto, 1999). Again, stops contrasting for [voice] behave in parallel fashion: the longer closures of voiceless stops follow shorter vowels than the shorter closures of voiced stops (Lisker, 1986). In languages where vowel and closure quantity covary inversely in this way, listeners perceive a consonant constriction as longer, i.e. more like a geminate, after a shorter than a longer vowel, but if they covary directly in the listeners' native language, then they perceive the consonant constriction as longer after a longer vowel instead (Kingston, Kawahara, Chambless, Mash, & Brenner-Alsop, 2009). Native language experience does not influence listeners' responses to corresponding non-speech analogues nor their discrimination of speech or non-speech analogues: all listeners judge a gap to be longer after a longer vowel analogue, and all discriminate short-short from long-long sequences better than short-long from long-short sequences (Kingston et al., 2009). What then is the phonetic basis for the widespread pattern of inverse covariation between consonant and preceding vowel quantity, and likewise between the parallel and equally widespread pattern of inverse

covariation between consonant and preceding vowel duration for consonants contrasting for [voice]?

3. Languages are more likely to contrast less sonorous consonants for geminacy than more sonorous ones, a preference that Kawahara (2007) attributes to the larger amplitude drop between flanking vowels and the consonant when it is less sonorous: the larger drop sharpens the boundary between the consonant and flanking vowels and by making it more detectable improves the accuracy with which listeners can estimate the consonant's duration. As Kawahara also observes, consonants often become less sonorous when they geminate, apparently to take advantage of this improvement. This extension of Kawahara's explanation complements Kingston's (2008) account of lenition as a means of reducing the interruption of a vowel sequence caused by an intervening consonant within a prosodic constituent – see also Kirchner (1998) for discussion of geminates' resistance to lenition. Reducing sonority is not, however, the only means speakers could use to enhance the contrast when the consonant is more sonorous; they could also lengthen more sonorous geminates more than less sonorous ones. That they don't do so shows that we once again have too many possible solutions, and don't know how to exclude the ones that aren't adopted.

These questions are simply ones for which we have tentative answers or at least a rough idea of how to find an answer. Other questions remain much harder to get a handle on. Perhaps first among them, what is the relationship between geminacy and what is referred to, perhaps more in older literature as strength of articulation, or a contrast between fortis or tense versus lenis or lax consonants (for recent discussion, see Jaeger, 1983; Kohler, 1984; Krähenmann, 2003)? In vowels, the tense:lax contrast is a matter of how far the articulators travel: the tongue and lips move to more peripheral or extreme positions in tense vowels, and because their movement does not speed up to compensate for the longer distance the articulators travel, tense vowels last longer as well as having more extreme formant values than their lax counterparts. Even if geminate consonants should also be analyzed as fortis or tense in contrast to lenis or lax singletons, their greater duration does not appear to be a side effect of the articulators moving farther but not faster. Even so, they may still be pronounced with greater force. Second, is geminacy a local property realized at the site of the contrasting consonant or instead a Firthian long component whose effects are detectable long before and long after that consonant, as Local & Simpson (1999) have suggested? This second question is part of a much larger one, namely, what is the role in production and perception of the considerable phonetic detail that apparently characterizes every minimal contrast (Hawkins, 2003)? Do speakers deliberately produce much of this detail or is some or all of it an unintended side effect of other deliberate articulatory acts, and, regardless of whether the detail is intended, do listeners make use of it in recognizing the phonological content of the message (Kingston & Diehl, 1994)? Third, why does the ratio of geminate to singleton durations vary so much across languages, from as little as 1.5:1 or less to more than 3:1 or even 4:1?

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