Covariation of voice onset time: a universal aspect of phonetic realization

Typological research in phonetics has established that the same traditional sound category (e.g., voiceless aspirated bilabial stop) can have different articulatory and acoustic realizations across languages. There are, however, significant restrictions on phonetic variation. For example, across languages high vowels have higher intrinsic fundamental frequencies than low vowels (Whalen & Levitt, 1995) and stop consonants with more posterior places of articulation have longer voice onset time (VOT) than more anterior stops (Cho & Ladefoged, 1999). In this paper, we provide evidence for a novel restriction on the phonetic realization of stop laryngeal specifications: members of the same laryngeal series must have essentially *uniform* glottal spreading and timing targets within a language, and consequently their VOT values tightly *covary* across languages. The typological pattern mirrors and magnifies the interspeaker VOT covariation found previously in American English (Chodroff & Wilson, 2017), suggesting that the uniformity constraint applies across sound systems with widely varying patterns of laryngeal realization.

We compiled previously reported VOT means of adult native speakers from 91 articles, theses, and grammars. The data represent 80 languages and 27 language families, as classified by WALS (Dryer & Haspelmath, 2013). Original laryngeal classifications were coded as having positive or negative VOT. As very few values fell just below 0 ms, this point served as a natural divider between broad laryngeal categories. Stops were further categorized into the three place categories of Labial ($n$=374), Coronal ($n$=353), and Dorsal ($n$=386).

Substantial cross-linguistic variation was observed in the realization of VOT, with VOT values ranging from -143 to 154 ms (Figure 1). The dorsal VOT was greater than that of the corresponding labial VOT in 93% of all cases. The ranking of the coronal VOT value was variable: in 30% of cases, the coronal value was less than the labial value, and in 13% of cases, the coronal value was greater than the dorsal value. Place-specific VOT means were almost perfectly correlated across languages ($r$ = 0.97 to 0.98, $p$s < 0.001), and covariation remained high within each laryngeal category. Among positive VOT stops, correlations ranged from $r$ = 0.92 to 0.95 ($p$s < 0.001) and among negative VOT stops, from $r$ = 0.75 to 0.92 ($p$s < 0.001).

The strength of covariation among stops with a shared laryngeal specification reveals constraints on the phonetics-phonology interface. In particular, we posit a uniformity constraint that operates universally on the mapping from phonological surface segments to phonetic targets. Uniformity requires highly similar (or identical) phonetic realization of a distinctive feature value for all segments that share that value. In the case of VOT, for any given talker, the phonetic implementation of a laryngeal feature value (e.g., [+s.g.] or [+voice]) should be uniform for all stops specified with that value. Critically, it has important implications for theories of the phonetics-phonology interface, as it directly influences the mapping from distinctive features (or intra-segmental components) to phonetic targets (cf., Hale & Reiss, 2000), and constrains context sensitivity in the phonetic implementation of distinctive features (cf., Cho & Ladefoged, 1999).

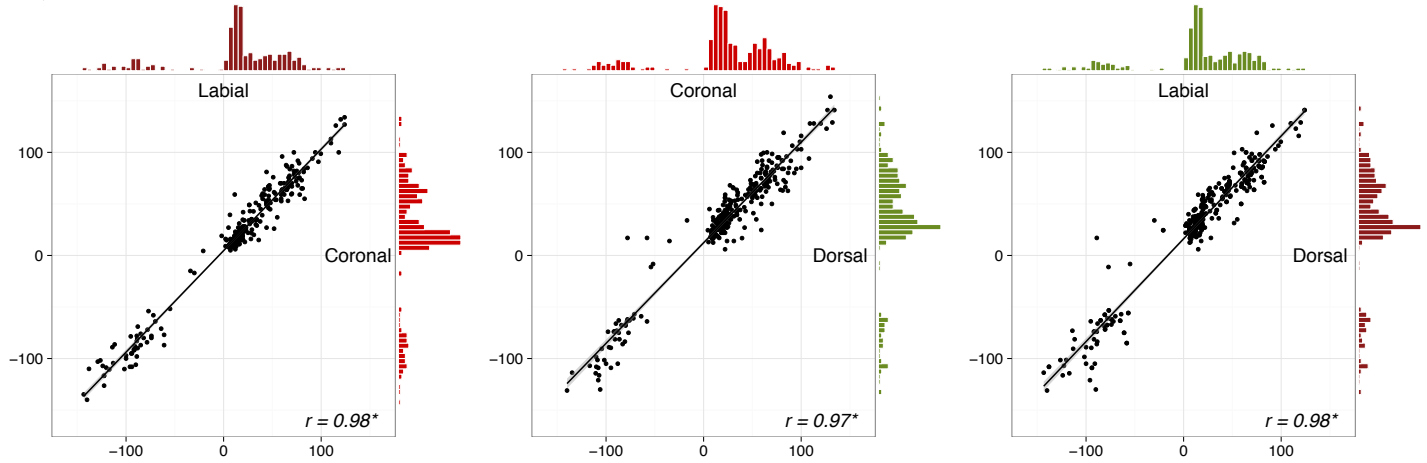


**Figure 1.** Correlations of language-specific VOT means (ms) across place of articulation. Each point represents a pair of language VOT means. Marginal histograms reflect the range of variation in VOT means across languages for a given place of articulation.

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