Glottal Modes in Consonant Distinctions

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Our most direct knowledge of how the larynx operates derives from observations by means of a laryngeal mirror inserted through the open mouth, from which we know that voicing involves adduction of the arytenoids so that the vibrating vocal folds are closely, but not tightly, approximated, that quiet respiration is accomplished with the glottis well opened, and that whisper, creaky voice, falsetto, murmur, "glottal stop," and "aitch" involve still other more or less easily distinguished modes of laryngeal adjustment. The observational method is, of course, not applicable to speech, and up till fairly recently whatever was said about the functioning of the larynx during speech was by inference, and subject in part to controversy. It was supposed, very plausibly, that during voiced intervals in which the mouth is open the larynx operates just as observed during the phonation of prolonged vowel-like sounds. There was less agreement, and sometimes less certainty, as to laryngeal functioning during voiceless intervals in running speech, which typically coincide more or less with constriction of the supraglottal airway. Given the structure of the vocal tract and the myoelastic-aerodynamic theory of phonation, and assuming the larynx fixed in the voicing mode, we should expect a more or less rapid extinction of voicing to be inevitable when there is severe constriction. Conversely we should expect the suppression of voicing only in that circumstance. Compatible with this is the observation sometimes made that sounds with little constriction are "normally" voiced, and its less often stated corollary that obstruents, particularly stops, are "normally" voiceless. If a language is "normal" in this way, then it seems reasonable to suppose that in fact a single glottal mode, that of voicing, is maintained without significant change in utterances of that language, with shifts in mode reserved for paralinguistic effects. The absence of a distinctive voicing feature is then matched by the absence of differential control of the larynx during speech. But while such languages are reported, they are not very common. The literature of phonetic description suggests, rather, a special affinity between voicing as a distinctive feature and stop consonants, so that voiced stops are by no means rare. If we suppose that the voicelessness of certain stops is compatible with the glottal mode appropriate to voicing, then the presence of voicing in others implies some other mode and/or some other way of maintaining the necessary transglottal airflow during occlusion. Theoretical arguments have been advanced (Halle and Stevens, 1967) for a shift in glottal mode as a necessary condition.

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for stop voicing, a shift which effects a reduction in the resistance to airflow through the glottis. Moreover, if voicelessness persists after the stop release, as in the case of voiceless aspirates, then still another mode of glottal adjustment would seem to be implicated.

It has been further asserted that, in addition to mode of glottal adjustment, a dimension of articulatory force plays a strong role in determining whether or not vocal-fold vibration accompanies a supraglottal constriction (Chomsky and Halle, 1968). This fortis-lenis dimension has been variously understood; currently it is the fashion to say that it determines the extent to which the pharynx is free to expand in response to an increase in air pressure such as occurs during obstruct production. Obviously a transglottal airflow can be better maintained during an occlusion if the pharyngeal cavity volume is increasing, and Rothenberg (1968) has reported experiments measuring the compliance of the cavity walls which yield values compatible with the durations of voiced closure observed in speech. In the case of aspiration, moreover, still another parameter, subglottal air pressure, has been enlisted by Chomsky and Halle (1968) as a significant factor by way of explaining the relatively high rates of airflow observed.

By and large, much of what is said to be known about the management of stop voicing and aspiration is more hypothetical than data-based, and where there are data, they are more often than not derived from nonsense exercises of the speech mechanism whose relation to running speech is not clear. With recent developments in instrumentation, new techniques have come into use which yield more direct information on the glottis in consonant production. Studies in transillumination, electroglottography, electromyography, and fiberoptics and X-ray cinephotography have already provided some findings that fail to confirm some of the recently stated theories of glottal behavior as it relates to distinctive voicing. From transillumination and fiberoptics studies carried on at Haskins Laboratories, for example, it appears that voiceless unaspirated stops, in English at least, most often involve some opening movement of the arytenoids, while on the other hand there is no detectible movement of these cartilages in a large majority of voiced stops observed (Sawashima et al., 1970). If a shift in glottal mode is in theory required for stop voicing, and if it is superfluous for the voiceless unaspirated stops, then it is puzzling that evidence of a special glottal adjustment in the first case is so elusive and in the second seems so clear. If there is, in fact, a gesture of devoicing rather than to ensure voiced occlusion, it might be inferred that a fortis-lenis difference is of less than crucial importance, at any rate for fluent American English. Nor has there been any demonstration that higher subglottal pressures are required for aspiration, while there is clear evidence that the area of glottal aperture at the time of stop release is directly related to the prominence of this feature. The mechanism by which aspiration, or something much akin to it, is produced during the release of voiced stops is not well studied. It seems possible, though, that this variety of aspiration is voiced, unlike the more commonly found aspiration, simply because the glottal aperture does not become large enough for vocal-fold vibration to cease in the absence of an articulatory constriction.

In summary, it seems to us that theories of stop voicing and aspiration that stress the importance of extralaryngeal factors can claim less basis in observed fact than does one which stresses the paramount role of the larynx, specifically the positioning of the arytenoid cartilages as it determines
glottal aperture. It is difficult to deny that extralaryngeal factors may affect voicing significantly, but it is one thing to argue that they have the capability, another to demonstrate that they do in fact regularly operate in a manner consistent with that capability. Glottal adjustment alone does not determine the voicing state of a stop consonant, but no other factor seems to be nearly as important.

REFERENCES