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Reprinted from
LANGUAGE AND SPEECH
Vol. 13, Part 4, October-December 1970, pp. 215-230

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Generally higher levels of intra-oral air pressure during occlusion are regularly reported for English /p,t,k/ as compared with /b,d,g/, and considerable significance has been attached to such observations, particularly by phonologists. Many of the published bodies of data, however, represent quite limited speech samples, consisting in the main of short nonsense utterances which contain stops in only a few contextual situations. In the present study ten readings of a list of twenty short English phrases were recorded for a single speaker. The phrases contained stops in initial, medial and final positions, and under various conditions of stress. A pressure transducer mounted at the end of a nasal catheter was introduced into the pharynx, and variations in intra-oral pressure were recorded on a multi-channel penwriter. From the pressure records obtained it appeared that /p,t,k/ and /b,d,g/ differ in their mean peak pressures, but that this difference is not equally significant in all contexts. Both initially and medially before a stressed vowel the two categories show peak pressures that overlap very extensively. This makes questionable the view that such differences more regularly co-exist with the /p,t,k/:/b,d,g/ distinction than any difference in voicing or mode of laryngeal operation, and that they demonstrate the "fortis":"lenis" nature of the distinction.

Measurements of gross air movements and accumulations within the vocal tract are, for the most part, matters of more interest to laboratory phoneticians concerned with understanding the physical and physiological processes of speech production and perception than to linguists, who focus attention more narrowly on those phonetic attributes for which a distinctive function is posited. Thus air flow and pressure data, whose relevance to the study of large-scale variations in loudness and pitch has long been recognized, do not ordinarily provide a basis for statements included in the phonetic description of a language. An important class of exceptions consists of statements referring to the "fortisness" or "lenisness", i.e. the level of speech effort, with which certain consonants are produced, inasmuch as this dimension of phonetic description has been linked with the measure of supraglottal air pressure. Thus, on the basis of this measure, Stetson (1951) asserted that each member of the set of English /p,t,k/ is fortis as compared with the homorganic lenis stop of the /b,d,g/ set. Moreover Stetson went on to claim that the two sets of stop phonemes are distinguishable as fortis versus lenis in contexts where they may not differ in respect to either voicing or aspiration, the two more readily observed attributes that singly

* *A preliminary version of this paper was read at the annual meeting of the Modern Language Association in Chicago, December 1963. The preparation of the present report was supported by the National Institute of Child Health and Human Development.*

***Also, the University of Pennsylvania.*

or in conjunction separate the two categories of stops in most contexts. This view of Stetson's as to the independence of a fortis-lenis dimension and its priority over the voicing dimension as *the* phonetic basis for the /p,t,k/ : /b,d,g/ contrast appears to have gained wide acceptance among linguists, although it is not entirely clear why this should be so. To be sure, many published data[1] do in fact corroborate Stetson to the extent of showing generally greater pressures for /p,t,k/ than for /b,d,g/, but they demonstrate neither the independence of a fortis-lenis dimension nor its priority over voicing as a distinctive feature for the English stop system.[2] In the present discussion I shall present additional air pressure data and try to show that they are both consistent with the earlier published data and at the same time counter to the view of a fortis-lenis difference *qua* buccal air pressure difference as fundamental to the /p,t,k/ : /b,d,g/ contrast.

The measurements to be reported were made at the Haskins Laboratories,[3] using a Statham Pressure Transducer Model P 23-BB, whose output, appropriately amplified, was recorded by a penwriter. The pressure-sensitive element, fixed to a catheter, was introduced into the pharynx through the nose and held in position above the glottis in such a way that speech activity was not noticeably impeded.[4] While one channel of the penwriter was recording the output of the pressure transducer, another channel was used to record the output of a throat microphone held against the neck just beside the thyroid cartilage. At the same time a conventional tape-recording of the subject's speech was made for monitoring purposes.

A single speaker, native to Philadelphia, served as subject, recording a set of dissyllabic phrases with stops in various positions relative to the utterance boundaries and stress location. The items of this set were pronounced as normally as possible under the conditions required by the observational task, with no noticeable variations in tempo or general levels of pitch and loudness. The phrases recorded, which were

[1] *See Black (1950), Malécot (1955, 1956, 1968), Fischer-Jørgensen (1963), Isshiki and Ringel (1964), Yanagihara and Hyde (1965/66), Subtelny, Worth and Sakuda (1966), and Arkebauer, Hixon and Hardy (1967). Malécot (1955) is of particular interest in that, instead of just assuming the physical reality of a fortis:lenis distinction for English stops, he elicited subjects' judgments of the relative effort expended in producing various consonants, and then showed a direct relation between those judgments and intra-oral air-pressure measurements.*

[2] *Our attention is restricted to the English stops, and the relevance of any findings to other classes of consonants cannot be assumed without question.*

[3] *The assistance of Robert Rosov and Malcolm H. Schvey, who provided the engineering and medical skills needed for the present study, is gratefully acknowledged.*

[4] *Listeners were generally unable to distinguish between recorded utterances produced with the nasal catheter in place and those produced without this encumbrance.*

read out from a random-order list in which each occurred ten times, were the following:

people	rabid	debate	a piece
tepid	maple	repel	abyss
couple	Mabel	rebel (verb)	depict
debit	feeble	a pet	repair
rapid	rubble	a bet	a beet

The different stop phonemes are, unfortunately, not all well represented in this list. The unevenness in representation is explained in part by the need to keep the number of items small enough so that the subject might manage ten repetitions without undue strain. Moreover, it is in part justifiable on the basis of a preliminary set of observations which indicated that there are no marked differences in pressure between stops of different places of articulation.[5]

The set of pressure traces obtained for the recorded utterances, of which those shown in Fig. 1 are representative, was examined to ascertain that repetitions of the same phrases yielded substantially similar profiles. This comparison, when considered together with statements made by other investigators (in particular Malécot, 1966) suggested the following as potentially useful and appropriate measures for quantifying the pressure relations among the stops of our sample:[6]

(1) peak pressure
(2) the time integral of the instantaneous pressure[7]
(3) the duration of pressure buildup
(4) the duration of pressure decay

In carrying out these measurements I estimated pressure values to tenths of a millimeter of water and then rounded to the nearest five millimeters, while time determinations were made to the nearest five milliseconds.

Earlier discussions are not always very explicit as to just what measure of pressure is being presented, or precisely what its relation is to the /p,t,k/ : /b,d,g/ dichotomy, but some of them may be understood to imply the strong hypothesis that the two

[5] *For the variety of English examined, markedly lower pressures are recorded for the medial apical consonants in words like* butter daddy, *but these are ordinarily called "flaps" or "taps" rather than proper stops. Closure is certainly very brief, and very possibly there is no complete blockage of air flow.*

[6] *These traces are from Lisker (1963), in which paper there is also some non-quantitative discussion of the relative usefulness of various measures of the pressure profiles for the stops in different positions relative to stress and utterance boundaries.*

[7] *Malécot (1966, 1968) claims that this measure, the "pressure pulse", "not only provides the best overall distinction but in some cases the only one" (1966, p. 72).*

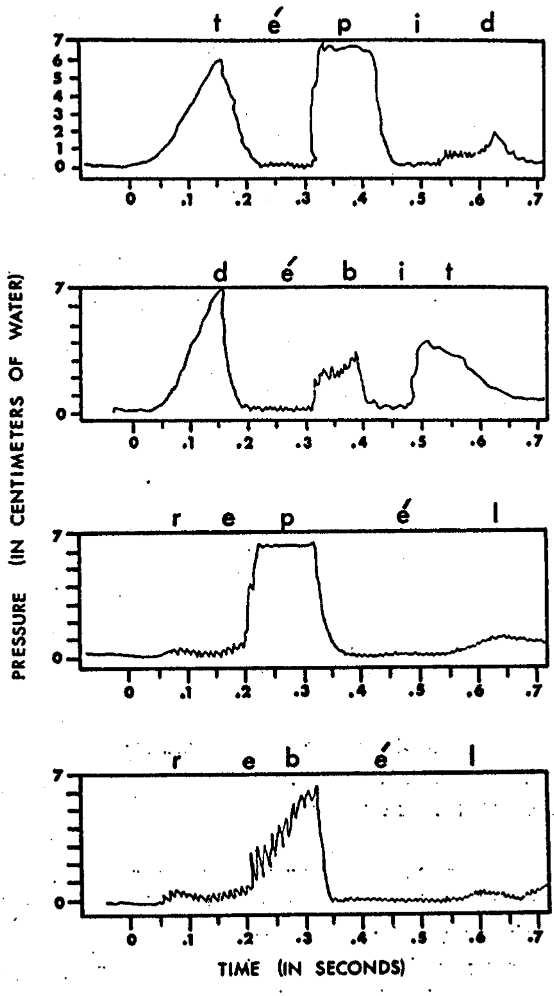

Fig. 1. Examples of pressure profiles recorded for representative tokens of the utterances *tepid debit repel rebel.*

phoneme sets are characterized by distinct ranges of peak pressure values which are essentially invariant, although not perhaps totally independent of context.[8] That this hypothesis is utterly untenable is indicated by the display in Fig. 2, which presents our peak pressure measurements in the form of frequency distributions for the two

[8] *Thus the mean pressures given in Malécot (1955) are greatest for medial stops and least for those in final position, but at the same time the highest mean value for any member of /b,d,g/ is considerably lower than the lowest determined for any of /p,t,k/.*

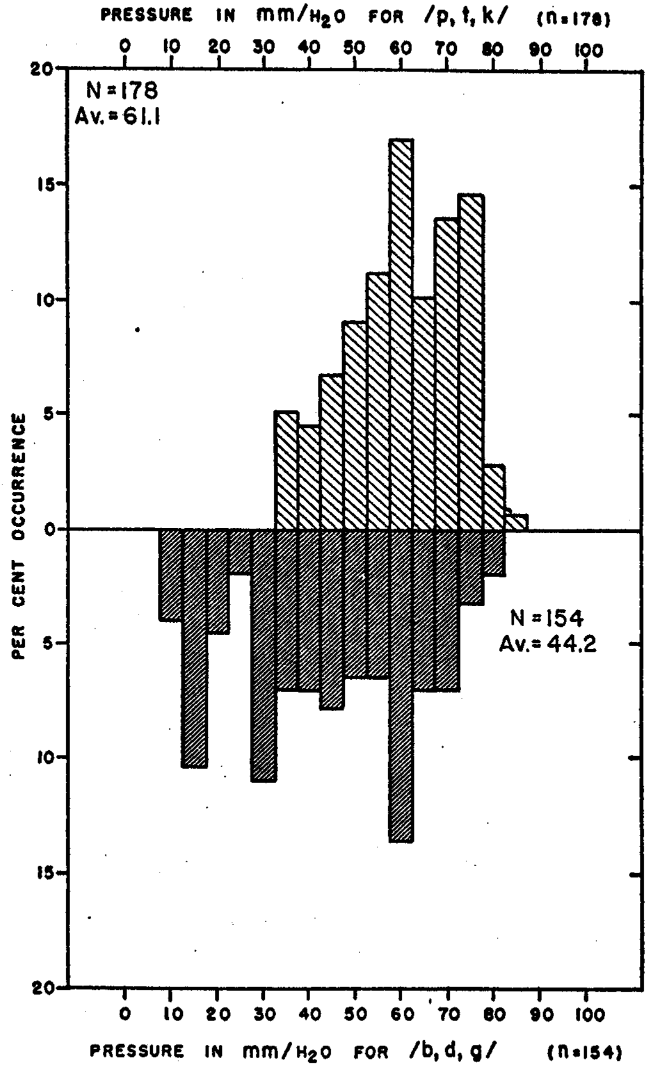

Fig. 2. Frequency distributions of peak pressure values for the two stop categories undifferentiated as to position within utterances.

phoneme sets. While the two distributions are clearly different, and in fact not incompatible with the data provided by the earlier studies, the range of overlap between the two categories is so extensive as to preclude the possibility of identifying most stops as members of one set or the other solely from their peak pressures. Unless our sample is completely unrepresentative of American English stops, it must be significant that no more than about 15% of the stops measured have pressures so low that they can be classed with /b,d,g/ with certainty, and that only a bare 2% have pressures so great that they are unambiguously /p,t,k/. Thus the overwhelming majority of the stops in our sample cannot be identified with confidence solely on the basis of their peak pressures.

Having disposed of the possibility that the two phoneme sets are characterized by sharply different absolute peak pressures, we may entertain a weaker hypothesis concerning the relation between peak pressure and the /p,t,k/ : /b,d,g/ distinction—namely, that a consistent difference holds between members of the two sets which occupy similar positions within utterances. In other words, we suppose that pressure depends not only on whether the stop belongs to the /p,t,k/ or /b,d,g/ set, but on some aspect or aspects of the context in which it is produced.[9] To test this hypothesis the stops in our sample were divided into classes, first according to their position relative to beginning and end of utterance, and then with respect to the presence or absence of stress on the immediately adjacent syllable nuclei.

From the distributions given in Fig. 3 it is quite clear that the pressure developed during an occlusion depends significantly on whether the stop is initial, medial or final in the utterance. This dependence can be described in two ways. First of all, peak pressures are generally highest in medial position and lowest in final.[10] This is because both categories show their lowest mean values in final position, while /p,t,k/ are produced with greater pressures in medial position than in initial. Second, and more immediately relevant to our concern, is the fact that the relations between the categories are radically different in the three positions specified. Initially the two sets of stops are quite the same in respect to their peak pressures; finally they show pressure ranges that are categorically distinct; and medially they have distributions whose relation is much like the one shown in Fig. 2 for the stops undifferentiated

[9] *The contextual factor most commonly recognized is position relative to word boundary. Because much of the published data on intra-oral pressure derive from recordings of isolated nonsense monosyllables and dissyllables, the effect of stress has less often been noted. In two recent studies (Subtelny, Worth and Sakuda, 1966; Arkebauer, Hixon and Hardy, 1967) the factors of overall vocal effort and syllable rate are shown to affect pressure significantly. In the case of vocal effort, in fact, the effect is as large as that attributable to any linguistic contrast.*

[10] *This finding is in complete agreement with Malécot (1955, 1968), and not inconsistent with the findings of other investigators.*

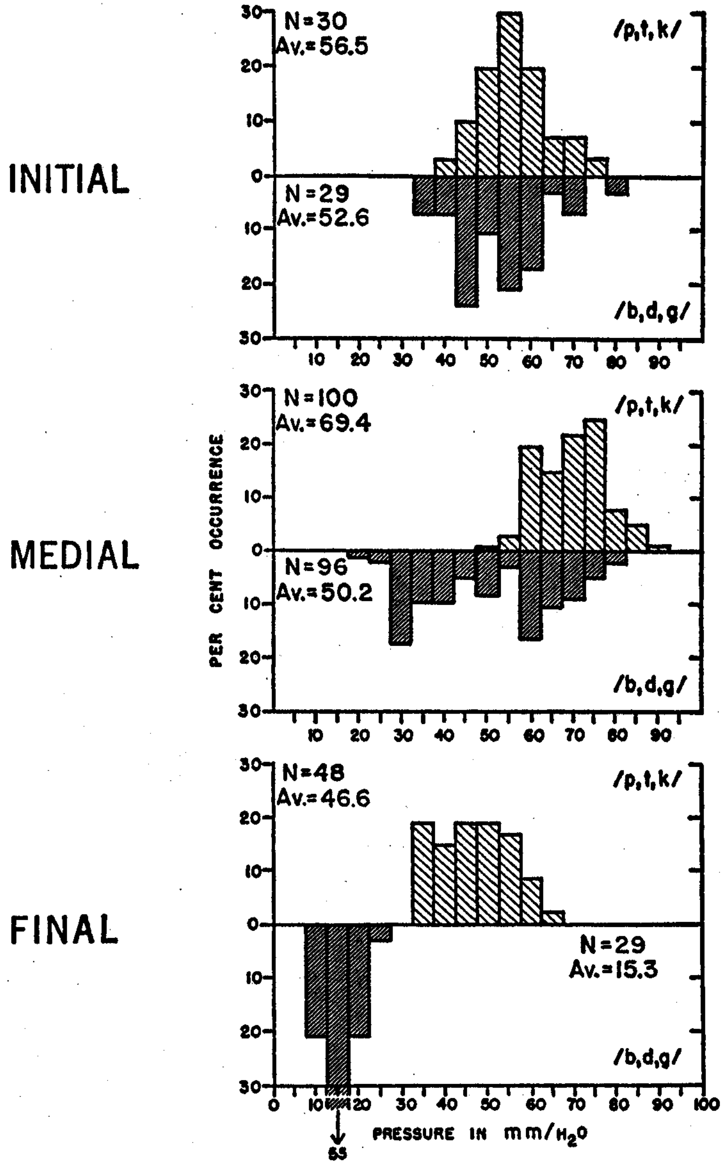

Fig. 3. Frequency distributions of peak pressures for the two stop categories in initial, medial and final positions within utterances.

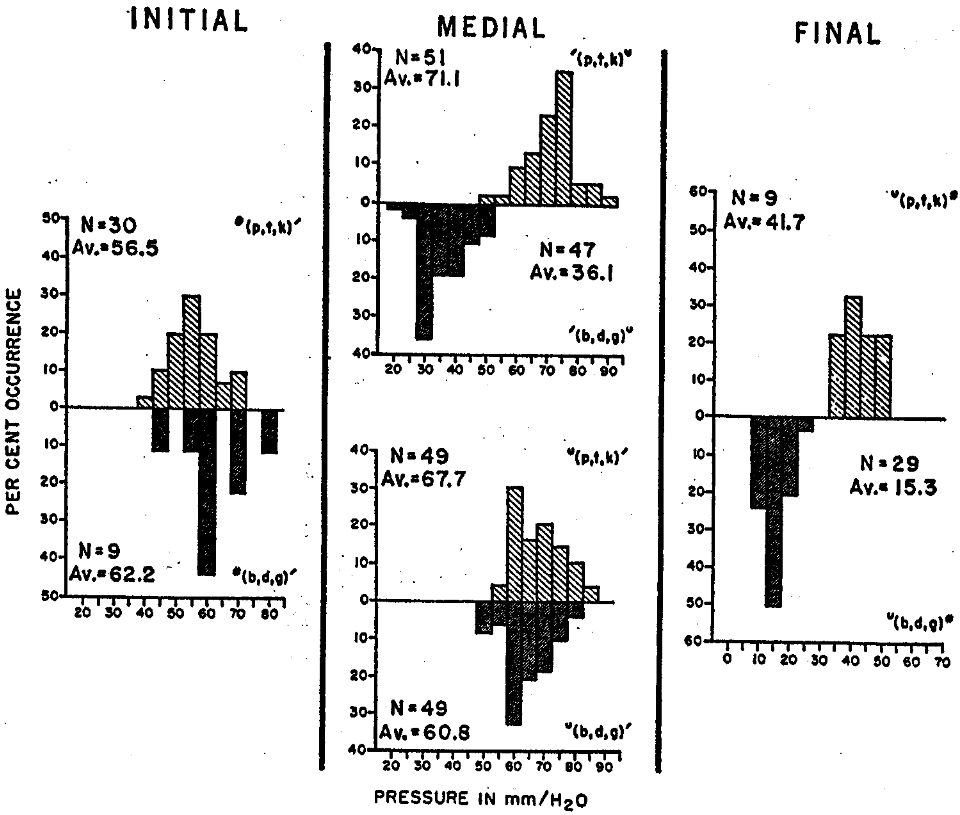

Fig. 4. Frequency distributions of peak pressures for the stops differentiated with respect to both utterance boundary and stress. (Initial stops preceding unstressed vowels and final stops following stressed vowels are not represented in this figure.)

as to position within the utterances. Thus we are led to conclude that the relation between the peak pressures for the two sets of English stops is far from being an invariant one.

There is, as a matter of fact, good reason to suppose that the degree of stress on a syllable may be at least as important a factor governing the pressure developed during stop production as its position within the utterance. There are two mutually supporting arguments for this: Phoneticians have long related the feature of aspiration which sometimes accompanies /p,t,k/ releases directly with stress, and the prominence of this aspiration has been ascribed to the air-pressure level developed behind the occlusion;[11] moreover, evidence has been accumulated to show that stressed syllables differ from unstressed in that the former are produced with greater subglottal pressures (Ladefoged, 1962; Lieberman, 1967). There is, of course, most certainly an intimate connection between the pressures developed above and below the glottis during the production of simply articulated stop consonants.

Our sample is unfortunately not extensive enough to include stops produced under all possible stress conditions in initial, medial and final positions, so that anything like a full statement of the relation between stress and peak pressure cannot be attempted here. It is possible, however, to show that there are at least two cases where, under similar stress conditions and in the same sequential positions, /p,t,k/ and /b,d,g/ are *not* distinguishable on the basis of their peak pressures. In Fig. 4 the two stop categories show similar pressure distributions in initial position and medially before a stressed syllabic. The only clear gain achieved by taking stress into account in analysing the data is in the case of medial stops which follow a stressed syllabic, where /p,t,k/ and /b,d,g/ occupy virtually non-overlapping ranges of values. If we can generalize from the incomplete picture presented in Fig. 4, it seems that the two sets of stops differ in peak pressure if they follow a stressed syllabic, and do *not* differ significantly if they precede one. Of stops not adjacent to a stressed syllabic nothing very positive can be said on the basis of our sample; there is at most an indication that such stops in initial position show no difference between /p,t,k/ and /b,d,g/, but have generally lower pressures than initial stops before stressed syllabics, and that finally the /p,t,k/ : /b,d,g/ distinction is as well-marked after unstressed syllabics as it is after stressed.

In sum, then, our data indicate that the measure of peak pressure provides a less than completely adequate basis for separating /p,t,k/ and /b,d,g/ in all positions in which both sets are found. Casual inspection of the pressure profiles of the stops under various contextual conditions suggests three other simple measures of pressure that might better serve to separate the two sets of stops. These measures, already referred to above, are the following: (1) onset time, or the duration of the interval during which pressure builds up to its peak value; (2) decay time, duration of the interval over which pressure decreases from peak value to the level characteristic of the following segment; (3) the time integral of the pressure (the "pressure pulse", Malécot, 1966), which is geometrically the area bounded by the line indicating instantaneous pressure and the base-line. Two of these measures, those of onset time and pressure pulse, will clearly serve to separate the two stop categories in those positions where the peak pressure is effective, and will in addition distinguish them in medial position preceding a stressed syllabic. In this last-named position, where

[11] *Thus Heffner (1949, p, 120). Data showing a direct relation between stress and the duration of the voiceless interval separating the release of initial /p,t,k/ from voicing onset are given in Lisker and Abramson (1967).*

peak pressures and closure durations[12] are the same for both categories,[13] the very large difference in onset time, and consequently in pressure pulse, is ascribable to a number of factors, one of which is a difference in the mode of operation of the larynx.[14]

From the foregoing it follows that the case of the initial stops represents the only real test by which to determine whether any one of these measures of supraglottal air pressure provides the physical basis for claiming that the /p,t,k/ : /b,d,g/ distinction is better described as fortis : lenis (in Stetson's definition) than as voiceless : voiced. Fig. 5 displays the frequency distributions of values for each of the four pressure measures that were carried out. The best resolution of the two stop categories in initial position seems to be provided by the measure of decay time. With respect to the time required for pressure to reach peak value the two categories show no difference. To the extent that the measure of pressure pulse is effective, it would seem merely to reflect the much larger difference in decay time. Since this difference in decay time also distinguishes /p,t,k/ from /b,d,g/ medially before a stressed syllabic, but fails adequately to separate them in medial position after a stressed syllabic, it would appear that the measure is largely a reflection of the duration of aspiration.

Our findings may be summarized conveniently by a table in which the various measures applied to our pressure records are scored as positive in those contexts where they sharply differentiate /p,t,k/ from /b,d,g/, and otherwise as negative.

[12] *To a first approximation the time interval between the onsets of pressure rise and pressure decay may be taken to indicate the duration of stop closure, although in fact the pressure should begin to build up some little time before the closure is completed. In Fig. 1 the durations of the pressure profiles are about the same for /p/ and /b/ in* repel *and* rebel, *and different in* tepid *and* debit. *Acoustic measurements of closure duration in post-stress (Lisker, 1957; Sharf, 1962) and in pre-stress intervocalic position (Lisker, 1957) indicate that these durational relations hold generally true for the labial and dorsal stops in the two positions relative to stress. However, Malécot (1966) reports longer closures for /p,t,k/ in medial position before stressed vowels.*

[13] *Since in this position /p,t,k/ are aspirated and /b,d,g/ are not, it appears that the amount of aspiration, insofar as it is a matter of duration, is not determined entirely by the peak pressure, as is implied in Heffner (1949). At the same time, however, it must surely be the case that, if the timing of glottal adjustment for voicing were held fixed, then the* intensity *of the aspiration noise would vary directly with the peak pressure. That high intra-oral pressure may be developed during aspirated voicless stops is shown by the data for post-stress /p,t,k/. A similar situation for Korean voiceless unaspirated stops is reported in Kim (1967).*

[14] *Data derived from transillumination of the larynx (Lisker, Abramson and Schvey, 1969) indicate that glottal aperture may be significantly smaller for post-stress unaspirated /p/ than for the aspirated variety of English /p/. Cineradiographic observations of Korean voiceless unaspirated stops (Kim, 1967) yield a similar finding.*

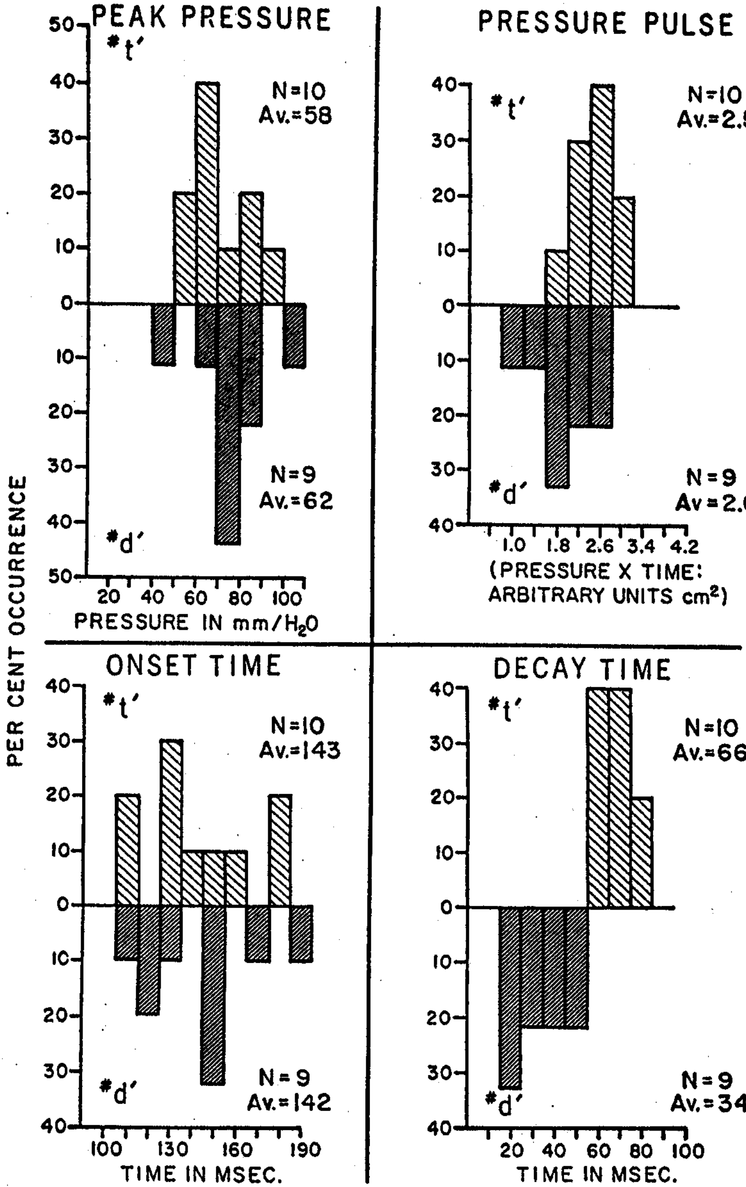

Fig. 5. Frequency distributions of values for four pressure parameters measured for /t/ and /d/ in utterance-initial position.

TABLE 1

	INITIAL	MEDIAL		FINAL
		Pre-stress	Post-stress	
Peak pressure	−	−	+	+
Onset time	−	+	+	+
Decay time	+	+	−	+
Pressure pulse	−	+	+	+

The display in Table 1 permits a number of observations: (1) each of the measures serves to distinguish the categories in some contexts; (2) no one measure is a reliable index of the contrast in all the contexts examined; (3) in each context one or more of the measures provides a basis for separating the categories; (4) the number of effective measures is larger in those contexts where there exists a clear difference in voicing, while it is minimal where the phonetic difference between the categories is said to be less a matter of voicing than of aspiration and force of articulation. We further observe that (5) the measures of onset time and pressure pulse are effective in precisely the same contexts; (6) the measure of peak pressure is somewhat less useful than any of the others; and (7) in order to separate the two categories at least two measures are needed, and one of these is the measure of decay time. It follows from observations (5) and (7) that we may, out of some feeling for "symmetry", dispense with the measure of pressure pulse and say that /p,t,k/ and /b,d,g/ are everywhere distinguished by different durations of pressure build-up, or by different durations of pressure decay, or by both. As for the relation of these two measures to the peak pressure, it appears that neither of them either determines, or is determined by, the latter. From this it is, of course, also clear that the presence of aspiration (= long decay time) is not guaranteed by a high peak pressure.[15] It can be argued that both the pressure onset and decay times are primarily a matter of the timing of laryngeal adjustments, and that there is an acoustic measure of the timing of voice onset and cessation which is no less, and quite possibly more, effective in separating the two categories of English stops (Lisker and Abramson, 1964). Nor do these observations lend much support to the view that differences in intra-oral pressure constitute evidence for the existence of a fortis: lenis dimension independent of and more fundamental than one of voicing.

Since the conclusions drawn from the pressure measurements just described are not the same as those reached by other investigators, it is reasonable to ask whether these data are consistent with other published findings on intra-oral pressure during the production of English stops. This question cannot, however, be answered unless we know whether the different sets of data represent observations of comparable events, and unfortunately this is sometimes difficult to decide from the descriptions of the

[15] *Though very possibly the absence of a high peak pressure excludes the possibility of aspiration.*

speech samples examined. Thus in several cases the reader does not learn whether initial /b,d,g/ tokens were produced with voicing during closure or not,[16] or whether medial stops preceded or followed a stressed syllabic. Moreover, in none of the earlier papers cited have pressure data been presented for speech samples other than one- and two-syllable nonsense utterances.[17] The most nearly comparable data are those of Malécot (1966) and my own for medial pre-stress stops: his mean peak values of 59.8 mm/H_2O for /b,d,g/ and 83.2 mm/H_2O for /p,t,k/ are not very different in order of magnitude from my own of 60.8 mm/H_2O and 67.7 mm/H_2O respectively. Mean values of 44.5 mm/H_2O and 63.1 mm/H_2O for intervocalic /b,d/ and /p,t/ (stress condition not specified), reported by Subtelny, Worth and Sakuda (1966), also suggest a degree of variability in pressure values such that there is little warrant for disallowing our new data on the ground of an obvious incompatability with those published earlier.

The findings just reported would suggest, then, that those linguists who have adopted the fashion of asserting that the /p,t,k/ : /b,d,g/ contrast of English is more one of articulatory force than of voicing have been misled in believing that an *a priori* perfectly reasonable hypothesis is in fact demonstrably true. Their argument might be stated as follows. If the assumption is made that there must be some invariant phonetic difference characterizing the contrast, and that there are no relevant phonetic features other than aspiration, voicing and articulatory force, and if neither the first nor the second of these suffices to distinguish the two stop categories in all contexts, then it follows that the third feature is fundamental to the contrast. Furthermore, it is reasonable to suppose (though in fact untrue) that a difference in peak intra-oral air pressure regularly underlies the difference in aspiration as well as the one of voicing. Thus it is not difficult to understand the appeal of Stetson's argument for the primacy of pressure over voicing as the basis for the contrast. But that argument seems open to serious doubt, both on the ground that there exists no extensive body of data demonstrating that the pressure difference is more nearly invariant than one of voicing, and because no plausible account has been offered as to how a pressure difference might be produced, in the case of the English stops, without involving some difference in the operation of the larynx. In view of the fact that many linguists observe the fashion of referring to English /p,t,k/ as "fortis" rather than "voiceless", and to /b,d,g/ as "lenis" rather than "voiced", there is remarkably little interest in determining the perceptually significant acoustic consequences of an independently controlled variation in intra-oral air pressure.

It is not difficult to suggest mechanisms whereby differences in intra-oral air pressure during articulatory closure might be generated independently of laryngeal action. Greater contraction of certain muscles of the upper vocal

[16] *In a number of studies the use of the terms "voiced" and "voiceless" as labels for the phoneme sets /b,d,g/ and /p,t,k/ respectively is thoroughly ambiguous.*

[17] *An exception is Subtelny, Worth and Sakuda (1966), where a short sentence provided a small part of the data presented.*

tract might constrict the supraglottal cavity during production of /p,t,k/ and thus yield higher intra-oral pressures for those stops, possibly in conjunction with a greater amount of pulmonary thrust. Alternatively, or in conjunction with these, there might be differences in degree of closure of the oral cavity, with some leakage of air into the nose or through the oral constriction during production of /,bd,g/. Now as a matter of fact, recent X-ray studies (Perkell, 1965, 1965a) reveal pharyngeal enlargement during /b,d,g/, but the explanation offered for this articulatory manoeuvre is that it permits the regulation of intra-oral pressure *so as to facilitate voicing during stop closure.* So that far from permitting any claim that articulatory force, as equated with intra-oral pressure, is independent of voicing, these changes in cavity size are cited by way of explaining why the two phonetic features are *not* independent,—how it happens, in other words, that the terms " fortis " and " lenis " have become associated with the voiceless and voiced stops respectively. Furthermore, techniques recently applied to determine the amount of muscle contraction by electromyographic measurements (Harris, Lysaught and Schvey, 1965; Fromkin, 1966) or by measurement of the mechanical pressures exerted during stop occlusion (Malécot, 1966a) have uniformly failed to yield any very significant differences between the two categories of English stops. To be sure, failure to confirm the notion that /p,t,k/ are produced with a greater expenditure of energy than are /b,d,g/ does not rule out the possibility of one day determining correlates of an independent fortis: lenis dimension of phonetic description.[18] However, so far as intra-oral pressure is concerned, it seems most reasonable for the present to suppose that the major determinant, during production of fully articulated stops in running speech, is the mode of laryngeal operation, which controls the degree of coupling between sub- and supraglottal cavities. That there exist other ways of regulating intra-oral air pressure during stop production is undeniable; that one or more of these may be used on occasion by speakers of English is not at all improbable; but that some one of them is more regularly used in running speech than the larynx is far from demonstrable on the basis of present knowledge,[19] and seems quite improbable to this writer.

It is difficult to avoid an impression, from a survey of much of the literature on phonology, that the data on intra-oral air pressure have been exploited in an essentially frivolous manner. The basic reason for this may be the tendency on the part of

[18] *The question of whether there exists a fortis:lenis dimension, independent of and co-ordinate with those of voicing, aspiration, nasality, etc., even if not answerable on the basis of studies of the English stops, might be decided by investigating cross-language differences, such as those by which English /b/ and Spanish /p/ may be distinguished, or by seeking out languages whose stops are said to differ exclusively in force of articulation. For English the best that can be done is to show that there are articulatory differences other than laryngeal which are associated with differences in the voicing dimension.*

[19] *A remarkably thorough and lucid discussion of stop production from the aerodynamic aspect is presented in Rothenberg (1968).*

linguists, and of other speech researchers as well, to confine serious attention to those aspects of speech activity that seem to serve a directly distinctive function, and to dismiss other aspects as "uninteresting." Thus the pressure differences associated with a phonological distinction were worthy of notice, since they might be cited as "proof" of the physical reality of the distinction. On the other hand certain pressure differences, as for example those between pre- and post-stress medial /b,d,g/, were given no attention, although they might be related to features with which the linguist is forced to reckon in his phonetic description.[20] But certainly it would seem inadmissible to impute significance to the dimension of intra-oral pressure merely to suit the linguist's convenience, and not recognize the need for a general understanding of the relation between that dimension and other features of speech activity. Professing a lack of interest in all but the distinctive features of speech is, in short, no excuse for misusing physical data.

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[20] *These are the vowel durational differences associated with the /p,t,k/ : /b,d,g/ contrast, together with those connected with the different stress patterns. The very different durational relations, involving both the adjacent syllabics and the closure intervals of the stops themselves, which are found in the two contexts, may provide a good part of the explanation for the pressure data reported above. More precise information on the timing of the subglottal pressure pulse that marks the stressed syllable (Ladefoged, 1962; Lieberman, 1967), relative to supraglottal articulation, might help explain why the pressure patterns for /b,d,g/ differ so much more with stress than do the /p,t,k/ patterns. The absence of significant pressure difference in the latter case may turn out to be connected with the fact that the durational relations here vary less with stress.*

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