

glossa

AN INTERNATIONAL JOURNAL OF LINGUISTICS

EDITORIAL BOARD

B. E. Bartlett
P. W. Davis
R.C.DeArmond
E. W. Roberts
R. Saunders
M. St.-Jacques

CONSULTING EDITOR

G. L. Bursill-Hall

CIRCULATION AND BUSINESS MANAGER

B. E. Bartlett

Published twice a year in April and October for the GLOSSA society, Department of Modern Languages of Simon Fraser University. Subscription rate for one year -\$6.00. Orders for subscriptions may be addressed to the Circulation Manager, GLOSSA, Department of Modern Languages, Simon Fraser University, Burnaby 413, British Columbia.

Manuscripts may be written in any language utilizing Latin or Cyrillic alphabets. Articles and discussions should be addressed to the Editorial Board, GLOSSA, Department of Modern Languages, Simon Fraser University, Burnaby 413, B.C. Reviews or books for review may be addressed to the Review Editor, GLOSSA, Department of Modern Languages, Simon Fraser University, Burnaby 413, B.C.

@ 1973 by GLOSSA Society

Lithographed In Canada by Evergreen Press

PAUL J. HOPPER,
State University of New York

GLOTTALIZED AND MURMURED OCCLUSIVES IN INDOEUROPEAN'

Abstract: Indo-Europeanists have traditionally reconstructed for ProtoIndo-European (PIE) a system of stops consisting of two voiced members (*Idl* and *Idhl*) and either one or two voiceless (*Itl* or *Itl* and *Itlh*). For those who posit a three-stop system *Itl*, *Idl*, and *Idhl*, the problem of typological improbability presents itself, for a typologically plausible triple stop system should have only one voiced stop. In this paper, two main points are made: (1) the voiced aspirates should be regarded as partially voiced (murmured) rather than as aspirated or tense, and (2) the supposed 'plain voiced' stops (*Idl*, etc.) show many of the typological characteristics of glottalized stops (ejectives), e.g. they are excluded from inflectional affixes, they may not co-occur with one another in the same root, etc. Combining these two observations, we may

state the constraint in PIE which prevented roots of the type **tebh* in a highly plausible way: two nonglottalized occlusives must agree in voicing. This formulation is possible because the murmured stops are the only ones with voicing. Areal and typological consequences of this hypothesis are mentioned, and a possible trajectory of the proposed *ltl-lt'l-lidl* system in Germanic and other IE dialect groups is discussed.

1. In the enterprise of reconstructing proto-languages, linguists have customarily assumed that the hypothetical entities which are posited are constructed within the same parameters as those found in extant languages. It is only fairly recently, however, beginning perhaps with Jakobson's paper "Typological Studies and their Contribution to Historical Comparative Linguistics" (1957), that the value of language typologies and language universals has been recognized as a working method.

Typological studies may be used in at least two ways, as a control and as a discovery procedure. In the first of these uses, a linguistic system which may seem to be realistic on purely comparative grounds may be either confirmed or rejected when the typological evidence is examined. As an example, we may take Dempwolff's reconstruction of the Proto-Austronesian consonant system. Dempwolff (1934) posited stops in voiced and voiceless pairs at five points of articulation, and a single fricative, the voiced velar fricative /ɣ/. A system of this kind would have to be viewed as unnatural to a degree where its existence could confidently be denied.

The use of typological studies as a discovery procedure in comparative linguistics is seen in the application of implicational universals, i.e. statements of the kind: 'If a language has feature X, it will also have feature Y.' As a matter of fact, comparativists have probably always worked implicitly with projections of this kind. But it is only since universals have been stated explicitly that linguists have consciously applied them in recovering details of the structure of proto-languages. From the widespread presence in earlier Indo-European languages of a comparative adjective construction of the type Latin *melle dulcius* 'sweeter than honey', with the word order standard noun plus comparative, and one or two other diagnostic features, we may infer that Proto-Indo-European belonged to a type of language in which the direct object of the verb preceded the verb, where there was a tendency for modifying elements to precede the modified element (genitive plus noun rather than noun plus genitive, etc.), and so on, cf. Lehmann 1972, Greenberg 1966.

2. A Typological Critique of the Indo-European Obstruent System as Usually Reconstructed

In this paper the generally assumed obstruent system of Proto-Indo-European will be examined from the point of view of phonetic and systematic phonemic universals. I shall be concerned principally with the manner of articulation of the stops.

During the present century, the main changes which have come about in notions about the Proto-Indo-European consonant system have been the result of (1) the positing of further consonant phonemes through the laryngeal theory, and (2) the re-evaluation of systematic aspects of Indo-European phonology through theoretical advances, mainly in phonological theory. The phonetic nature of the system of stops which the Neo-Grammarians reconstructed was rarely discussed.

However, several writers have at different times expressed reservations about the phonetic realism of the system propounded by Brugmann, while continuing to live with systematic aspects of the scheme. For example, Prokosch (1938: 39-41), while rejecting the idea of a voiced aspirate series, continues to use the symbols *bh*, *dh*, etc., partly for the sake of conformity to other works, and partly because his interpretation of these sounds as lenis unvoiced fricatives does not affect his exposition of the facts of the obstruent changes as they occurred in Germanic. Similarly, Hirt (1927: 218-219) is able to get by with a few brief paragraphs of discussion of the voiced aspirates, and after pointing out that a 'true' voiced aspirate such as the segment sequence in the middle of the word *Rebhuhn* pronounced as a single segment is practically impossible from a phonetic point of view, he continues throughout the work to represent the voiced aspirates as units composed of voiced occlusives plus *h*.

Other writers are equally agnostic about the phonetic properties of the reconstructed units of sound. Meillet (1936: 88) says of the voiced aspirates that they were characterized by 'a glottal articulation which we have no means of determining exactly'. And according to Lehmann (1955: 11): 'From a structural point of view the phonetic interpretation is of secondary importance.' Discussion of the phonetic realization of the phonological units of Indo-European has, in fact, occupied a rather marginal place in comparative studies of the language family in the twentieth century. Whatmough's suggestion (1937) that the labiovelars were characterized phonetically by coarticulation ([*kpl*, etc.), a type of phoneme common in African languages of the West Atlantic Coast, appears to have given rise to no discussion among other linguists.

2.2 Few comparative linguists these days would be content with a purely algebraic account of sound changes. In recent years, linguists have insisted with increasing emphasis that language

change and hypothetical proto-languages should not only have internal consistency, but should also conform to some standard of 'naturalness', i.e. should have generalizable analogs in documented systems and diasystems. It is clear that the task of the historical linguist must now be seen as that of defining diachronic naturalness and finding empirical evidence for what constitutes natural as opposed to unnatural systems. There remains in addition the awesome task of devising an adequate formalism for expressing hypothesized natural systems and changes, many of which are assumed to be natural solely because of their cross-linguistic frequency of occurrence. The present article is intended as a serious attempt to discuss the obstruent system of Proto-Indo-European in the light of 'natural' phonological systems. Accordingly it should be said in advance that the attempt will suffer from the inevitable defects of inadequate formalization and a certain recourse to impressionism with respect to 'plausibility'.

2.3 The Generally Assumed *PIE* Obstruent System. The Proto-Indo-European obstruent system generally assumed by scholars is substantially that set forth in Lehmann's Proto-Indo-European Phonology (1955). This system assumes three points of articulation: labial, dental, and velar (excluding laryngeals); three glottalic types: unvoiced, plain voiced, and voiced aspirate; and a contrast in the velar series between labialized and unlabialized. The system also has a single fricative, /s/ (again excluding laryngeals), and displays a surprising gap in the labial series, the plain voiced stop **/b/* being absent. Figure 1 shows the occlusives as phonemic units, and Figure 2 displays the same

	LABIAL	DENTAL	VELAR/ LABIOVELAR
VOICELESS	/p/	/t/	/k/, /k ^o /
VOICED		/d/	/g/, /g ^o /
VOICED ASPIRATE	/bh/	/dh/	/gh/, g ^o h

Figure 1

F	p	b	bh	t	d	dh	k	g	gh	k ^o	g ^o	g ^o h
obstruent	+	+	+	+	+	+	+	+	+	+	+	+
continuant	-	-	-	-	-	-	-	-	-	-	-	-
anterior	+	+	+	+	+	+	-	-	-	-	-	-
coronal	-	-	-	+	+	+	(-)	(-)	(-)	(-)	(-)	(-)
round	(-)	(-)	(-)	(-)	(-)	(-)	-	-	-	+	+	+

	)	)		)	)							
voiced	-	+	+	-	+	+	-	+	+	-	+	+
tense	(-)	-	+	(-)	-	+	(-)	-	+	(-)	-	+

Figure 2

glossa 7:2 (1973)

information as a distinctive feature matrix; the articulatory features used are those of Chomsky and Halle (1968). The use of the feature $\pm$ tense to differentiate plain and aspirated voiced stops has become customary in discussions of Indo-European phonology, but it will be examined critically in a later section. For the purposes of the present paper, I shall assume that the points of articulation are adequately specified, although it should be pointed out that the non-labialized velars were possibly palatalized, since they develop into palatals in many dialects (satem languages). Tenseness is redundant in the labial series if */b/ is not assumed, for /bh/ is set off from /p/ by voicing alone.

2.4.0 Discussion of Phonetic Features of *PIE* Stops.

2.4.1 The Two Voiced Stops. As has often been noticed (most recently by Peeters, 1971), at each point of articulation except the labial there is a triple contrast, necessitating two distinctive features with a redundancy in one specification, viz. either:

	t	d	dh
voiced	-	+	+
tense	0	-	+

or

	t	d	dh
tense	-	+	+
voiced	0	-	+

It is now possible to argue that the voiced aspirates may have had voiceless allophones or dialectal variants, since the presence or absence of voicing would not affect the triple contrast. The appearance of voiceless sounds in Greek and Italic is thus readily explained. The proposals which I shall make in this paper do not, as far as I can see, ultimately conflict with this suggestion.

2.4.2 Aspiration and Tenseness. It has become customary in recent phonological studies of Indo-European and of the Indo-Aryan languages to assign the feature [+ tense] to the presumed voiced aspirates. The main advantage of this specification lies in the fact that it permits four manners of articulation to be accounted for with two features:

	t	th	d	dh
voiced	-	-	+	+
tense	-	+	-	+

The justification for tenseness disappears, however, when dealing with a language having no voiceless aspirates. We must ask the question whether tenseness in physiological-phonetic terms can be assumed as a functional articulatory factor in Proto-Indo-European, and, if so, whether tenseness would be realized as a type of phoneme characterized by voicing and aspiration.

2.4.2.1 The second of these two claims, that the third series of obstruents was voiced and aspirated, has never been held with great enthusiasm by Indo-Europeanists. None of the attempts to replace the voiced aspirate hypothesis has found wide acceptance, however.

Probably the main reason why Indo-Europeanists continued to use the 'voiced aspirate' convention has been the implicit priority of Sanskrit phonology. It is true that the primacy of Sanskrit had been repeatedly disproven through such discoveries as the original vowel system in e/o, the syllabic nasals, and the apparently derivative nature of the voiceless aspirates. Nonetheless, the Sanskrit 'voiced aspirates' could be shown to represent a class of sounds which showed up as fricatives in Italic and Germanic, and which furthermore patterned in important respects like the voiceless aspirate stops, which were phonetically established for Sanskrit. Thus Grassmann's Law operated not only on forms containing two voiced aspirates inherited from the protolanguage, but also on derivative roots containing two voiceless aspirates (*khya*- 'see', *cakhyau* (pf.)). The rule could be stated neatly as an across-the-board dissimilation of aspirates, voiced or unvoiced. Sanskrit also showed a morphophonemic alternation of voiced aspirates with a phoneme transcribed as /h/, as in *hanti/ghnanti* 'he strikes/they strike', representing a Proto-Indo-European ablaut alternation *g^ohen-/g^ohn-.

The correspondences in other Indo-European languages were also strongly suggestive of the analysis of the third series as voiced stops 'plus' something else. That this extra feature should be aspiration accounted for the Greek reflexes ph, th, and kh, which were known to be voiceless aspirates, and made

the development into fricatives under some circumstances in Italic and Germanic plausible.

If the term 'aspiration' as used in conjunction with the description 'voiced stop' is taken literally, then phonetic observation would have to rule out completely the possibility of such a combination of features. An aspirated obstruent is one characterized by a pause between the offset of the obstruent and the initiation of voicing in the following vowel (or the articulatory motion of obstruency in the following consonant). During this pause, phonation continues, with the vocal organs generally in the articulatory position of the following phone. With voiceless aspirates this simply means that voicing in a following vowel is delayed. In the case of the supposed voiced aspirates, however, voicing would have to be momentarily suspended between the voiced obstruent and the voicing of the vowel. Such a suspension, while not physiologically impossible, is inconvenient and, linguistically, highly improbable. The two components of the medial cluster in the German word *Rebhuhn* (Hirt's example) are both unvoiced, and are in any case separated by a very distinct phonological boundary. The situation is summed up by Ladefoged (1971: 9), who, after describing hypothetical 'voiced aspirates' in these terms, remarks that 'such a sound has not yet been observed in any language.'

2.4.2.2 The theory that one of the distinctive features marking the PIE 'voiced aspirates' was tenseness must be examined from the point of view of the phonetic nature of tenseness and its cross-linguistic distribution. The probability that Proto-Indo-European possessed a series of tense voiced occlusives must be considered very low.

In the sense of the word tense as used by Chomsky and Halle, its main use is to distinguish tense and lax vowels, the former being produced with supraglottal muscular pressure, the latter without such pressure. Occlusives may also be tense, but in this case they are of necessity concomitantly voiceless: "It is obvious that voicing can occur only if two conditions are met: the vocal cords must be in a position that will admit voicing, and there must be a flow of air through the glottis. When a stop is produced and the oral cavity is blocked while the vocal cords are in the appropriate position for voicing, pressure will build up in the cavity and will rapidly . . . increase to the point where it is approximately equal to the subglottal pressure. This will halt the flow of air through the glottis, thereby making further vocal vibrations impossible. Under these conditions there is only one way in which the pressure buildup inside the vocal tract can be slowed down and voicing allowed to take place during the closure phase of the stop, that is by allowing the vocal tract to expand. If the walls of the tract are rigid as the result of

muscular tension, this expansion of the cavity volume cannot take place, and therefore tense stops will not show any voicing during the closure phase" (Chomsky and Halle, 1968: 325).

We may conclude that the distinguishing feature from a genetic point of view of the 'voiced aspirates' cannot have been supraglottal tenseness, as in fact Chomsky and Halle point out in their discussion of 'the aspirated voiced stops of languages such as Hindi' (326).

We have seen that the 'voiced aspirates' cannot be said to be aspirated in any literal sense of the word. Chomsky and Halle have assumed that they are produced with 'heightened subglottal pressure' (326), a feature which must be distinct from tenseness in that unlike tenseness it is not incompatible with voicing in occlusives. Yet Ladefoged reports that there is no clear experimental evidence for heightened subglottal pressure in this type of obstruent, at least not insofar as such pressure is 'an independently controllable aspect of the speech event' (the condition placed by Chomsky and Halle on their features); if there is an increase in subglottal pressure, 'it might be simply the result of variations in the state of the glottis, and not independently controllable in any way' (Ladefoged 1971: 96). Accordingly, any attempt to substitute a lenis/fortis distinction for a tense/lax one in the 'voiced aspirates' must also fail. In fact, Ladefoged's investigations suggest that phonological contrasts deriving from a difference in expiratory force are exceedingly rare among the world's languages, and there is no evidence at all that the phenomenon is characteristic of Indo-European.

2.5 Summary. The discussion so far has pointed to two main conclusions about the PIE third series of stops: (1) that they were not phonetically 'voiced aspirates', and (2) that it is not appropriate to use the terms tense or fortis to distinguish them from the plain voiced stops. In the next section, I will discuss alternative possibilities concerning the phonetic and phonological nature of the PIE occlusive system.

3. It should be recalled that conclusions about the phonological or other systems of a proto-language are drawn from two general sources: the comparative and internal data offered by the daughter-languages, and the constraints on language structure imposed by universal linguistic considerations. From the point of view of the first of these sources, the positing of a voiced aspirate series made *prima facie* good sense. Unaspirated stops showed good sets of correspondences over the entire area of the language family, the main divergences being devoicing in Germanic and Armenian. In addition, there clearly existed a further class of occlusives which showed up as plain voiced stops in some dialects (e.g. Slavic), voiced fricatives in others (e.g. Germanic, in the earlier view), and aspirated stops in Greek and Indo-Aryan,

Comparative evidence supplied the phonological features for this set of stops: voicing was indicated by most dialects, the main exceptions being Greek and Italic; stop articulation was also widespread, and languages which showed fricatives at all or some points of articulation, such as Italic and Germanic, also had stops as positional or dialectal variants. Aspiration was not so obvious, but the evidence of Greek and Sanskrit weighed heavily, because of their antiquity and prestige, even though they were in the numerical minority, and the fricatives in Latin and Germanic suggested a tensed or prolonged plosive consonant. Qualms about the phonetic nature of 'voiced aspirated stops' could be eased by citing the supposed existence of such sounds in Sanskrit and the modern Indo-Aryan languages. Indeed we may assume that were it not for the direct evidence of these sounds in languages of India, including Sanskrit, the common etyma of words containing Greek *kh*, Germanic **γ*, and Slavic *g* would have been posited only hesitantly and with much disagreement among scholars,

3.1 A New Hypothesis about the PIE Stops. Thus far I have questioned the usual description of some of the PIE obstruents on grounds of phonetic probability, arguing that aspiration is incompatible with voicing, and that the features of lenis versus fortis, or lax versus tense, which linguists have sometimes posited as the phonological counterpart of aspiration in the voiced obstruents, are either implausible or impossible when applied to the PIE 'voiced aspirates'. A second cogent argument against the system of consonants generally assumed for Proto-Indo-European is its typological improbability. Obstruent systems in which two voiced stops are opposed to a single voiceless stop at each point of articulation are not unknown, but they are very rare, and of course such a system has not survived in any of the Indo-European daughter-languages, although this fact alone would not exclude it from the proto-language. Hockett (1955: 122-124) mentions only two languages with two voiced~one voiceless obstruent systems (Fijian and the Mixtecan language Chatino). Of these, only the Chatino system, with voiceless, plain voiced, and prenasalized voiced stops, can be seriously considered, as the Fijian obstruent system is hopelessly defective. The Chatino prenasalized stops are susceptible of analysis as clusters of nasal plus stop, according to Hockett. One should, however, be cautious about analyzing away all suspected instances of unbalanced consonant systems. It would be most unwise to regard the assumed obstruent system of ProtoIndo-European as impossible in the same sense as Dempwolff's reconstruction of Proto-Austronesian obstruents (referred to above 1) is 'impossible'. It can, however, reasonably be regarded as

improbable, or at least as unusual enough to justify considering alternative hypotheses,

3.1.1 The Phonetic Classification of Obstruents. Proceeding from Meillet's attribution to the voiced aspirates of 'a glottal articulation which we have no means of determining', I will begin by assuming that the voiced aspirates were stops with some kind of voicing action, probably partial voicing or murmur. The extension of this murmuring feature into the following vowel accounts for the 'aspirated' effect which observers notice in such sounds.

(closure)	1. Glottalic
	2.
	3. Creaky
(full voicing)	5. Voiced
	6.
	7. Murmur
	8.
(aperture)	9. Voiceless

Figure 3. Some States of the Glottis during Phonation
(Adopted from Ladefoged, 1971).

On the continuum between complete aperture and complete closure of the glottis (voicelessness and glottal stop respectively), it is possible to make a theoretically infinite number of distinctions. The recent survey by Ladefoged (1971) proposes a tentative nine-fold distinction, which, using Ladefoged's numbering but ignoring several of the intermediate states, may be displayed as in Fig. 3. In addition, obstruents may be classified according to the point - again along a continuum - at which full voicing is initiated; this dimension is displayed by Ladefoged along the lines indicated in Fig. 4.

1	2	3	4	5
voicing throughout		voicing immediately after		voicing considerably later

Figure 4. Timing of Voice On set (Ladefoged, 1971)

3.1.2 It is evident that, by combining these two tables, we will obtain a two-dimensional schema which will allow for considerable scope in positing obstruent phonemes for Proto-Indo-European without bringing in features such as tense, or positing two fully voiced phonemes against one voiceless. Figure 5 shows

Glottalic	1			
Creaky	3			
Voiced	5	/d/		/dh/?
Murmur	7			
Voiceless	9		/t/	
		1	3	5
		Voicing throughout	Voicing immediately after	Voicing delayed

Figure 5. Chart of laryngeal activity in obstruents (Ladefoged 1972), with plotting of traditionally assumed Indo-European stops.

the two tables combined, with a putative charting of the traditionally assumed PIE obstruent system (with dentals as usual standing for each point of articulation). The anomalous nature of the term 'voiced aspirate' is highlighted by the attempt to place such a phoneme on the chart: it must itself be 'voiced', yet the initiation of voicing in the following phone must be 'delayed'!

If we assume that the obstruent system of Proto-Indo-European was characterized by a triple manner contrast, then the table in Fig. 5 offers several typologically plausible alternatives to the traditionally assumed system. The optimum one, it seems to me, would be a system containing two voiceless and one voiced stop, perhaps with a contrast of aspiration in the voiceless stops, or perhaps with one of the voiceless stops glottalized. For a number of reasons, the most probable

alternative system to the one posited traditionally is, I believe, one in which the murmured stop is the only one marked for voicing, and the assumed plain voiced stop is glottalic, ie, marked +checked], i.e. the correspondences between the two systems are as in Fig. 6. The assumption that the third series was represented by murmured stops is a concession to the phonetic realization of these phonemes in the Indo-Aryan languages and in Greek, Latin, and other dialects where the evidence suggests a stop which was not of the plain voiced variety.

"Classical" System	Proposed Revised System
t	t
d	t'
dh	d

Figure 6

3.1.2.1 In an important article 'A reformulation of Grimm's Law', Emonds (1972) has suggested that an original system identical to the one proposed here except that the traditional 'voiced stops' are considered plain lax voiceless stops (i.e. /t/) and the traditional voiceless stops are tense (/t h /, etc.) can account in a simple manner for developments in various IndoEuropean dialect areas. Thus the voicing of the lax stops is common to a Central area, and the appearance of voiceless stops in Germanic, Armenian, and (according to Emonds) Hittite is regarded as a relic area phenomenon. In all probability the views expressed in Emonds' treatment and those presented here are not incompatible. I have preferred to begin with the problem of typological plausibility, and believe that the evidence for a glottalic series is compelling enough to suggest at least a reformulation of Emonds' work. In particular, Emonds' solution requires that in at least one dialect area (Greek) a stage must be posited in which the 'traditional' stop series appears, namely /t', /d/, /dh/. His claim that the traditional formulation cannot express in distinctive feature terms the generalization that suffixes may not begin with the 'voiced stops' is true, yet his own formulation ("IE suffixes begin only with tense stops" 115) seems strangely unmotivated; in the present treatment, suffixes may not begin with checked consonants - a situation true also of Georgian (cf. 3.2.7 below). Future discussion of the whole question will, I hope, clarify the question whether the two viewpoints can be reconciled, i.e. whether Emonds' rules can be modified so as to accept proto-language forms containing glottalics in place of lax voiceless stops.

3.1.3 The substitution of a glottalic series for the plain voiced stops has great advantages from a typological point of view, and can also be justified on grounds internal to the Indo-European language family, as I hope to show later in this paper.

Phonetically, glottalized sounds may be of several types. The term 'glottalic' or 'glottalized' has been used in at least two ways by linguists: (1) to denote the specific class of ejectives (sounds pronounced with pharyngeal air only and followed by a glottal release), and (2) as a cover term for laryngealized sounds and sounds characterized by upward or downward movement of the larynx (ejectives and implosives). I shall use the term in a somewhat narrower sense than the second of these, equating it with Ladefoged's feature of 'glottalic stricture'. I shall assume that laryngealized variants of ejectives developed into voiced stops over a large area of the Indo-European speaking territory. Ladefoged's analysis of Hausa describes a situation in which ejectives and laryngealized stops are never in contrast, and are subsumed as a natural class under the same feature of glottalic stricture:

„[Hausa] contains a set of voiced stops, a set of voiceless stops, and a set of glottalized stops which includes the laryngealized sounds b and d and the ejective k'. The latter sound . . . can be said to have a glottal closure <state 1> throughout the articulation and for a short period after its release, before the beginning of regular voicing. It thus appears on the chart very close to b and d. At the systematic phonetic level all these sounds may be said to have the maximum degree of glottal stricture and may be marked /1/, Hausa having the possibilities /1 2 3/ for the feature at this level" (Ladefoged, 1971, 21-22).

Using Ladefoged's two-dimensional chart to plot the degree of glottalic stricture beside the timing of voice onset, the proposed revision would give Proto-Indo-European a system of occlusives as in Fig. 7. In this Figure, dotted lines indicate the

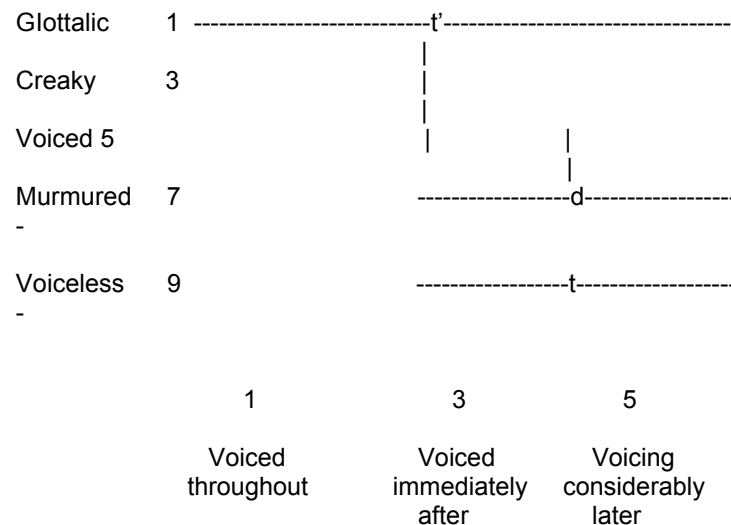


Figure 7. Hypothesized Proto-Indo-European Stops. (Dotted lines represent allophonic and dialectal range of proposed phonemes)

range of allophonic and dialectal variation of each type. It must be remembered that the hypothesized range of these variants is much greater than would probably be found in a single language area; this broadness is a reflection of the lack of refinement possible in specifying features of a reconstructed language.

3.2 The Indications for a Glottalized Series.

3.2.1 Typologica/ Indications. Whereas obstruent systems with voiceless, plain voiced and voiced aspirate (Murmured) stops are rare or nonexistent in known languages, the type represented by the proposed revision is both common, and importantly, has a wide geographical and cultural spread. It is represented in the Old World by the Caucasian languages, in Africa by Hausa, and in the Americas by Quechua and a number of North American languages. The Georgian system of stops, to give one example, is as follows:

Voiced b d 3 i g

Voiceless p t c Č k

Glottalic p' t' c' ċ' k' q'

3.2.2 Areal Implications. If, as seems probable, the focal region of the Indo-European languages is to be sought in the area of the Black Sea and the Cis-Caucasian Plain, we might profitably look for structural similarities between Proto-Indo-European and languages assumed to have been spoken in that region. The work of the Georgian linguist Thomas Gamkrelidze (1966) points toward surprising parallels between Indo-European and Proto-Kartvelian (South Caucasian) in morpheme structure conditions. Further similarities are noted by Schmidt (1967). These parallels might, of course, be purely typological, but the strong possibility of earlier geographical ties between the two language groups must be reckoned with. Since glottalic consonants are a pervasive feature of all three Caucasian families, the supposition of such sounds in Proto-Indo-European would add strength to Gamkrelidze's idea of an 'Indo-Caucasian' Sprachbund.

3.2.3 Proto-Indo-European *b. The rarity or absence of the phoneme /b/ in Proto-Indo-European is well-known, and most of the handbooks comment on it. In the medial position, b occurs in some dialects as a sporadic voicing of p, as perhaps in Latin bibō 'I drink' Sanskrit pibāti 'drinks'. Initially, examples of *b are difficult to find; those usually cited are often onomatopoeic or expressive, or else are restricted to a smaller number of dialects. The set of cognates often cited is Latin (de-)bilis 'lacking strength', Sanskrit bal- 'strong', Greek beltíōn 'better', etc., but other examples are dubious.

From the point of view adopted here, the missing phoneme is the glottalic bilabial stop /p'/. It turns out that a gap in the labial series of a language with glottalized stops is a common situation. Greenberg, in his valuable paper 'Some Generalizations concerning Glottalic Consonants, especially Implosives' (1970) states: 'Preferences regarding point of articulation for glottalic obstruents are summarized in the following formula: injectives tend to have front articulation, ejectives to have back articulation.' He goes on to observe: "A gap in the class of ejectives at the bilabial point of articulation is found in a number of world areas...Some Caucasian languages of the North-East group, namely Avar, Andi, and Lak...have an extensive series of glottalic ejectives, which once more show a gap in the bilabial position" (127)

The phonetic reason for this seemingly arbitrary preference for back articulation in ejectives is apparent: the articulatory energy involved in producing such stops is greater the larger the air chamber between the glottis and the articulator. If the missing PIE phoneme *b was in fact aligned with the glottalic

series, then its absence is explicable on general typological and, eventually, phonetic grounds.

3.2.4 The '*Marked*' Status of the Plain Voiced Stops. Meillet points out that the phonological role of the plain voiced stops was far less than that of the voiced aspirates or the voiceless stops. He remarks:

" In historical times, especially in Indo-Iranian and Greek, the system of plain voiced stops is in contrast with that of plain voiceless stops. But certain features indicate that, at least at a very early date, the system of plain voiced stops was not as essential in Indo-European as were those of the plain voiceless stops and the voiced aspirate stops. Whereas *p is as essential as *t and *k, and *bh as essential as *dh and *gh, *b is in Indo-European a rarity, and betrays itself as of secondary origin in part" (Meillet, 1936, 84).

Hand-in-hand with this observation go the statistical rarity of the plain voiced stops in general, and the constraints on the phonemic structure of roots. These constraints are discussed in more detail below, but for the moment we will notice that the plain voiced stops are the only series which may not occur twice in the same root. It looks as if the 'plain voiced stops' represented a marginal set of phonemes in Proto-Indo-European. Yet this situation is surely anomalous, since the most highly marked obstruents from the point of view of primary feature specifications were the voiced aspirates, which were marked (+) for both voicing and tenseness (aspiration, or whatever). We should somehow expect that in a language with fully voiced, partially voiced, and unvoiced stops the primary phonological role would be between the fully voiced and the unvoiced stops, i.e. t-d-ɖ rather than t-ɖ-d. This feeling is solely impressionistic, however, since I know of no language having a double opposition of precisely this kind.

Assuming a glottalic series in place of the plain voiced series, the marking distribution is a highly natural one. According to Trubetskoy (1969), 'If . . . the correlation of recursion is one component of the correlation bundle, the 'mid' member of the gradational series is a (voiced or voiceless) lenis with in-fraglottal expiration (t-d-t')' (152-153).

A glottalic series of consonants might be expected typologically to play a minimal role in suffixation, and this is certainly true of the 'plain voiced stops' of Indo-European (Meillet 1936: 84). Languages in general display a preference for 'simple' phonemes in affixes, such as [n], [s], [t], etc. The generalization is difficult to formalize, but the truth of it is intuitive to the experienced linguist. In Georgian, voiced and voiceless consonants occur freely in affixes: [-eb], noun plural suffix; [g-] 2nd pers. sing, object; [-t] 1st/2nd pers.plur. subject (verbal affixes);

etc. On the other hand, no inflectional affixes contain glottalics. The glottalic consonants appear almost to be on the periphery of the consonant system (their frequent occurrence in nursery words and onomatopoeic words, in both Georgian and Indo-European, is probably also symptomatic of this situation).

The peripheral nature of the glottalics is supported also by an observation of Greenberg's concerning the widespread crosslinguistic tendency for glottalic consonants to lose their feature of glottalicity (1970: 134). This observed tendency would account for the absence of a glottalic series of obstruents in general in the recorded dialects of Indo-European.

3.2.5 Distinctive Features of PIE Stops. According to modern phonological theory, phonological distinctive features are specified at some point (or perhaps interpreted) with the sign M or U (marked or unmarked), and these signs, if specified, are later converted into (+) or (-) by universal rules. The 'cost' of U F, as opposed to M F, (where F, is any feature) must be reckoned in terms of the total grammatical system, and not merely the initial matrix, so that we must eventually take into account the number of times a feature will be mentioned, in the rules and the lexicon, before assuming that a specification M F, is a priori more costly than U F,.

The assumption of plain and aspirated voiced stops in Proto-Indo-European, as has been pointed out, entails the assignment of the highest marking value to the voiced aspirates, i.e.:

t d dh

voiced	U M M
aspirated	U U M

Accordingly, occurrences of /dh/ in the rules and lexicon of Proto-Indo-European will be more costly than occurrences of /d/. Yet this situation is inconsistent with the phonological role of the 'voiced aspirates'. It could, of course, be argued that the unmarked value of aspiration in Proto-Indo-European was (+) but this would seem to be at variance with the condition on naturalness. A more natural system for Proto-Indo-European would be one in which only two M's appeared, e.g.:

	(t)	(d)	(dh)
F,	U	U	M
F ₂	U	M	U

(where F, F₂ are manner features). This in fact is precisely the system which would have existed if one of the series was glottalic:

	t	t'	d
voiced	U	U	M
checked	U	M	U

A further advantage which now accrues is that it is possible to refer to the 'plain voiced' stop by a single feature, and the voiceless stops and the murmured stops form a natural class of [-checked] stops.

There is one aspect of Indo-European phonology which is, I believe, considerably clearer if the new alignment is assumed: the constraints on the phonemic structure of the roots.

3.2.6 Root Structure Constraints in Indo-European. It is known that of the theoretically possible forms which a monosyllabic root of the type CVC could take in Indo-European, several types were excluded by systematic constraints on the cooccurrence of consonantal phonemes within the root. These restrictions were apparently as follows (Lehmann 1955: 17-18):

A. The two consonants must differ in point of articulation regardless of the manner feature.

B. The root may not contain two plain voiced stops.

C. The root may not contain both a plain voiceless stop and a voiced aspirate stop.

Focussing on the constraints involving manner features (B and C, we may sum up the restrictions as follows (assuming the vowel /e/, and using dentals for the initial stop and velars for the final stop):

Permitted Sequences Prohibited Sequences

tek	*deg
teg	*tegh
dek	*dhek
degh	
dheg	
dhegh	

In looking for a unified explanation for the constraints on manner features, we are struck by the apparent arbitrariness which they show. Why should sequences of voiceless stops and sequences of voiced aspirate stops be allowed, but sequences of plain voiced stops prohibited? And what possible linguistic reason could there be for permitting types such as *teg* but excluding types such as **tegh*?

With regard to the exclusion of the **tegh* type - that with a voiced aspirate and a voiceless stop - we might claim that the constraint was one which forbade the co-occurrence of two obstruents separated by more than one manner feature. Yet the principle does not seem to be assimilatory, for the opposite process operates in the plain voiced stops. It appears as if the constraints B and C have to be considered irreconcilable: two unrelated means of restricting the possible root shapes.

Some of the arbitrariness of the root structure constraints is removed if the plain voiced stops are held to be glottalics. We have seen that the assumption of glottalics brings about a realignment of the feature specifications such that the 'plain voiced' stops (i.e. the glottalics) now form a natural class in opposition to the voiceless and murmured stops as [+checked] versus [-checked]. We can exploit this class in making two succinct and linguistically plausible statements of the constraints:

- (1) Each root contains at least one [-checked] obstruent;
- 2) When both obstruents are [-checked], they must agree in voicing.

The Proto-Indo-European root structure constraints may now be represented as follows, where d, g are murmured stops (marked for voicing only at this level of representation), and *t*', *k*' are glottalics:

	<i>t</i> , <i>k</i>	<u>d</u> , <u>g</u>	<i>t</i> ', <i>k</i> '	Permitted	Prohibited
voiced	-	+	-	<i>tek</i>	<i>*t'ek'</i>
checked	-	-	+	<i>tek'</i>	<i>*teġ</i>
				<i>t'eg</i>	<i>*dek</i>
				<u>dek'</u>	
				<i>t'ek</i>	
				<i>deġ</i>	

This restatement of the root structure constraints of Proto-Indo-European seems to have both phonetic and cross-linguistic phonological validity. Glottalic stops, being articulated with supraglottal airstream only, are in a sense outside the voiced/voiceless contrast, and are therefore neutral

as to voice. Consequently they do not participate in the constraint which requires voicing agreement between stops in the same root. The restriction (1) has surprising parallels in three widely separated languages having glottalized phonemes, Hausa (West Africa), Yucatec Maya (Mexico), and Quechua (South America).

In Hausa, "two heterorganic glottalized consonants (including /ʔ/) never cooccur in the same word" (Parsons 1970: 280). The constraint in Yucatec Maya is identical. This language has basic roots of the shape CVC, just as in Proto-Indo-European before the addition of suffixes, and there are both manner and point of articulation constraints. One of these constraints is that: 'If both consonants in the root are ejectives . . . then they must be identical in every other respect' (Straight 1972: 59).

According to Orr and Longacre (1968): " . . . in Quechuan forms found in our cognate sets, there is but one laryngealized stop or affricate per word. Thus where certain Aymara cognates in a Quechumaran set have two laryngealized phonemes, the second laryngealized phoneme will correspond to an unlaryngealized phoneme in Proto-Quechua. It therefore follows that all **C' and **Ch phonemes have not only the corresponding Proto-Quechua laryngealized reflexes but also reflex*C. On the Quechuan side, a dissimilation of laryngealized phonemes (to unlaryngealized) affects the second laryngealized phoneme of any Quechumaran form. Thus PQA **t'ant'a gives Ay. t'ant'a but PQ t'anta" (549).

In Proto-Indo-European there is no evidence that homorganic or identical consonants escaped the stricture against two glottalics in the same root, since homorganic stops are, of course, prevented from occurring by the constraint A. The cross-linguistic tendency to avoid sequences of glottalic phonemes reinforces the hypothesis of the existence of these sounds in Proto-Indo-European and their identification with the 'plain voiced stops'.

3.3 I have argued that the positing of glottalic obstruents in Proto-Indo-European not only gives the consonant system greater typological plausibility, but is also capable of accounting for the root structure constraints. At this point it is necessary to grapple with the difficult question whether we have not merely pushed problematical aspects of Indo-European consonantism back into a 'Pre-Indo-European' period, or whether developments in the Indo-European dialects can plausibly be traced directly to the obstruent system posited here. Naturally, we shall have gained little with respect to typological plausibility if it is necessary to admit some intermediate stage of Proto-Indo-European identical in every respect to that traditionally posited. In this section, I hope to show that the

consonant systems assumed to be present in the various sub-families of Indo-European can either be derived immediately from the hypothesized basic system, or else are derivable through intermediate stages which have documented typological parallels.

3.3.1 The 'Sound Shifts' of Germanic and Armenian. It is well known that Germanic and Armenian share a remarkable systematic change in their obstruent systems. In both languages, the Proto-Indo-European 'plain voiced' stops became voiceless, and the 'voiced aspirates' became plain voiced stops. The original voiceless stops became fricatives in Germanic, and in Armenian underwent a change to voiceless aspirates, with consequent further changes according to the place of articulation.'

From the point of view of the original Indo-European obstruents adopted here, the changes which took place in Germanic and Armenian are seen as minor phonetic differences. In particular the supposed shift from voiced stops to voiceless stops never occurred; instead, as Emonds has pointed out, Germanic and Armenian are to be viewed as 'relic areas' which were not affected by the general Indo-European trend to realize glottalic stops as fully voiced stops.

It might now be objected that the Armenian system of obstruents is remarkably similar to that of its long-time neighbor, Georgian, which also has a contrast of voiced and voiceless stops and a full set of glottalic stops. Clearly, the long symbiosis with Caucasian languages must be held responsible for the continued existence of Caucasian-like manner contrasts in Armenian; yet, as I have indicated, one should not ignore the possibility that Proto-Indo-European itself bore typological and areal similarities to Caucasian languages. Armenian was spoken (or came to be spoken) in an area which was linguistically favorable to the retention of the original system.

3.3.2 Greek and Latin. According to Meillet and Vendryes (1948: 69-74), the consonant system of Latin is traceable to a system identical with that of an earlier stage of Greek, i.e.

p t k k^w

b d g g^w

ph th kh k^wh

In this system, the Proto-Indo-European glottalic stops appear as voiced stops, and the murmured stops are represented by voiceless stops with aspiration. If these two changes were not simultaneous, then the change from murmured stops to

voiceless aspirates must have been first, since, otherwise, the manner contrasts would have yielded t-d-d, the same system as the traditionally posited one. I therefore assume a prior stage with three voiceless stops: /t/, /th/, and /t'/ (plain, aspirated, and glottalic). There is ample typological precedent for this kind of system, e.g. in Chippewyan, Chiricahua Apache, and Yokuts (Hojjer, 1946). A second stage in which the glottalic stops became voiced would have yielded the system underlying that of Greek and Latin. In Latin, voiceless aspirated stops occur as /f/ (labials and dentals) or /h/ (velars), sometimes with further changes.

3.3.3 Sanskrit. In Sanskrit, as in Greek, Slavic, etc., the glottalic stops show up as voiced stops; and a distinct voiceless aspirate series makes its appearance. The original murmured stops remain as the sounds traditionally spelled *dh*, *bh*, *gh* (with numerous changes internal to Sanskrit). After the genesis of the voiceless aspirates, whatever their source, there may have been a stage in which three voiceless stops (/t/, /t^h/, /t'/) contrasted with a single voiced series. Unusual as it may seem, there are nonetheless languages known to have this configuration. Trager's analysis of Taos (New Mexico) (Hojjer 1946: 187) has the three voiceless stops and a voiced stop at labial, dental and velar points of articulation. Such a system, while highly marked, is thus not without documented parallels.

3.3.4 Adding to these examples language groups such as Celtic and Slavic, in which the glottalic stops and the murmured stops merged into a set of fully voiced stops, we may represent the trajectories of the Proto-Indo-European system of stops as in Figure 8. It should be recalled that the purpose of this diagram, and of the discussion in this section, has been not to prove that the development of the Indo-European stops into the dialects was along the lines indicated, but simply to suggest that beginning with a Proto-Indo-European system of obstruents having one (partially) voiced, one unvoiced, and one glottalic stop at each

(Table omitted from web version for typographical reasons)
Figure 8. Possible Trajectories of Indo-European Obstruents.

point of articulation, we do not need to assume any stage in which voiced sounds were in the numerical majority. Weak as this claim may appear to be, it is important to show that we can avoid positing typologically unprecedented systems at any point in the trajectory.

4. Conclusion. In this paper, I have discussed phonetic and phonological aspects of the Proto-Indo-European system of

stops. I have attempted to show that universal phonetic and systematic considerations lead to the conclusion that the sounds classified as voiced tense or aspirated stops were probably partially voiced sounds (murmured stops), and that the supposed plain voiced stops were glottalized. This explanation accounts in a realistic way for the phonological constraints on Indo-European root structures.

NOTES

1-1 am grateful for comments and encouragement received from T. Gamkrelidze, E. Hamp, R. King, Saul Levin, and E. Polomé. Thanks are also due, less directly but nonetheless sincerely, to A. Kuipers, with whom I studied Georgian and Caucasian languages at Texas in 1967. In response to my sending him a prior version of this paper, T. Gamkrelidze sent me a long and friendly letter describing the work of himself and V. Ivanov (December 1972) along closely similar lines to my own work. I find the close coincidence of our views, independently arrived at, immensely gratifying. It is my hope that the present article, besides presenting fresh insights, will serve the function of supporting the Soviet (Russian and Georgian) scholars in their position, and helping make their views known in the English-speaking world. Any errors which remain are, of course, my own responsibility.

2-For a more detailed treatment of problems of this nature from a theoretical viewpoint, cf. Stockwell and Macaulay 1972.

3-Sequences of glottalic consonants are found in Old Georgian, but under obviously definable conditions. Molitor's Glossar (1952) yields clear examples only in borrowed words such as *p'inak'i* 'key', *p'et're* 'Peter' (where Greek voiceless stops appear as glottalics), and in tautosyllabic clusters (*t'q'avi* 'skin, leather', etc.). In later stages of the language, borrowings are not so easily identified, and glottalic sequences are quite common. T. Gamkrelidze informs me in a personal communication that a constraint against heterorganic sequences of glottalics must be reconstructed for Proto-Kartvelian; a most important typological and areal datum.

4-For the Germanic and Armenian sound shifts, cf. Meillet 1967: 116-124.

REFERENCES

Chomsky, Noam, and Morris Halle. 1968. *The Sound Pattern of English*. New York, Harper and Row.

- Dempwolff, Otto. 1934. Vergleichende Lautlehre des Austronesischen Wortschatzes, Band 1: Induktiver Aufbau einer Indonesischen Ursprache. (Beiheft 15, Zeitschrift für Eingeborene Sprachen.)
- Emonds, Joseph. 1972. 'A reformulation of Grimm's law.' In: M. Brame (ed.), Contributions to generative phonology. Austin, University of Texas Press, 1972.
- Gamkrelidze, Thomas. 1966. 'A Typology of Common Kartvelian,' Lg. 42.1. 69-83.
- Gamkrelidze, T.V., and Ivanov, V.V. Dec., 1972 'Lingvističeskaja tipologija i rekonstrukcija sistemy indoevropskix smynyx,' Working Papers of the Conference on the Comparative-Historical Grammar of the Indo-European Languages (12-14 December, 1972). Moscow, Akademija Nauk, 15-18.
- Greenberg, Joseph. 1966. 'Some universals of grammar, with particular reference to the order of meaningful elements,' Universals of language, ed. by Joseph Greenberg. Cambridge, M.I.T. Press.
- 1970. 'Some generalizations concerning glottalic consonants, especially implosives,' IJAL 36.123-145.
- Hirt, Herman. 1927. *Indogermanische Grammatik*, 1. Heidelberg, Carl Winter.
- Hackett, Charles. 1955. *A Manual of Phonology*. (Memoir 11, IJAL) Baltimore, Indiana University Press.
- Hojer, Harry ed. 1946. Linguistic structures of native America. (Viking Fund publications in anthropology, 6.) New York, Viking Fund Inc.
- Jakobson, Roman. 1957. 'Typological studies and their contribution to historical comparative linguistics,' Proceedings of the *Eighth International Congress of Linguists* (Oslo), 17-25.
- Ladefoged, Peter. 1971. Preliminaries to Linguistic Phonetics. Chicago, University of Chicago Press.
- Lehmann, Winfred P. 1955. Proto-Indo- European phonology. Austin, University of Texas Press.
- 1972. 'Contemporary Linguistics and Indo-European studies,' PMLA 87.5, 976-993.
- Meillet, Antoine. 1936. Introduction à l'étude comparative des langues indo-européennes. Eighth Edition. (Reprinted as Alabama Linguistic and Philological Series, 3. University of Alabama Press, 1964) Paris.
1967. The Indo-European dialects. English translation, by Samuel N. Rosenberg, of Les dialectes indoeuropéens, 1908. (Alabama Linguistic and Philological Series, 15) University (Alabama), University of Alabama Press.

- Meillet, Antoine, and J. Vendryes. 1968. *Traité de grammaire comparée des langues classiques*. 4th edition, by J. Vendryes. Paris, Champion.
- Molitor, Joseph. 1952. *Altgeorgisches Glossar zu ausgewählten Bibeltexten*. Rome, Pontificium Institutum Biblicum. (Manumenta *Biblica et Ecclesiastica*, 6).
- Orr, Carolyn, and Robert Longacre. 1966. 'Proto-Quechumaran', *Language* 44,3: 528-555.
- Parsons, F.W. 1970. 'Is Hausa really a Chadic language? Some problems of comparative phonology,' *African Language Studies* 11.272-288.
- Peeters, C. 1971. 'A phonemic definition of I-E bh, dh, gh', *KZ* 85.1.1-4
- Prokosch, Eduard. 1938. *A Comparative Germanic grammar*. (William Dwight Whitney Linguistic Series.) Baltimore, Linguistic Society of America.
- Schmidt, Karl Horst. 1967. 'Beiträge zu einer typologischvergleichenden Grammatik der indogermanischen und südkaukasischen Sprachen,' *Münchener Studien zur Sprachwissenschaft* 22.81-92.
- Salta, G.R. 1963. *Die armenische Sprache*. (Handbuch der Orientalistik, 1. Abteilung, 7. Band: Armenisch und Kaukasische Sprachen). Leiden/Köln, E.J. Brill.
- Stockwell, Robert P., and R.K.S. Macaulay, eds. 1972. *Linguistic change and generative theory*. (Indiana University studies in the history and theory of linguistics.) Bloomington, Indiana University Press.
- Straight, H. Stephen. 1972. *Yucatec Mayan pedolectology: segmental phonology*. Dissertation, Department of Linguistics, University of Chicago.
- Trubetzkoy, N.S. 1969. *Principles of phonology*. Translation, by Christiane A.M. Baltaxe, of *Grundzüge der Phonologie* (Prague, 1939). Berkeley and Los Angeles, University of California Press.
- Whatmough, Joshua. 1937. 'Indo-European labiovelars,' *Festschrift for Holger Pedersen*, 45-56.

(Received April 1973)