Abstract and Keywords

This chapter discusses the use of typological arguments in historical phonology, concentrating on the evaluation of hypotheses by typological considerations rather than other kinds of relations between typology and sound change. After a general introduction, this is exemplified by a case study about the ‘glottalic’ reconstruction of Proto-Indo-European stops. The problem is first introduced, then the proposed reconstructions are evaluated from both a synchronic and a diachronic typological perspective, followed by a summary of both and an attempt to find a solution taking into account the typological arguments. In the conclusion, the usefulness of typology in accounts of sound change is discussed from a general theoretical perspective, including the problem of whether our present knowledge of diachronic phonological typology is sufficient.

Keywords: diachronic typology, glottalic theory, historical phonology, Proto-Indo-European, reconstruction, sound change, synchronic typology, typology

1 Introduction

Historical phonology has to deal with the problem that historical data normally do not provide all the information we need to understand the phonology or phonological history of a given language (see Lass, Minkova and Unger, all this volume, on the limits and possibilities of interpretation of historical data from written sources for past stages of languages). Therefore, parts of historical linguistic ‘reality’ have to be reconstructed, which means that we must produce a hypothesis which sets up probable or at least possible synchronic stages and possible or preferably probable changes (see Fox, this volume). To evaluate the probability of such assumed states and changes, typological considerations can be used, among others. Linguistic typology mostly involves comparing languages around the world (or across a given area) synchronically. This contrasts with the ‘comparative method’ of historical reconstruction, i.e., the comparison of genetically related languages aiming at the reconstruction of their ancestor (see Fox, this volume). Typology can, however, be both synchronic and diachronic—we can compare reconstructions with what can be found synchronically (for discussions of which, see Maddieson 1984 and Maddieson & Precoda 1989, both often referred to as ‘USPID’—the ‘UCLA Phonological Segment Inventory Database’—, and Mielke 2008), and we can also compare the changes which would be needed to map a reconstruction onto attested stages of a language with what is thought to be diachronically common (see Cser, this volume, on basic types of change, and Blevins, this volume, and also Mailhammer et al, this volume, for a more theorized approach). Typological comparison aims at finding linguistic patterns that result from general or even universal factors rather than language-specific developments, especially ‘types’, i.e., bundles of features typically patterning together. Typological data represent an empirical background for judging the probability of proposed historical reconstructions: if a phenomenon or a change is cross-linguistically well attested, it can be considered as generally more probable than a less well-supported alternative. Typological considerations thus cannot be decisive on their own, but they may tip the balance in favour of one or the other solution in reconstruction.
Sound change and synchronic phonological typology may also be related in the opposite way, since sound change can be used to explain attested sound patterns as having emerged by change; cf. the arguments in Hansson (2008) or Mielke (2008)—based on a typological investigation—that distinctive features are not innate but emergent from phonological patterns, one important source of which may be sound change (cf. Bybee, this volume). These approaches will, however, not be the focus of this article.

In this chapter I exemplify some relevant theoretical principles and their application to historical phonology in connection with one of the most famous cases where typological data have been explicitly applied to historical phonology, namely the ‘glottalic theory’ of the Proto-Indo-European (PIE) stop system.

2 The Reconstruction of PIE Stop Series

The stop system of the parent language of the IE family was originally reconstructed as the system of Old Indo-Aryan (Sanskrit), with voiceless and voiced unaspirated as well as voiceless and voiced aspirated stops. However, with the acceptance of the so-called laryngeal theory the traditionally reconstructed voiceless aspirated stops were widely interpreted as secondary and therefore disappeared from the reconstructed PIE phonemic inventory. The resulting reconstruction now consisted of voiceless unaspirated stops (tenues), voiced unaspirated stops (mediae), as well as voiced aspirates (mediae aspiratae, MA). This new reconstruction was immediately challenged as typologically problematic, mainly because the traditional mediae aspiratae no longer had support from voiceless aspirates (see section 2.1).

A reinterpretation of the traditional system was also supported by some peculiar distributional facts: it has been observed that mediae are suspiciously absent from endings and suffixes (cf. Hopper 1973: 156–7; Dunkel 2001: 3–4, 9), while aspirates can occur (if not in the most basic layers) and tenues seem to be the norm. This points to a marked status of the mediae vs the tenues and aspirates. These obviously form a class, as is shown by some root structure constraints: stops in one root (if not preceded by *s or a nasal, cf. de Vaan 1999) must be either both tenues or aspirates, while mediae may co-occur with other type but not with another media. These constraints for mediae are similar to constraints found for glottalic stops (ejectives) in some languages, giving rise to the idea that the traditional mediae should be reinterpreted as ‘glottalic’ stops (Hopper 1973; Gamkrelidze and Ivanov 1973), and the mediae aspiratae might have been non-glottalic voiced stops. This is the core of the so-called ‘glottalic theory’ of PIE stops.

Table 1 gives an overview of four different ‘glottalic’ models compared with the neo-traditional ‘non-glottalic’ model of PIE stops. Table 2 gives an overview of the basic reflexes of PIE stop series (as traditionally reconstructed) in the (proto-languages of the) main branches of IE; in both tables phonologically conditioned variants are marked by a tilde (~), and dialectal variants or alternative reconstructions are marked by a slash /. In both tables, dental stops serve as examples for the whole series.

Table 1. Different reconstructions of PIE stop series

<table>
<thead>
<tr>
<th>T</th>
<th>H</th>
<th>G</th>
<th>K</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>*t</td>
<td>*t</td>
<td>*tʰ~t</td>
<td>*t</td>
<td>*tʰ</td>
</tr>
<tr>
<td>*dʰ</td>
<td>*dʰ/d</td>
<td>*dʰ~d</td>
<td>*dʰ</td>
<td>*d</td>
</tr>
<tr>
<td>*d</td>
<td>*t’/t̰</td>
<td>*t’</td>
<td>*d̥ [’d̥]</td>
<td>*t’</td>
</tr>
</tbody>
</table>


Kortlandt’s ‘pre-glottalized lenis’ may be interpreted as ‘creaky voiced’ (Ladefoged and Maddieson 1996: 53 ff.), ‘voiced laryngealized’ (Maddieson 1984: 111 ff.), or ‘voiceless implosive’ (Ladefoged and Maddieson 1996: 87–90), all of which may represent one phonological class (cf. Clements and Osu 2002: 313); on the relics of voicing

### Table 2. Main reflexes of PIE stop types in the different branches (simplified)

<table>
<thead>
<tr>
<th>IE (non-glottalic)</th>
<th>*t</th>
<th>*dʰ</th>
<th>*d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anatolian</td>
<td>t/t̄</td>
<td>d/ð</td>
<td>d/ð</td>
</tr>
<tr>
<td>Tocharian</td>
<td>t</td>
<td>t→ts &lt; *dʰ</td>
<td>ts/Ø/t &lt; *d</td>
</tr>
<tr>
<td>Indo-Iranian</td>
<td>t−tʰ</td>
<td>dʰ~d</td>
<td>D</td>
</tr>
<tr>
<td>Armenian</td>
<td>tʰ−t</td>
<td>d/dʰ</td>
<td>t/t’</td>
</tr>
<tr>
<td>Greek</td>
<td>t</td>
<td>tʰ−t</td>
<td>D</td>
</tr>
<tr>
<td>Italic</td>
<td>t</td>
<td>f−&lt;*θ−→ð−d</td>
<td>D</td>
</tr>
<tr>
<td>Celtic</td>
<td>tʰ−t</td>
<td>d−→ð−</td>
<td>d−→ð−</td>
</tr>
<tr>
<td>Germanic</td>
<td>θ−t</td>
<td>d−→ð−</td>
<td>T</td>
</tr>
<tr>
<td>Balto-Slavic</td>
<td>t</td>
<td>d</td>
<td>:d (‘d?)</td>
</tr>
<tr>
<td>Albanian</td>
<td>t</td>
<td>d</td>
<td>D</td>
</tr>
</tbody>
</table>

Now, what is the basis for reconstructing the PIE stops series? Three main types of stop correspondences between the individual IE branches can be observed in the material (cf. Table 2). In one case, the main reflexes are plain voiceless or (less often) voiceless aspirated, traditionally reconstructed as plain voiceless stops (tenues). In the second case, we mostly find voicing and/or aspiration, and therefore voiced aspirates (mediae aspiratae) were traditionally reconstructed. To be sure, these sounds in attested IE languages are phonetically neither voiced nor aspirated, but articulated with ‘breathy voice’ (or ‘murmured’; cf. Ladefoged and Maddieson 1996: 57 ff.), placed between voicelessness and modal voice on the continuum of vocal-fold configurations. Phonologically, however, this may still be interpreted as a combination of voicing and aspiration, exhibiting both features (and thus ‘doubly marked’). In the third case, the reflex is never aspirated and normally voiced, but it may be voiceless in languages where the tenues are (or had been) distinctly aspirated, and this series was traditionally reconstructed as plain voiced (mediae). Thus we arrive at a system with one plain voiceless series, but two contrasting ‘voiced’ series that must have been distinguished by an additional feature. One major uncertainty in all this is the definition of the kind of opposition traditionally described by the term ‘voice/voicing’: while the feature of voicing ([±slack vocal folds]) is certainly unproblematic for many languages (including large parts of IE), there are also many cases where this is quite problematic, and the opposition seems to be mainly based on different features. In such cases linguists often use the (sometimes deliberately) imprecise terms ‘fortis’ vs ‘lenis’ which can variably refer to either aspiration ([±spread glottis]) or differences in duration or articulatory strength (‘tense’ vs ‘lax’). The description of laryngeal phonology in such languages is still not fully agreed and needs further clarification. Within IE, especially Anatolian, Germanic, Celtic, Armenian, and at least some Iranian languages warrant mention. Bear in mind in the following that terms like ‘voiced’, etc. may refer to something (potentially very) different phonologically.

### 2.1 Synchronic Typology

Against the reconstructed system with voiced aspirates the following typological objections have been raised:
1. Voiced aspirates never occur without contrasting voiceless aspirates (and an h-sound) according to Jakobson (1958: 22–3). However, this is not entirely true: There is at least one language that exhibits ‘voiced aspirates’ without possessing voiceless aspirates, namely Kelabit in Northern Borneo (cf. Blust 1974, 2006). In fact, the voiced aspirates there are even more correctly called ‘voiced aspirates’ than the sounds attested in IE languages, since the latter are breathy voiced [dʰ], while the Kelabit aspirates are not really murmured, but rather described as beginning voiced and ending with voiceless aspiration, [dtʰ] (Blust 1974: 50; cf. Ladefoged and Maddieson 1996: 62–3). But still these different phones might be considered belonging to one phonological class combining ‘voicing’ and ‘aspiration’ (or [+slack voice], [+spread glottis]).

2. According to Hopper (1973) ‘a typologically plausible triple stop system should have only one voiced series’. But this is not really true either if we consider the variation found in the world’s languages. Even if most attested system types with two voiced series are quite rare, one such type is rather frequent: about 16 per cent of the three series languages counted by Maddieson (1984: 28–9) exhibit a system of voiceless stops opposed to plain voiced explosives and voiceless implosive stops. In this sample (as in Greenberg 1970), implosives were not distinguished from laryngealized voiced stops (cf. Clements and Riallond 2008: 55–6; Hamann and Fuchs 2008: 104–5). However, recent research has provided evidence that ‘implosives’ should rather be defined as ‘nonexplosive’ or ‘nonobstruent’ stops—ingressive airstream being only a secondary feature (see Stewart 1989: 231 ff.; Clements and Osu 2002, 2005; Clements and Riallond 2008: 56–7)—and that ‘laryngealized voiced stops’ are ‘nonexplosive’ stops with distinctive glottalization and less voicing, something like [ʔ] (Clements and Riallond 2008: 56–7). But even if that distinction is made, the type remains rather frequent (mainly in Africa). The parallel to PIE is not perfect, since this type does not show two voiced explosive series, as traditional Indo-European is assumed to do. But as changes from nonexplosives to explosives seem to be rather common (cf. Stewart 1989: 236 ff.; Clements and Riallond 2008: 59), the PIE system might easily be derived from such a type.

All this means that the (neo-)traditionally reconstructed system of PIE is probably not impossible—and we should be cautious not to normalize data without a compelling reason (see Kortlandt 1985: 185, following Dunkel 1981: 566; cf. Haider 1983: 81). But of course such a system is still improbable, so different models of PIE should be tested: which of them are better attested and therefore more probable?

In what follows I give an overview of three-stop series systems and their frequency in languages of the world, mainly based on the UPSID database as given in Maddieson (1984), but also including later additions to that database and other languages as well that I happen to know about. Parallels to systems reconstructed for PIE are indicated by the abbreviations used in Table 1 above.

There is much uncertainty in the data of this very broad sample as it is based on descriptions of very different quality and phonetic-phonological precision. This is especially problematic in the case of VOT distinctions, since ‘voiced’ and ‘voiceless’ may often be rough labels covering real voicing distinctions as well as other features like aspiration or duration (as already mentioned). For a rough statistical generalization these uncertainties cannot be avoided at our present state of knowledge, but it should not be forgotten that, e.g., phonological voicing might be less frequent than normally assumed.

2.1.1 Three-Stop System Types Cross-Linguistically

I illustrate the stops by the respective dental-alveolar stops: the stops series are divided by a tilde (~), ordered from the widest opening of the vocal cords to the narrowest: tʰ > t > dʰ > d > d̥ > t̥; after a description of the system type, the names of languages are given that (seem to) belong to this type. The number of languages in Maddieson (1984) is given as (UPSID X) after the type schema.

(a) Frequent types

1. The ‘Caucasian’ type (= H’,V), i.e., two non-glottalic stops (with some kind of VOT distinction) and one ejective, Maddieson (1984) distinguished three different types, namely tʰ ~ t ~ t’ (UPSID 12) or tʰ ~ d ~ t’ (UPSID 5) or t ~ d ~ t’ (UPSID 13). But since descriptions of the same languages often differ depending on whether voicing or aspiration is taken to be the decisive feature distinguishing the two non-ejective stop series, it seems better to lump them together: Ossetic, Artvin Armenian (IE); Kabardian; Georgian (Kartvelian); South Arabian, Ethiopic (Semitic); Dizi, Kefa (Omotic); Tlingit, Navaho, Chipewa, Hupa, Tolowa (Na-Dené); Haída; Klamath (Plateau Penutian); Chontal, Tzeltal (Mayan); Kwak’wala;
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(Wakash); Quileute (Chemaku); Puget Sound (Salish); Pomo, Yana (Hoka); Acoma (Tarascan); Wichita (Sioux); Quechua, Jarguar (Quechumaran); Gununa-Kena (Chon), etc.

(2) The ‘Greek’ type, i.e., aspirated, voiceless, voiced (three different VOT settings): tʰ ~ t ~ d (UPSID 19): Romani, Panjabi, Kashmiri, Shina, Kalam Kohistani, Wotapuri, Tirahi, Khowar, Shumashiti, Damberi, Northern Pashai; Khotanese, Northern Zazaki, Kurmanji Kurdish; Agulis/Sasun Armenian; Ancient Greek (IE); Thai (Tai-Kadai); Burmese (Tibeto-Burmese); Burushaski (?), etc.

(3) The ‘implosive’ type (= K’), i.e., two explosives and one implosive: t ~ d ~ d’ (UPSID 12): Katcha, Kadugli, Dan, Ogbia, Tarok, Doayo, Mbatto (Niger-Kordofanian); Tama, Mursi, Daju (Nilosaharan); Angas, Margi, Dangaileat; Laal (Afro-Asiatic); *Proto-Mon-Kher, Proto-Monic/Old Mon (Austro-Asiatic); Gorontalo, Bima, Hawu, Ngad’a (Austronesian); *Proto-Sai? (Tai-Kadai); with d only: Aizi, Bete, Kpelle, Gwari; Mumuye (Niger-Kordofanian).

(b) Rare types

All other combinations seem to be significantly rarer.

(1) A type that combines implosives and ejectives in one ‘glottalic’ series (cf. also Salmons 1993: 53–4): t ~ d ~ t’/d (UPSID 3): Ik (Nilosaharan); Iraqw, Hausa (Afro-Asiatic); Hamer (Omotic); Mam, Tzutujil (Mayan).

(2) A variant of (a3) with aspiration instead of voicing for the non-implosive series: tʰ ~ t ~ d (UPSID 3): Swahili (N-K); Vietnamese, Khmer, Khmu? (Austro-Asiatic); Karen, Phlong (Sino-Tibetan).

(3) Variant of (a3) with laryngealized stops rather than implosives (= K’): t ~ d ~ d (UPSID 2): Lugbara (Nilosaharan); Kera, Lame?, Kanakuru? (Afro-Asiatic); *Proto-Sai? (Tai-Kadai).

(4) The same type with aspiration rather than voicing: tʰ ~ t ~ d (UPSID 2): Lakkia, Lungchow (Tai-Kadai); Cham (Austronesian); t ~ d ~ d (UPSID 2): Somale (Afro-Asiatic); Wapishana (Arawakan).

(5) A type similar to (a1) but with laryngealized voiceless stops instead of ejectives: tʰ ~ t ~ t’ (UPSID 1): Korean (?); Tof (Hoka).

(6) Pre-nasalization combined with a VOT opposition: tʰ ~ t ~ “d” (UPSID 2): Hakka (Sinitic); Nambakaengo (Central Melanesian); similarly t ~ d ~ “d” (UPSID 1): Sinhalese, Divehi (closely related, IE).

(7) A VOT opposition combined with breathy voice: tʰ ~ t ~ dʰ (not in UPSID): Erevan Armenian (IE); Xhosa (N-K); *Old Chinese (Sinitic); similarly tʰ ~ dʰ ~ d (not in UPSID): Sivas Armenian (IE).

(8) A variant of (a1) with implosives instead of voiced explosives: tʰ ~ d ~ t (UPSID 1): Maidu (Maiduan).

(9) ‘Aspiration’ only in (partly) voiced stops (= T): t ~ dtʰ ~ d (not in UPSID): Kelabit (Austronesian).

(c) Systems not (yet) attested

(1) Ejectives and allophonic aspiration both for voiceless and voiced stops (= G): t’/t ~ d’/d ~ t’.

(2) Ejectives and breathy voiced stops (= H): t ~ dʰ ~ t’.

(3) Laryngealized stops with aspirated ‘lenis’ stops (= K): t ~ dʰ/gʰ ~ d.

This overview shows that some proposed ‘glottalic’ systems are not attested at all if all phonetic specifications are taken into account: there is no system with breathy voice and ejectives, as in the two earliest ‘glottalic’ proposals, nor is there a system with laryngealized lenes and lenis aspirates, as Kortlandt originally proposed. But variants of these proposals do very much better: If breathy voice (or aspiration) was post-PIE, all ‘glottalic’ systems correspond to system types attested by significantly more than one known language—while ‘non-glottalic’ PIE does not. We have to conclude that ‘glottalic’ reconstructions of PIE do indeed provide a more probable synchronic system. But is this synchronic plausibility matched by a corresponding diachronic plausibility?

2.2 Diachronic Typology

We do not yet possess a worldwide database of sound changes corresponding to the large synchronic sample of Maddieson (1984), and therefore, we still have to work with more limited data. Even smaller comprehensive collections on sound change from a typological perspective are rare, because historical linguists normally concentrate on individual language families, and much typological work has been synchronic. Most statements in the literature therefore rely on data accidentally known to linguists but not on systematic observation. A worldwide collection of sound correspondences has been done by Brown, Holman, and Wichmann (2013) using data from the ASJP project (MPA Leipzig) in a lexical list of forty items. However, this method is not really diachronic and cannot indicate the direction of change lying behind a particular correspondence. Furthermore, their classification of
sounds is too phonetically coarse with regard to obstruent articulation. A much more comprehensive database of sound changes is being constructed by the UniDia project, <www.diadm.ish-lyon.cnrs.fr/unidia/index.php>, but so far the data are limited in terms of families covered. Consonantal changes from the history of a rather large sample of some 200 languages have been collected and classified by the present author (Kümmel 2007), but this sample is genetically and areally biased, including only IE, Uralic, and Semitic languages. However, in the absence of more exhaustive data, this investigation may be used as a provisional basis for testing the probability of changes presupposed by different reconstructions of PIE. It does at least cover most of the areas where the older IE languages were spoken and their neighbours. In the following, I compare the basic values of the ten main branches of IE, as given in Figure 2, with respect to their derivation from the competing proposals for the reconstruction of earlier stages.

1. The traditional tenues are represented as follows: voiceless aspirates (ʰ) in three branches (although this somewhat dubious for Celtic, and in Germanic they underwent further developments); plain voiceless stops (t) in the remaining seven. In terms of features this means that all branches point to [-voice], and three have [+asp] vs seven with [-asp].

The most probable alternatives would be to reconstruct voiceless unaspirated stops or voiceless aspirated stops. In the first case, we would have to assume secondary aspiration (partially followed by secondary fricativization) in a minority of branches—changes that are quite frequent and assured for younger stages of IE languages from different branches (see Kümmel 2007: 168 ff.). Alternatively, we would have to assume secondary de-aspiration in most branches—this is certainly possible, but not so well attested (Job 1989: 128-9; Kümmel 2007: 93–4) and should thus be judged less probable. To sum up: a system with unaspirated voiceless stops as predecessors of the tenues is most probable from a diachronic viewpoint. This means that Hopper’s and Kortlandt’s models are as good as the traditional model, but Vennemann’s and Gamkrelidze’s are less likely.

2. The traditional aspiratae show a more complicated picture: eight of ten branches have [+voice] segments, while aspiration (+asp) is attested or presupposed in half of the branches. The majority of languages exhibits voiced plosives. Aspiration is directly attested in two branches (Indo-Iranian dʰ and Greek tʰ), and at least two further branches show some traces of it. In Italic, we find voiceless fricatives in initial position but voiced ones in internal position, but since internal voicing might be secondary, voiceless fricatives could have been the primary reflex (at least initially, cf. Stuart-Smith 2004: 202–3), and these might go back to voiceless aspirates as in Greek; in any case, devoicing is more probable for voiced aspirates rather than fricatives. In Tocharian, the respective dental stop merged with the distinct reflex of a simple voiced stop only before a following original aspirate which suggests the dissimilation of aspiration like in Sanskrit, pointing to aspiration as well as voicing as original features (cf. Ringe 1996: 47–8). In Modern Armenian we find plain voiced stops, breathy voiced stops, voiceless (‘lenis’ or ‘fortis’) stops, and voiceless aspirated stops. Therefore, breathy voiced stops (dʰ) have to be reconstructed for previous stages of quite some modern dialects and probably for Proto-Armenian. In Germanic, most dialects show voiced fricatives in postvocalic position but stops in initial and postnasal positions (a typologically frequent pattern of allophony), corresponding to voiced or voiceless stops in High German.

All these reflexes can easily be derived from the ‘voiceless aspirates’ of the traditional model and the identical ‘murmured’ stops of Hopper’s model or the ‘allophonically aspirated’ voiceless stops of Gamkrelidze’s model, but what would the other models presuppose? If a plain voiced stop had been original, we would have to assume a secondary development to breathy voice for five branches—and such a change does not seem well attested (at least for languages that do not already exhibit an aspiration opposition; cf. Kümmel 2007: 171–2). If we start from original voiceless lenis stops, we would have to assume unconditioned voicing for most branches, and typological evidence for such a kind of change seems to be meagre (Kümmel 2007: 47 ff.). Models with voiceless aspirates would not do better, since it is not probable for (voiceless) aspirated stops to become unconditionally voiced or breathy voiced (for conditioned voicing; cf. Kümmel 2007: 53). To sum up, the non-glottalic model is as probable diachronically as all glottalic models with ‘voiceless aspirates’ (viz. K, H, G), but clearly better than the others. However, it should not be forgotten that on the basis of the sample, statements on the probability of changes to breathy voice may not be too reliable, as most languages in the sample only have inherited breathy voice. The inclusion of data from other language families might thus provide more insights (see section 3).

3. Last but not least, the traditional mediae show the following reflexes: voicing (with [+voice]) is present in eight branches; aspiration does not really occur; one or maybe two branches can show glottalization, but at...
least eight branches do not. In Armenian the dialectal reflexes include ejectives, voiceless lenis stops, and fortis stops (with rather long duration). In Germanic, dialectal reflexes include aspirated stops, pre-aspirated stops, pre-glottalized stops, and affricates, but plain voiceless stops are attested in some regions of almost all sub-branches, and their distribution rather looks like that of an archaism (cf. Kümmel 2007: 295). For these two subfamilies the traditional model requires the assumption of a ‘Lautverschiebung’ from voiced to voiceless stops, and evidence from loanwords seems to corroborate this (cf. Rasmussen 1987: 9–12 = 1999: 224–7).

Since changes of that kind are clearly attested in the later history of IE languages and others (cf. Kümmel 2007: 138 ff.), they cannot be considered problematic—but of course, the preservation of voiceless stops as per most ‘glottalic’ models would not be a problem either. Although the appearance of glottalic or laryngealized articulation in some dialects would be accounted for most easily by the ‘glottalic’ models, it might also be secondary. But for the majority of branches, most ‘glottalic’ models have to posit a change from voiceless glottalized stops to plain voiced ones. Such a change is not easy to support typologically and therefore rather unlikely (cf. Job 1989; Kümmel 2007: 47–8, 189–90). Since it is much more probable for pre-glottalized lenis stops (= laryngealized plosives) than for ejectives, we can conclude again that the phonetic details of Hopper’s, Gamkrelidze’s, and Vennemann’s models are not favoured by diachronic typology, the details of Kortlandt’s are clearly better, but the traditional model is the most probable.

I conclude that the diachronic typology of systemic developments clearly favours the traditional reconstruction of the plosives as against all ‘glottalic’ models, but the best of the latter seems to be Kortlandt’s. Note that Kortlandt has argued for direct reflexes of glottalized PIE mediae in more IE branches than is normally assumed (see the summary in Kortlandt 1985, but also 1978, 1981, 1988, 1997). However, his arguments are not based on typology (for critical discussion cf. Kümmel 2007: 303–9, 2012: 299–301).

2.3 Typological Conclusion

To sum up the findings of the typological investigation into this case study: synchronic typology favours ‘glottalic’ models, but diachronic typology rather contradicts this. Typology alone does not resolve the issue. To put it differently: the internal structure of the PIE system as well as synchronic typology plead for a revision of the traditional reconstruction, while diachronic typology rather favours the traditional approach.

Therefore, a model based on Pedersen’s old (1951) assumption might be best (even if positing additional changes): pre-PIE could have had a different system that shifted to the traditionally reconstructed one already in PIE (cf. Miller 1977a, 1977b; Haider 1983). The most probable source of the PIE ‘mediae’ would have been ‘voiced’ as was the source of the ‘aspirates’: PIE *t ~ d ~ d < *tt ~ d ~ D [+voiced]. If the later aspirates had originally been ordinary voiced stops, what might have characterized the later ‘mediae’?

3 A ‘Nonobstruent’ Solution

From the perspective of system typology, the most promising solution to this last question above will be an implosive—or rather a ‘nonexplosive’ stop. As already mentioned, recent work shows that (voiced) implosives are distinguished from normal stops mainly by the fact that there is no pulmonic air pressure behind the closure and thus no puff with release; even if there is an obstruction, there is simply no air that ‘wants to get through’. In this respect, implosives are not obstruents—although in other respects they clearly are. In this sense implosives are ‘nonobstruent’ stops rather than glottal stops.

Such a reconstruction might also help to explain why PIE stops were neutralized to ‘mediae’ in final position (cf. Kümmel 2007: 301 ff.): probably stops were not released in this position, and unreleased stops were more similar to nonexplosive stops than to explosives. Haider (1983: 84 ff.) had proposed reconstructing pre-PIE implosives as the source of the ‘mediae’, but with the assumption that such sounds must be classified as glottalic; in a similar fashion, Salmons (1993: 42–3, 53–4) pointed out advantages of positing (glottalic) implosives coexisting with ejectives within one glottalic series (as in languages like Hausa, above). A very similar scenario has now also been argued for independently by Weiss (2009) and supported by a possible diachronic parallel: in Cao Bang, a northern Thai language, an older opposition of implosives and voiced explosives was changed into an opposition of simple voiced stops and breathy voiced stops. In fact, a similar intermediate stage is most probable for other Tai or Mon-Khmer languages where original voiced stops have turned into voiceless aspirates, while contrasting...
Implosives became voiced explosives and the original voiceless stops remained unaspirated, as, e.g., Old Mon > Nyah Kur (Diffloth 1984); Proto-Tai > Thai, Lao, and Saek (cf. Li 1977; Pittayawat 2009)—in contrast to cognate languages where the old implosives were preserved and the plain voiced stops were devoiced without aspiration. Also, in Madurese, original plain voiced stops became voiceless aspirates, while new plain voiced stops arose from different sources (mainly borrowing, Stevens 1966: 152–5). Thus, a shift from plain voiced stops to breathy voiced stops seems to be better attested than concluded above on the basis of more limited data.

A similar opposition is found in West African Kwa systems like Mbatto with ‘lenis’ implosives = nonexplosive stops vs ‘voiced forties’ with possibly redundant murmur, as argued by Stewart (1989: 236–7). In their neighbourhood a system shift parallel to Grimm’s Law seems to be attested in cognate Tano languages (Stewart 1989: 237 ff.; 1993): *t > *tʰ > Ø; *d > *dʰ > Ø; *d > t, which might provide a parallel for Germanic and Armenian.

If we thus assume original implosives, we have to consider the chronology of their shift to simple voiced stops that triggered the development of phonemic breathy voice in the original voiced stops. Was it already PIE, or did it only apply to dialectal IE? It should be borne in mind that there is no evidence for breathy voice in Anatolian, Celtic, and Balto-Slavic, and, seemingly, the languages from Messapian to Phrygian—i.e., in some languages of the western, southern, and northeastern periphery. This might point to a central IE innovation that spread to most but not all dialects.

Typological considerations from both synchronic and diachronic may thus point to the IE stop system reconstructed in table 3 (for the dorsal series cf. Kümmel 2007: 310–27), but there remain many points to be clarified.

### Table 3. Early and late (P)IE stops

<table>
<thead>
<tr>
<th></th>
<th>labial</th>
<th>coronal</th>
<th>‘palatal’ = velar</th>
<th>labiovelar</th>
<th>‘velar’ = uvular?</th>
</tr>
</thead>
<tbody>
<tr>
<td>voiceless</td>
<td>*p</td>
<td>*t</td>
<td>*k</td>
<td>*kʷ</td>
<td>(*q?)</td>
</tr>
<tr>
<td>voiced &gt; breathy</td>
<td>*b&gt;b̤</td>
<td>*d&gt;d̤</td>
<td>*g&gt;ɡ̇</td>
<td>*ɡʷ&gt;ɡ̇ʷ</td>
<td>(*ɡ&gt;c̣?)</td>
</tr>
<tr>
<td>implosive &gt; voiced</td>
<td>*ɓ&gt;b̤</td>
<td>*d&gt;d</td>
<td>*ɡ&gt;ɡ</td>
<td>*ɡʷ&gt;ɡʷ</td>
<td>(*d&gt;c̣?)</td>
</tr>
</tbody>
</table>

### 4 Conclusion: Typology and Sound Change

As the example discussed here has shown, typological evidence can be (and has in fact always been5) used as a tool for deciding between competing accounts of diachronic phonology. Even if typological data normally allow us to make statements about probabilities rather than universals, this does not affect their value too much. Within the field of phonological typology the distinction between synchronic and diachronic typology is important. Synchronic typology can help to evaluate proposals about synchronic language systems of historical languages—not only those reconstructed as a whole but also those phonological aspects of attested historical languages that are not directly observable: proposed synchronic stages are more plausible if they can be supported by typological probability. Diachronic typology contributes crucially to the evaluation of proposed sound changes: the plausibility of changes is in fact an important criterion for judging alternative accounts of diachronic phonology, be it the reconstruction of proto-languages or smaller aspects for unattested periods of attested language histories; and to be plausible, proposed changes should be possible or even probable from a typological perspective. However, as the discussion shows, our knowledge of diachronic typological tendencies is certainly underdeveloped and we badly need better and broader collections of reliable data even more than synchronic typology. To make typological arguments stronger, a better basis is needed.

### References


**Notes:**

(1) The present chapter builds on the first part of my contribution to the proceedings of ‘The Sound of Indo-European’ conference, held in Copenhagen 2009, published as Kümmel (2012), and extensively reworked for this volume. I profited much from discussion with the editors, but of course all remaining faults are my own. This work would not have been possible without a Heisenberg Fellowship from the Deutsche Forschungsgemeinschaft (DFG).

(2) Independent of their phonological status, these sounds will be marked by ʰ rather than subscript ̤ in the present article.

(3) On the problem of voiced vs lenis and related matters, see Iverson and Salmons (1995) and related literature.

(4) See Garrett (1998) against the assumption of Pisowicz (1976) and Vaux (1998: 238–41) that the development of breathy voicing was a post-Old-Armenian innovation from simple voiced stops.

(5) Even the comparative method partly builds on judgements about the probability of changes which were always based on a kind of comparative evidence that is typological rather than anything else; cf. Salmons (1993: 68–9) on
The role of ‘naturalness’ to diachronic typology.

**Martin Kümmel**

Martin Kümmel has just taken over the chair of Indo-European Linguistics at the University of Jena after having worked at the University of Freiburg for many years. He has published on historical phonology and IE historical grammar, especially Indo-Iranian. He was one of the authors of the *Lexikon der Indogermanischen Verben* (2nd ed. 2001, Reichert), has written two books on the Indo-Iranian verb and one on consonantal sound change (*Konsonantenwandel*, 2007, Reichert). Recently, he has become one of the editors of the *International Journal of Diachronic Linguistics and Linguistic Reconstruction*. 