Did murmur spread in Pre-Proto-Indo-European?

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Abstract

The reconstructed stop consonants of Proto-Indo-European (PIE) present something of an anomaly from the perspective of linguistic typology. Whereas murmured (breathy-voiced) stops are cross-linguistically rare (indeed, they are non-existent in nine of the ten historic branches of the Indo-European languages), they are more widespread in the lexicon of PIE than their plain-voiced counterparts. In this paper we present statistical evidence to establish that the preponderance of murmured stops in PIE is atypical, and propose a novel explanation for their distribution: namely, that murmur — already present in pre-Proto-Indo-European — was in the process of spreading through the PIE lexicon to the plain-voiced stops, especially in initial position. We offer some possible phonetic mechanisms that may have given rise to the spread of murmur.

Proto-Indo-European (PIE) is the reconstructed source of many of the languages of India and most of the languages of Europe. The profile of consonants appearing in the PIE lexicon generally mirrors that of their presence or absence in the majority of the world's languages. For example, in a sample of 1674 of the world's languages from the PHOIBLE database, 1616 (97%) have at least one plain voiceless stop, and 1206 (72%) have all three of /p t k/ (Moran *et al* 2013); correspondingly, voiceless stop sounds are well represented in the reconstructed PIE lexicon, where 54% (549/1026) of the stop-initial roots begin with voiceless stops (Pokorny 1959).

However, if we turn our attention to the reconstructed voiced stops of Proto-Indo-European we encounter an anomaly. The most common voiced stops in the languages of the world are the plain voiced stops (e.g., /b d g/, symbolized collectively as D); in the same PHOIBLE sample of 1674 languages, 1287 (77%) have at least one plain voiced stop and 827 (49%) have all three of /b d g/, but these sounds are relatively rare in PIE (only 17% of PIE stop-initial roots begin with *D; Pokorny 1959). In contrast, the murmured (or breathy-voiced) stops are among the rarest sounds cross-linguistically: only 41 languages (2%) have at least one murmured stop in the PHOIBLE database, and only 8 (0.5%) have all three of /b^{ɦ} d^{ɦ} g^{ɦ}/ (symbolized collectively as D^{ɦ}), but the murmured stops are unexpectedly frequent in PIE (30% of PIE stop-initial roots begin with *D^{ɦ}; Pokorny 1959). The anomaly of this situation in Proto-Indo-European is underscored by the fact that the murmured stops were eventually lost through devoicing or de-aspiration (or both) in nine of the ten historic branches of Indo-European (Barrack 2002:7).

Of course it is not necessarily true that a speech sound that is typologically rare cross-linguistically will also be distributionally rare within the lexicons of languages that have the sound. However, if we examine six other languages selected based on the similarity of the murmur mechanism in their stop series (Ladefoged and Maddieson 1996:57–58), but that are regarded as genealogically unrelated to PIE, that is precisely what we find: within each language, murmured stops in word-initial pre-vocalic position are rare compared to plain voiced or voiceless stops in similar position (see Figure 1). As stated above, the opposite pattern holds in PIE: root-initial plain voiced stops are relatively rare and murmured stops are more common.

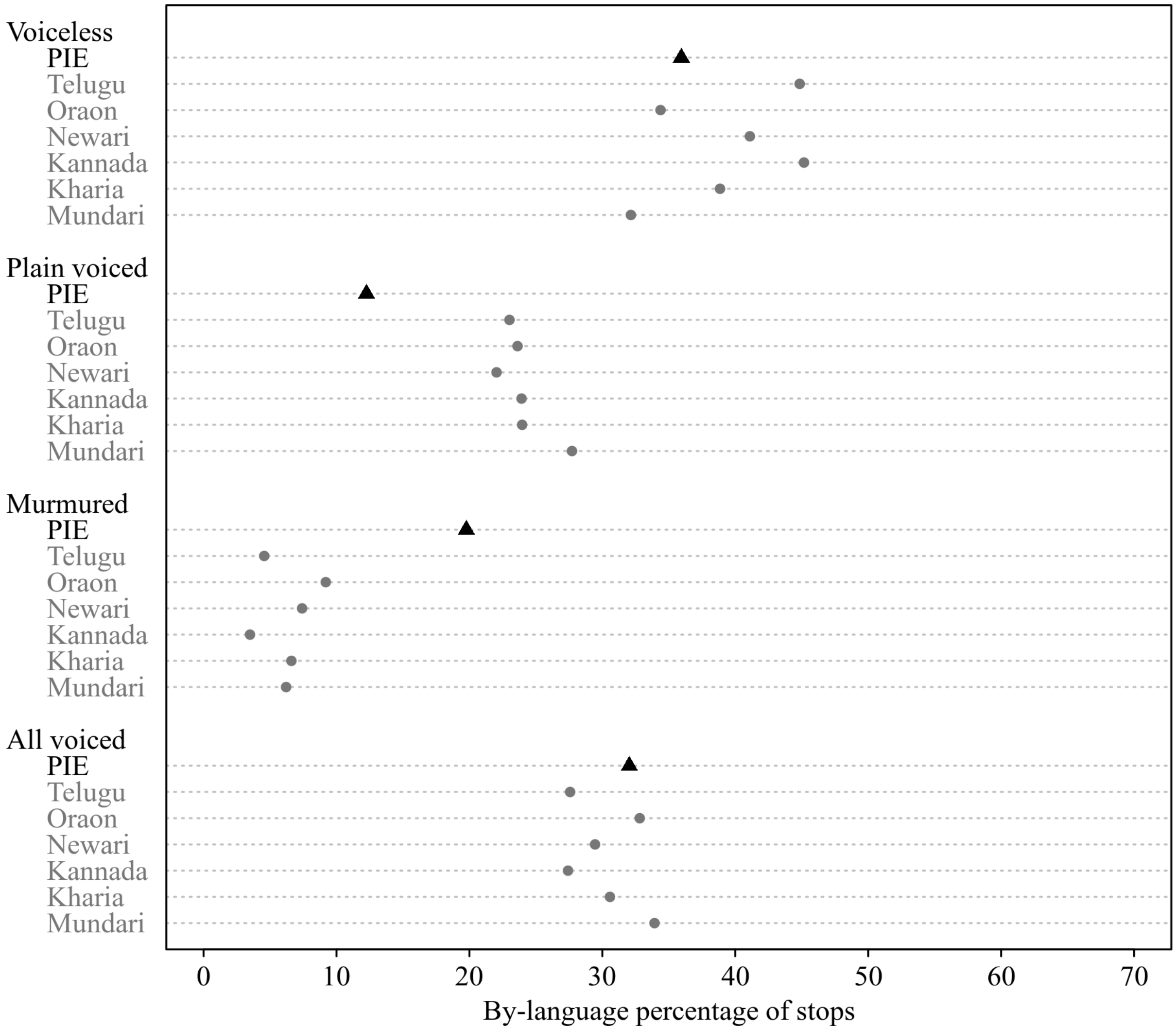

Figure : Percentages of stop-consonant types (voiceless, plain-voiced, murmured, and voiced + murmured) in six modern languages that are genealogically unrelated to PIE (grey circles) and in PIE (black triangles). The trend of murmured < plain voiced is reversed in PIE. If plain and murmured voiced stops are collapsed as in the final row of the figure, the anomaly vanishes. See Appendix 1 for raw data and sources.

The difference in proportion of stop consonant types seen between PIE and the six other languages is statistically significant (χ^2=168.0, p<0.0001). The question arises: what phonological process could have caused this anomalous phoneme distribution to develop in PIE? Interestingly, if we collapse the plain-voiced and murmured stops, as in the last row of Figure 1 ("All voiced"), the discrepancy between PIE and the group of six non-Indo-European languages disappears. The relationship between voiceless stops and the *combination* of plain-voiced and murmured stops suggests a possible solution to the enigma: perhaps in early- or pre-PIE the plain voiced stop series was in the process of developing murmur: *D ... > *D^{ɦ}. Such a development would account for the unusually high ratio of *D^{ɦ} to *D in PIE.

What might motivate the spreading of murmur to the plain-voiced stops, creating an increase in the murmured series in stem initial position? We posit that it is the result of an interaction between two factors: domain initial gestural fortition, and perceptual reanalysis of voice quality cues in gesturally fortified positions. Domain-initial gestural fortition (sometimes referred to as *domain initial strengthening*) is a tendency seen cross-linguistically that results in the spread of laryngeal features (or gestures) to the following vowel. This spreading is most commonly seen in prosodically conditioned aspiration (as in the aspiration of word-initial voiceless stops of English), or at least an incremental increase of voice onset time (VOT), in languages that are as linguistically diverse as English (e.g. Lisker and Abramson 1964), Japanese (Riney *et al* 2007), Korean (Jun 1993, Cho and Jun 2000), Taiwanese (Hsu and Jun 1998), and French (Keating *et al* 2004) to name just a few. This process can be seen as a way both of marking the prosodic prominence of word/root edges and simultaneously a way of making the voicing contrast perceptually stronger in domain initial position (see for example Beckman 1996, Keating *et al* 2004, and Keating 2006 for discussions). Domain-initial strengthening can be interpreted as an exaggeration of the underlying laryngeal adjustments, and the concomitant acoustic and perceptual effects, related to voicing or voicelessness in oral stop consonants (see Keyser and Stevens 2006).

With regard to domain-initial strengthening of voiced stops in particular, studies have shown two relevant gestural adjustments that work to facilitate voicing during stop closure: lowering the larynx to enlarge the supraglottal cavity (Westbury 1983), and slackening the vocal folds (Stevens 1977). Increasing supraglottal volume facilitates voicing during stop closure by delaying equalization of the pressure differential across the glottis, while slackening the vocal folds facilitates voicing by decreasing the resistance at the glottis. Crucially, slackening the vocal folds also creates a phonatory state that is perceptually similar to murmured voicing at the stop release: reduced vocal fold vibration and a lower-frequency bias in the voicing spectrum (House and Fairbanks 1953, Gordon and Ladefoged 2001). Moreover, larynx lowering has the concomitant effect of decreasing longitudinal tension (stiffness) of the vocal folds (Honda *et al* 1993), so that a more murmur-like phonatory state is likely even when larynx lowering is the primary gesture involved in domain-initial strengthening. In this way, the result of the adjustments of the laryngeal gestures in fortified positions creates an environment which can obscure the distinction between modal voicing in plain voiced stops and breathy voicing in murmured stops, and shift the perceptual balance toward the murmured series. If this is indeed what happened in PIE, the result would be the loss of plain voiced stops in the prosodically strong stem-initial position.

In addition to laryngeal modifications, there are both active and passive aspects of the supralaryngeal vocal tract that have an effect on the duration of voicing. In bilabial stops the walls of the vocal tract have the greatest compliance (softest tissue) resulting in the greatest amount of passive expansion (Ohala 1983). In addition, there are other means of enlarging the supraglottal cavity besides larynx lowering (namely, lowering the jaw) — a gesture that is most effective during bilabial stops due to compensatory articulations of the lips that maintain closure while allowing for a significant expansion of the volume of the supralaryngeal cavity behind that closure. Jaw lowering is less effective during coronal stops, since the coarticulatory compensation to maintain closure results in a displacement of the tongue away from the floor of the mouth; this results in less overall cavity expansion behind the coronal closure (Ohala 1983). In dorsal stops jaw lowering is possible, but the effect on phonation is minimal since the oral closure is relatively close to the hinge point of the jaw, and consequently most of the expansion occurs anterior to the oral closure and thus does not affect airflow or pressure differential across the larynx.

For these reasons, one might expect labial sounds to lead in a sound change from *D to $*D^{ɦ}$, and in fact this is exactly what we see in PIE. Whereas the ratio of the entire class of plain voiced *vs.* murmured stops in Proto-Indo-European is 0.57 in initial prevocalic position, the ratio of the labial *b to $*b^{ɦ}$ in the same environment is even smaller: 0.19 (see Table 1). If we again compare PIE to other non-Indo-European languages, but this time with regard to just the labial sounds, we see a more extreme version of the pattern described above for all stop consonants (see Figure 2).

Table : Root-initial stop types in PIE (Pokorny 1959).

	Labial	Coronal	Dorsal	Total
Voiceless	132	120	308	560
Plain voiced	25	57	109	191
Murmured	133	67	108	308
Plain/murmured ratio	0.19	0.85	1.01	0.62

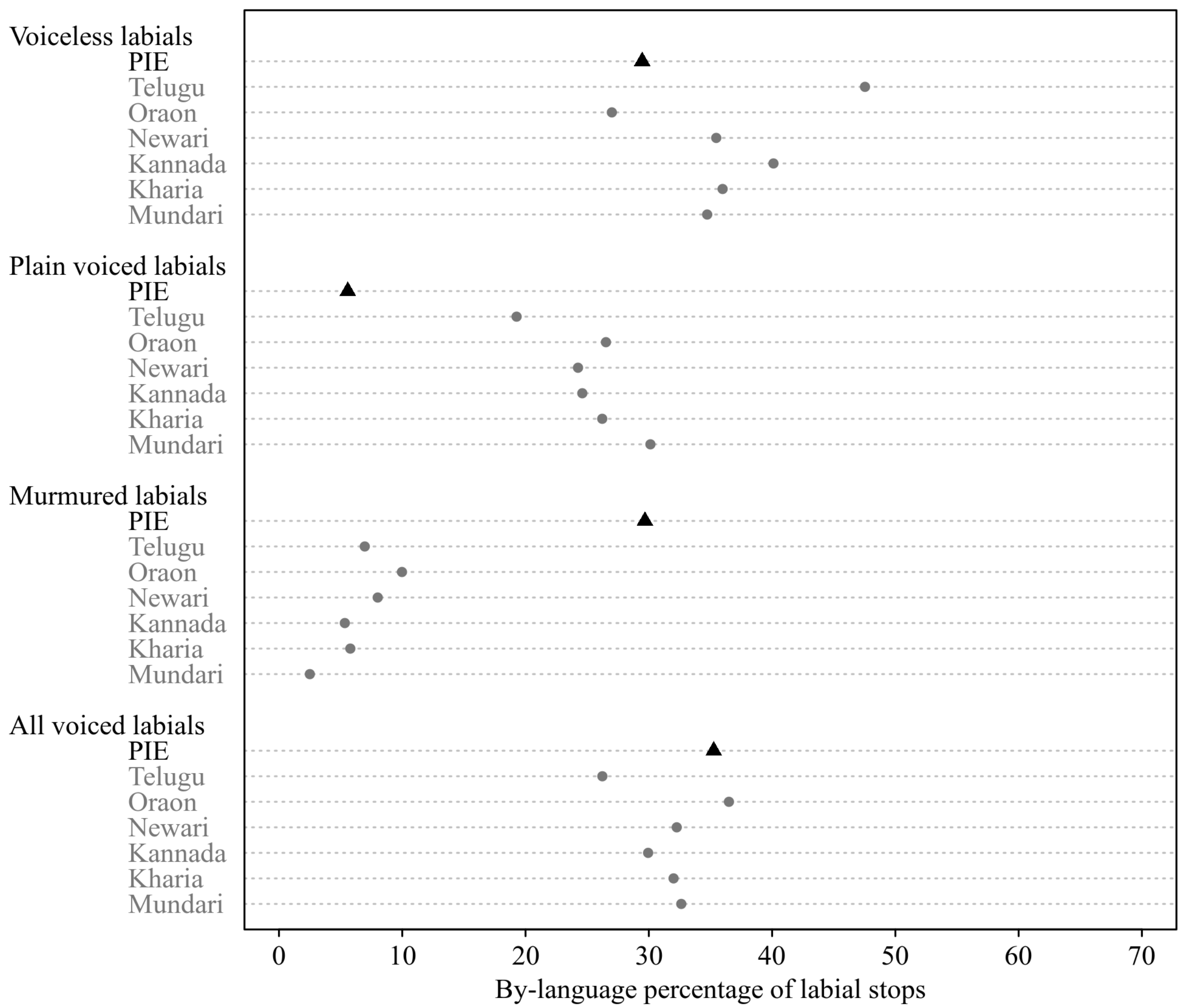

Figure 2: Percentages of labial stop-consonant types in six modern languages that are genealogically unrelated to PIE (grey circles) and in PIE (black triangles). The trend of murmured labial < plain-voiced labial is reversed in PIE. See Appendix 1 for raw data and sources.

The differences in proportion of labial stop types seen between PIE and the six other languages are statistically significant (χ^2=122.5, p<0.0001). Moreover, we once again see that the anomaly disappears if we collapse plain-voiced and murmured stops into a single category (see last row of Figure 2). These data, while far from conclusive, are at least consistent with the hypothesis that a sound change from *D to *Dʱ was underway in pre-PIE.

It is worth noting that the occurrence of a change from *D to *Dʱ as an instance of domain-initial strengthening does not entail that a corresponding change should also have occurred in the voiceless stops (*T > *Tʰ). The voiceless plain versus aspirated distinction is more redundantly encoded and more perceptually salient than the murmured versus plain distinction in voiced stops. Specifically, the distinction between aspirated and plain voiceless stops is perceptually encoded by voice onset time (VOT), relatively high-intensity aspiration turbulence, release burst amplitude, and relative onset of energy in the region of the first formant of the following vowel (see, e.g., Repp 1979). In contrast, murmur is primarily distinguished from plain voicing through weakening of the energy in the higher harmonics, and secondarily by any low-amplitude turbulence that might be present (Shrivastav 2003, Shrivastav & Camacho 2010).[1] In other words, the perceptual distinction between plain voiceless and aspirated voiceless stops is more stable — even under conditions of domain-initial strengthening — than is the corresponding contrast between plain voiced and murmured stops.

Thus, we posit that domain initial strengthening, broadly observed in the world's languages and motivated by prosodic marking of word and stem edges, exaggerates laryngeal gestures resulting in conditions that increase the perceptual distance between the voiced and voiceless series broadly speaking, but decrease the perceptual distance between the plain voiced (*D) and murmurred (*Dʱ) series. The gestural fortition in the plain voiced series (*D) resulted in a signal that was acoustically and perceptually similar to the breathy voicing found in the murmured series (*Dʱ). The result was a tendancy to collapse the *D~*Dʱ contrast primarily in stem initial position and more frequently among labials. The presence of the murmured series in PIE created the situation whereby the plain voiced series could be perceptually reassigned (which would not

1 The relatively subtle ways in which the murmured vs. plain-voiced stop contrast is perceptually encoded is likely a determining factor in the cross-linguistic rarity of such contrasts.

have happened in a language without a pre-existing voice quality contrast between plain and murmured stops).

Conclusion

A cross-linguistic statistical analysis reveals an unusual distribution of stop consonant types in PIE, and is consistent with the hypothesis that murmured phonation was in the process of spreading to the plain voiced stop series in pre-PIE, a change that may have been led by the bilabial stops. Given the presumed prior existence of both voiced *D and murmured $*D^ɦ$ stops in PIE, laryngeal adjustments to facilitate voicing in the plain-voiced series is offered as a plausible mechanism for a change from *D to $*D^ɦ$ in pre-PIE roots, due to the two voicing types becoming perceptually confusable in root initial positions. Differences in articulation between labial, coronal, and dorsal stops (in particular, the enhanced ability to expand the supralaryngeal cavity via jaw lowering during labials) are posited as a possible explanation for the fact that the anomalous distribution of stops in PIE is strongest among the labial consonants. We must of course acknowledge the speculative nature of our proposed mechanism for change in this case; we present it to support the plausibility of our hypothesis rather than as a necessary explanation for the change.

We note, however, that the alternation of plain voiced with murmured stops is a well-documented phenomenon: see, for example, Kiliaan (1911:65-71) for discussion of such free variation in Madurese. This same alternation appears in several words in at least two of the six languages in our survey. For example, in Mundari we find pairs like *bāgoā* / *bhāgoā* “a short loin cloth worn by old men,” *dhangar* / *dangar* “rich, wealthy,” *dasnā* / *dhasnā* “slope of a hill” (Bhaduri, 1983). In Oraon we find, for example, *bādhrī* / *bhadrī* “bat,” *dagā* / *daghā* “stain,” and *gadrārnā* / *gadhrārnā* “firm but not hardened” (Grignard, 1986). Most importantly, there are several roots in PIE that are reconstructed as showing such variation between *D and $*D^ɦ$ (for example, *b(e)u- / bh(e)u-* “to boil, swell or puff up”; *gal- / ghal-* “to be able”; Pokorny 1959: 98ff., 351). These cases of free variation may reflect the instability of the perceptual distinction between plain-voiced and murmured stops, and provide additional support for the plausibility of a sound change from *D to $*D^ɦ$ such as we have suggested here.

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Appendix: Data table and sources

Table : Number of word-initial prevocalic stop consonant occurrences in the roots of PIE and in the lexemes of six modern languages that have murmured stops but are genealogically unrelated to PIE. Forms representing inflectional variants of the base entry were not included in these counts, nor were variant stem pronunciations that differed after the initial stop+vowel sequence. Sources for the data: Bhaduri 1983 (Mundari), Biligiri 1965 (Kharia), Reeve 1979 (Kannada), Gurshow *et al* 1987 (Newari), Grignard 1986 (Oraon), Vemuri 2002 (Telugu), Pokorny 1959 (PIE).

	Mundari	Kharia	Kannada	Newari	Oraon	Telugu	PIE
voiceless labials	347	199	2103	155	563	1100	132
voiceless coronals	321	117	1564	139	520	594	110
voiceless dorsals	362	219	3531	133	764	1077	307
plain voiced labials	301	145	1290	106	553	446	25
plain voiced coronals	424	95	963	79	371	481	38
plain voiced dorsals	163	90	1559	44	345	495	111
murmured labials	25	32	280	35	208	161	133
murmured coronals	145	36	158	27	203	80	67
murmured dorsals	29	23	119	15	83	41	103