

Phonetic Features of the PIE “Laryngeals”: Evidence from Misperception Data of Modern Gutturals

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1 Introduction

1.1 The PIE “Laryngeals”

- Three phonemes referred to as “laryngeals” are generally reconstructed in Proto-Indo-European
 - These sounds were lost in many of the daughter languages, leaving indirect traces
 - They are reflected as vowels in certain environments in some daughter languages
 - $*h_2$ and $*h_3$ caused lowering and backing, respectively, of neighboring $*e$
 - $*h_2$ and $*h_3$ were preserved as consonants in Anatolian
- Their phonetic characteristics remain in question; likely gutturals, based on synchronic behaviors and diachronic outcomes
 - $*h_1$ often reconstructed as a glottal, with $*h_2$ and $*h_3$ as pharyngeals or uvulars
 - Potentially $*h_2$ and $*h_3$ developed from uvulars to pharyngeals after Anatolian split off from the rest of PIE [4]

1.2 Misperception Data

- There are parallels between misperception of sounds and sequences in laboratory experiments and attested sound changes [1], perhaps reflecting related processes underlying both [6]
- I present data on patterns of misperception of gutturals in modern Arabic in an experimental setting as a comparison for developments of PIE laryngeals.

2 Experiment Design

- Stimuli were Arabic nonce words, designed to test the perception of each consonant in the phonological environments of interest, heard in masking noise
- Responses were selected from a button array written in the Arabic script
- Structure: Response arrays allowed a mix of syllable structures in responses.
 - Syllable shapes, consistent-structure blocks: CV, ?VC
 - Syllable shapes, mixed-structure blocks: ?VC, ?VRC, ?VRV, and ?VR ə C¹
- Sounds Included
 - Arabic has seven guttural consonants: /q/, /χ/, /ʁ/, /ħ/, /ʕ/, /h/, and /ʔ/
 - For comparison, there were ten oral consonants and three uvularized consonants

3 Data and Discussion

- High correlation between attested sound changes involving gutturals and patterns of synchronic confusions (seen in Tables 1 and 2, respectively): $R = 0.84$ ($p < 0.0001$).
 - This strong correlation justifies the comparison of misperception data and sound changes

¹R = l, r; V = i, a, u; C = each of the consonants listed above

Table 1: Diachronic Development Matrix for Guttural Consonants (as percents)

	t/d	k	q	χ	ʁ	ħ	ʕ	ʔ	h	ɑ	∅
q	0	11	57	6	0	6	6	6	8	0	0
χ	0	22	0	47	3	19	0	0	9	0	0
ʁ	0	0	3	14	39	0	23	9	6	0	6
ħ	0	0	0	19	0	36	3	0	26	0	16
ʕ	0	0	0	0	0	0	40	30	0	0	33
ʔ	0	0	0	0	0	0	4	67	4	0	25
h	0	3	0	0	0	12	0	6	53	0	26

Table 2: Native Arabic Listeners' Confusion Matrix for Guttural Consonants (as percents)²

	t/d	k	q	χ	ʁ	ħ	ʕ	ʔ	h	ɑ	∅
q	2	6	71	5	3	0	1	4	0	0	0
χ	2	0	5	77	3	2	0	0	4	0	2
ʁ	2	0	1	1	79	0	2	0	1	0	3
ħ	1	1	3	3	0	74	6	3	5	0	4
ʕ	0	1	4	2	1	1	67	16	3	1	4
ʔ	2	0	2	1	1	0	2	77	4	1	6
h	3	1	3	7	2	16	2	5	52	1	6

3.1 Word-final post-vocalic consonant loss before a pause

- In Proto-Indo-European, laryngeals were lost with no compensatory effects before a significant prosodic break [3]
 - Anatolian data is partially obscured by later analogical restoration of word-final *h* and the more general loss of word-final **h₂* [5]
 - *in pausa* laryngeal loss might not have been shared by Anatolian and the rest of PIE

Table 3: Consonant Deletions Word Finally after a Vowel (as percents)

	Native Listeners	Non-native Listeners
t	7	3
d	0	8
s	2	4
k	6	5
q	2	4
χ	7	7
ʁ	4	6
ħ	7	15
ʕ	15	22
ʔ	20	33
h	13	25

- In my data, guttural consonants were frequently not perceived word-finally
 - More fricative-like /ʕ/ was less prone to loss than stop realizations

²Numbers do not all add up to 100, because most uncommon outcomes were omitted.

- More creaky realizations of /ʔ/ were less prone to loss than purely consonantal realizations
- Glottals and the pharyngeal stop were particularly prone to loss in this environment, consistent with such values for some of the laryngeals in late (non-Anatolian) PIE

3.2 Word final consonant loss following a liquid

- Saussure Effect: PIE laryngeals were lost following a sequence of /o/ and a sonorant and preceding a sequence of sonorant and /o/ [7]
 - In addition to clear evidence in several branches, there is also somewhat weaker evidence for this effect in Anatolian [2]
- Vowel quality did not have a strong effect on consonant loss for most consonants in this study, perhaps indicating that the particular set of vowel contrasts in PIE was crucial
 - Arabic does not contain /o/; the most appealing comparison is /a/, because PIE *o seemed to be low, merging with *a in many daughter languages
 - The environment tested for this loss was ?VRC³

Table 4: Native Arabic Listeners' Post-Liquid Consonant Deletions (as percents)

	a	i	u	overall
t	2	4	2	8
d	6	4	8	17
s	0	0	0	0
k	2	4	0	5
q	0	0	0	0
χ	0	6	5	4
ʁ	7	17	12	13
ħ	16	5	12	11
ʕ	5	5	11	4
ʔ	11	11	6	9
h	29	14	6	15

- Strongly in favor of /h/ as one of the laryngeals (probably *h₁)
- Potentially consistent with pharyngeal *h₂ and/or *h₃
- Potentially consistent with uvular *h₂ and/or *h₃ in early PIE; the infrequent loss of /χ/ could be due to its largely velar realization in the Arabic dialects tested

3.3 Vocalic outcomes of consonants

- Are vowel outcomes of PIE laryngeals due to vocalizations of the laryngeals themselves, or the result of vowel anaptyxis followed by laryngeal loss?
- Misperception of consonants as vowels was uncommon within my data, both among non-guttural consonants (1%) and guttural consonants (2%)
 - Misperception of clusters with gutturals as being separated by a vowel was common (10%, vs. 6% for non-guttural consonants)
 - Loss of gutturals following vowels was common (10%, vs. 4% for non-guttural consonants)
 - This supports the vowel anaptyxis explanation

³V = vowels (i, a, u); C = consonants (listed in Table 4); R = liquids (l, r)

3.4 Directionality in confusions among guttural consonants

Asymmetry in perceptual confusions could contribute to evaluating the relative likelihood of possible phonetic shifts of the PIE laryngeals

Table 5: P-values for Asymmetry, Selected Sound Pairs

	Native Listeners	Non-native Listeners	directionality
$h \sim \hbar$	< 0.0001***	< 0.0001***	$h > \hbar$
$\text{ʕ} \sim \text{ʔ}$	< 0.0001***	< 0.0001***	$\text{ʕ} > \text{ʔ}$
$\chi \sim \hbar$	0.61	< 0.0001(***) ⁴	neither
$\text{ʕ} \sim \text{ʔ}$	0.0016(**)	< 0.0001(***)	neither

- Glottal /h/ being identified as pharyngeal /ħ/ was significantly more frequent than the converse, but pharyngeal /ʕ/ identified as /ʔ/ was more common than the converse
- No evidence for directionality between uvulars and pharyngeals
- Perhaps the directionality found in typological studies (uvular > pharyngeal > glottal) is a weaker trend than has been previously suggested

4 Conclusions

- Patterns of perceptual confusions and loss of guttural consonants in particular phonological environments provide a new source of data for evaluating reconstructions the PIE laryngeals
- Based on this data, I add a new line of evidence for the view that vocalic outcomes of PIE laryngeals were the result of vowel anaptyxis and subsequent laryngeal loss
- The misperception patterns are most consistent with glottal and pharyngeal values for the PIE laryngeals, though the evidence also is consistent with an earlier uvular stage of $*h_2$ and $*h_3$

References

- [1] Garrett, A., & K. Johnson. “Phonetic Bias in Sound Change.” *Origins of Sound Change: Approaches to Phonologization*. Ed. A. Yu. Oxford: Oxford University Press, 2013. 51-97.
- [2] Kloekhorst, A. “Studies in Lycian and Carian Phonology and Morphology.” *Kadmos* 47 (2008): 117-146.
- [3] Kuiper, F. “Traces of Laryngeals in Vedic Sanskrit.” *India Antiqua: A Volume of Oriental Studies, Presented by his Friends and Pupils to Jean Philippe Vogel on the Occasion of the Fiftieth Anniversary of his Doctorate*. Leyden: Brill/Kern Institute, 1947. 198-212.
- [4] Kümmel, M. *Konsonantenwandel: Bausteine zu einer Typologie des Lautwandels und ihre Konsequenzen für die Vergleichende Rekonstruktion*. Wiesbaden: Reichert Verlag, 2007.
- [5] Oettinger, N. *Die Stammbildung des Hethitischen Verbms*. Nürnberg: Hans-Carl Verlag, 1979.
- [6] Ohala, J. Phonetics and Historical Phonology. *The Handbook of Historical Linguistics*. Eds. B. Joseph & R. Janda. Oxford: Blackwell Publishing, 2003. 669-686.
- [7] de Saussure, F. “D’ὠμῆλυσις ἃ Τριπτόλεμος: Remarques étymologiques.” *Mélanges Nicole*, Genève: Imprimerie W. Kündig & Fils, 1905. 503-514.

⁴Marks in parentheses indicate that the significant difference was due to a large number of confusions of one of the sounds with a third sound, rather than a directionality between the two sounds.