Some basics of Indo-European phonology

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§1 Introduction

[1] Two phonological processes in (1–2) are standardly reconstructed for Proto-Indo-European (PIE):

(1)

HETEROMORPHEMIC SIBILANT DEGEMINATION: **(Mayrhofer 1986:120–1)**

s + s → s

"In an /s-s/ sequence, an /s/ is deleted."

(2)

REGRESSIVE VOICING ASSIMILATION: **(Mayrhofer 1986:110)**

[−SON, (−S.G.)] → [αVOI] / ___ [αVOI]

"('Unaspirated'/non-breathy voiced) obstruents assimilate the voicing quality of an immediately following obstruent."

· Whether or not (2) applies to [+spread glottis] segments depends on the PIE status of BARTHOLOMAE'S LAW (Bartholomae 1883:48); for simplicity, it is assumed here that Bartholomae's Law was post-PIE (cf. Collinge 1985:7–10, Byrd 2015:22, *i.a.*).

[2] On the basis of Anatolian evidence, Kloekhorst (2016) has argued that neither of these processes is reconstructible for PIE but are rather innovations of Proto-Nuclear-Indo-European (PNIE).

- The putative non-operation of (1–2) is taken as support for his broader hypothesis that PIE did not have the traditionally reconstructed stop system in (3) but instead a system like (4) (cf. Jäntti 2017):

(3)

	[−VOI]	[+VOI]	[+VOI, +S.G.]
LAB	*/p/	*/b/	*/b$^{\text{ɦ}}$/
COR	*/t/	*/d/	*/*d$^{\text{ɦ}}$/
DOR	*/k̂ k k$^{\text{w}}$/	*/ĝ g g$^{\text{w}}$/	*/ĝ$^{\text{ɦ}}$ g$^{\text{ɦ}}$ g$^{\text{wɦ}}$/

(4)

+LG	[−LG, +"PGL"]	−LG
*/pː/	*/ʔp/	*/p/
*/tː/	*/ʔt/	*/t/
*/k̂ː kː kːʷ/	*/ʔk̂ ʔk ʔkʷ/	*/k̂ k kʷ/

· Kloekhorst contends (4) was inherited into Proto-Anatolian (PA) and preserved mostly intact in Hittite.

[3] Proposed reconstruction in (4) is highly implausible; critique developed here focuses primarily on the status of the phonological processes in (1–2) in Anatolian and in PIE.

[4] Three arguments advanced today:

i) Anatolian shows direct evidence for the operation of (1) SIBILANT DEGEMINATION.

ii) Alleged Hittite counter-evidence to (2) REGRESSIVE VOICING ASSIMILATION is in fact phonologically regular under a properly constrained formulation of STURTEVANT'S LAW (Sturtevant 1932).

iii) Both (1) and (2) are reconstructible for the synchronic phonology of PIE.

§2 Sibilant degemination in (P)IE

§2.1 Counter-evidence to PIE sibilant degemination?

[5] Kloekhorst's (2016:238–40) case against sibilant degemination in PIE centers on the 2SG.NPST.ACT form of the verb 'be' (**h₁es–* + **–si*) — specifically, he contends that:

i) Hitt. <*e-eš-ši*> 'you are' (OH+) with [sː] directly continues PIE **h₁éssi*.

ii) PNIE innovated degemination: PIE **h₁éssi* > PNIE **h₁ési* > Ved. *ási*, OAv. *ahī*, Gk. ἐῖ; OCS *jesi*; etc.

[6] More broadly, Kloekhorst takes this putative change as evidence that PNIE innovated a new dispreference for geminates, which drove the change from a stop inventory like (4) to (3) above.

§2.2 Sibilant degemination from an NIE perspective

[7] Yet already in the oldest NIE languages, degemination looks like an archaism, not an innovation.

[8] Even if the copula tends to resist analogical renewal, re-built 2SG forms with [sː] are attested in at least three separate NIE language branches, i.e. (5):

(5) a. Hom. & W.Gk. ἐσσί
b. Lat. *ess* (Pl.)
c. OPruss. *assei/assai*

[9] Even where PNIE **h₁ési* is preserved, degemination may not apply synchronically — e.g., in Vedic:

(6) a. Ved. /sádas - sú/ → ***sádassu*** 'in (their) seats' (RV VII.85.3a) (cf. Ved. *ási* 'you are')
b. Ved. /śās - si/ → ***śā́ssi*** 'you instruct' (RV I.31.14d)

[10] Strong tendency for sibilant degemination to be lost within earliest NIE runs counter to Kloekhorst's (2016) hypothesis that it was a PNIE innovation.

§2.3 Evidence for sibilant degemination in Anatolian

[11] Moreover, Palaic attests a relatively secure case of sibilant degemination — i.e, *mūši* in (7):

(7) *lālan=ta kuiš tartan marišši maš=pa=ši* ***mūši***
'You who crush the (evil) tongue (and) curse, **you shall enjoy** yourself as much (as you can).'

(KUB 35.165+ rev. 9–10; OS)

- Taken by Carruba (1970:64) as 2SG.IMP to root *muš–* 'enjoy oneself (+ REFL *=šši*)'(cf. Melchert 1984:36), but this analysis encounters clear morphological problems:
  - *muš–* is a radical verb (3PL *muš-ānti*), which rules out *–i* as sporadic contraction of /-iye-∅/ (cf. *ari*/*arie* 'raise!'; KUB 35.165+ obv. 22/8).
  - *i*-imperatives of type observed in Hittite (< **–si* according to Jasanoff 2012) are otherwise unattested in Palaic, and even within Hittite, effectively restricted to *media tantum* (Oettinger 2007).
- Better, then, is the analysis of Yakubovich (2006): Pal. *mūši* ← /mu**s** - **s**i/.

⇒ Direct evidence in Palaic for sibilant degemination.

⇒ Anatolian inherited sibilant degemination from PIE.

⇒ As traditionally assumed, Hitt. *ēšši* is an analogical innovation just like (5a–c) above.

§3 Regressive voicing assimilation in PIE

§3.1 Counter-evidence to PIE regressive voicing assimilation?

[12] Kloekhorst's (2016) case against regressive voicing assimilation in PIE is founded on the Hittite outcomes of certain stop-stop clusters — in particular, in words like (8) (cf. Jäntti 2017:28):

(8) Hitt. *nekuz* (*meḫur*) '(time) of evening' cf. Lat. *noctis*, Gk. νυκτός, Lith. *naktiẽs*

[13] Kloekhorst's basic argumentation can be summarized as follows:

i) All of the NIE forms derive unambiguously from a voiceless word-medial cluster *[kʷt].

ii) Yet the expected outcome of PIE *[kʷts] in Hittite is *–kkuz(za)* with geminate cluster-initial stop via STURTEVANT'S LAW (cf. §3.2 below).

iii) Accounting for Hitt. *–kuz(za)* requires a word-medial cluster with initial voiced stop, i.e. *[gʷ⁽ʰ⁾t].

iv) Because such clusters are reconstructible, PIE did not have voicing assimilation, which was thus a PNIE innovation.

· Kloekhorst (2016) takes (iv) as further evidence that PIE stops did not have a phonological opposition in voice but rather one in length, as in his proposed system in (4).

[14] This reasoning depends crucially on how STURTEVANT'S LAW is understood — here, it will be argued:

i) STURTEVANT'S LAW is a conditioned development.

ii) Hitt. *–kuz(za)* ([kʷt͡s]) with singleton cluster-initial stop is the *lautgesetzlich* outcome of a voiceless cluster PIE *[kʷts].

iii) Anatolian provides no counter-evidence to reconstructing voicing assimilation for PIE.

§3.2 On Sturtevant's Law

[15] Established at least since Sturtevant (1932) that Hittite shows a contrast between orthographic geminate and singleton stops that is regularly maintained intervocalically — some minimal pairs in (9):

(9)

	GEMINATE		vs.	SINGLETON	
a.	<*pa**d-d**a-an*>	'dig.PTCP.N.NOM/ACC.SG'		<*pa-**t**a-a-an*>	'foot.ANIM.GEN.PL'
b.	<*ḫa-a**t-t**a-an-za*>	'pierce.PTCP.ANIM.NOM.SG'		<*ḫa-**t**a-an-za*>	'dry.PTCP.ANIM.NOM.SG'
c.	<*še-e**k-k**án*>	'know.PTCP.N.NOM/ACC.SG'		<*še-**k**án*>	'cubit.N.NOM/ACC.SG'

[16] Until recently, there was general agreement that this orthographic distribution is due primarily to the operation of STURTEVANT'S LAW, which was originally formulated as in (10):

(10) "[O]riginal voiceless stops are usually represented in Hitt. by doubled consonants wherever the cuneiform makes this possible, while the tendency is to write single *p, t* (*d*) and *k* (*g*) for original voiced stops and voiced aspirates" (C.L. Mudge *apud* Sturtevant 1932:2).

• Some (mostly) uncontroversial examples of STURTEVANT'S LAW below — voiced (11) vs. voiceless (12):

(11) a. PIE **kʷó-**bʰ**i* > Hitt. *kuwā**p**i* 'where?' (ADV) (cf. Ved. *–bhi*)

b. PIE **pé**d**-om* > Hitt. *pē**d**an* 'place' (N.NOM/ACC.SG) (cf. Gk. πέδον)

c. PIE **dʰé**gʰ**-ōm* > Hitt. *tē**k**an* 'earth' (N.NOM.SG) (cf. Gk. χθών)

(12) a. PIE **h$_1$ó**pi*** >> Hitt. ***āppa*** 'back' (ADV/ADP) (cf. Gk. ἐπί)
b. PIE **kḿ**t**ō/a* >(>) Hitt. *ka**tta*** 'down; beside' (ADV) (cf. Gk. κατά/κάτω)
c. PIE **twé**k**-m̥* >> Hitt. *tue**kk**an* 'body' (ANIM.ACC.SG) (cf. Ved. *tvácam*)

· With Kloekhorst (2016), I reject Pozza's (2011; 2012) view that (10) is a "tendency" rather than a rule/law.

· By Kloekhorst's (2016)'s reconstruction in (4), it is rather PNIE that undergoes what is effectively a "reverse Sturtevant's Law" (e.g., PIE **tt* > PNIE **t*, etc.), but it remains the case that PNIE voiced/voiceless stops stand in correspondence with Hittite singleton/geminate stops.

· For derivation of Hitt. *katta* in (12b) and CLuw. *zanta* from PIE **ĝ̑m̥tV*, see Goedegebuure (2010).

[17] Whatever the phonetic interpretation of the orthographic contrast (cf. §3.4), STURTEVANT'S LAW is standardly viewed as an unconditioned "development," affecting all stops that were voiced/voiceless on the surface at the time of its operation.

- Under this view, pre-Hittite voiceless stops should correspond with Hittite geminate stops *wherever the orthography permits*.
- PIE 'night' is thus (wrongly) predicted to surface in Hittite spelled as in (13):

(13) PIE **né**k**^{w}t-s* 'of night' > Hitt. ^{x}<*ne-e**k**-**k**u-uz(-za)*> (cf. Hitt. <*ne-**k**u-uz(-za)*>)

[18] To account for apparent counter-examples like (13), Melchert (1994:61) posits that in all word-medial positions PIE **k^{w}* underwent voicing to PA **g^{w}*; yet this hypothesis encounters problems:

- Lacks phonetic motivation, being esp. unlikely before voiceless obstruents as in (13).
- Incorrectly predicts singleton stop spellings in examples like (14):

(14) PIE **=k^{w}e* > Hitt. *=kku* (… *=kku*) 'both…and; whether…or' (cf. *takku* 'if', *nekku* 'not?')

◦ Is it necessary then to reconstruct PIE *$*[\mathrm{g}^{\mathrm{w(h)}}\mathrm{t}]$ to account for Hitt. *nekuz*?

§3.3 Constraining Sturtevant's Law?

[19] Alternatively, STURTEVANT'S LAW may have been a conditioned sound change, which did not apply (e.g.) in (13) — specific proposal in (15):

(15) Initial stop in voiceless stop-stop clusters did not (orthographically) geminate by STURTEVANT'S LAW.

[20] Hittite forms in (16) provide a testing ground for (15); in each example:

- A voiceless stop-stop cluster is etymologically secure (Kloekhorst 2008:s.vv; cf. *LIV*^{2}:620–1).
- Cluster-initial stop is **never** attested with geminate spelling, despite the possibility of an orthographic singleton/geminate distinction in pre-consonantal position (cf. (17) below).

(16) a. PIE **so**k**^{w}t(h$_2$)–* > Hitt. <*ša-a**k**-ut-ta-i*>, <*sa-**k**u-ta-a-e*> 'thighs' (cf. Ved. *sákthi–*)
b. PIE **(we/o)-**t**k^{w}–* > Hitt. <*wa-a**t**-ku-zi*>, *wa-a**t**-ku-ut-ta*> 'leap' (cf. Ved. *tak–* 'hurry')
c. PIE **h$_2$r̥**t**ĥ̑o–* > Hitt. <*ḫar-**t**ág-ga-aš*>, $^{\mathrm{LÚ}}$<*ḫar-**t**a-ak-ki*> 'bear(-man)' (cf. Gk. ἄρκτος)

(17) a. ^{x}<*sa-ak-ku-ut-ta-i*> cf. <*a**k**-**k**u-uš-ke-zi*> 'drinks'
b. ^{x}<*wa-at-tu-uk-zi*> cf. <*ta**r**-**r**u-uḫ-zi*> 'conquers'
c. ^{x}<*ḫar-at-tág-ga-aš*> cf. <*ša-a-a**k**-**k**a$_4$-aḫ-ḫi*> 'I know'

[21] Total absence of spellings like (17) with geminate cluster-initial stop supports hypothesis in (15).

[22] Counter-evidence to hypothesis in (15) is limited and uncertain — some possible examples in (18), but unclear whether these contain real stop-stop clusters.

(18) a. PIE **h$_1$(e)**p**-(o)to$^?$* > Hitt. *<a**p**-**p**a-at-ta-at>* '(s)he was taken' (cf. *a**pp**-anzi* 'they take')

b. PIE **leu**k**-(o)tor$^?$* > Hitt. *<lu-u**k**-**k**at-ta>* 'dawns' (cf. *lu**kk**-ešta* 'got bright')

· Spellings like *<e-ep-ta-at>* (KUB 52.83 i 5) and *<lu-uk-ta>* (KBo 25.86 rev 6) suggest a stop-stop cluster interpretation of (18); alternatively, (18) continue a renewed ending **–o-to(r)* (Watkins 1969:85–7; cf. Oettinger 1979:274–5; Yoshida 2016:508–9), in which case they are regular.

- But even if (18) have real geminate clusters, these — in contrast to (16) — occur only at transparent morpheme boundaries, where they may arise by trivial paradigmatic analogy.

[23] Empirical evidence thus consistent with hypothesis that the initial stop in voiceless stop-stop clusters — including PIE 'night' in (13) — did not develop regularly by STURTEVANT'S LAW.

◦ Why did STURTEVANT'S LAW (orthographic) gemination fail to apply in this environment?

§3.4 What is Sturtevant's Law?

[24] To understand why STURTEVANT'S LAW would (not) apply in a given environment, it is necessary first to determine the phonological properties of its outputs — i.e., what actually happened to inherited voiced/voiceless stops in Hittite.

[25] Synchronic phonological interpretation of Hittite stops remains controversial (cf. Hoffner and Melchert 2008:35); two predominant views on orthographic singleton/geminate contrast:

(19) a. Stops (still) distinguished phonetically primarily by voice: *–tt/dd–* = [t], *–t/d–* = [d], etc.
⇒ STURTEVANT'S LAW is an orthographic rule, not a sound change.

b. Stops distinguished phonetically primarily by length: *–tt/dd–* = [tː], *–t/d–* = [t], etc.
⇒ STURTEVANT'S LAW is a sound change.

[26] Both Melchert (1994:14–21) and Kloekhorst (2014:544–547) argue for (19b), which is supported by:

- (Some) evidence that vowels preceding geminate stops behave prosodically (i.e., stress/length) like vowels preceding consonant clusters for prosodic processes.
- Orthographic parallelism with sonorants, where a voicing distinction is highly unlikely and a length distinction often historically explicable (via assimilation).
- Lack of synchronic voicing assimilation (cf. Kloekhorst 2016:214–5) — under (19a) one would incorrectly expect the derivation in (20a), whereas (19b) correctly predicts the derivation in (20b):

(20) a. ✘ /eg^{w} - si/ → [éːk^{w}-si] (*^{x}<e-e**k**-**k**u-uš-ši>, <e-uk-ši>*) 'you drink' (2SG.NPST.ACT)

b. ✔ /ek^{w} - si/ → [éːk^{w}-si] (*<e-**k**u-uš-ši>, <e-uk-ši>*) 'you drink' (2SG.NPST.ACT)

· The attested form in (20b) in fact replaces historically expected **ēkkušši* with devoiced (> geminate) final stop by PIE **s*; note that historical devoicing survives synchronically as a morphophonological gemination process conditioned by the imperfective suffix *–ške–* in some roots, e.g. Hitt. *a**kk**uške–* 'drink' (⇐ Hitt. *e**k**u/a**k**u–* < PIE **h$_1$eg^{wh}–*); but cf. *we**k**iške–* 'demand' (⇐ *wek–*).

[27] These facts suggest that the general historical changes in (21) constitute STURTEVANT'S LAW:

(21)

PRE-HITTITE	*[p]	*[t]	*[k, k^{w}]	*[b]	*[d]	*[g, g^{w}]
HITTITE	[pː]	[tː]	[kː, kː^{w}]	[p]	[t]	[k, k^{w}]

[28] If (21) is correct, the more precise question that arises is:

◦ Why did the first stop in inherited voiceless stop-stop clusters fail to develop into a geminate/long stop by STURTEVANT'S LAW?

§3.5 Motivating the non-application of Sturtevant's Law

[29] Exceptional treatment of voiceless stop-stop clusters w.r.t. STURTEVANT'S LAW in fact finds natural motivation under the view in (19b) that Hittite stops were distinguished primarily by length.

[30] It was known already to Sturtevant (1932:12) (see further Einarsson 1932) that cross-linguistically voiceless stops tend to be phonetically longer than voiced stops (cf. Denes 1955, Lisker 1957, *i.a.*).

- This durational contrast provides a phonetic basis for STURTEVANT'S LAW, which would amount to the reanalysis of a voicing opposition as a length opposition (cf. Blevins 2004:175–7).

[31] Accordingly, the Hittite reanalysis of stops may have been context dependent — specifically, on the availability/robustness of closure duration and other phonetic cues (Wright 2004) distinguishing voiceless and voiced stops in the relevant environment.

- Acoustic/auditory cues for obstruent voicing are highly perceptible in intervocalic position, but relatively difficult to perceive before obstruents, esp. stops (cf. Steriade 1997, *i.a.*).
- Closure duration tends to be reduced before consonants and durational contrasts poorly discriminated in this environment (e.g., Dmitrieva 2017, 2018).

[32] These facts together recommend the following diachronic scenario for STURTEVANT'S LAW:

- In general, voiceless stops were reanalyzed as [+long] and voiced stops as [−long] primarily on the basis of the greater intrinsic duration of voiceless than voiced stops.
- But before another stop, where their duration was reduced and the contrast between them poorly cued, both voiced and voiceless stops were identified with the [−long] set.

§3.6 A revised Sturtevant's Law and its PIE implications

[33] If the proposal developed in §§3.3–3.5 is correct, then STURTEVANT'S LAW is a conditioned development consisting of the two (ordered, but likely concomitant) pre-Hittite changes in (22):

(22)

STURTEVANT'S LAW: **(provisional)**

a. [+del rel, −voice] > [+long] / ___ [−del rel]
b. [+del rel] > [−voice]

"Before non-stop consonants, voiceless stops are lengthened; then all stops are devoiced."

[34] Under (22), inherited voiceless and voiced stops have the same outcome before stops in Hittite, both yielding non-geminate stops.

⇒ Hitt. *nekuz(za)* can continue voiceless PIE *[k^wt] cluster just like its NIE cognates, — i.e. (23):

(23) PIE ***nék^w-t-(e/o)s*** 'of night' >(>) Hitt. ***nekuz(za)*** ([né:$k^w\widehat{ts}$]), Lat. ***noctis***, Gk. νυκτός, Lith. ***naktiẽs***

· The related verb Hitt. *nekuzzi* / *nekutta* 'gets/got dark' — which occurs only in 3SG in Hittite and presumably also in pre-Hittite — is similarly regular from surface ***nék^w-t(i)***; the voicing/aspiration of the root-final stop cannot be determined from Anatolian.

[35] Two further implications of this analysis for PIE phonology:

i) Hittite provides no basis for reconstructing *[$g^{w(h)}t$] in PIE 'night' or other clusters with non-identical [voice] specification.

ii) REGRESSIVE VOICING ASSIMILATION can be straightforwardly reconstructed for PIE on the basis of NIE evidence.

§4 Conclusions & discussion

[36] §§2–3 were broadly concerned with two basic phonological processes — repeated in (24–25) — that have long been standardly reconstructed for PIE:

(24)

HETEROMORPHEMIC SIBILANT DEGEMINATION: **(Mayrhofer 1986:120–1)**

s + s → s

"In an /s-s/ sequence, an /s/ is deleted."

(25)

REGRESSIVE VOICING ASSIMILATION: **(Mayrhofer 1986:110)**

[−SON, (−S.G.)] → [αVOI] / ___ [αVOI]

"('Unaspirated'/non-breathy voiced) obstruents assimilate the voicing quality of an immediately following obstruent."

[37] With respect to these processes, three arguments have been advanced (contra Kloekhorst 2016):

i) Anatolian provides direct (if limited) support for reconstructing (24) for PIE (§2).
ii) No compelling Anatolian counter-evidence to reconstructing (25) for PIE (§3).
iii) The traditional reconstruction of both (24) and (25) for PIE is correct.

⇒ These processes provide no support for Kloekhorst's (2016) proposed radical revision of the PIE stop inventory.

[38] §3 also developed a new diachronic analysis of STURTEVANT'S LAW whereby:

- Pre-Hittite voiceless/voiced stops developed regularly into Hittite geminate/non-geminate voiceless stops in most environments.
- First stop in stop-stop clusters developed into a non-geminate regardless of historical voicing.

[39] Some upshots of this analysis:

i) Correctly predicts consistent Hittite non-geminate outcomes of inherited cluster-initial voiceless stops in stop-stop clusters.
ii) Consistent with a phonetically grounded view of STURTEVANT'S LAW — the greater duration of voiceless than voiced stops was phonologized only where it was robustly cued phonetically.

[40] This approach to STURTEVANT'S LAW opens up new questions — in particular:

◦ Is the proposed description of this law — repeated in (26) — sufficiently constrained?

(26)

STURTEVANT'S LAW: **(provisional)**

a. [+del rel, −voice] > [+long] / ___ [−del rel]
b. [+del rel] > [−voice]

"Before non-stop consonants, voiceless stops are lengthened; then all stops are devoiced."

[41] Whether there are other phonological environments in which STURTEVANT'S LAW did not apply regularly (and why it did not) calls for further research.

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