

On Proto-Anatolian Verbal Ablaut: The Hittite *ašanzi*-Type Reexamined

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§1 Introduction

Today I'd like to revisit an old problem in Anatolian phonology, namely, the controversial source of the initial vowel *#a-* we find in the weak stem of Proto-Anatolian verbal paradigms that continue Proto-Indo-European roots of the shape **h₁eT* (where **T* = any stop or **s*). The four roots in question are in the table in (1); all four stand at the core of the lexicon, and consequently are richly attested in the Anatolian languages:

[1.1] **The problem:** A matter of ongoing controversy is the source of the initial vowel [*#a-*] apparent in the weak stem of Proto-Anatolian (PA) verbal paradigms which continue Proto-Indo-European (PIE) roots of the shape **h₁eT* (where **T* = any stop or **s*). The four roots in question are in (1), all very frequent and belonging to the core of the lexicon:

	(strong)	(weak)
PIE <i>*h₁eT-</i>	PA <i>*eT-</i> > Hitt. <i>eT-</i>	PA <i>*aT-</i> > Hitt. <i>aT-</i>
(1) <i>*h₁eg^{wh}-</i> ‘drink’	<i>ekuzi</i> ‘drinks’ [3s.pres.act.]	<i>akuanzi</i> ‘they drink’ [3pl.pres.act]
<i>*h₁ed-</i> ‘eat’	<i>ēz(za)z(z)i</i> ‘eats’ [3s.pres.act.]	<i>adanzi</i> ‘they eat’ [3pl.pres.act]
<i>*h₁ep-</i> ‘take’	<i>ēpzi</i> ‘takes’ [3s.pres.act.]	<i>appanzi</i> ‘they take’ [3pl.pres.act]
<i>*h₁es-</i> ‘be’	<i>ēšzi</i> ‘is’ [3s.pres.act.]	<i>ašanzi</i> ‘they are’ [3pl.pres.act]

cf. Pal./Luw. *as-*, Lyc. *ah-* ‘be’; Pal./Luw. *ad-* ‘eat’; Lyc. *app-* ‘take’, etc.

Essentially three accounts have been proposed to explain the evident *#a*-vocalism of their weak stems:

- (i) The classic account, which is concisely summarized and reviewed by Kimball, is that the vowel directly reflects the ‘vocalization’ of the laryngeal **h₁* in the zero-grade, i.e. initial PIE **h₁ + T* becomes PA **#aT-* (cf. Kimball 1999: 390-91, with lit.).
- (ii) A competing position has been advanced by Alwin Kloekhorst, who argues that the vowel is the orthographic representation of a glottal stop [ʔ], which is itself the preserved reflex of the PIE glottal stop **h₁* (cf. Kloekhorst 2004, 2007).
- (iii) Lastly, there is the account of Melchert (1994), for whom the vowel is analogical on the basis of **TeT* roots and **ses-* ‘sleep’, where PA **TaT-* and **sas-* are the developments of PIE sequences with ‘schwa secundum’ (cf. Melchert 1994: 66-67).

[1.2] **Previous scholarship:** Essentially three accounts have been proposed to explain the vocalism of the weak stem:

- (i) The vowel directly reflects vocalization of the laryngeal $*h_1$ in the zero-grade, i.e. PIE $*\#h_1T-$ > PA $*\#aT-$ (cf. Kimball 1999: 390-91, with lit.).
- (ii) The vowel is the orthographic representation of a glottal stop [ʔ], the preserved reflex of the PIE glottal stop $*h_1$ (cf. Kloekhorst 2004, 2007).
- (iii) The vowel is analogical on the basis of $*TeT$ roots and $*ses-$ ‘sleep’, where PA $*TaT-$, $*sas-$ is the development of (already) PIE $*T_əT-$, $*s_əs-$ (cf. Melchert 1994: 66-67).

However—and this is [1.3] on your handout—each of these accounts faces certain difficulties, though some more so than others.

[1.3] **... and its issues:** Each of these accounts is, to varying degrees, problematic:

First, the vocalization account suffers from circularity; as observed already by Melchert (1994:67), there is no compelling evidence for the vocalization of $*h_1$ except in the very paradigms it is posited to explain.

[1.3.1] **The ‘vocalization’ account (i):** As observed already by Melchert (1994:67), there is no compelling evidence for the vocalization of $*h_1$, viz. outside of the very paradigms ‘vocalization’ is intended to explain.

As for Kloekhorst’s proposal, I cannot treat its issues in any detail here; instead I refer you to Melchert’s (2010) review of the Luwian arguments, and Weeden’s (2011) critique of the Hittite—the latter in particular convincingly refuting Kloekhorst’s evidence for the putative Akkadian orthographic practice on which the Hittite spellings would be based.

[1.3.2] **The ‘spelling’ account (ii):** The proposal advanced by Kloekhorst (2004, 2007) that initial Hitt. <a->, HLuw. <á-> spells a glottal stop [ʔ] is untenable; for critiques of the Hittite and Luwian evidence, see Weeden (2011) and Melchert (2010) respectively.

Finally, and much more plausible—this is [1.3.3] on your handout—is the analogic account of Melchert; if his proposed analogy were indeed simply the case of extending a dominant $*e/a$ morphological pattern, it would be essentially unproblematic. However, the assumed nucleus of verbs that would manifest this pattern is less than robust—in fact, the only assured example is $*ses-$ ‘sleep’, with weak stem *šašanzi*. Therefore, given the very limited evidence for the analogical base from which the vowel was hypothetically introduced into the paradigms of these roots, an alternative to the ‘analogic account’ is to be desired.

[1.3.3] **The ‘analogic’ account (iii):** The evidence for a nucleus of verbs manifesting an e/a morphophonological pattern assumed by Melchert (1994:66-67) is less than robust—in fact, the only assured example is $*ses-$: $*sas-$ ‘sleep’; its analogic extension is therefore unlikely

In view of these issues, I will develop an a new approach according to which the initial a -vocalism emerges directly from the interaction of inherited ablaut patterns and evolving phonotactic constraints in the synchronic grammar of PA; in what follows, I will argue:

- (i) First, that the $*e/\emptyset$ root ablaut of Proto-Anatolian simple *mi*-verb paradigms may be modeled as a *synchronic* morphophonological process of vowel reduction (to zero, if possible) that stably continues the PIE situation (§2)
- (ii) Second, that the problematic PA $*[\#a-]$ vocalism is the expected outcome of the interaction between this synchronic process and the same blocking principle invoked to explain the root vocalism of Hitt. *šašanzi* ‘they sleep’ from a PA/PIE $*[s_{\emptyset}s-énti]$ with schwa secundum, which has been extended to roots of the shape $*FeT$ (where $*F$ is $*s$ or any of the Proto-Indo-European laryngeals), whence (e.g.) Hitt. *ašanzi* ‘they are’ like *šašanzi* (§3)
- (iii) Third, that this extension owes to the emergence of new phonotactic constraints in PA—specifically, a highly-ranked SONORITY SEQUENCING PRINCIPLE—the role of which in the grammar can be motivated by the treatment of initial $*/\#FT-/$ onsets in the attested Anatolian languages (§4)
- (iv) And finally, that modeling PA phonology in terms of OPTIMALITY THEORY allows for a unified account of the effects of the SSP on these word-initial onsets as well as its interaction with ablaut in Proto-Anatolian and beyond

[1.4] **A new proposal:** I will develop an alternative approach whereby $*\#a-$ emerges directly from the interaction of inherited ablaut patterns and evolving phonotactic constraints in the synchronic grammar of PA; in what follows, I will argue that:

- (i) the $*e/\emptyset$ root ablaut of PA *mi*-verb paradigms may be modeled as a *synchronic* morphophonological process of vowel reduction (to zero, if possible) that stably continues the PIE situation (§2)
- (ii) the problematic PA $*[\#a-]$ vocalism is the expected outcome of the interaction between this synchronic process and the same blocking principle invoked to explain the root vocalism of Hitt. *šašanzi* ‘they sleep’ < PA/PIE $*[s_{\emptyset}s-énti]$, which has been extended to roots of the shape $*FeT$ (where $*F = \text{PIE } *s, *h_x$), whence (e.g.) Hitt. *ašanzi* ‘they are’ like *šašanzi* (§3)
- (iii) this extension owes to the emergence of new phonotactic constraints in PA—specifically, a highly-ranked SONORITY SEQUENCING PRINCIPLE—the role of which in the grammar can be motivated by the treatment of initial $*/\#FT-/$ onsets in the attested Anatolian languages (§4)
- (iv) modeling PA phonology in terms of OPTIMALITY THEORY (Prince and Smolensky 1993) allows for a unified analysis of both the effects of the SSP on initial $*/\#FT-/$ onsets and its interaction with PA ablaut (§5)

§2 Toward a Synchronic Model of PA Ablaut

I’d like to begin, then, here in §2, with a relatively simple case, and some fairly uncontroversial assumptions. Simple root formations of the Proto-Anatolian *mi*-conjugation are an important locus for the preservation of regular alternations between full-grade of the root in the singular—that is, the strong stem—and zero-grade of the root in the plural—the weak

stem. It is all but universally assumed that these Proto-Anatolian lexical items recapitulate their Proto-Indo-European predecessors; this parallelism is illustrated schematically for **TeT* and **TeR* root shapes in the table in (2)

[2.1] ***[e/∅] Verbal ablaut in PA and PIE** Root formations of the PA *mi*-conjugation preserve regular paradigmatic alternations between full-grade **[e]* singular (strong stem) and zero-grade **[∅]* plural (weak) which are generally assumed to recapitulate their PIE paradigms; this parallelism is illustrated schematically for **TeT* and **TeR* root shapes in (2):

		PIE		Proto-Anatolian		Examples	
(2)	3rd s.	<i>*[TéT-ti]</i>	<i>*[TéR-ti]</i>	<i>*[TéT-ti]</i>	<i>*[TéR-ti]</i>	Hitt. <i>šēšzi</i>	Hitt. <i>kuēnzi</i>
	3rd pl.	<i>*[T_əT-énti]</i>	<i>*[TR-énti]</i>	<i>*[TaT-énti]</i>	<i>*[TR-énti]</i>	<i>šašanzi</i>	<i>kunanzi</i>

cf. Ved. *sásti* : *sasánti*, *hánti* : *ghnánti*

In these forms we observe a one-to-one correlation between surface accent and full-grade; unaccented morphemes appear in zero-grade with the single exception of the weak stem of **TeT* roots, where the normal operation of ablaut would yield the phonotactically inadmissible sequence ^X*TT-*; the outcome here was instead a reduced vowel, schwa secundum, which eventually yields PA **[-a-]*.

[2.2] **An observable alternation:** The data in (2) show a one-to-one correlation between surface accent and full-grade; unaccented morphemes appear in zero-grade, except in the weak stem of **TeT* roots, where the normal operation of ablaut would yield the phonotactically inadmissible sequence ^X*TT-*, whence PA **[-a-]* < PIE **[-ə-]*.

- On weak **[T_əT]* already in PIE, see Mayrhofer (1986:175-76) and Oettinger (1979:78); cf. Schindler (1977:31)

This distribution of accent and ablaut—and this is [2.3] on your handout—recalls the situation traditionally posited for Pre-PIE, where it is assumed that full-grade was underlying, and surface alternations between **[e]* and **[∅]* were governed by a synchronic process of syncope in unstressed syllables; the fact that PA preserves precisely the same regular alternations strongly suggests, at least in this morphological class, this synchronic process of (Pre-)PIE is inherited stably into PA and continued into the attested Anatolian languages—for example, a PIE/PA underlying **/ TeR -énti /* undergoes syncope—or, as we’ll call it momentarily, ZERO-GRADE—and surfaces as **[TRénti]*.

One small, but important thing you may notice here is that I make the distinction, even in reconstructed forms, between their underlying and surface representations, marking underlying forms—as is standard in the generative paradigm—with slant brackets and, and their surface representations with straight brackets. I impose this distinction because—in a proto-language just as in a living language—it is crucial to a meaningful discussion of synchronic processes, which are operative in mapping between these levels, as we’ll soon see.

[2.3] **Toward a synchronic analysis:** This distribution recalls the situation traditionally posited for Pre-PIE, where it is assumed that full-grade **/e/* was underlying, and surface alternations between **[e]* and **[∅]* governed by a synchronic process of syncope in unstressed syllables (cf. Schindler 1975b: 261); the same regular alternations in PA strongly suggest that, in this morphological class, this synchronic process of (Pre-)PIE is inherited stably into PA and continued into the attested Anatolian languages, e.g. PIE/PA **/TeR-énti/* → **[TR-énti]*.

- While it has long been clear that the exact correspondence between accent and ablaut internally reconstructed for pre-PIE no longer holds for PIE generally, this fact does not invalidate the claim that this relationship is maintained in a specific morphological class (cf. §6 for further discussion); further, a small methodological note: it is no less true for the analysis of a *proto-language* than of a living language that the distinction in the generative paradigm between underlying forms (UR) and their surface representations (SR) is prerequisite to a meaningful discussion of synchronic phonological processes; reconstructed forms will therefore consistently be marked with standard notation for these levels—slant brackets / - / for UR, square brackets [-] for SR.

Moving, then, to [2.4]—if we want to model this synchronic process in a rule-based framework, we can do using two basic ordered rules: first, ZERO-GRADE, which reduces unaccented **e* to zero; and second, UNACCENTED VOWEL REDUCTION, which reduces remaining *e* vowels to schwa; these rules together instantiate PIE/PA ABLAUT.

[2.4] Modeling PIE/PA Ablaut: This process may be modeled, in a rule-based framework, with two basic (ordered) rules, (3a) and (3b), which together instantiate PIE/PA ABLAUT:

(3) PIE/PA ABLAUT:

- a. ZERO-GRADE (∅-Gr.): Unaccented **/e/* → **[∅]*
- b. UNACCENTED VOWEL REDUCTION (VR): Unaccented **/e/* → **[ə]*

- Rule (3b) can be conceived as a much shallower process, approximating the phonetic reduction commonly found cross-linguistically in unaccented vowels; on the gradient nature of vowel reduction—with deletion as the extreme case (cf. Zuraw 2002)—see the cogent discussion of Nishimura (2008:44-49, 121-22); such a rule may therefore be more easily subject to diachronic rule loss

In principal either of these rules could be blocked by phonotactic constraints—viz. when they would create an illicit phonological sequence—but in practice, it is only ZERO-GRADE which encounters this problem, since only it creates new consonant clusters. We can see the application of these rules to the PIE data in the table in (4); the PA situation is identical, given the development of schwa to PA *a*. Significantly, we observe that the application of ZERO-GRADE is blocked in the weak stem of **TeT* roots; UNACCENTED VOWEL REDUCTION therefore applies, yielding a surface form with schwa [*T_əT-énti*], which matches Hittite *šašanzi* as we expect.

[2.5] Deriving PA Verbal Ablaut Patterns: Applying the rules in (3) to the data in (2), the surface forms are correctly derived in (4); as in (Pre-)PIE, phonotactic constraints block the application of (3a) in the 3rd pl. of **TeT* roots:

		PIE (=PA)			
	UR	<i>*/TéT-ti/</i>	<i>*/TeT-énti/</i>	<i>*/TéR-ti/</i>	<i>*/TeR-énti/</i>
(4)	∅-Gr.	–	X	–	<i>*TR-énti</i>
	VR	–	<i>*T_əT-énti</i>	–	–
	SR	<i>*[TéT-ti]</i>	<i>*[T_əT-énti]</i>	<i>*[TéR-ti]</i>	<i>*[TR-énti]</i>

- In (4), ‘–’ indicates that the environment for the rule is not met, while ‘X’ means that the rule’s application has been blocked by phonotactic constraints; this derivation is treated in a constraint-based framework in [5.3], below

Now, until this point—and this is [2.6] on your handout—we’ve really seen nothing new, except for the formal apparatus; I’ve taken traditional assumptions about accent and ablaut deep in the proto-language and, for this small morphological class, derived the patterns posited by Schindler and others that have since become the standard handbook reconstruction. This might lead us to question the need for this type of formalization; I believe, however, there are two advantages to this approach:

[2.6] **To what end?** Up to this point, the analysis of PIE/PA verbal ablaut proposed here will yield precisely the same patterns as the traditional paradigmatic approach, which may seem to call into the question the necessity of introducing new formal apparatus; there are, however, at least two advantages:

The first is on purely linguistic grounds; any system we posit should be learnable, since, like speakers of living languages, PIE and PA language learners did not simply lexically list the surface phonetic forms they encountered; rather, they constructed underlying phonemic representations and phonological rules on the basis of which surface forms are predictable; in the case at hand, a speaker need acquire only the knowledge that the root bears an accent in the singular, but is unaccented in the plural, and vice-versa for the inflectional suffix, as well as the simple generalization in (5), which cognitively approximates the rules in (3) above, namely: “Unaccented $*/e/$ is reduced to $*[\emptyset]$ if possible, otherwise to $*[\partial]$ ”. The very simplicity of this grammar may help to explain its remarkable stability over approximately two millenia.

[2.6.1] **Learnability:** Like speakers of living languages, PIE/PA language learners did not simply lexically list the surface phonetic forms they encountered; rather, they constructed underlying phonemic representations and phonological rules on the basis of which surface forms are predictable (cf. Hale 2007:146-47); in the case at hand, a speaker need acquire only the knowledge that the root bears an accent in the singular, but is unaccented in the plural, and vice-versa for the inflectional suffix, as well as the simple generalization in (5):

- (5) PIE/PA ABLAUT GENERALIZATION:
Unaccented $*/e/$ is reduced to $*[\emptyset]$ if possible, otherwise to $*[\partial]$

The second, and even more important reason for adopting this approach is that it will give us a means to address the problematic *a*-vocalism of the roots discussed in §1 that are the primary object of this investigation; we will turn to this point now in §3.

[2.6.2] **PA $*[\#a]$ -vocalism:** The need for a synchronic approach will become apparent when, in §3, we turn to roots of the shape $*h_1eT$ and their problematic $*[\#a]$ -vocalism in the weak stem of verbal paradigms.

§3 An Innovation in PA: the Hittite *ašanzi*-Type Reexamined

Now we know that in PIE $*h_1eT$ - roots inflected in the same way as roots of the shape $*TeR$; if we consider, for example, the weak stem of the root h_1es - ‘be’, we see that ZERO-GRADE applies, leading to the surface form with zero-grade of the root which, after the loss $*h_1$ and the other laryngeals, directly feeds the *s*-initial forms we find in Ved. *sánti*, Osc. *sent*, Goth. *sind*, and the like.

[3.1] **The PIE pattern:** There can be no doubt that, in PIE, $*h_1eT$ - roots inflected in the same way as roots of the shape $*TeR$; the derivation of (e.g.) $*h_1es$ - ‘be’ is schematized in (6a), with forms reflecting the derived SRs in the attested languages in (6b):

		*h_1eT Roots in PIE	
(6)	a.	UR	$*/h_1és-ti/$ $*/h_1es-énti/$
		∅-Gr.	– $*h_1s-énti$
		VR	– –
		SR	$*[h_1és-ti]$ $*[h_1s-énti]$

- b. $*[h_1és-ti]$ > Ved. *ásti* ; Lat. *est* ; Goth. *ist* ; OCS *jestŭ* ; etc.
 $*[h_1s-énti]$ > Ved. *sánti* ; Osc. *sent* ; Goth. *sind* ; OCS *sotŭ* ; etc.

In Proto-Anatolian, however—and this is [3.2] on your handout—speaking from a purely descriptive perspective, we observe that the attested Anatolian 3rd plural form are not the reflex of the PIE surface form with zero-grade of the root; instead, they have the same surface ablaut pattern as $*TeT$ roots; we can therefore mechanically derive the desired 3rd pl. surface pre-form $[*h_{1\varnothing}s-énti]$ with schwa by the application—and non-application—of the same rules, as the table in (7) shows.

[3.2] Divergence in PA: Attested Anatolian 3rd pl. forms do not directly continue $*[h_1T-énti]$ as in PIE, but rather $*[h_{1\varnothing}T-énti]$ > Hitt. *ašanzi*; however, since the surface ablaut pattern of $*h_1eT$ roots is descriptively identical to $*TeT$ (: Hitt. *šašanzi*) roots in PA, this SR can be mechanically derived in (7) by the (non-)application of the same rules:

		*h_1eT Roots in PA		
(7)		UR	$*/h_1és-ti/$	$*/h_1es-énti/$ cf. $*/TeT-énti/$
		∅-Gr.	–	X [?] X
		VR	–	$*h_{1\varnothing}s-énti$ $*T_{\varnothing}T-énti$
		SR	$*[h_1és-ti]$	$*[h_{1\varnothing}s-énti]$ $*[*T_{\varnothing}T-énti]$

This derivation assumes that, like PIE ablaut in $*TeT$ roots, some phonotactic constraint blocked the normal application of ZERO-GRADE in Proto-Anatolian roots of the shape $*h_1eT$ that did not affect these same roots in PIE.

[3.3] Extending the blocking principle: While PIE ablaut was blocked by a strong constraint against word-initial onsets $*[\#TT-]$, $*[\#h_1T-]$ onsets were clearly permissible (whence $*[h_1s-énti]$ > Ved. *sánti*, etc. in (6b), above); the unexplained blocking apparent in (7) can be attributed to phonotactic changes in PA, where $*[\#h_1T-]$ had evidently become problematic—but why?

The hypothesis I'd like to pursue—and this is [3.4]—is that the phonotactic difference between Proto-Anatolian and PIE which causes this divergence is the emergence of a highly-ranked SONORITY SEQUENCING PRINCIPLE (or SSP) in Proto-Anatolian, which will lead to changes in the treatment of sibilant-stop and laryngeal-stop onsets, that is, the natural class of fricatives in Indo-European; in the next section, I'll attempt to motivate the role of this constraint in the grammar of Proto-Anatolian.

[3.4] A minimal innovation in PA (hypothesis): The problematicity of word-initial onsets $*[\#FT-]$ (where $*F = \text{PIE } *s, *h_x$) in PA is due to the emergence of a highly-ranked SONORITY SEQUENCING PRINCIPLE (SSP); the evidence for this development will be assessed in §4.

- For $*s$ and $*h_x$ as a natural class of fricatives in PIE, cf. Byrd (2010: 4-5 with lit.)

§4 Motivating the SSP in PA:

Turning, then, to §4, we might ask first: “What is the SSP?” The SSP is a likely universal tendency for segment sonority to increase approaching a syllabic nucleus, which may be formalized as in (8): “Between any member of a syllable and the syllable peak, only sounds of higher sonority rank are permitted.”

[4.1] **What is the SSP?** The observed cross-linguistic tendency—perhaps universal—for segment sonority to increase approaching a syllabic nucleus, formalized in (8):

- (8) SONORITY SEQUENCING PRINCIPLE (SSP): Between any member of a syllable and the syllable peak, only sounds of higher sonority rank are permitted

(cf. Clements 1990)

Some effects of this principle in Hittite phonology have been convincingly demonstrated by Kavitskaya in her 2001 study; a prominent locus she identifies is the Hittite treatment of Proto-Indo-European—and Proto-Anatolian—underlying word-initial $*/\#sT-/$ onsets; these violate the SSP, since fricatives are more sonorous than stops, and are therefore regularly repaired in Hittite by epenthesis—specifically, via addition of the prothetic vowel $\#i-$. We can see this treatment in the table in (9): a well-established PIE root like, for example, $*spend-$ with ready cognates like Greek and Latin *spendō*, surfaces in Hittite as *ispand-*. This type of repair is typologically well-established as a response to sonority restrictions; a perhaps familiar example is Spanish, where we can compare *escribir* ‘to write’ with Latin *scribere*.

[4.2] **The SSP in Hittite:** The important role of the SSP in the phonology of Hittite has been demonstrated by Kavitskaya (2001) (cf. Yakubovich and Kassian 2002); it motivates (*inter alia*) the treatment of PIE/PA $*/\#sT-/$ clusters, which are regularly repaired by epenthesis (or prothesis; cf. Melchert 1994:29-33) in Hittite, e.g. (9):

	PIE $*/\#sT-/$	Hitt. $*i\check{s}T-$
(9)	$*spend-$	<i>išpanti</i> ‘libates’
	$*skolH-$	<i>iškallai</i> ‘splits’
	$*st(e)w-$	<i>ištuwāri</i> ‘becomes visible’
	$*sh_2em-$	<i>išhamai</i> ‘sings’

- The phonological interpretation of the *very* few secure examples of inherited $*/\#h_xT-/$ clusters (e.g. Hitt. *ḫatukzi* ‘is fearful’; cf. Gk. ἀτύζομα ‘am afraid’)—viz. direct evidence for the treatment of an underlying $*/\#h_xT-/$ onset in PA—remains unclear; one possibility is that there was a very early epenthesis in this sequence (cf. Keydana 2012:233 and n. 24), given that an onset $*/\#h_xT-/$ is a more flagrant violation of the SSP than $*/\#sT-/$, since $*h_x$ is more sonorous than $*s$ (cf. Byrd 2010:4)

I’ll note here too, in passing, that this account poses no problem for word-initial underlying laryngeal-resonant onsets; there is no violation of the SSP here, since fricatives are less sonorous than resonants, hence there is no repair, as we see in [4.2.1] for Hitt. *link-* and Cuneiform Luwian *likk-* ‘swear’, which surface with just an initial resonant after the general loss of $*h_1$ in late Proto-Anatolian.

[4.2.1] **A non-problem:** Since $*/\#h_xR-/$ does not violate the SSP, no repair is necessary; this initial sequence is preserved until the general loss of $*h_1$ in late PA, whence Hitt. *link-*, CLuw. *likk-* ‘swear’ $< *h_1leng^h-$ (cf. Gk. ἐλέγχω).

In Luvian—and this is [4.3] on your handout—we find that PIE $*sT-$ roots consistently surface without the initial fricative; this deletion is most economically understood as a different mode of phonological repair in response to the same problem, namely, onsets that violate a highly-ranked SSP; these Luvian deletions are evident in the table in (10), where the corresponding Hittite lexemes clearly show epenthesis, e.g. the morphological (near) equation between Cuneiform Luvian *parritti* ‘spreads’ and Hittite *ispari*.

[4.3] **The SSP in Luvian and the comparison with Hittite:** Luvian similarly exhibits effects of a highly-ranked SSP, where it instead drives deletion, e.g. (10):

	PIE $*/\#sT-/$	CLuw. <i>T-</i>	Hitt. <i>išT-</i>
(10)	<i>*spor-</i> ‘spread’	<i>parritti</i>	<i>išpāri</i>
	<i>*st(e)h₃men-</i> ‘ear’	<i>tummān</i>	<i>ištāmanan</i>

- Significantly, note that the root-initial $*\#s-$ remains where it does not violate the SSP: CLuw. *hišhiyanti* ‘they bind’ ($< \text{PIE } */h_2i-sh_2-/$)

The SSP-driven effects we observe in these languages—different repairs in each, as evident in (11), but motivated by the same phonological principle—give us good reason to believe that the SSP was also highly-ranked in Proto-Anatolian, and therefore provide independent motivation for assuming that it could also function to block the regular operation of ablaut—specifically, the Zero-Grade rule—that we hypothesized in section [3.3] above in order to derive the surface form that will properly yield Hittite *ašanzi*.

[4.4] **Reconstructing the SSP in PA:** The treatment of underlying PIE/PA $*/\#FT-/$ onsets in Hittite and Luvian—summarized in (11)—provide independent motivation for a highly-ranked SSP in PA and, as such, compelling evidence for its function in blocking the regular operation of PA ablaut (viz. rule (3a), above).

$$(11) \text{ PA } */\#FT-/ > \text{ Hitt. } [/\#iFT-], \text{ Luw. } [/\#T-]$$

Significantly, however, it must be understood that ‘highly-ranked’ is a relative term. While PA ablaut is blocked where its operation would result in onsets that violate the SSP, the differing developments of *underlying* $*/\#FT-/$ in Hittite and Luvian strongly suggest that this sequence remained intact in PA surface forms, viz. underlying word-initial $*/\#FT-/$ mapped to surface $*/\#FT-$. The most economical interpretation of these two facts is, as stated in (12), that falling sonority (viz. SSP-violating) onsets were phonotactically problematic already in PA—not so bad that underlying sequences were repaired, but bad enough to prevent new violations from arising on the surface.

In the next section, I’d like to discuss how this generalization—an important one, I think, with potential systemic consequences for Proto-Anatolian phonology—can be implemented in a formal model.

[4.5] **Ranking is relative:** PA ablaut is blocked where it would create SSP violations; however, the differing developments of *underlying* */#FT-/ in Hittite and Luwian strongly suggest that this sequence remained intact in PA surface forms, viz. */#FT-/ → *[#FT-]; these facts point to the general principle in (12), which will be formalized in §5:

(12) PROTO-ANATOLIAN SSP GENERALIZATION::

Falling sonority (viz. SSP-violating) onsets are phonotactically problematic in PA: underlying sequences are not phonologically repaired, but additional violations are not permitted on the surface.

§5 Modeling SSP-Effects in Proto-Anatolian:

In order to capture this generalization—and this is §5 on your handout—we need an approach that allows us to formalize the interaction between conflicting phonological imperatives, namely, reduction of unaccented vowels and the avoidance—but significantly, not the wholesale elimination—of SSP violations. Though this isn't possible in a purely rule-based approach, it lends itself quite naturally to implementation in terms of OPTIMALITY THEORY (or OT).

I propose here an analysis which utilizes just the three basic and two Indo-European specific constraints in (13). The two PA/PIE-specific constraints are, in effect, OT 'translations' of the rules formulated above in (3), that is, (3a) ZERO-GRADE, which deletes unaccented */e/, and (3b) UNACCENTED VOWEL REDUCTION, which reduces unaccented */e/ to *[ə]; significantly, we'll recall that both of these rules are based on traditional assumptions about Proto- or, more accurately, Pre-Proto-Indo-European ablaut processes. The other three constraints are staples of OT: MAX-C militates against deletion, DEP-V against epenthesis, and SSP, predictably, against SSP violations. In the interest of time, I'd like to focus generally on the constraint rankings and the insights this analysis yields rather than the details of its implementation; however, I've sketched a somewhat more complete OT solution to this problem, including full tableaux, in the Appendix to this paper, to which I refer those who are interested.

[5.1] **Toward a formal model:** While this phonological generalization is difficult to capture in a (purely) rule-based approach, it may be formally implemented in terms of OPTIMALITY THEORY (OT) (Prince and Smolensky 1993); this analysis utilizes the three basic and two PIE/PA-specific constraints in (13)—for a fuller solution (with tableaux), see the Appendix in §7:

- (13)
- | | | |
|--------|--|------------------------|
| MAX-C: | A [-syll] segment (C) in the input must have a correspondent in the output | (= Don't delete!) |
| DEP-V: | A [+syll] segment (V) in the output must have a correspondent in the input | (= Don't epenthesize!) |
| SSP: | Violations of the SSP are not permitted. | |
| *è : | Unaccented [e] is not permitted in the output. | (= rule (3a), above) |
| *ə : | [ə] is not permitted in the output. | (= rule (3b), above) |

Now, in order to generate the non-repair of Proto-Anatolian word-initial underlying */#FT-/, we assume a highly-ranked SSP that is minimally outranked by MAX-C and DEP-V, which prevent the repair strategies we see realized in Hittite and Luwian; these languages have independently innovated in re-ranking of the SSP with respect to one of these

faithfulness constraints: the SSP is promoted above DEP-V in Hittite, leading to epenthesis; and above MAX-C in Luwian, resulting in deletion; the constraint rankings at each stage are schematized in (14):

[5.2] **(Re)-ranking PA constraints:** The (non-)repair of PA underlying $*/\#FT-/$ is generated by assuming a highly-ranked SSP that is (minimally) outranked by MAX-C and DEP-V, which militate against the repair strategies evident in Hittite and Luwian; these languages have independently innovated in re-ranking of the SSP with respect to one of these faithfulness constraints: the SSP is promoted above DEP-V in Hittite (\Rightarrow epenthesis) but above MAX-C in Luwian (\Rightarrow deletion); the constraint rankings at each stage are schematized in (14):

- (14) **Proto-Anatolian:** MAX-C, DEP-V \gg SSP
Hittite: MAX-C \gg SSP \gg DEP-V \Rightarrow epenthesis
Luwian: DEP-V \gg SSP \gg MAX-C \Rightarrow deletion

With these constraints established—and this is [5.3]—we are now equipped to take on the ablaut problem. The constraint ranking in (15), with the SSP crucially dominating our constraint against surface schwa, will predict the correct surface form with schwa $*[h_{1\sigma}s-énti]$ that eventually gives us Hitt. *ašanzi*.

[5.3] **The Interaction of the SSP and PA Ablaut:** The separate ranking reversals evident in Hittite and Luwian *independently* motivate a high-ranking SSP in PA; the constraint ranking in (15), with the SSP crucially dominating $*\sigma$, predicts the correct surface form $*[h_{1\sigma}s-énti] >$ Hitt. *ašanzi*.

- (15) **Proto-Anatolian:** SSP, $*\acute{e} \gg * \sigma$

Unifying this constraint ranking with the ranking established for the initial $\#FT-$ onsets, it is possible to reconstruct for PA the preliminary constraint grammar which allows us to accomplish our purpose in adopting an OT framework, namely, to implement in formal terms the phonological generalization stated above in (12), and for convenience repeated below:

[5.4] **Building a constraint grammar for PA:** Unifying the constraint rankings established in (14) and (15), it is possible to reconstruct for PA, Hittite, and Luwian the preliminary constraint grammars in (21); these rankings capture in formal terms the phonological generalization stated in (12), repeated below:

- (16) **Proto-Anatolian:** MAX-C, DEP-V \gg SSP, $*\acute{e} \gg * \sigma$
Hittite: MAX-C \gg SSP, $*\acute{e} \gg$ DEP-V $\gg * \sigma$
Luwian: DEP-V \gg SSP, $*\acute{e} \gg$ MAX-C $\gg * \sigma$

- (12) **PROTO-ANATOLIAN SSP GENERALIZATION:**
 Falling sonority (viz. SSP-violating) onsets are phonotactically problematic in PA: underlying sequences are not phonologically repaired, but additional violations are not permitted on the surface.

§6 Conclusions, Considerations, and Future Research

Very briefly, then, to wrap up here in §6: in this study, I've aimed to show that a primarily synchronic approach to Proto-Indo-European and, in turn, Proto-Anatolian ablaut grounded in traditional assumptions about its operation in the proto-language can derive not only the standard handbook reconstructions for Proto-Indo-European verbal paradigms, but also handle recalcitrant data—specifically, it offers a purely morphophonological explanation for the Proto-Anatolian weak stem $*[\#a\text{-}]$ -vocalism in Hitt. *ašanzi*, *adanzi*, etc.

[6.1] Toward a new conception of PA ablaut: I have demonstrated that a primarily synchronic (and shallow diachronic) approach to PA ablaut grounded in traditional assumptions about its operation in the proto-language can not only account for the ‘normal’ alternations reconstructed for PIE verbal paradigms, but also for a wider range of phenomena, including offering a purely morphophonological explanation for the problematic PA weak stem $*[\#a\text{-}]$ -vocalism in Hitt. *ašanzi*, *adanzi*, etc.

This problematic vocalism is derived from the interaction of ablaut and phonotactic constraints which are *independently* motivated in the grammar—in the case at hand, the observable effects of the SSP in Hittite and Luwian on word-initial $*/\#FT\text{-}/$ onsets; I have repeatedly emphasized this point because, like rule-based approaches, Optimality Theory can be very powerful—too powerful, in fact, since constraints can be devised *ad hoc* to capture virtually any phonological phenomenon; this power is checked only if we find the constraints we posit doing work elsewhere in the grammar, that is, quite separate from the problem we have adduced them to solve.

[6.2] OT in diachronic phonology: This problematic vocalism is derived in OT from the interaction of ablaut and phonotactic constraints which are *independently* motivated in the grammar—in the case at hand, the observable effects of the SSP in Hittite and Luwian on initial $*/\#FT\text{-}/$ onsets.

- For the correct application of this principle, see Byrd (2010:esp. 128-29).

Furthermore—and this is [6.3] on your handout—this investigation has identified at least one case in which the attempt to map from a Pre-PIE reconstructed form directly into the attested languages has rendered a morphophonological problem entirely invisible; its recognition and, thereupon, solution depends crucially on reconstructing intermediate stages—principally here, Proto-Anatolian—and allowing for diachronic change in the interaction of synchronic phonological processes. This critique has been leveled, more generally, at the traditional paradigmatic approach to accent and ablaut—perhaps most cogently by Mark Hale in FsMelchert. I hope that this study constitutes a small step toward a viable alternative approach.

[6.3] On Reconstructing Ablaut in PA and PIE: In the case of PA verbal ablaut, the attempt to map directly from a (Pre-)PIE reconstructed form into the attested languages has obscured a morphophonological problem that can be solved by reconstructing synchronic phonological systems at intermediate stage(s) (viz. PA); for this critique of the traditional paradigmatic approach to accent and ablaut, see esp. Hale (2010:87-88).

- More generally, the traditional ‘paradigmatic’ approach to PIE ablaut and its relationship with word accent (e.g. Schindler 1972, 1975a,b) has been criticized for non-trivial shortcomings with respect to both descriptive adequacy

(explaining actual attested forms) and empirical coverage (extending to all morphological classes), as well as typological plausibility, e.g. Kiparsky (2010), Kümmel (2013, 2014), Kim (2002, 2013), and Keydana (2005, 2013).

That said, I readily acknowledge that Proto-Anatolian simple root *mi*-verbs constitute a very exceptional morphological class in that full-grade and surface accent stand in a 1-to-1 relationship—if only the same were true for the rest of Indo-European morphology! In order to productively apply this approach to more complex categories will require a more nuanced view of the principles of accent assignment in Proto-Indo-European. Some promising work has been done on this front recently by Paul Kiparsky and Martin Kümmel, among others; and tomorrow we'll see some of these ideas pursued in more detail by my colleagues Jesse Lundquist and Ryan Sandell.

[6.4] An easy case? PA simple root *mi*-verbs constitute a very exceptional morphological class in that full-grade and surface accent correlate 1-to-1; to apply this approach to more complex categories will require a more nuanced view of the principles of accent assignment in PIE (cf. Kiparsky 2010; Kümmel 2013, 2014; Keydana 2005, 2013).

I'd like to end today by just briefly mentioning a few interesting problems in Anatolian phonology where the synchronic, constraint-based approach I've employed today can be applied, tested, and ultimately, refined.

[6.5] Looking forward: Some potential applications of the synchronic, constraint-approach here employed:

An advantage of working in an OT framework is that, in assembling a constraint set sufficient to account for SSP-effects—in particular, its interaction with verbal ablaut in Proto-Anatolian and the Anatolian languages—a preliminary constraint grammar has been established for PA that can be used to investigate other phonological phenomena in the attested Anatolian languages; a very promising candidate is the epenthesis regularly observed in Hittite iterative/inchoative verbal forms built by adding the inherited *-ske-* suffix to consonant-final roots, e.g. *appiške-* to *app-* 'take'; this process seems very likely to be, at least in part, sonority-driven, though a number of important details remain to be worked out.

[6.5.1] Refining the constraint set: In determining the constraints necessary to account for SSP-effects in Proto-Anatolian and the attested Anatolian languages, a preliminary constraint grammar has been established for PA that can be used to investigate other phonological phenomena in the attested Anatolian languages, such as Hittite *-ške-* (< PIE **-ské/ó-*) epenthesis, e.g. Hitt. *appiške-* : *epp-/app-* 'take' (cf. Melchert 2013:178-80).

Furthermore, if this approach to Proto-Anatolian ablaut is essentially correct, it should be possible to extend analysis to the nominal system; we should be encouraged by the fact that it generates correct predictions for the good Proto-Indo-European 'earth' word realized in Hittite with nom./acc. s. *tēkan* and genitive *taknāš*, but this—and many others questions—await systematic study.

Thank you.

[6.5.2] **Extension to nominal paradigms:** If this approach to PA ablaut is correct, it should be possible to extend it to the nominal system; it is recommended by the correct predictions it makes for Hitt. *tēkan* / *takn-* ‘earth’ < * $[d^h \acute{e}g^h - \bar{o}m]$ / * $[d^h \circ g^h m - \acute{V}]$, but the question calls for much further systematic research.

§7 Appendix: An OT Solution

[7.1] **An OT approach to PA phonology:** The solution developed here in the formal framework of OPTIMALITY THEORY (Prince and Smolensky 1993) utilizes the set of constraints in (17):

- (17)
- MAX-C: A [-syll] segment (C) in the input must have a correspondent (= Don’t delete!) in the output
 - DEP-V: A [+syll] segment (V) in the output must have a correspondent in the input (= Don’t epenthesize!)
 - SSP: Violations of the SSP are not permitted.
 - *è : Unaccented [e] is not permitted in the output. (= rule (3a), above)
 - *ə : [ə] is not permitted in the output. (= rule (3b), above)

[7.2] **The (non-)repair of PA */#FT-/:** As noted in [4.5], underlying */#FT-/ onsets surface unchanged in PA, undergoing neither epenthesis (as in Hittite) nor deletion (Luwian); this PA pattern emerges from the ranking in (18a), correctly generating SR * $[sp\acute{o}r-ei]$, as confirmed by the tableau in (18b):

- (18) a. **Proto-Anatolian:** MAX-C, DEP-V \gg *SSP

b.

Input: / <i>spór-ei</i> /	MAX-C	DEP-V	SSP
a. $\text{𐎗𐎎} \text{ } sp\acute{o}r-ei$			*
b. <i>pór-ei</i>	*!		
c. <i>ispór-ei</i>		*!	

[7.3] **An independent innovation:** Hittite and Luwian have separately innovated in re-ranking of the SSP with respect to one of these faithfulness constraints; it is promoted above DEP-V in Hittite, resulting in epenthesis, and above MAX-C in Luwian, resulting in deletion; (19) contrasts the relative rankings in Hittite and Luwian with Proto-Anatolian; the corresponding tableaux are in (19b) and (19c) respectively:

- (19) a. **Proto-Anatolian:** MAX-C, DEP-V \gg *SSP

Hittite: MAX-C \gg SSP \gg DEP-V

⇒ epenthesis

Luwian: DEP-V \gg SSP \gg MAX-C

⇒ deletion

- b. **Hittite:** Hitt. *išpāri* ‘spreads’

Input: / <i>spór-ei</i> /	MAX-C	SSP	DEP-V
a. <i>spór-ei</i>		*!	
b. <i>pór-ei</i>	*!		
c. $\text{𐎗𐎎} \text{ } i\acute{s}p\acute{o}r-ei$			*

c. **Luwian:** CLuw. *pari(tti)* ‘spreads’

Input: /spór-ei/	DEP-V	SSP	MAX-C
a. spór-ei		*!	
b. ☞ pór-ei			*
c. ispór-ei	*!		

[7.4] **Motivating reversal(s):** The separate ranking reversals evident in Hittite and Luwian are explained most plausibly by assuming a highly-ranked SSP in PA, the effects of which are (minimally) suppressed by still higher-ranked MAX-C and DEP-V; as argued already in [4.4], they constitute *independent* motivation for ranking the SSP such that it blocks PA ablaut processes.

[7.5] **PA Ablaut and the SSP:** The constraint ranking in (20a) will predict the correct surface form *[h₁ə̌s-énti] > Hitt. *ašanzi*, as shown in the tableau in (20b):

- (20) a. **Proto-Anatolian:** *è, SSP ≫ *ə̌
 b. PA *[ašánti] < *[h₁ə̌s-énti]

Input: /h ₁ es-énti/	*è	SSP	*ə̌
a. h ₁ es-énti	*!		
b. h ₁ s-énti		*!	
c. ☞ h ₁ ə̌s-énti			*

[7.6] **Building a constraint grammar for PA:** Unifying the constraint rankings established in (18a) and (20a), it is possible to reconstruct for PA the preliminary constraint grammar in (21); these rankings capture in formal terms the phonological generalization stated in (12):

- (21) **Proto-Anatolian:** MAX-C, DEP-V ≫ SSP, *è ≫ *ə̌
Hittite: MAX-C ≫ SSP, *è ≫ DEP-V ≫ *ə̌
Luwian: DEP-V ≫ SSP, *è ≫ MAX-C ≫ *ə̌

[7.7] **Nominal paradigms and PIE ‘earth’:** The same constraint set that correctly predicts PA verbal ablaut patterns also correctly generates the weak stem of Hitt. *takn-* ‘earth’ < *[d^hġ^h-m-ŷ], suggesting that this approach may be productively applied in the nominal domain.

- (22) **Hittite:** Hitt. *taknāš* ‘earth’ [n. gen. s.] < *[d^hə̌ġ^hmós]

Input: /d ^h eġ ^h -em-ós/	*è	SSP	*ə̌
a. d ^h eġ ^h -em-ós	*!*		
b. d ^h eġ ^h -m-ós	*!		
c. d ^h ġ ^h -m-ós		*!	
d. ☞ d ^h ə̌ġ ^h -m-ós			*

References

Byrd, A. M. (2010). *Reconstructing Indo-European Syllabification*. Ph. D. thesis, University of California-Los Angeles.

- Clements, G. N. (1990). The role of the sonority cycle in core syllabification. In J. Kingston and M. Beckman (Eds.), *Papers in Laboratory Phonology I: Between the grammar and physics of speech*, pp. 282–333. Cambridge, UK / New York: Cambridge University Press.
- Hale, M. (2007). *Historical Linguistics: Theory and Method*. Oxford: Blackwell.
- Hale, M. (2010). *Návyasā vácaḥ*: To Praise with a Really Old Word. In R. Kim, N. Oettinger, E. Rieken, and M. Weiss (Eds.), *Ex Anatolia Lux: Anatolian and Indo-European Studies in honor of H. Craig Melchert on the Occasion of his Sixty-Fifth Birthday*, pp. 85–97. Ann Arbor, MI / New York: Beech Stave Press.
- Kavitskaya, D. (2001). Hittite Vowel Epenthesis and the Sonority Hierarchy. *Diachronica* 18(2), 267–269.
- Keydana, G. (2005). Indogermanische Akzenttypen und die Grenzen der Rekonstruktion. *Historische Sprachforschung* 118, 19–47.
- Keydana, G. (2012). Evidence for non-linear phonological structure in Indo-European: The case of fricative clusters. In B. N. Whitehead, T. Olander, B. A. Olsen, and J. E. Rasmussen (Eds.), *The Sound of Indo-European: Phonetics, Phonemics and Morphophonemics*, pp. 223–242. Copenhagen: Museum Tusulanum Press.
- Keydana, G. (2013). Proterokinetische Stamme, Akzent und Ablaut. In G. Keydana, P. Widmer, and T. Olander (Eds.), *Indo-European Accent and Ablaut*. Copenhagen: Museum Tusulanum Press.
- Kim, R. I. (2002). *Topics in the Reconstruction and Development of Indo-European Accent*. Ph. D. thesis, University of Pennsylvania.
- Kim, R. I. (2013). Metrical grid theory, internal derivation and the reconstruction of PIE nominal accent paradigms. In G. Keydana, P. Widmer, and T. Olander (Eds.), *Indo-European Accent and Ablaut*. Copenhagen: Museum Tusulanum Press.
- Kimball, S. (1999). *Hittite Historical Phonology*. Innsbruck: Institut für Sprachwissenschaft der Universität Innsbruck.
- Kiparsky, P. (2010). Compositional vs. Paradigmatic Approaches to Accent and Ablaut (revised version at <http://www.stanford.edu/~kiparsky/>). In *Proceedings of the 21st Annual UCLA Indo-European Conference, Los Angeles, October 30-31, 2009*. Bremen: Hempen.
- Kloekhorst, A. (2004). The Preservation of **h₁* in Hieroglyphic Luwian: Two Separate *a*-Signs. *Historische Sprachforschung* 117(1), 26–49.
- Kloekhorst, A. (2007). *Etymological Dictionary of the Hittite Inherited Lexicon*. Leiden / Boston: Brill.
- Kümmel, M. (2013). Proterokinetic problems again: the genitive plural. Paper presented at the 32nd East Coast Indo-European Conference, Poznań, June 2013.
- Kümmel, M. (2014). Zum “proterokinetischen” Ablaut. In N. Oettinger and T. Steer (Eds.), *Das indogermanische Nomen: Akten der Arbeitstagung der Indogermanischen Gesellschaft, Erlangen, 2011*. Wiesbaden: Reichert.
- Mayrhofer, M. (1986). *Indogermanische Grammatik, Band I/2: Lautlehre*. Heidelberg: Carl Winter.
- Melchert, H. C. (1994). *Anatolian Historical Phonology*. Amsterdam / Atlanta: Rodopi.
- Melchert, H. C. (2010). The Spelling of Initial /A-/ in Hieroglyphic Luwian. In I. Singer (Ed.), *ipamati kistamati pari tumatimis: Luwian and Hittite Studies Presented to J. David Hawkins on the Occasion of his 70th Birthday*, pp. 147–58. Tel Aviv: Emery and Claire Yass Publications in Archaeology.
- Melchert, H. C. (2013). Hittite “Heteroclitite” *s*-Stems. In A. I. Cooper, J. Rau, and M. Weiss (Eds.), *Multi Nominis Grammaticus: Studies in Classical and Indo-European linguistics in honor of Alan J. Nussbaum on the occasion of his sixty-fifth birthday*, pp. 175–184. Beech Stave Press.
- Nishimura, K. (2008). *Vowel Reduction and Deletion in Italic: Effects of Stress*. Ph. D. thesis, University of California-Los Angeles.
- Oettinger, N. (1979). *Die Stammbildung des hethitischen Verbuns*, Volume 64. Nürnberg: Carl.
- Prince, A. and P. Smolensky (1993). *Optimality Theory: Constraint interaction in generative grammar*. New Brunswick, NJ: Rutgers University Center for Cognitive Science.

- Schindler, J. (1972). L'apophonie des noms-racines. *Bulletin de la Société de Linguistique de Paris* 67, 31–38.
- Schindler, J. (1975a). L'apophonie des thèmes indo-européens en *-r/n-*. *Bulletin de la Société de Linguistique de Paris* 70, 1–10.
- Schindler, J. (1975b). Zum Ablaut der neutralen *s*-Stämme des Indogermanischen. In H. Rix (Ed.), *Flexion und Wortbildung: Akten der V. Fachtagung der Indogermanischen Gesellschaft, Regensburg, 9. bis. 14. September 1975*. Wiesbaden: Reichert.
- Schindler, J. (1977). A Thorny Problem. *Die Sprache* 23, 25–35.
- Weeden, M. (2011). Spelling, phonology and etymology in Hittite historical linguistics. *Bulletin of the School of Oriental and African Studies* 74(01), 59–76.
- Yakubovich, I. and A. Kassian (2002). The Reflexes of IE Initial Clusters in Hittite. In V. Shevoroshkin and P. Sidwell (Eds.), *Anatolian Languages*, pp. 10–49. Canberra: Association for the History of Language.
- Zuraw, K. (2002). Vowel Reduction in Palauan Reduplicants. In *Proceedings of AFLA 8: The Eighth Meeting of the Austronesian Formal Linguistics Association*, pp. 385–398.