Functional grounding inside the phonology: Evidence from positional augmentation

Jennifer L. Smith
University of North Carolina, Chapel Hill, USA
jlsmith@unc.edu

I. Overview of the talk

(1) This talk addresses **markedness/unmarkedness** in the sense of **well-formedness conditions on phonological structures**

Question: Why do phonological patterns often involve well-formedness conditions that make sense phonetically?

(2) Possible explanations

(a) Phonetic factors have effects ***internal to the phonological grammar***
(e.g., Archangeli & Pulleyblank 1994; Flemming 1995; Boersma 1998; Kirchner 1998; Hayes 1999)

(b) Phonetic factors provide influence ***external to the phonology***
• speech perception • language acquisition • diachronic change

▸ the formal phonology is phonetics-free
(e.g., Anderson 1981; Blevins & Garrett 1998, 2004; Hale & Reiss 2000; Ploch 1999; Hyman 2001; J.A. Barnes 2002)

(3) Today's argument

(a) **Positional augmentation constraints** (markedness constraints on prominent positions) are **restricted by functional factors**

(b) The functional restrictions on these constraints **cannot all be reanalyzed as the effects of diachronic misperception+phonologization processes**

▸ At least some functional grounding is *internal* to the formal grammar.

Structure of the talk
II. The functional grounding debate
III. Positional augmentation — overview
IV. Positional augmentation — case studies
V. A misperception account for PA?
VI. Conclusions

II. The functional grounding debate

A. Functional grounding as a restriction on formal grammars

(4) Formal phonological grammars allow for the expression of both "natural" and "unnatural" rules/constraints/processes (Chomsky & Halle 1968; Eisner 1997)

(a) Unnatural rule

[+nas] → [-voi] / __ [+lab]	'Nasals become voiceless before labials'
cf. **[+nas]** → [+lab] / __ **[+lab]**	'**Nasals** become labial **before labials**'
[-son] → **[-voi]** /__ #	'Obstruents **become voiceless** when final'

(b) Unnatural constraint

*[+NAS, +VOI]	'Segments are not both nasal and voiced'
cf. *[**+NAS**, -VOI]	'**Segments are not both nasal** and voiceless'
*[-SON, **+VOI**]	'Segments are not both obstruent **and voiced**'

(5) A way of addressing the problem of formal overgeneration:
functional grounding (term due to Archangeli & Pulleyblank 1994)

- The proposal that **phonological entities or processes** are based on, determined by, or restricted by **functional factors** (phonetic, psycholinguistic, ...)
  - ▸ functional factors themselves are usually assumed to be external to the formal grammar

(6) Example (after Archangeli & Pulleyblank 1994:168)

(a) *If [-sonorant] then [-voice]* — this implication is grounded

(b) *If [-sonorant] then [+voice]* — not grounded; does not reflect physical correlates of the feature values involved

(7) Many researchers propose that functional grounding is ***internal to the grammar***
- ▸ the formal objects and operations in the phonological system are directly constrained by functional factors

- Examples of this position include
  - The discussion of markedness in Chomsky & Halle (1968:Ch 9)
  - Natural Generative Phonology (Vennemann 1974, Hooper 1976)
  - Natural Phonology (Stampe 1973, Donegan 1978, Donegan & Stampe 1979)
  - Archangeli & Pulleyblank (1994)

(8) Grammar-internal functional grounding has also been implemented in Optimality Theory (OT; Prince & Smolensky 1993; McCarthy & Prince 1995)

▸ usually as a requirement that some, or all, of the **constraints** in the grammar are grounded (have phonetic or psycholinguistic motivation)

• Examples of OT work that assumes this principle:

- Beckman (1995, 1998)
- Casali (1996)
- Flemming (1995)
- Hayes (1999)
- Jun (1995)
- Kirchner (1998, 2001)
- Padgett (1995, to appear)
- Prince & Smolensky (1993:§5.1)
- Smith (2000, 2002)
- Steriade (1997, 2001)
- Walker (1998)
- Wilson (2001)
- Zhang (2000, 2001)
- *many articles in* Hayes, Kirchner, & Steriade (2004)

(9) OT **facilitates** the assumption of grammar-internal functional grounding, but does not **entail** this assumption

(a) OT provides a formal mechanism that allows functionally motivated tendencies to determine the grammars of natural languages

• The phonologies of individual languages are the result of interactions among ranked and violable constraints

• Constraints are a straightforward way of directly modeling functional pressures as part of the phonological grammar

(b) However, the OT framework does not inherently require all of the constraints in the system to reflect functionally motivated tendencies

(10) Consequences

(a) If constraints are functionally motivated, we need separate theories of
- which constraints are grounded
- how the grounding is enforced

(Eisner 1997; Hayes 1999; Smith 2002)

(b) A phonological system that does **not** assume grammar-internal functional grounding is equally compatible with the basic OT framework

B. Another view: Functional factors are grammar-external

(11) The formal grammar is ***not*** functionally grounded
(Ohala 1981, 1993; Anderson 1981; Blevins, to appear; Blevins & Garrett 1998, 2004; Hale & Reiss 2000; Hyman 2001; Kavitskaya 2001; Kochetov 2001; J.A. Barnes 2002)

(a) Apparent patterns of functional grounding have a **simpler explanation** outside the formal phonology
• speech perception • language acquisition • diachronic change

(b) If functional factors constrain the way that language is transmitted from one generation to the next, there is no need to duplicate these factors in the formal grammar, thereby complicating the grammatical model

C. Example: The vowel reduction asymmetry

(12) The pattern: Many languages reduce some or all vowels to [ə] in **unstressed syllables**

(13) The question: Why are there no languages that reduce vowels to [ə] in **stressed syllables?**

(14) Functional explanation:
• Unstressed syllables are often shorter than stressed syllables (especially in languages with vowel reduction! — Crosswhite 1999)
▸ longer stressed syllables allow fuller realization of articulatory targets
▸ shorter unstressed syllables are subject to articulatory undershoot

• How do we relate this functional explanation to the formal grammar?

(15) **Grammar-internal functional grounding account**
One implementation: Positional markedness (Steriade 1993; Crosswhite 1999)

(a) Posit a constraint *VPLACE/ŏ 'No vowel place features, in unstressed syllables'

(b) There is no formally equivalent *VPLACE/ó, because such a constraint is **not functionally grounded**

(c) The absence of the non-grounded *VPLACE/ó from the universal constraint set accounts for the lack of languages with vowel reduction in stressed syllables only

(16) **Misperception+phonologization account** (after J.A. Barnes 2002)

(a) Start from a language with no vowel reduction

(b) In unstressed syllables, speakers may fail to achieve V targets

UR	*Articulatory intent*	*Acoustic pattern produced*
/páta/	**[páta]**	[páte] ~ [pát̯e] ~ **[pátə]**

(c) Learners may **misperceive** speakers' articulatory intent, and assume that the undershoot form [pátə] is the intended articulation

➡ **vowel reduction is phonologized**

UR	*Articulatory intent*	*Acoustic pattern produced*
/páta/	**[pátə]**	[pátə]

(d) Vowel reduction can never develop in ǵ only, because no speech community will have articulatory undershoot in ǵ only

(e) Crucial difference from the grammar-internal grounding account:
Non-grounded constraints like *VPLACE/ǵ are **not formally excluded** from the universal constraint set.

- These "undesirable" constraints are harmless, because the process of diachronic change through misperception will never lead speakers to rank them high enough to be active in the grammar of any language.

(17) Question: Can the misperception+phonologization approach account for **all** proposed cases of functional grounding in the constraint set?

- If yes:
  - ▸ whenever a formally possible, but functionally unmotivated, constraint seems to be "missing" from the constraint set,
  - ▸ there should be a misperception+phonologization account of the constraint's "absence"

However —

- **Positional augmentation constraints,** which involve the addition of perceptually salient properties to phonologically strong positions (defined below), pose problems for this approach

III. Positional augmentation — overview

(18) **Positional augmentation:** The basic claim (Smith 2000, 2002)
- When a phonological requirement specifically affects **phonologically strong positions,** that requirement must **enhance perceptual salience**
  - ▸ hence the term ***augmentation*** (inspired by Zoll 1998)

(19) **Strong positions**

(a) Have phonetic or psycholinguistic salience (Steriade 1993; Beckman 1998)

(b) Examples:
- stressed syllable
- onset/released consonant
- long vowel
- root
- initial syllable

(c) Known for their characteristic ability to **resist** neutralization processes affecting other positions (Trubetzkoy 1939; Steriade 1993; Beckman 1998)
  - ▸ however, this talk considers cases where strong positions are the **targets** of neutralization processes

(20) Patterns of positional augmentation

(See **Appendix** for language examples, references)

	Strong position	***Prominent property required in that position***
(a)	Main-stress syllable	Heavy syllable High tone Low tone High-sonority peak Onset Low-sonority onset
(b)	Long vowel	High-sonority peak
(c)	Initial syllable	Onset Low-sonority onset
(d)	**Root**	**Stress**
(e)	**Onset**	**Supralaryngeal place**

▸ case studies in next section focus on **root** and **onset**

(21) Formal implementation of positional augmentation in OT
- **Positional augmentation (PA)** constraints:
  markedness constraints specific to ***phonologically strong positions***
  (see also de Lacy 2001, Parker 2001 for discussion and examples)

  ▸ **Markedness constraints**
  - Require some property to hold of surface forms
  - Examine only output (surface) forms; do not regulate input-output relationship

(22) The inventory of PA constraints is **functionally restricted**

(a) Markedness constraints on strong positions always **demand the presence of a perceptually salient property** (perceptual salience ≈ greater neural response)
- Other formally possible markedness constraints on strong positions are not observed to be phonologically active
  ▸ example: *LABIAL/Onset 'Onset consonants are not [Labial]' — *unattested*

(b) This restriction complements other aspects of strong-position behavior
- Strong positions are less susceptible to markedness requirements
  ▸ strong-position-specific markedness constraints are highly restricted

- PA constraints...
  ▸ take a position with intrinsic salience on some dimension
  ▸ and give it additional perceptual salience
  ▸ thereby "making the strong stronger" (compare: the harmonic alignment of prominence scales in Prince & Smolensky 1993:§5.1)

IV. Positional augmentation case studies

A. Root stress (I): Roots must be stressed

The pattern

(23) **Diegueño** (Yuman; Langdon 1975, 1977) — Roots are always stressed

- Data from Langdon (1977:239-240); roots are underlined

(a)	mát	'land'
(b)	tə-xə-mə-k^{w}án-p	'is tangled up'
(c)	m-aːkuːxáp-c-mə-ju *you-catch.up-SAME.SUBJ-you-be*	'Are you catching up with him?'*

*Langdon (1977:239) states that the stem *aːkuːxáp* contains three prefixes, but she does not segment them. Since roots are monosyllabic (Langdon 1975, 1977), the root must be *áp* or *xáp*.

(24) **Tahltan** (Athabaskan; Cook 1972; Alderete 1999; Alderete & Bob to appear)
Roots are stressed (small number of exceptions)

• Data from Alderete & Bob (to appear); roots are underlined

(a)	dè-tʃóʃe	'soft'	
(b)	mèʔe-k'áhe	'his/her fat'	
(c)	ʔèθiː-dlı̂n	'We (dual) danced'	▸ cv̀.***cvː***-ccv́c
(d)	ʔùdes-ʔúːt	'I whistled'	
(e)	ʔudèθiː-dlét	'We (dual) melted it'	▸ cv.cv̀.***cvː***-ccv́c
(f)	dà#dah-séɬa	'Did you (pl) holler?'	▸ cv̀#***cvc***-cv́.cv
(g)	mè-detɬ'ój	'his/her pelts'	

▸ **stress on root,** even if non-root CVV/CVC syllable remains unstressed

The analysis

(25) What constraint ranking is responsible for root stress?

(a) Some constraint must call for root stress
• HAVESTRESS/Root Roots bear stress (formal definition in Smith 2002)

(b) This constraint must outrank other stress-placement constraints, such as
• WEIGHT-TO-STRESS If heavy, then stressed (Prince 1990)
• ALIGN-R(ó, Wd) Every ó is at the right edge of the word (McCarthy & Prince 1993; Walker 1997)
• ALIGN-L(ó, Wd) Every ó is at the left edge of the word

(c) **HAVESTRESS/Root >> { WEIGHT-TO-STRESS, ALIGN-R(ó, Wd), … }**

(d) dà#dah-séɬa 'Did you (pl) holler?' (Tahltan)

...cvc-cvc+v	HAVESTRESS/ Root	WEIGHT-TO-STRESS	ALIGN-R (ó,Wd)	…
☞ a. ...cvc-cv́.cv		*	σ	…
b. ...cv́c-cv.cv	*!		σσ	…
c. ...cvc-cv.cv́	*!	*		…

(26) HAVESTRESS/Root is a PA constraint
- The constraint imposes a requirement on the root
- The root is a strong position (McCarthy & Prince 1995; Beckman 1995, 1998; Casali 1996; Alderete 1999, 2001)
- Stress is perceptually salient ✓

B. Root stress (II): Default stress falls on root

(27) **Tuyuca** (Tucanoan; J. Barnes 1996; Smith 1998)
When default stress is inserted, it appears on the root

▸ HAVESTRESS/Root not always satisfied, but able to drive alternations

The pattern

(28) Tuyuca has lexical contrasts between:
- Stressed and unstressed roots
- Stressed and unstressed suffixes (no prefixes in the language)

(29) Stressed and unstressed roots and suffixes

(data from J. Barnes 1996)

	Roots		**Suffixes**	
Stressed	hóa	'to write'	-mḗnã	'with'
	póa	'hair'	-mãkḗ	'stuff'
	hóo	'to plant manioc'	-díkɨ	'only'
	waí	'fish'	-sotoá	'on top of'
	kapéa	'eye'	-jú	'beforehand'
	keeró	'lightning bug'	-wí	(an evidential)
			-gó	(fem. sg. vb. sfx.)
Unstressed	hoo	'to submerge oneself'	-a	(an evidential)
	nõã	'who'	-i	(an evidential)
	waka	'splinter'	-je	(change of focus)
	waso	'to change'	-sa	(thematic importance)

(30) Exactly one stress per prosodic word (PrWd = root + optional suffixes)

(J. Barnes 1996:41)

		Roots	
		stressed	*unstressed*
Suffixes		(a) /hóa/ 'to write'	(b) /waso/ 'to change'
stressed	(c) /-jú/ (ASP.)	*(i)* hóaju	*(iii)* wasojú
unstressed	(d) /-i/ (EV.)	*(ii)* hóai	*(iv)* wasói

- Stressed root (a) always surfaces with stress *(i, ii)*
- Roots not always stressed — Unstressed root (b) with stressed suffix (c) leads to surface stress on suffix *(iii)*
- **If no lexically stressed morpheme, root bears surface stress** *(iv)*

The analysis

(31) In Tuyuca, HAVESTRESS/Root can be violated ➡ it is dominated

(32) **Unstressed root + stressed affix —> Stress on affix**

(a) **{ MAX-PROM *or* DEP-PROM }, NOSHIFT >> HAVESTRESS/Root**

- MAX-PROM — Stress is not deleted
  A metrical prominence (=stress) in the input has an output correspondent (Alderete 1999, 2001)
- DEP-PROM — Stress is not inserted
  A metrical prominence (=stress) in the output has an input correspondent (Alderete 1999, 2001)
- NOSHIFT — The location of a stress does not shift
  Corresponding prominences have corresponding sponsors, links (NOFLOP-PROM; Alderete 1999, 2001)
- HAVESTRESS/Root — Roots bear stress

(b) /hoo + wí/ *submerge.oneself*-EV 'he submerges himself'

/hoo+wí/	MAX-PROM *or* DEP-PROM	NOSHIFT	HAVESTRESS/Rt
i. hoówi (new stress)	*!		
ii. hoòwi (shifted stress)		*!	
☞ iii. hoowí			*

(c) With this ranking, HAVESTRESS/Root can never force stress in a lexically unstressed root **if** a lexically stressed affix is present

(33) Though dominated, HAVESTRESS/Root is crucial for the Tuyuca stress pattern
- only HAVESTRESS/Rt can account for **default stress insertion into roots**

(34) **Unstressed root + unstressed affix —> Stress on root**

(a) MAX-PROM, DEP-PROM irrelevant when no morpheme has lexical stress
- one stress must be inserted (DEP-PROM violation unavoidable)
- no stress is deleted (MAX-PROM not violated)
- the effects of HAVESTRESS/Root emerge — root stress is chosen

(b) Root stress here cannot be driven by special faithfulness to roots
- default root stress actually **violates** root faithfulness
  (an input property of the root is changed in the output)

(35) Analysis for default root stress

(a) CULMINATIVITY drives stress insertion: **CULMINATIVITY >> DEP-PROM**

• CULMINATIVITY Every prosodic constituent has exactly one head (Alderete 1999)

(b) /hoo + a/ *submerge.oneself*-EV 'I submerge myself'

/hoo+a/	CULM	DEP-PROM	MAX-PROM	HAVE STRESS/Rt	DEP-PROM/Rt
i. hooa	*!			*	
☞ ii. hoóa		*			*
iii. hooá		*		*!	

(36) **Summary:** Tahltan, Diegueño, Tuyuca provide evidence for a phonological requirement that roots bear stress
- ▸ additional languages with root stress
  - • Chukchee (Paleo-Siberian; Krause 1979)
  - • Nancowry (Nicobarese; Radhakrishnan 1981)
  - • Mbabaram (Australian; Dixon 1991)

The constraint responsible for this requirement, HAVESTRESS/Root, meets the criteria of a PA constraint
- ▸ bearing stress makes the root more perceptually salient

C. Supralaryngeal place in onset consonants

(37) Chamicuro (Arawakan; Parker 1994, 2001)
Glottal consonants cannot be onsets

The pattern

(38) Coda [h ʔ] contrastive in Chamicuro (data from Parker 2001:364-5)

(a)	me**ʔ**sa	'sea lion'	(d)	a**ʔ**tikana	'we'
	me**ː**sa	'party'		a**h**tini	'path, trail'
	me**Ø**sa	'table'		uana**s**ti	'I watch, look'
(b)	itʃe**h**ki	'it burns'	(e)	sa**ʔ**pu	'lake'
	itʃe**ː**ki	'it is abundant'		ka**h**pu	'bone'
(c)	me**ʔ**na	'woodpecker'		sje**k**putʂle	'pot-bellied'
	ne**t**na	'how much?'			
	je**l**na	'man, husband'			
	me**Ø**nu	'tongue'			

(39) Distributional pattern: Onset glottals [h ʔ] do not occur
- • Supporting evidence that the absence of onset glottals is linguistically significant?
  - ▸ no alternations are caused by morpheme concatenation (Parker 2001:373)
  - ▸ however, onset glottals are actively altered in loanword adaptation

(40) Evidence from Spanish loanwords in Chamicuro (Parker 2001:373)
• Parker states that Spanish <*j*> is [h], not [x], in lowland jungle Peru

	Spanish		**Chamicuro**	
(a)	*naranja*	naran**h**a	alan**ʃ**a	'orange'
(b)	*jabón*	**h**aβon	**ʃ**awona	'soap'
(c)	*cojo*	ko**h**o	ko**ʂ**o	'lame, crippled'

▸ [h] borrowed as Chamicuro [ʃ] ([ʂ] before back rounded V; *[ʃo], [ʃu])

▸ evidence that the grammar of Chamicuro **actively avoids [h] onsets**
• The phonological repair chosen during loanword adaptation is not necessarily the same as the default repair in the (native) phonological system (Yip 2002; Smith 2004)
• But, the fact **that a repair occurs** is what is important — glottals are actively avoided
• And there is no evidence that this feature-change repair does differ from the default

(41) Other languages that restrict glottal consonants to coda position:
• Tiriyó, Carib, Macushi (Parker 2001:362)
• Yatzachi Zapotec — [ʔ] is an insufficiently salient onset (Borroff 2003)

The analysis

(42) Asymmetry in the inventory of onset and coda segments
• Onsets — can be labial, coronal, palatal, dorsal
• Codas — can be labial, coronal, palatal, dorsal, **glottal**

(43) The only workable analysis involves a **markedness constraint against onset glottals** (see Parker 2001 for detailed argumentation)

• HAVEPLACE/Onset Every onset segment in the output has a [supralaryngeal] Place specification (Parker 2001:371)

(44) Glottal codas surface intact

(a) **MAX-SEG >> IDENT[Place] >> *LAR(YNGEAL)** after Parker (2001:(12))

• MAX-SEG Segments are not deleted
Input segments have output correspondents (McCarthy & Prince 1995)

• IDENT[Place] Place features are not changed
Corresponding segments agree in Place features (McCarthy & Prince 1995)

• *LARYNGEAL Output segments have no [Laryngeal] feature
(Lombardi 1999, 2001)

(b) /nihpa/ 'louse'

/nihpa/	MAX-SEG	ID[Place]	*LAR
☞ a. ni**h**.pa			*
b. ni_.pa	*!		
c. ni**s**.pa		*!	

(45) Glottal onsets surface as non-glottals

(a) **{ HAVEPLACE/Onset, MAX-SEG } >> IDENT[Place]** >> *LARYNGEAL
after Parker (2001:(15))

(b) /nihapa/ hypothetical form

/nihapa/	HAVEPLACE/Onset	MAX-SEG	ID[Place]	*LAR
a. ni.**h**a.pa	*!			*
b. ni._a.pa		*!		
☞ c. ni.**ʃ**a.pa			*	

(46) HAVEPLACE/Onset is a PA constraint
- The constraint imposes a requirement on the onset
- The onset (or, [+release consonant]) is a strong position
  (Kingston 1985, 1990, to appear; Lombardi 1991; Padgett 1995; Steriade 1993, 1997)
- Consonants with supralaryngeal Place features are perceptually salient ✓
  (Stevens 1971; Warner 1998)

V. A misperception account for positional augmentation?

(47) Can the misperception+phonologization approach account for **all** proposed cases of functional grounding in the constraint set? (=(17) above)

- If yes:
  - ▸ whenever a formally possible, but functionally unmotivated, constraint seems to be "missing" from the constraint set,
  - ▸ there should be a misperception+phonologization account of the constraint's "absence"

- **Markedness constraints on strong positions** that do not enhance perceptual salience are unattested — can this gap be explained via misperception?

(48) Review: **Misperception/phonologization account** of functional grounding
- Phonological patterns tend to be phonetically plausible
  - ▸ not because the formal grammar is explicitly limited by functional factors
  - ▸ but because phonological patterns originate when learners misperceive aspects of the acoustic signal and incorporate them into their grammars

A. Specific problems posed by these case studies

(49) Diegueño, Tahltan *(mandatory root stress)*
- What acoustic factors could cause listeners to "misperceive" stress on a root that was not originally stressed?

(50) Tuyuca *(default stress is on the root)*
- Even more problematic, since root stress is not a surface-true generalization

(51) Chamicuro *(onset consonants cannot be glottal)*
- What is known about the diachronic development of glottal consonants does not seem likely to lead to a Chamicuro-type pattern

(a) Diachronically, glottal "fortition"/"buccalization" (change to a different Place feature) is sporadically attested for [h] (Blevins, to appear), but essentially unattested for [ʔ] (Trask 1995)

(b) Deletion of glottal onsets through failure to perceive them at all would indeed give rise to a language with no glottal onsets, but this should imply loss of glottal codas as well (instead, codas persist in Chamicuro)

▸ codas are **less** perceptible than onsets, a fact that is often emphasized in misperception+phonologization accounts of coda neutralization

B. General problems posed by positional augmentation

(52) PA constraints act to **add** perceptual salience
- ▸ their effects are not compatible with a misperception origin

- If X has a salient cue that Y lacks, listeners may misperceive salient X as Y (i.e., they may fail to hear the salient cue)
- However, **listeners do not "imagine" the presence of a nonexistent salient cue** and misperceive Y as salient X (Plauché, Delogu, and Ohala 1997; Chang, Plauché, and Ohala 2001)

(53) Can PA effects come about through the phonologization of perceived salience originating in "low-level" articulatory effects?

(a) A possible source: the phonologization of domain-initial articulatory strengthening? (Keating, Cho, Fougeron, & Hsu 2004)

- stressed syllables ➡ mandatory low-sonority onsets
- word-initial syllables ➡ mandatory low-sonority onsets

(b) But, this is not a plausible explanation for cases where the prominent property enforced by the constraint has **no intrinsic connection** to the position being augmented — like those discussed above

- roots ➡ mandatory stress
- onsets ➡ mandatory supralaryngeal Place features

(54) More broadly: Why PA is hard to reduce to misperception+phonologization

▸ the functional restriction on PA constraints (=perceptual salience) is **abstract** — it is a general functionally determined requirement, not tied to characteristics of particular constraints or particular strong positions

(55) Compare: a similar argument against the misperception+phonologization account raised by Steriade (2001:233) for nasal place assimilation

(a) Cross-linguistically, nasals are the most likely consonants to undergo place assimilation

(b) Results from perceptual-confusion experiments (Hura, Lindblom, & Diehl 1992) show that place features are more easily confused in nasals than in stops or fricatives

(c) But, nasals were most often misperceived, not as assimilated nasals, but as alveolar nasals

(d) Steriade (2001:233):

- "Nasals do tend to be misperceived, but not primarily in assimilatory ways. Therefore, bare misperception is unlikely to be the root of assimilation."
- "This may be an example of knowledge of perceptibility **used as a phonological tool**." [emphasis added]

C. PA and grammar-internal functional grounding

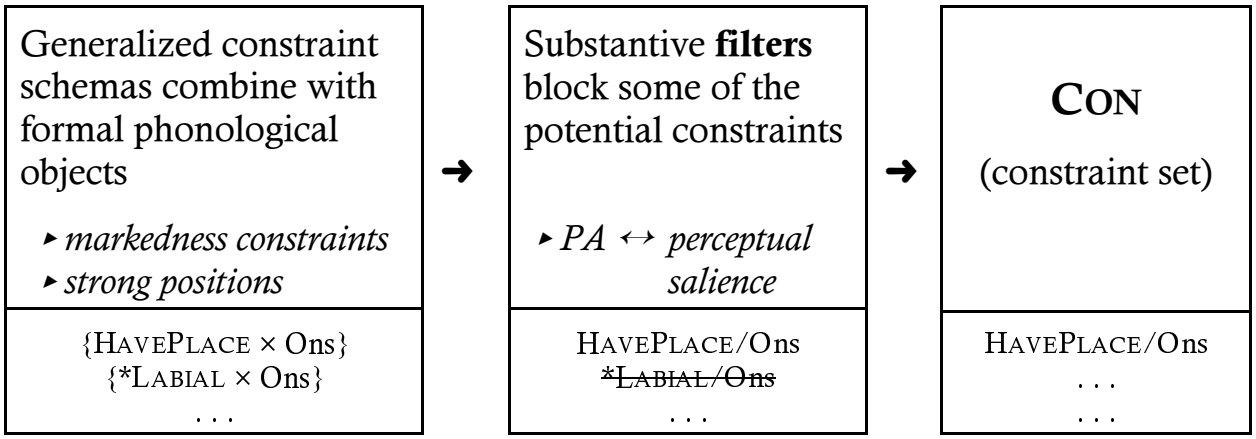
(56) Alternative: A **grammar-internal functional grounding account** for PA constraints (Smith 2002, to appear; an extension of Hayes 1999/"Inductive Grounding")

(a) Combine any markedness constraint with any strong position

(b) Use real-world, functional knowledge to see if the markedness constraint passes more-salient structures and penalizes less-salient ones

- If yes, the constraint is functionally grounded, so it is admitted into the universal constraint set
- If no, the constraint is non-grounded, so it is rejected from the constraint set

(57) The Schema/Filter model of CON (Smith 2002, to appear)



(58) Advantages of this model of the formal/functional interface

(a) Allows for the kind of "abstract" functional grounding seen in PA

(b) Addresses the criticism that phonology, as part of grammatical competence, is an abstract formal system that has **no direct connection to physical factors** (see especially Anderson 1981; Hale & Reiss 2000)

- Here, a formal, symbolic phonological grammar has a **restricted point of contact** with functionally based conditions that merely sort plausible from implausible constraints
  (Hayes 1999; Smith 2002; see also Archangeli & Pulleyblank 1994:281)

(59) For future work:

- What is the division of labor between **synchronic** and **diachronic** sources of phonetic effects on phonological patterns?
- Explicit, predictive theories of each may advance our understanding of synchronic grammar, diachronic change, and their interactions

VI. Conclusions

- Positional augmentation constraints are subject to a functional restriction: Markedness constraints relativized to strong positions must act to increase perceptual salience
- This restriction cannot be reduced to patterns attributable to diachronic change via misperception and phonologization
- Crucially, PA constraints are functionally grounded in an abstract, non-contextual sense — they must involve perceptual salience, but there need be no direct connection between the salient property and the nature of the position in question
- In the absence of a successful diachronic-grounding account, we conclude that some aspects of functional grounding are found within the synchronic grammar

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Appendix

Markedness requirements on strong positions, with representative examples
(see Smith 2002 for references and discussion of cases not covered above)

Strong position	*Prominent property*	*Languages*
Main-stress syllable	Heavy syllable	• Mohawk • West Germanic • Aguacatec
	High tone	• Slave • Golin • Serbo-Croatian
	High-sonority peak	• Zabiče Slovene • Mordwin • English

	Onset	• Dutch • W. Arrernte
	Low-sonority onset	• Niuafo'ou • Pirahã
Long vowel	High-sonority peak	• Yowlumne [Yawelmani]
Onset	Supralaryngeal place	• Chamicuro • Tiriyó • Carib • Macushi • Yatzachi Zapotec
Initial syllable	Onset	• Arapaho • Guaraní • Guhang Ifugao • Hausa • Tabukang Sangir
	Low-sonority onset	• Campidanian Sardinian • Mongolian • Kuman • Guugu Yimidhirr • Pitta-Pitta • Mbabaram
Root	Stress	• Tahltan • Chukchee • Diegueño • Nancowry • Tuyuca • Mbabaram

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