What should phonology explain?

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A standard **observation** about the phonological patterns found in the world's languages, and a standard **explanation** of this observation:

(1) Phonetically motivated ("natural") processes are common in the phonologies of the world's languages, while phonetically unmotivated ("unnatural") ones are uncommon.

(2) The causes of phonological patterns are represented in the mental grammar. A phonological process is "natural" to the extent that it is easily expressed by the tools of the theory.

This is **markedness** in a general sense, though the specifics vary:

(3) a. It is a central aspect of **Natural Phonology** (cf. Stampe 1969, Vennemann 1974, Hooper 1976, Donegan and Stampe 1979; for reactions see Hellberg 1978, Anderson 1981, etc.)

b. It also broadly characterizes **mainstream generative approaches** (including Chomsky and Halle 1968, Kiparsky 1973, and the subsequent tradition).

c. It is a basic assumption of much recent work in Optimality Theory (Prince and Smolensky 1993) that incorporates into the phonology **phonetic constraints on outputs**, ranging from perceptibility of acoustic cues in particular contexts to the general principle of least effort (cf. Flemming 1995, Myers 1997, Boersma 1998, Kirchner 1998, Steriade 1999).

I argue that while (1) is certainly correct, the markedness explanation in (2) makes **false predictions** regarding the historical development of phonological systems (cf. Ohala 1974, 1981, 1997, Kaye 1989, Hale and Reiss 1998, in press, Hyman 1998, Kingston 1999). Instead, the appropriate explanation for the frequency of phonetically motivated sound patterns is simply that they are **more likely to arise historically** than "unnatural" ones.

(4) The phonetic causes of phonological patterns occur in the **transmission** of language from speaker to learner. They are not (redundantly) represented in the grammar.

This view leaves open the possibility that **unnatural processes will arise for various reasons**, and predicts that learners construct **grammars that do not distinguish** between natural and unnatural patterns.

While phonetically driven approaches correctly identify the factors that lead to common alternations, it is problematic to incorporate these factors into the grammar itself. From the learner's (and the grammar's) point of view, the **original cause** of an alternation is **irrelevant**: the learner's only goal is to reproduce the language she hears around her.

I. Phonetically motivated vowel lowering

A phonetically natural, and therefore widely attested, pattern is **lowering of vowels next to a uvular consonant**. This lowering has **clear motivation** in the similar articulations of the low uvular consonants and the lowered vowels (see also Maddieson and Ladefoged 1996:36 for acoustic effects). I illustrate with three languages, giving a range of stages in **phonologization**.

In West Greenlandic Eskimo, /i, u/ lower to [ɛ, ɔ] when followed by a uvular /q, ʀ/ (Schultz-Lorentzen 1945, Fortescue 1984). This process is allophonic; phonemic vowels are /i, u, a/.

(5)	a.	sɛʀmi̱-t	'glaciers'	sɛʀmɛ̱-q	'glacier'
	b.	uvdlu̱-t	'days'	uvdlɔ̱-q	'day'
	c.	iki̱-t	'your wound'	ikɛ̱-ʀput	'our wound'

In Quechua, a similar lowering is found on either side of a uvular stop (Daza 1983). It too is allophonic in origin, though massive Spanish borrowings have introduced distinctive /e, o/.

(6)	a.	ikma	'widow'	eqeqo	'talisman'
	b.	kiru	'tooth'	qeru	'ritual mug'
	c.	ukuku	'bear'	onqoy	'sickness'
	d.	kukuli	'dove'	qolqe	'money, silver'

In Kashaya, all vowels **collapse to [a] after a uvular** stop (unless rounding is also present, in which case [o]) (Oswalt 1961, Buckley 1994a). This change neutralizes phonemic distinctions.

(7)	a.	sima:q-eti	→	sima:qatí	'although he's asleep'
	b.	miku:ṭ-q-e:	→	mikuṭʰqá:	'must have hummed'
	c.	ʔusaq-in	→	ʔusá:qan	'while washing the face'
	d.	ht-aq-i	→	taqá	'stretch your leg out!'

In Kashaya the phonetic tendency has been granted **categorical** influence, no doubt the result of ever more lowering over time and collapse of vowel distinctions in that context.

II. A "crazy rule" in Pomoan

The Southern Group of Pomoan (northern California) contains an odd but quite productive rule: in Kashaya, Southern Pomo, and Central Pomo, a vowel that normally surfaces as [i] occurs as **[u] after [d]** (Oswalt 1976). Examples here are from Kashaya (Oswalt 1961, Buckley 1994a); the symbol *c* is [č].

(8) *KASHAYA: singular imperative -i*

a.	šu-ḑa:ṭ-i	→	šuḑa:ṭi	'groan!'
	du-ṡe:ḱ-i	→	duṡe:ḱi	'pleat it!'
b.	wa-ad-i	→	wa:d**u**	'come here!'
	cad-i	→	cad**ú**	'look!'

(9) *KASHAYA: same-speaker simultaneous -in*

a.	mo-mul-in	→	momú:lin	'while running around'
	du-ḱis-in	→	duḱisín	'while scratching'
b.	mahsad-in	→	mahsad**ún**	'while taking away'
	mo-aq-ad-in	→	mo:qad**ún**	'while running out from here'

(10) *KASHAYA: conditional -iʔba*

a.	ḑo-c-iʔba-em	→	ḑocíʔbem	'could drink that'
	da:qaċ-iʔba	→	daqa:ċíʔba	'would like it'
b.	ciċ-id-iʔba	→	ciċí:d**uʔba**	'would do'

The reconstruction of Pomoan aspectual suffixes by Mithun (to appear) points to the origin of this unusual pattern in a **reanalysis of morphological juncture** in one suffix, the Imperfective.

(11)	a.	ORIGINAL SUFFIX	*-a·du	
	b.	LATER VARIANTS	-adu	*where vowel is necessary for syllabification*
			-ad	*after application of syncope, where permitted*
	c.	REANALYSIS	-ad	*underlying form*
			-adu	*insertion of [u] to permit syllabification*

Mithun argues that this basic suffix has been **grammaticalized** as part of a large number of aspectual suffixes in Pomoan. These examples are from Central Pomo (slightly simplified).

(12) a. Imperfective - ad(u)
b. Progressive - w - ad(u)
c. Continuative - h - du - w
d. Habitual imperfective - ad - ad(u)
e. Habitual perfective - ad(u)
f. Frequentative - h - du - w - ad - ad(u)

The point here is that the recycling of this suffix entailed the **spread** of the *u~Ø* alternation to a variety of contexts, with its eventual **reinterpretation** as a purely phonological process.

(13) a. *Syllabically determined allomorphy (**natural**)*
Delete /u/ of *-adu* when permitted by syllable structure (a general syncope process?)

b. *Morphologically conditioned epenthesis (naturalness is **moot**)*
Insert [u] after *-ad* when necessary for syllabification

c. *Phonologically conditioned epenthesis (**unnatural**)*
Insert [u] after /d/ when necessary for syllabification (rather than usual [i])

d. *Phonological rule (**unnatural**)*
Change [i] to [u] after /d/ (fed by usual [i]-epenthesis rule, also applies to non-epenthetic /i/)

Because rule (d) has spread widely to other suffixes, it must be **encoded in the grammar** just like the more phonetically motivated rule [i] → [a] after [q]; the changes to [a] and to [u] are equally productive in Kashaya.

In fact, it is the organization of the grammar, or the learning process, that must have lead to the generalization of the rule beyond its original morphological context.

(14) a. For example, learners (like linguists) **prefer purely phonological rules** to morphologically conditioned ones (step c).

b. They apparently also **prefer epenthesis to syllabically conditioned deletion**, perhaps due to the simpler underlying representations — obviously not a phonetic criterion, but a true phonological one (step b).

Judging from the overall time-depth of the family (Oswalt 1976), the [u] rule has remained in these languages for **perhaps a thousand years** despite its phonetic arbitrariness. If phonetic naturalness were a significant direct pressure on the phonology, this rule should have been **abandoned** rather that being **extended** to new domains. What rules like this indicate is that **naturalness is not a pressure on the mental grammar**.

III. Menominee vowel length

The Kashaya [du] rule arose by morphological reanalysis, but most unnatural rules begin as perfectly natural phonological changes. A dramatic example of how **several natural changes can result in an unnatural pattern** comes from Menominee (Bloomfield 1962, Hayes 1995), vowel length is subject to several changes depending on foot structure, which is **iambic** (right-strong quantity-sensitive), from left to right. The final consonant is extrametrical, so final syllables behave as open syllables.

(15) *MENOMINEE: lengthening of strong vowel in the first foot*

a.	natom-a:-w	→	(nato:)(ma:)w	'he is called'
	ne-natom-a:-w	→	(nena:)(toma)w	'I call him'
b.	nɛkan-a:-w	→	(neka:)(na:)w	'he is left'
	ke-nɛkan-a:-w	→	(kenɛ:)(kana)w	'you$_{sg}$ leave him'

This uniform lengthening happens only in the first foot of the word. In later feet, a long vowel will actually **shorten** if the strong vowel is in an **open syllable** (cf. also the previous examples). In a **closed syllable**, however, **lengthening** also happens in non-initial feet.

(16) *MENOMINEE: shortening of strong vowel in a non-initial foot (open syllable)*

a.	ahsam-a:-w	→	(ahsa:)(ma:)w	'he is fed'
	net-ahsam-a:-w	→	(neta:h)(sam<u>a</u>)w	'I feed him'
b.	nɛkan-ɛ:k	→	(neka:)(nɛ:)k	'when you$_{pl}$ leave him'
	nɛ:kan-ɛ:k	→	(nɛ:)(kan<u>ɛ</u>)k	'when you$_{pl}$ left him'

(17) *MENOMINEE: lengthening of strong vowel in a non-initial foot (closed syllable)*

a.	payo:se-yan-en	→	(payo:)(seya)nen	'whenever I embark'
	payo:se-yahken	→	(payo:)(sey<u>a:</u>h)ken	'whenever we embark'
b.	nɛkan-ehtwa:ʔ	→	(neka:)(nehtua)ʔ	'when they are left'
	nɛ:kan-ehtwa:ʔ	→	(nɛ:)(kan<u>i:</u>h)(tua)ʔ	'when they were left'

These last examples are **quite surprising** compared to iambic lengthening in other languages (Hayes 1995, Buckley 1998): more often it's **closed syllables that resist lengthening**, and we certainly don't expect **shortening of the stressed vowel**. Part of the answer is that coda consonants in Menominee don't make the syllable heavy, but it's still a "crazy rule".

Hayes (1995: 220) notes that "the best account of such rules often is to reconstruct their diachronic origins, explaining them away as the **synchronically unnatural result of a sequence of natural changes**." He proposes the following possible scenario.

<u>STAGE 1</u>:
Lengthen vowels in the heads of disyllabic feet (normal iambic lengthening).

(18) (osá:)(mepé:h)(katá:)m ⇔ [os<u>á:</u>mep<u>é:</u>hkat<u>á:</u>m]

<u>STAGE 2</u>:
Long vowels in non-initial feet are "somewhat **reduced**" in their phonetic duration. This is plausibly in **contrast to a main stress on the first foot**.

(19) (osá:)(mepè:h)(katà:)m ⇔ [osá:mep<u>è</u>·hkat<u>à</u>·m]

<u>STAGE 3</u>:
By restructuring, the phonetically intermediate-length vowels in non-initial feet are **analyzed as phonologically short**, but just in **open** syllables. Long vowels are normally shorter in closed syllables (Maddieson 1985), so these can still be treated as phonologically long.

(20) (osá:)(mepé:h)(kat<u>á</u>)m ⇔ [osá:mepé·hkatá·m]

At this stage the contrast in degree of stress is gone, so the difference in phonetic duration between stressed vowels in initial and non-initial feet is reinterpreted as phonological length. Evidently, outside the first foot, the duration in closed syllables was sufficient to be interpreted by learners as phonologically real; whereas similar duration in open syllables was attributed to minor phonetic lengthening of an open stressed syllable.

<u>STAGE 4</u>:
Loss of the intermediate length in the phonetic realization of short stressed open syllables. **Present rule system**, with lengthening and shortening in crazy environments.

(21) (osá:)(mepé:h)(katá)m ⇔ [osá:mepé·hkat<u>á</u>m] 'he waters it to excess'

Thus while the modern situation may have resulted from small motivated changes, the end result is in some regards the **opposite** of the natural situation; yet the rules have remained vigorous.

IV. Ojibwa palatalization

Eastern Ojibwa further illustrates the fact that what begins as a **natural** phonetic process often becomes part of a phonetically **opaque** alternation (Bloomfield 1946, 1957, Kaye 1978, Piggott 1980). In the proto-language, /t, θ/ palatalized to [č, š] before [i, i:, y].

(22) *PROTO-ALGONQUIAN: palatalization*

a.	***pema:t**-esi-wa	'he lives'	***mi:ka:**θ-e:wa	'he fights him'
b.	***pema:č**-i̱h-e:wa	'he makes him live'	***mi:ka:š**-i̱	'fight him!'

This place assimilation can be motivated on the grounds of **ease of articulation**. But various subsequent changes in the daughter languages have obscured the original phonetic plausibility; for example, in Ojibwa *θ became [l] and then [n], leading to the unusual alternation [n] ~ [š].

(23) *OJIBWA: sound changes*

a. *θ AND *l MERGE AS [l] (attested in 17th century)
palatalization extended to reflexes of *l in addition to *θ

**na:θ*	ki-**na:n**-a:	'you fetch him'
	ki-**na:š**-i-mi	'you fetch us'
**mi:l*	ki-**mi:n**-a:	'you give him'
	ki-**mi:š**-i-mi	'you give us'

b. [l] FROM *θ AND *l MERGE WITH [n] (beginning of 19th century)
palatalization **not** extended to reflexes of *n; rule undergoer becomes **opaque**

**we:pin*	ki-**we:pin**-a:	'you leave him behind'
	ki-**we:pin**-i-mi	'you leave us behind'

c. SHORT FINAL VOWELS DELETE
rule trigger becomes **opaque**: original **trigger** of palatalization is lost

**-i*	ki-**mi:š**	'you give me' (from **ki-**mi:š**-i*)

d. *e MERGES WITH [i]
rule trigger becomes **more opaque**: it applies only before some tokens of [i]

**i*	ki-**mi:š**-i̱-mi	'you give us'
**e*	ki-**mi:n**-i̱n	'I give you'

The alternation between [n] and [š], though **unnatural** and opaque, remains quite **productive** in inflectional paradigms, while the **natural** alternation between [t] and [č] has been **restricted** in its range of application. For example, where we find stem-final [n]~[š] we find nonalternating [t].

(24) *OJIBWA: loss of t~č alternation*

a.	***nesič**-i	>	**nisit**	'my foot'
b.	***nesit**-ali	>	**nisit**-an	'my feet'

It's the **natural rule that was curtailed**, rather than the unnatural one. Kaye (1978: 154) attributes this change to "historical accident":

(25) Recall that l-palatalization is well established in the inflectional morphology, particularly in the verbal morphology. This is due to the fact that many T[ransitive] A[nimate] verb stems ended in *θ and *l. Within the TA paradigm there are several suffixes which began with *i. So it is here that the alternations show up. On the other hand, no TA verb stem ended in *t, and as a result, no *t~č* alternations appear within verbal paradigms. Perhaps it was because of this lack of support that all noun alternations involving *t~č* came to be lost.

In other words, what matters to the learner is how well **attested** an alternation is, not whether it is phonetically **motivated**. If the alternation is clear, it will be learned; otherwise it may be lost. In other words, the motivation that matters is an identifiable **pattern**, not phonetic naturalness.

V. Explanations and markedness

What is an "explanation"? Salmon (1984:19) cites the following basic definition:

(26) To give scientific explanations is to show how events...fit into the causal structure of the world.

We know that most **phonological patterns originate in historical sound changes** — that is their cause. Inquiry into phonetics can yield understanding of the specific **mechanisms** that are most often involved. But by Occam's Razor, it makes no further contribution to our explanation if we posit that these mechanisms are recapitulated in the mind of the language learner; the sufficient explanation for the sound pattern is already provided by its historical causal origin.

It is entirely plausible that the **distal causes** of phonetically motivated sound patterns — i.e. properties of articulation and perception — have been incorporated into the mental grammar by a version of the **Baldwin effect** (whereby "learned" influences are indirectly favored by natural selection), or by children learning directly about their phonetic environment. If so, then these physical properties would also be (at least part of) the **proximal cause** of the patterns as they arise in the learner's mind, by predisposition to discover and posit natural patterns.

However, again by Occam's Razor, it is simpler to assume no such multiple instantiation of physical properties (or knowledge of them); it must be shown that a theory without mentally represented phonetic naturalness cannot account for phonological **behavior** (which is not the same thing as "explaining" the **frequency** of natural patterns). Prima facie evidence **against** such incorporation: children learn crazy rules; these rules persist and become crazier; abandonment of or change in rules seem due to computational complexity rather than naturalness.

Phonologists frequently write about restricting the "generative capacity" or "predictive power" of the theory as one of their major goals, and this notion is generally behind efforts to encode naturalness and markedness in the grammar. But any theory that cannot account for a **child's mastery of bizarre and unnatural rules** — not to mention these rules' emergence and their persistence over time — is simply inadequate as an "explanatory" theory of possible languages. The only explanation it provides is superfluous.

The processes discussed in this paper lead to the same conclusion that many others have reached before. An effective **summation** comes from Hyman (1975: 181f):

(27) Although sound changes are sometimes blocked by considerations within a paradigm [...] no corresponding force has been discovered which would strive to keep rules natural. Instead, the above examples show the great tendency for rules to become unnatural [...] that is, to lose their phonetic plausibility and become morphologically conditioned.

Cf. also Kaye (1989:48f; emphasis in original):

(28) Phonological processes may be *expressed* in phonetic terms, but this does not mean that they are *caused* by phonetic factors.

Under this sort of view, which I will call the **Cognitive** view, the phonology is a **computational system** that manipulates abstract categories and does not incorporate information about phonetic naturalness. The following two substitutions are therefore equally acceptable.

(29) *COGNITIVE MODEL*

a. `i → e / q __` *(cf. Greenlandic and Quechua)*

b. `i → u / d __` *(cf. Kashaya)*

This notion of Cognitive phonology takes seriously the ideas of **cognitive science** (for the term, cf. Kaye 1989, Lakoff 1993). See especially Hale and Reiss (1998, in press) for relevant recent discussion.

Under a view that does incorporate information about phonetic naturalness into the grammar, which we can call the **Phonetically Driven** model (cf. Hayes 1996), rule (a) is easy to express, while (b) must be treated as arbitrary. Quite schematically:

(30) *PHONETICALLY DRIVEN MODEL*

a. `i → e / q __` ⇒ "Sacrifice vowel height to articulatory ease"

b. `i → u / d __` ⇒ ARBITRARY SUBSTITUTION? *(however that is formalized)*

But this distinction is actually the same one that is expressed by **Markedness** in standard generative approaches to phonology, such as feature geometry (following a distinction I made for these very rules in Buckley 1994a).

(31) *MARKEDNESS MODEL*

a. `i → e / q __` ⇒ "Spread [+low] from a uvular to a following vowel"

b. `i → u / d __` ⇒ "Insert [+round] after /d/" *(if mere insertion is permitted)*

Here, natural assimilation rules are formalized by **autosegmental spreading**, while unnatural rules (to the extent they are discussed) require other operations, e.g. arbitrary **insertion**. But if arbitrary insertion rules can be learned, and seem to be unpenalized in the historical development of languages, why create another, superfluous mechanism such as spreading?

VI. Belief systems

The argument I have presented here is by no means new. There is a **widespread mainstream belief** that phonology is very much **distinct from phonetics**, and those who hold this belief are opposed to the renewed trend toward Phonetically Driven analyses (particularly at home in the context of Optimality Theory). But these same people are very often proponents of the Markedness approach, which **shares a basic tenet** of the Phonetically Driven approach.

It seems to me the matter hinges on **two views** that can be stated roughly as follows.

(32) a. *Principle of Phonetic Explanation*: Many or most phonological patterns are motivated by detailed phonetic properties of human language, such as the robustness of acoustic cues and the ease of specific contextual articulations.

b. *Principle of Explanatory Phonology*: The causes of phonological patterns are represented in the mental grammar. A phonological process is "natural" to the extent that it is easily expressed by the tools of the theory.

Phonetically Driven Phonology is, in fact, the standard Markedness model brought to its **logical conclusion**. It takes more seriously the question of what makes a process natural and common in the world's languages, while maintaining the standard commitment to express these insights in the grammar. A schematic outline of belief systems:

(33)

		Phonetic Explanation	*Explanatory Phonology*
a.	Standard Markedness Phonology	REJECT	ACCEPT
b.	Phonetically Driven Phonology	ACCEPT	ACCEPT
c.	Cognitive Phonology	ACCEPT	REJECT

I believe that Phonetically Driven phonology is **correct** is attributing the motivation of many phonological patterns to the phonetics; but **mistaken** in the further (traditional) step of incorporating this motivation into the mental grammar.

The **cross-linguistic frequency of "natural" processes** is explained by the fact that all languages are produced in the same phonetic universe. The nature of production and perception of phonetic signals exerts its influence in the **transmission of language** from generation to generation. If, for

example, some featural distinction is difficult to perceive in some context (cf. the cues of Steriade 1997), the child may fail to hear the distinction, leading to a grammar that neutralizes it. But **the effect of the cues is in transmission**, not in the representation.

Borrowing from Ohala (1981), here is a **much compressed illustration** of what must have happened in the genesis of the Kashaya rule of **lowering to [a] next to a uvular**.

(34)

SPEAKER		LISTENER		SPEAKER	
qi		qi → qe	⇒ *target* ⇒	qe	
⇓		⇑		⇓	
coarticulated		*interpreted*		*coarticulated*	
⇓		⇑		⇓	
[qe]	⇒ *heard* ⇒	[qe]		qa	⇒ *heard...*

The **unintentional coarticulation** of consonant and vowel was interpreted as an **intentional rule**. This process went to the level of [e, ɛ] for Quechua and Greenlandic, but continued to operate in Kashaya until it reached the bottom of the vowel space, merging with /a/.

VII. Polish raising

How far can the abandonment of synchronic explanation be taken? Consider the example of Polish raising, a process often cited in phonology textbooks (cf. Kenstowicz 1994:74f). The vowel /o/ raises to /u/ before a voiced word-final consonant (except nasals); data from Gussmann (1980).

(35)	a.	/por/	pur	'time-GEN.PL.'	pora	'time-NOM.SG.'
	b.	/moj/	muj	'my-M.SG.'	moja	'my-F.SG.'
	c.	/dom/	dom	'house-NOM.SG.'	domi	'house-NOM.PL.'

While we can understand the failure of raising before a nasal as the effect of vowel nasalization — nasalized vowels are often lowered (cf. Hajek 1997) — the failure before voiceless consonants is more mysterious. And why have **raising before voiced consonants** in the first place?

Historically there is an easy explanation: This alternation began as a relation between **vowel length** and voicing in a following consonant — an extremely widespread association, well known in English. By the early 16th century, Polish lost distinctive vowel length, in most cases merging the long and short versions of the same vowel. But **long /ō/ merged with /u/**, resulting in a new raising (rather than lengthening) alternation (Stieber 1973; Carlton 1990).

The following scenario illustrates how the changes took place. Rather than outright lengthening before voiced consonants, loss of the final yer vowel triggered **compensatory lengthening**, and this process was prevented by a following voiceless consonant.

(36) a. *inherited situation*

Some case forms with YER vowel [ĭ] Others with regular vowel such as [a, i]	por-ĭ	por-a	dom-ĭ	dom-i

b. *around 1000*

Loss of weak yer vowels Compensatory lengthening before voiced C	pōr	pora	dōm	domi

c. *by around 1350*

Secondary qualitative distinctions (e.g.long mid higher than short mid)	pǭr	pora	dǭm	domi

d. *beginning after 1450*

Elimination of length distinction Preservation of quality: ō, o → ọ, o	pọr	pora	dọm	domi

e. *beginning after 1600*

Vowel merger ọ → u Except ọ → o before a nasal	pur	pora	dom	domi

Thus what began as a perfectly natural length alternation has, due to a similarly natural vowel merger, become an odd raising rule.

An additional complication, one that make these facts of particular interest to phonologists, is the further effect of **word-final devoicing**, which occurred perhaps in the fourteenth century (Stieber 1973:115f).

(37)	a.	/lod/	lut	'ice-NOM.SG.'	lodi	'ice-NOM.PL.'
	b.	/lot/	lot	'flight-NOM.SG.'	loti	'flight-NOM.PL.'

The standard analysis (cf. Kenstowicz 1994:77) makes use of rule ordering to relate these two phenomena: the devoicing of final obstruents and the raising of /o/ in a final syllable before a voiced sound.

(38)	a.	*Underlying Representation*	/lod/	/lot/
	b.	*o-Raising*	lud	—
	c.	*Final Devoicing*	lot	—

The o-Raising rule is not "natural", as Kenstowicz (p. 78) explicitly states. So in this approach, it is not necessary to explain **why raising should take place in this context**; that much is assigned to **history** (Kenstowicz and Kisseberth 1977:64).

But what about the question of the **relation of raising and devoicing**? The rule-ordering analysis certainly attempts to explain this in synchronic terms, but **its origin lies in history as well**. Further, a look at the facts shows that there are many **exceptions** to this supposed relationship, calling into question just what needs to be "explained".

For example, some underlying /o/'s followed by **voiced** consonants **don't** undergo Raising.

(39)	a.	/tor/	tor	'rail-NOM.SG.'
	b.	/skrob/	skrop	'scrape-IMP.'

And some (seven listed by Gussmann) followed by **voiceless** consonants **do**!

(40)	a.	/stop/	stup	'foot-GEN.PL.'	stopa	'foot-NOM.SG.'
	b.	/robot/	robut	'work-GEN.PL.'	robota	'work-NOM.SG.'

Borrowed words sometimes follow the pattern, sometimes don't (especially before a final liquid; cf. also Bethin 1978):

(41)	a.	/mod/	mut	'fashion-GEN.PL.'	moda	'fashion-NOM.SG.'
	b.	/metafor/	metafor	'metaphor-GEN.PL.'	metafora	'metaphor-NOM.SG.'

Typically such data are not considered important; as Gussmann (p. 115) claims, "These exceptions can in no way obscure the basic regularity of the raising." But such exceptions are exactly what we should expect if, in fact, Raising has become a **property of specific vowels** rather than the grammar as a whole.

I suggest that once final devoicing had obscured the context for the application of Raising, it became an **arbitrary property of certain vowels**. A way of marking this distinction, following my analysis of a similar pattern in Kashaya (Buckley 1994b, cf. Kiparsky 1993), is by **selective use of underspecification**: vowels that are stably [u] or [o] have an explicit value for [high] (or a value that is reliably filled in by default); vowels that alternate between [u] and [o] are unspecified, and that value is filled in by rule or determined by constraints.

(42)	a.	stable /u/	[+high]
	b.	stable /o/	[−high]
	c.	"raisable" /O/	[high]

For historical reasons, underspecified /O/ tends to be located in particular contexts, i.e. before an underlyingly voiced consonant. But this inventory correctly predicts exceptions to this tendency, and that **borrowings will be assimilated in various ways**, partly determined by resemblance to existing words.

A point of serious interest is the extent to which this sort of feature specification tends eventually to be eliminated from grammars, and to what extent this elimination can be attributed by identifiable cognitive factors.

VIII. Future directions

A basic point: If the child learner can **master strange and complex alternations** without apparent prejudice, there is no reason to think that natural processes are easier to learn (i.e. more easily accommodated by the tools of the mental grammar). In fact, the learner will treat natural alternations as if they are arbitrary — which is accurate, since no language exhibits every phonetic tendency in its phonology. The set of rules in a language, even if all are natural, is synchronically an **arbitrary subset** of all possible natural (and unnatural) rules.

The question of interest is **whether a grammar treats "natural" and "unnatural" processes differently**, and the answer appears to be "no". The unnatural situations discussed above, and countless others, have persisted in their languages for many centuries, indicating that once an alternation comes about (whether for phonetic or other reasons), the child simply learns it without regard to its original motivation.

How far can we take the elimination of "explanation" from phonology? Cf. Ohala (1997: 693):

(43) The phonological grammars in speakers' heads — i.e., the rules and representations that underlie native speakers' mastery of their language — may be coded using unanalyzed phoneme-like units and large lookup tables.

I think this scenario might take things too far. The primary question that interests me right now is **what remains crucially in the cognitive representations** (i.e., "inside the box" in (34)) once we have correctly attributed to diachrony much of what preoccupies mainstream phonologists. A few examples from the data discussed in this paper:

(44)
- a. POMOAN: Reanalysis of (natural) syncope as (unnatural) **epenthesis** ("insert *u*")
- b. POMOAN: Reanalysis of special epenthesis as **general** vowel change ($i \rightarrow u$)
- c. MENOMINEE: Reference to **feet**, syllable **weight**, **open** vs. **closed** syllables
- d. MENOMINEE: Special status of **first** foot (cf. peripheral extrametricality, etc.)
- e. OJIBWA: Role of **productive** inflectional alternations in preserving rule
- f. POLISH: Perhaps **two kinds** of /o/ (raising or not), rather than a conditioned rule

Of course, it may be possible to attribute some of these factors to **language transmission** or the learning algorithm (e.g. the role of productivity in Ojibwa, though perhaps not the importance of inflection). It may also be possible to attribute many or all such factors to **general cognitive faculties**, rather

than specifically linguistic ones. But before that is possible we need to understand what's represented and what's not.

Some **directions for future research** that have potential to address more directly the cognitive-phonological contribution to the origins of sound patterns (cf. also Ohala 1986):

(45) a. **Unnatural** phenomena as truly diagnostic of possible grammars
b. More **abstract** categories (such as moras, syllables, feet, tone)
c. Tolerance for **opaque** interactions that develop over time
d. Language **games** as the exploitation of unused parts of the grammar toolbox
e. **Games** and **errors** as evidence for productive categories and non-listedness
f. Treatment of **loanwords** and **neologisms** as tests of non-listedness
g. Prosodically defined processes such as **reduplication** and **infixation**
h. Role of "emergence of the unmarked"? (McCarthy and Prince 1994)

Mainstream phonology currently gives a great deal of attention to providing explanations for patterns whose cause is already known. The more attention that is devoted to **patterns whose cause is less clear**, the more progress we can make in achieving meaningful phonological explanation.

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