ON SUBSTANCE IN PHONOLOGY

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1. Substance-free phonologies

By describing what they call "substance abuse" in phonology, Hale and Reiss (2000) implicitly suggest a provocative analogy in which phonetic content is cast as a dangerous, potentially addictive psychoactive drug to which many phonologists have succumbed. In recent years, this notion has been taken up in what is now often called 'substance-free' phonology (e.g., Blaho 2008; Odden 2006; Samuels 2011), but the approach is older than the name. For example, Fudge (1967: 26) argued that

> phonologists (above all, generative phonologists) ought to burn their phonetic boats and turn to a genuinely abstract framework. By so doing they will escape the fate of not only falling between two stools (the result of attempting to handle systematic phonemic and systematic phonetic levels in the same terms), but also ending up sitting in the very place which they have expended such strenuous and well-justified efforts to avoid.

The impetus to burn the phonetic boats and eliminate substance from phonology comes, in part, simply from the observation that phonology exists as a phenomenon distinct from phonetics at all. If phonology requires at least some formal, abstract, non-phonetic mechanisms, then it is reasonable to ask whether these devices might not be sufficient to account for phonological patterns on their own, with no direct role for phonetics. However, attempting to banish phonetic substance from formal phonology altogether risks losing the ability to account for substantive patterns in formal terms. In this paper, I briefly review the motives and methods of substance-free phonology, and then argue for an alternative in which substance does play a role in phonology, but a limited one.

1.1 Why go substance-free?

The motivations behind substance-free phonology are both empirical and conceptual. On the empirical side, proposals for universal systems of phonological features with identifiable phonetic content, such as those of Jakobson et al. (1952), Chomsky and Halle (1968), and Clements and Hume (1995), have run into difficulties in accounting for the range of cross-linguistically attested phonological patterns. These difficulties have led to theories in which features are not universal or do not have phonetic content (e.g., Mielke 2008), or in which their phonetic content is entirely opaque to the phonological component of the grammar (e.g., Hale and Reiss 2008).

Actes du congrès annuel de l'Association canadienne de linguistique 2014.
Proceedings of the 2014 annual conference of the Canadian Linguistic Association.

Conceptually, proponents of substance-free phonology have argued that it is redundant to have Universal Grammar stipulate in formal terms patterns that are derivable from physiological facts. For example, Hale and Reiss (2000) argue, *contra* Beckman (1997), that there is no reason to build positional faithfulness constraints into UG, because acquisition naturally produces the same patterns. Children will be more likely to misperceive sounds in less prominent positions, and so they are more likely to produce unfaithful input–output mappings in those contexts. There is no need for UG to stipulate that faithfulness in more prominent positions outranks faithfulness in less prominent positions if the same pattern emerges naturally through perception.

Mielke (2008: 27) makes a similar argument against positing innate feature geometries that are based on substantive articulatory properties:

> The organization recapitulates anatomical information which is built into the definitions of the features. A more compelling case for innate feature organization could be made on the basis of features which pattern in a certain way *in spite of* their phonetic definitions.

More broadly, Hale and Reiss (2000, 2008) argue that phonetic naturalness is phonologically irrelevant. If at least some phonological patterns are phonetically arbitrary, then the phonological computation must have some mechanism capable of generating such patterns. Any formal mechanism that can generate phonetically unnatural patterns can also generate phonetically natural ones, so it would be redundant to posit specialized mechanisms that *only* generate phonetically natural patterns. Adding phonetic substance to the computation thus neither restricts nor expands the power of the grammar in any useful or relevant way.

1.2 How to go substance-free? Two forms of phonetic arson

In current substance-free phonology, there are two principal ways of burning the phonetic boats:

Hale and Reiss (2008) propose a system of phonetically transparent features and arbitrary rules. They assume that features are innate and universal, and have substantive phonetic content along essentially the same lines proposed by Chomsky and Halle (1968). Indeed, they claim that UG *must* provide features in order for learners to assign phonological representations to inputs before they have acquired the full adult grammar.[1] The computational system of phonology, however, is entirely oblivious to the phonetic content of the features, which it manipulates as purely formal pluses and minuses. As Hale and Reiss (2008: 171) put it, "Articulatory and acoustic substance *are* related to the representations we construct, but not within the grammar."

The other version of substance-free phonology, pursued by Odden (2006) and Blaho (2008) (among others), is more in line with Fudge's (1967) approach and with the Emergent Feature Theory of Mielke (2008). In this view, features are not universal or innate,

[1] Cf. Dresher (2013) and Hall (2010a) for rebuttals of this claim.

but rather are induced by the learner. Featural representations are assigned on the basis of phonological behaviour, not acoustic or articulatory substance (although phonological properties often do happen to correlate with phonetic ones). This allows for rules that are maximally formally elegant, even when they are phonetically unnatural. As Blaho (2008: 22–23) puts it, "Features are indicators of the way members of an inventory behave, but they don't necessarily have any consistent phonetic characteristics even within the same system." Likewise, in Emergent Feature Theory, features do not necessarily have any content beyond identifying "the segments that do X" (Mielke 2008: 99).

1.3 Missing the boat

If we burn our phonetic boats, will we miss them? In some ways, substance-free phonology ends up looking very much like substance-based phonology (e.g., Steriade 2001; Flemming 2002). Both approaches reject formal explanations for substantive phenomena. Phonetically based phonology places functional explanations directly in the synchronic grammar; for example, Steriade (2001) posits that speakers make reference to the P-map, a repository of information about phonetic contrasts and confusability.

Substance-free phonology posits that phonetics can influence phonology only indirectly, though diachrony and acquisition, but nonetheless relies on functional phonetic explanations to account for why so many phonological patterns are phonetically natural, much as in Evolutionary Phonology (Blevins 2004, 2006). Much of the burden of explanation is thus shifted away from phonology itself.

If phonology is "a genuinely abstract framework," as Fudge suggested, then the role of Phonology (as a component of the human language faculty) in shaping phonologies (as components of the grammars of particular languages) is quite limited. For example, Hale and Reiss (2008) argue that Universal Grammar serves to delimit "humanly computable" languages within the set of "statable languages." They present the hierarchy of grammars in (1), making the point that we should not attempt to tailor our model of UG too closely to the range of languages that have actually been attested, because many grammars that the human mind is capable of implementing will never be attested for purely external reasons.

(1) Hierarchy of grammars (Hale and Reiss 2008: 3)
Attested $\subset$ Attestable $\subset$ Humanly computable $\subset$ Statable

a. Attested: Cree-type grammars, English type grammars, French-type grammars

b. Attestable: "Japanese" in 200 years, Joe's "English"

$\rightsquigarrow$c. Humanly computable: p $\rightarrow$ s / ___ r

d. Statable: V $\rightarrow$ V: in prime numbered syllables:
paka$_2$nu$_3$tipa$_5$fose$_7$ $\rightarrow$ paka:nu:tipa:fose:

There are interesting things to be said about the limits of computation in phonology. For example, Heinz et al. (2014) argue that all phonological mappings belong to a well-defined subclass of regular relations, whereas at least some syntactic mappings appear to be

context-sensitive. But is there nothing else that formal phonology should attempt to account for? There are many recurring patterns in the phonologies of the world's languages that cannot be explained by a UG that does little more than rule out reference to prime numbers; must they all be explained purely in terms of the diachronic influence of phonetics?

Banishing substance from phonology altogether gives up the possibility of offering formal explanations for substantive patterns. This banishment, I will argue, has been based in part on unwarranted assumptions about the rigidity of phonological representations. The moderate use of phonetic substance in phonology can allow us to explain certain kinds of patterns while still acknowledging that phonetics is not destiny.

2. The methodological case

Mielke's (2008) case for emergent (and potentially arbitrary) features draws support from the existence of phonological patterns involving unnatural classes of sounds. The same kinds of patterns could also be taken as evidence for the Hale and Reiss (2008) view, with universal features and arbitrary rules. If phonology is purely abstract and substance-free, then there is little reason to be skeptical about such patterns. They may arise diachronically through uncommon combinations of phonetically natural changes, but the synchronic learner can easily represent them.

However, if we assume that phonology is more restricted than this, that gives us a theoretical motivation to look more closely at such patterns, and to search for explanations in terms of natural classes. As Hall (2010b) and Godfrey (2012) show, such efforts at least sometimes meet with success. For example, Hall (2010b) discusses the case of Bukusu. Mielke (2008: 66–67), citing Austen (1975), observes that nasals in Bukusu delete before fricatives (2) and before other nasals (3):

(2) Nasal deletion before fricatives

a.	/i+**n**+**f**ula/	→	[e:**f**ula]	'rain'
b.	/i**n**+**s**om+ij+a/	→	[e:**s**omia]	'I teach'
c.	/i+**n**+**x**ele/	→	[e:**x**ele]	'frog'

(3) Nasal deletion before nasals

a.	/i**n**+**m**eel+a/	→	[e:**m**eela]	'I am drunk'
b.	/i**n**+**n**uun+a/	→	[e:**n**uuna]	'I suck'
c.	/i+**n**+**ɲ**aɲa/	→	[e:**ɲ**aɲe]	'tomato'
d.	/i+**n**+**ŋ**uaŋua/	→	[e:**ŋ**waŋwa]	'camel'

Before plosives (which would be included in any obvious natural class that encompasses both nasals and fricatives), nasals do not delete; instead, they assimilate in place:

(4) Homorganic nasal assimilation

a.	/i**n**+**p**im+a/	→	[e**mp**ima]	'I measure'
b.	/i**n**+**b**on+a/	→	[e**mb**ona]	'I see'
c.	/i+**n**+**g**oxo/	→	[e**ŋg**oxo]	'hen'

Mielke (2008) concludes from this that that nasal deletion is triggered by the unnatural class of nasals and fricatives. However, Bukusu systematically lacks geminates (Mutonyi 2000: 178), and so Hall (2010b) points out that the deletion of nasals before nasals can be united with degemination rather than with the deletion of nasals before fricatives. In this interpretation, no reference to unnatural classes is required. Nasals delete before the natural class of fricatives, and undergo place assimilation to the natural class of stops and nasals; degemination eliminates sequences of identical consonants, including those generated by place assimilation of nasals to nasals.

Methodologically, if we assume that any 'humanly computable' phonological system is possible, then our theory will seldom lead us to reject any observationally adequate description of any pattern, and if UG is more constrained than this, we will fail to discover that fact.

The possibility of emergent features without phonetic content also reduces the predictive value of distinctive feature notation in general.[2] For example, Mielke (2008: 122–123), citing Thompson and Thompson (1992), presents /t/-deletion in Thompson as an example of a process involving two 'crazy' classes, giving the descriptive rule in (5):

(5) $\mathrm{t} \rightarrow \varnothing \,/ \left\{ \begin{array}{c} \mathrm{n} \\ \mathrm{n'} \\ \mathrm{ʔ} \\ \mathrm{h} \end{array} \right\} \_\_ \left\{ \begin{array}{c} \mathrm{ʃ} \\ \mathrm{x^w} \\ \mathrm{n} \end{array} \right\}$

Suppose that there is a phonetically arbitrary feature in Thompson whose extension is /ʃ, x^{w}, n/. What would any of these segments turn into if we delinked this feature (or changed its value from + to −)? What would some other consonant of Thompson (such as /p/ or /x/ or /tɬ'/) turn into if we spread this feature onto it? A feature that is phonetically arbitrary has no intensional content, and so it is not clear whether a feature defined as identifying the segments that trigger /t/-deletion could play a role in anything other than /t/-deletion, or what that role would be.

As Mielke (2011: 398) points out, the statements in (6) are theoretical claims, not necessary properties of features:

(6) a. Claim: The distinctive features that define segmental contrasts also define changes in alternations.

b. Claim: The same features also define classes of sounds that may be involved in alternations.

But they are claims that have generally been deemed worth pursuing in phonological theory, and admitting 'features' that correspond to classes of sounds that cannot be characterized intensionally makes it harder to sustain them, or even to determine what predictions they make.

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[2]This objection does not apply to Hale and Reiss's (2008) version of substance-free phonology, in which features have phonetic content that is simply irrelevant to phonology.

3. Assumptions about features

Substance-free phonology is, in part, a reaction to the apparent failures of putatively universal systems of phonetically contentful features. But these failures are not necessarily the fault of substance *per se*.

Fudge (1967) cites Bloomfield (1933) and Nida (1949) in noting that organizing tables of phonemes according to their phonological behaviour is often analytically useful but at odds with phonetic reality. As an example, we can consider the fricative inventory of Czech (Hall 2007: §2.2; Dresher 2009: §3.3.3). A phonetically organized table of Czech fricatives would look something like (7):

(7) Czech fricatives (organized phonetically)

	labiodental	alveolar	postalveolar	velar	glottal
voiceless	f	s	ʃ	x	
voiced	v	z	ʒ		ɦ

From a purely phonetic perspective, it appears that /x/ has no voiced counterpart (ɣ), and /ɦ/ has no voiceless counterpart (h). However, if we are prepared to abstract away from the phonetic difference between the velar and glottal places of articulation, we can arrive at the symmetrical arrangement in (8):

(8) Czech fricatives (organized symmetrically)

	labial	alveolar	postalveolar	guttural
voiceless	f	s	ʃ	x
voiced	v	z	ʒ	ɦ

This view of the Czech fricative inventory is at a slight remove from phonetic reality, but only in that it is effectively underspecified. It would presumably be ruled out by any theory requiring full specification for a set of universal features, which would insist on representing the difference in place between /x/ and /ɦ/, but even such a system could be capable of recognizing that pair as constituting a natural class.[3] This is a considerably more modest sacrifice of phonetic precision than the arrangement of English voiceless plosives and fricatives in (9), which Twaddell (1962: 136) denounces as "diagrammatic symmetry, but of a merely ordinal sort."

(9) 'Merely ordinal' symmetry in English obstruent series (Twaddell 1962: 136)

p	t	ʧ	k
f	θ	s	ʃ

As Twaddell point out, it is difficult to imagine what feature might group /ʧ/ and /s/ together to the exclusion of both /t/ and /s/, and it is also not clear what insights this forced parallelism could offer into English phonology. The table in (8), on the other hand, turns

[3] E.g., $\begin{bmatrix}-\text{coronal}\\-\text{anterior}\end{bmatrix}$ in the feature system assumed by Davenport and Hannahs (2010), or $\begin{bmatrix}-\text{coronal}\\-\text{labial}\end{bmatrix}$ in that of Hayes (2009), would suffice to distinguish /x ɦ/ from the other Czech fricatives.

out to be phonologically astute: /x/ and /ɦ/ pattern as counterparts with respect to voicing assimilation and final devoicing (Short 1993).

In fact, a purely phonologically motivated configuration of the Czech fricatives would be less symmetrical than (8), although not in the same way as the phonetically based (7):

(10) Czech fricatives (organized phonologically)

	labial	alveolar	postalveolar	guttural
voiceless	f	s	ʃ	x
voiced		z	ʒ	ɦ
semi-sonorant	v			

Phonologically, /v/ is not like the other voiced fricatives in that it does not trigger regressive assimilatory voicing (Hall 2003, 2007). In this respect, it is like a sonorant, but, unlike sonorants, it does undergo both assimilatory and word-final devoicing.

Rather than following Bloomfield (1933) and Nida (1949) in dismissing non-phonetic tables of phonemes like (8) and (10) as mere conveniences for the researcher, Fudge dismisses phonetic reality from phonology altogether, proposing that features should be purely abstract computational units with arbitrary alphanumeric names and no obvious substantive content. For example, his treatment of Tswana includes a feature numbered 1, whose phonetic implementation in various contexts is governed by the rule in (11):

(11) Rule for realizing feature 1 in Tswana (Fudge 1967: 18)

$$1 \rightarrow \left\{ \begin{array}{l} \text{Ejective release} \,/\, \left\{ \begin{array}{c} \text{\_\_\_ a} \\ \text{[…3…][\_\_\_ b]} \end{array} \right\} \\ \text{Contact} \,/\, \left\{ \begin{array}{c} \text{[\_\_\_ (i)][close vowel]} \\ \text{\_\_\_ (ii)} \end{array} \right\} \\ \text{Lateral} \,/\, \text{\_\_\_ (i)} \\ \left. \begin{array}{l} \text{No articulatory effect or Contact} \\ \text{\quad (free variation)} \end{array} \right\} \,/\, \text{C\_\_\_ b q} \\ \text{No articulatory effect / C\_\_\_ b} \\ \text{Contact or Occlusion (free variation)} \end{array} \right\}$$

However, the class of Tswana consonants identified by feature 1 is not actually as phonetically unnatural as the realization rule might suggest. Fudge's rejection of phonetically substantive features seems to be based in part on the assumption that such features must have concrete definitions along the lines of Jakobson et al. (1952) that can be applied cross-linguistically in a perfectly transparent way.

(12) shows the consonant inventory of Tswana, grouped according to Fudge's features numbered 1, 2, and 3. Group 3 comprises the nasals, group 2 the aspirated stops and mostly voiceless fricatives, and group 1 the stops that are either voiced or glottalic. If the set of possible substantive features is a bit more flexible than Fudge assumed, and if not all features must be specified on all segments that they potentially describe, then Fudge's feature 1 could perhaps be replaced by something as simple and as substantive as [−spread glottis].

(12) Tswana consonant inventory, with Fudge's (1967) features 1, 2, and 3

1	p'	t'	tl'	ʦ'	ʧ'	k'	ʔ
	b	d/l			ʤ		
2	p^h	t^h	tl^h	$ʦ^h$	$ʧ^h$	kx/k^h	
	ɸ	r		s	ʃ	x/h	
3	m	n			ɲ	ŋ	

4. Contrast and content

The proponents of substance-free approaches are entirely correct in observing that the phonetic properties of phonemes do not dictate their phonological behaviour. But there is a way of curtailing the role of substance without eliminating it altogether.

The crucial factor is contrast. Distinctive features are inherently relational: even when they have phonetic content, they primarily serve to distinguish one segment from another, not necessarily to provide a full phonetic description of any individual segment. This property is important in several ways:

4.1 Intensions, extensions, and inventories

Least controversially, in any given language, a particular set of feature values will pick out natural subsets of that language's phonological inventory—not necessarily a natural class of sounds in any broader context. For example, we would not necessarily consider ejectives and voiced plosives as constituting a natural class in a general sense, but in the specific context of an inventory like the Tswana one in (12), in which they do not contrast with plain voiceless plosives, they can easily be picked out by some simple conjunction of substantive features.

4.2 Dimensions *versus* boundaries

In order to be described as phonetically contentful, a feature need only identify a phonetic dimension of contrast. It need not specify an absolute cutoff point, even within a given language. (See Hall (2011: §6.3) for further discussion.) What Fudge (1967: 12) says about the term 'rounded' in a phonetic realization rule can just as easily be applied to [+round] as a feature value:

> Questions like 'How rounded is "rounded"?'will be answered fully in the next section; for the present we will content ourselves with the rough answer 'Rounded enough to be distinguished from "neutral"'.

A feature [±round] can be phonetically substantive without specifying an absolute degree of lip-rounding (or an absolute F2 frequency) that consistently corresponds to the line between [+round] [−round]. Similarly, in a language with a vowel inventory /i a u/, a feature that divides the inventory into /i u/ vs. /a/ can be characterized as a height feature, but we shouldn't necessarily expect to be able to say whether it is [±high] or [±low].

Even consonant features, which typically lend themselves more readily to categorical definitions, need not have inflexible boundaries between + and −. E.g., Mielke (2005) points out that laterals and nasals pattern phonologically sometimes with [−continuant] segments and sometimes with [+continuant] ones.

4.3 Correlations and categories

Features can be emergent, and show cross-linguistic variation, without necessarily allowing for wholly arbitrary groupings of segments. Cowper and Hall (2013) propose that learners acquire features by identifying correlations. For phonological features, the relevant things to correlate are:

- contrast in lexical meaning
- contrast in phonetic realization
- contrast in phonological behaviour

Correlations between contrast in lexical meaning and contrast in phonetic realization tell the learner that there are phonemes that need to be distinguished by some feature, as in minimal pairs like *hat–hatch* or *laugh–lass*. Sometimes these correlations also align with differences in phonological behaviour (as in *hat*[s]–*hatch*[əz] and *laugh*[s]–*lass*[əz]).

Contrasts in meaning can also correlate with contrasts in behaviour without necessarily also involving a contrast in realization. This allows the learner to posit abstract phonemes like those posited by Hyman (1970) for the vowel system of Nupe.

Among the phones realized as [a] in Nupe, there is one that palatalizes preceding consonants (as do /i/ and /e/), another that labializes them (as do /u/ and /o/), and a third that does neither, as illustrated in (13):

(13) Vowel–consonant interactions in Nupe (Hyman 1970: 62)

PALATALIZING			LABIALIZING	
[ēgʲī]	‘child’		[ēgʷũ]	‘mud’
[ēgʲē]	‘beer’		[ēgʷó]	‘grass’
[ēgʲà]	‘blood’	[ēgā] ‘stranger’	[ēgʷā]	‘hand’

These different behaviours correlate with (arbitrary) differences in lexical meaning. In such cases, the phonemes, even though they do not differ in their own phonetic realizations, can still be distinguished phonologically by features whose phonetic content can be identified by their effects on other segments.

4.4 Contrastive specification

Contrastive specification offers a principled explanation for the fact that phonemes that have a particular phonetic property are sometimes ignored by phonological processes that refer to the feature corresponding to that property. One version of the central idea behind contrastive specification is given in (14):

(14) Contrastivist Hypothesis (Hall 2007: 20)
The phonological component of a language L operates only on those features which are necessary to distinguish the phonemes of L from one another.

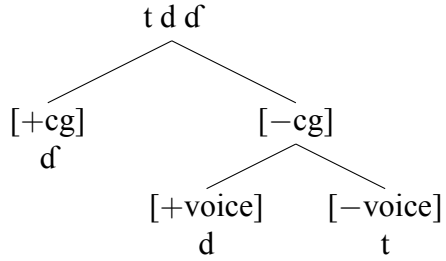
While (14) is a particularly strong version that would exclude redundant features from phonology altogether, any theory that assigns a special status to contrastive features (e.g., Archangeli 1988; Calabrese 1995; Nevins 2005, 2010) has the potential to offer explanations of this kind.

In order to implement any form of contrastive specification, it is necessary to be able to identify which features are contrastive in a given system. Dresher (2009) argues that the appropriate way to determine the contrastive or redundant status of a feature is by a contrastive hierarchy (as in Cherry et al. 1953; Halle 1959). Features are assigned by making successive divisions in the inventory; no feature is assigned unless it serves to mark some phonemic contrast. The hierarchical ordering of features can vary from one language to another.

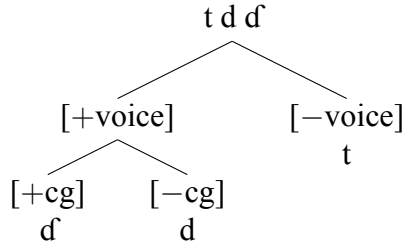
To see the explanatory benefit of this general approach, we can consider an example from Mackenzie (2013), involving laryngeal harmony patterns on consonants. If a language has a three-way contrast among voiced pulmonic egressives, voiceless pulmonic egressives, and implosives, then the contrastive hierarchy approach permits two ways of using the features [±voice] and [±constricted glottis] to distinguish them, as shown in (15):

(15) Two hierarchical orderings of laryngeal features (Mackenzie 2013: 300)

a. [constricted glottis] > [voice]



b. [voice] > [constricted glottis]



Either implosive /ɗ/ will be unspecified for voicing, as in (15a), or voiceless /t/ will be unspecified for glottal constriction, as in (15b). Mackenzie (2013) shows that both possibilities are attested.

In Ngizim voicing harmony, the phonetic voicing of implosives is phonologically irrelevant; co-occurrence constraints affect only pulmonic consonants. Voiced pulmonic obstruents cannot follow voiceless ones, as in (16a), but implosives can, as in (16b).

(16) Ngizim voicing harmony (Mackenzie 2013: 301, citing Schuh 1997)

a.	i.	[gâːzá]	‘chicken’	*k…z
	ii.	[də́bâ]	‘woven tray’	*t…b
	iii.	[zə̀dú]	‘six’	*s…d
	iv.	[kútə́r]	‘tail’	
	v.	[tásáu]	‘find’	
b.	i.	[kìːɗŭ]	‘eat (meat)’	
	ii.	[fə́ɗú]	‘four’	
	iii.	[pə́ɗə́k]	‘morning’	
	iv.	[də̀ɓú]	‘give water’	

The Ngizim pattern is consistent with the hierarchy in (15a), in which implosives are unspecified for [±voice]. Hausa, on the other hand, appears to have the hierarchy in (15b). In Hausa, co-occurrence restrictions prohibit a mismatch in [±constricted glottis] on homorganic voiced obstruents, as in (17a), but but a voiceless pulmonic egressive can co-occur with an implosive, as in (17b):

(17) Hausa [±c.g.] harmony (Mackenzie 2013: 302, citing Newman 2000)

a.	[ɗaɗa]	‘to strike a blow’	*ɗada
b.	[ɗata]	‘a small, bitter, green tomato’	

In Mackenzie’s analysis, the consonants subject to co-occurrence restrictions in each language are not arbitrary: they are defined by the *contrastive* presence of specific, contentful features.

4.5 Conclusions

Under the view of phonological representations proposed here, the task of the learner is to set up a system of features that is just sufficient to differentiate the phonemic inventory and that allows for the encoding of observed patterns. If the features themselves must be phonetically interpretable, then the learner’s job is simplified, and the analyst’s hypothesis space is constrained. The resulting representations are substantive enough to make ‘natural’ patterns the norm, but also abstract enough to account for the fact that phonetics does not determine phonological destiny.

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