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Duality of patterning: Absolute universal or statistical tendency?

Abstract: As more of the world's languages are described and compared, more absolute universals have joined the class of statistical tendencies. However, few have questioned the universality of the duality of patterning. Following Hockett, most linguists assume that in all human languages, discrete meaningless parts combine to form meaningful units that, themselves, recombine. However, an alternative interpretation, explored in this article, is that duality, like other proposed linguistic universals, is a statistical tendency reflecting a complex set of factors, and most centrally, the need for some minimal number of basic units that can recombine to yield a potentially infinite set of form-meaning correspondences. If this is the essence of duality, then we expect: languages where duality is not a central component of grammar; languages where most, but not all, utterances are decomposable into meaningless phonological units; and different types of phonological building blocks in different languages. These expectations appear to be confirmed by natural language data.

Keywords: duality of patterning, language universals, statistical tendencies, phonology, Charles F. Hockett

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1 Linguistic universals as statistical tendencies

Absolute universals are properties that all languages share. As more of the world's languages are described and compared, more absolute universals have joined the class of statistical tendencies, holding true of most languages, but not all. For example, in the realm of spoken language phonology, it was once thought that all languages make use of a coronal stop phoneme /t/, with this following from the unmarked status of coronal consonants cross-linguistically, and more generally, that all phonological systems have coronal phonemes (Hyman 2008). However, Northwest Mekeo, a Western Oceanic language of Papua New Guinea has the

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simple consonant inventory /p k β g m ŋ/, and not only lacks /t/, but appears to have no coronal phonemes at all (Blevins 2009). The existence of a language like Northwest Mekeo is good evidence that the contrastive use of coronal place of articulation in spoken languages is a strong statistical tendency whose source is not an innate design feature of language, but a range of independently convergent extra-grammatical factors including speech articulation, perception, aerodynamics, and language contact.

Absolute universals are also compromised when a particular language adheres to a universal most of the time, but not always. Language-internal statistical tendencies of this kind (referred to as "matters of degree" by Ladd 2012), challenge classical phonological theory, where universals of contrast, phonotactics, and alternations are stated categorically (Ernestus 2011). Consider, for example, 20th century analyses of Yawelmani Yokuts vowel alternations which incorporate closed syllable-shortening to enforce a constraint against CVVC syllables (Kuroda 1967; Kenstowicz and Kisseberth 1979; Kenstowicz 1994; McCarthy 1999). The great majority of CVVC syllables surface as simple CVC, but a small number do not (Blevins 2004). If closed syllable-shortening is attributed to the dominance of a universal preference for CVC vs. CVVC syllables in the grammar of Yawelmani, how does one explain the fact that a small number of CVVC syllables surface? While Sapir (1921: 39) observed early on that "all grammars leak", it seems we must also accept that *all universals seep*: within the grammar, most forms adhere to them, but at the periphery where function may dominate form, they are diluted and violable.

More general design features of human language (Hockett 1960) have also come under renewed scrutiny as more and better language descriptions become available. Recursion, once thought to be a universal feature of natural language syntax, has been reported to be absent in some languages (Everett 2005; Sakel and Stapert 2010). However, few have questioned the universality of the duality of patterning. Following Hockett, most linguists assume that in all human languages, discrete meaningless parts combine to form meaningful units which, themselves, recombine: "The meaningful elements in any language – "words" in everyday parlance, "morphemes" to the linguist – constitute an enormous stock. Yet they are represented by small arrangements of a relatively very small stock of distinguishable sounds which are themselves wholly meaningless" (Hockett 1960: 6; See Ladd 2012, for a comparison with Martinet's view of "double articulation").

Hockett's reference to duality as "a human design feature" suggests not only that small meaningless elements *can* recombine to form larger meaningful units, but that they *must* do so. Indeed, we find 21st-century textbooks stating that "The sounds of a language are intrinsically meaningless: their only purpose is to form

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the building blocks of which words are made" (Hayes 2009: 19). However, an alternative interpretation is that duality, like other proposed linguistic universals, is a statistical tendency reflecting a complex sets of factors, and most centrally, the need for some minimal number of basic units that can recombine to yield a potentially infinite set of form-meaning correspondences. If this is the essence of duality, then our expectations regarding universality will be quite different from the rigid interpretation of Hayes and others.

First, we expect that though rare, there may actually be a natural human language where duality is violated, or not a central component of grammar. Though duality of patterning is evident in all widely established sign languages (Stokoe 1960; Sandler 1989; Sandler and Lillo-Martin 2006), there may be some exceptions. A case of this kind is suggested by research on a relatively young sign language, Al-Sayyid Bedouin Sign Language. In their on-going description of Al-Sayyid Bedouin Sign Language grammar, Sandler et al. (2011) propose that this natural human language lacks duality of patterning, despite its apparent well-developed prosody, relatively large lexicon, productive word-formation processes, stable SOV constituent order, and normal usage in everyday life. If this is true, then, as with use of the coronal stop phoneme /t/ in spoken languages, duality of patterning may be a strong statistical tendency whose source is not an innate design feature of language, but related more directly to functional issues such as means of productive word-formation processes, limits on memory, and/or limits on word-specific articulatory routines.

Second, we expect to find languages where most, *but not all*, utterances are decomposable into meaningless features, segments and other phonological flotsam and jetsam. Since universals seep, there may be edges of the language that are external to this seepage. In these far corners we may see holistic non-compositional utterances on the one hand, or meaningful bits and pieces on the other. In the sections that follow, I suggest several places where spoken languages show grammar-internal violations of duality: in sub-systems of sound symbolism where single features are systematically meaningful, and in what I call 'holistic morphemes' where, at the level of sound, utterances resist decomposition. However, before discussing these, it is worth noting that, while Al-Sayyid Bedouin Sign Language may show an extreme case where duality of patterning is nearly absent, other sign languages may have central iconic 'channels' which also lack duality. For example, in Nepali Sign Language, duality is clear in some signing, but not in other, and not consistently (Graif 2011). In discourse, it is common for signers to go back and forth between iconic and arbitrary signing, and lexical and iconic (non-decomposable, holistic) signs are interchangeable. The sociolinguistic context lends some understanding to the situation. As Graif (2011: 10) describes:

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> NSL [Nepali Sign Language:JB] is a language, but it is also a language that keeps banker's hours: at 5 pm, the clubs, schools, and offices that host Kathmandu's deaf community close and the majority of NSL-speakers go home to non-fluent signing environments. Deaf people are always – already [sic] immersed in highly complex linguistic and semiotic worlds, and it appears that deaf languages represent this fact by incorporating complex mechanisms of interdiscursivity into the core of grammatical competency.

A third expectation we might have if duality is a way of making a lot of linguistic "molecules" out of smaller linguistic "atomic elements", is that these atomic elements or building blocks need not be limited to "distinguishable sounds": distinctive features, which are abstract and not pronounceable or distinguishable alone, might also serve as meaningless combinatory elements, and bigger phonological units like syllable templates could do the same. This is, of course, what is found in spoken languages. Segments are fruitfully viewed as composites of distinctive features, and it is only when these features have meaning (see below), that we are forced to admit that the segment is too gross a level of description. The same is true for bigger units: in the many Semitic languages where syllabic templates like CVCVC (vs. CVCCVC) lend meaning to words, one is forced to admit that syllable structure (independent of segmental content) can act as an atomic element in word-formation. In other words, though there is a clear statistical tendency for spoken languages to make greater use of the combinatorial properties of meaningless single segments than smaller feature-sized units, or larger sequences of segments, there is no reason to expect that either of these possibilities will be ruled out, and indeed, they are not.

While combination and recombination are clear properties of phonological features and segments, in this paper I suggest that duality not be regarded as an obligatory design feature of languages for two central reasons. First, though the smallest bits of spoken language are typically meaningless, and thus, can rightly be referred to as "cenemes" (< Greek *ken-* 'empty') within Martinet's (1949, 1980) model of double articulation, the exact same elements within a language can be meaningful, and hence worthy of the "plereme" (< Greek *pleth-* 'full') label. But if this is the case, duality is violated, since it is not possible to decompose every sequence of pleremes into a sequence of cenemes. In Hockett's more familiar terms, there is a strong statistical tendency for meaningful units of speech to be represented by small arrangements of a relatively very small stock of distinguishable features or sounds which are themselves wholly meaningless, however, this is not always the case. The very small stock of combining elements can also, in some contexts, in some languages, be meaningful. Section 2 discusses cases of this kind, including a brief discussion of how meaningful sequences may arise from chance distributional skewings. A second reason to question the obligatory

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status of duality in spoken human languages is that not all utterances can be analyzed into smaller meaningful parts. Like the signed languages discussed above, spoken languages tolerate holistic meaningful utterances that are relatively long and complex, but not decomposable. Some cases of this kind are described in Section 3.

Throughout this article, I assume that the features and segments that are identifiable in spoken human languages are particulate, and maintain their discreteness when combining to form new objects (Abler 1989; Studdert-Kennedy 1998; Fontana and Buss 1996). Though the discreteness of distinctive features (or gestures) and segments may be compromised greatly depending on other syntagmatic and paradigmatic properties of the utterance, this will not play a role in the discussion that follows.

2 Meaningful building blocks in spoken language phonology

While all spoken human languages make use of seemingly meaningless features, segments and prosodies to distinguish lexical meanings, Hayes' (2009: 19) claim that segments *only* serve as building blocks is too strong. In many languages, features, segments and prosodies can serve one of two meaningful functions. They can be the sole exponents of morpho-syntactic features, or they can denote lexical meaning directly within language-specific sound-symbolic systems. In the following subsections, I illustrate meaningful functions for what are usually considered the smallest units of phonological combination, single features.

2.1 Meaningful segments

Before examining these less common cases, consider, as shown in Table 1, a small sample of languages where single segments can be the exponents of morphemes with lexical (e.g. Kabardian /ʔ/ 'say') and grammatical content.

While the existence of single-segment sized morphemes is not in question in morphological theory, or grammatical analysis more generally, the implications of the existence of such morphemes should be clear. If, in principle, single-segment morphemes, like other morphemes, have arbitrary sound/meaning correspondences, then there should be cases where, at the level of segmental analysis, we cannot find discrete *meaningless* parts within a word, because every segment is a morpheme, and is meaningful.

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Language	Family	Morpheme	Meaning	Source
Delaware	Algic/Algonquian	n- k- -w	1st p subj 2nd p subj 3rd p subj	Goddard (1979)
English	Indo-European/ Germanic	-d -z_1 -z_2	simple past plural genitive	
Kabardian	NW Caucasian	z- i- -ʔ-	locative 3rd sg subj 'say'	Colarusso (1992)
Mandarin	Sino-Tibetan/ Sinitic	-r (standard) -l- (Pingding)	diminutive diminutive	Lin (1989) Yu (2004)
Tsou	Austronesian	m- -a -i	active voice patient voice locative voice	Zeitoun (2005)

Table 1: Meaningful segment-sized morphemes

Admittedly, there are not many languages with words of this type, but Kabardian verbs provide many examples (Colarusso 1992). Kabardian, a Northwest Caucasian language, is well known for its relatively large consonant inventory (48–50 phonemes, depending on dialect), and relatively small vowel inventory, with only two distinctive vowel qualities, /a/ and /ə/. Less appreciated is the enormous complexity of words in this language, and the minimal form of many stems and affixes which results in words like those illustrated in (1).

(1) No meaningless parts: Segment-sized morphemes in Kabardian

a. ǎ'- a- q^w (Colarusso 1992: 5)
man- CONNECTIVE- son
'sons of a man' (Kabardian clan rankings)

b. ø- y- a- w- g^y- a (Colarusso 1992: 54: 91d)
3.ABS-3.OBL- DAT- PROG- call- to
'reads' (tr.)

c. ø- ø- t- y- a- ǎ- ś (Colarusso 1992: 76: 136b)
3- 3 SURF- DIR- DAT- lie- AFF
'lies' (on a surface)

Of course, the meaning of the morpheme-sized segments in Kabardian is not solely a function of their phonological form, but also their position within the

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complex word: /a/ is a connective morpheme in the noun (1a), but a dative marker when prefixed to a verb (1b,c). Even so, it is clear from this example that there is nothing, in principle, which appears to prohibit minimal combining segment-sized morphemes, or words in which all segments are meaningful. A full lexicon of this type might be unexpected, since nothing, in principle, would inhibit the grammaticization of minimal /C/ and /V/ morphemes into bigger CV morphemes over time (CV syllables being possible syllable types in all languages), however, rigid morphological templates defining monosegmental shapes for roots and affixes could result in such a system, at least for open word classes like nouns and verbs.

Since duality of patterning is thought to be a necessary feature of human language in enabling the creation of large lexicons, or at least large open classes of content (nominal/verbal) roots, languages like Kabardian are significant reminders that large segment inventories can contribute greatly to morpheme-inventory size, even where morphemes are segment-size. Compare Hawaiian with 8 consonants and 5 vowel qualities which combine in VV (long vowels + diphthongs) for 25 syllabic nuclei (Elbert and Pukui 1979, 1986). This yields 125 possible monosyllables (all of which are attested), and 15,625 disyllables. The majority of morphemes in Hawaiian are monosyllabic or disyllabic, so we can assume that the 15,750 possible distinct strings is a fine starting point for minimal units of meaning, which themselves can recombine in numerous ways. Is it possible to arrive at a number of this kind from a language with a larger segment inventory, even if morphemes are monosegmental? I think the answer is yes. Consider the now extinct Northwest Caucasian language Ubykh, a relative of Kabardian (Vogt 1963; Dumézil 1965). Ubykh had approximately 80 distinct consonants and, like Kabardian, only two distinct vowels. As in Kabardian, monosegmental morphemes occurred, and CV and CVC syllables were both possible. Now imagine a language like Ubykh, where each of the 80 consonants is meaningful, and where lexical (vs. grammatical) meaning of the morpheme is dependent on the position in the stem. As illustrated in (2), stems have the form $[C_1\text{-}(V)\text{-}(C_2)]_{stem}$. In C_1 position, consonants have lexical meanings, while in C_2 position, their meanings are grammatical. (Tri-partite stems are a common feature of Algic languages, see Goddard 1990 and Garrett 2004).

(2) An Ubykh-like language with only mono-segmental morphemes
# of distinctive consonants = 80 # of distinctive vowels = 2
Stem structure (for nouns and verbs) = $[C_1\text{-}(V)\text{-}(C_2)]_{stem}$
| |
lexical grammatical

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In this Ubykh-like language with 80 contrastive consonants and two vowels, there would be 80 distinct C-stems, 160 distinct CV stems, 12,800 distinct CVC stems, and 6,400 distinct CC stems, for a total of 19,440 possible distinct stems. Even if half of the CC-stem types were unattested, the total would be 16,240, – comparable with the 15,750 {monosyllabic + disyllabic} stringset available in languages like Hawaiian.

Given the existence of the Northwest Caucasian languages with numerous mono-segmental morphemes, some degree of templatic morphological structure, and CV and CVC syllables as well as consonant clusters, the absence of languages with all and only mono-segmental morphemes could be viewed as accidental. A language with these features, and a tri-partite stem structure, as sketched in (2), would allow for over 15,000 distinct stems, comparable to multi-segmental stems in simple phonological systems like that found in Hawaiian. However, within nearly all phonological models, the segment is decomposed into smaller meaningless units. In the following section I discuss cases where even the smallest atoms of sound in spoken human languages must be viewed as meaningful, and consider the implications of these systems for the duality of patterning.

2.2 Meaningful features

Most phonologists are in general agreement that the smallest units of analysis in speech are distinctive features, or, within Articulatory Phonology, gestures (Browman and Goldstein 1992). In many cases, these two types of atomic units of speech define more or less the same articulatory or acoustic event. For example, the distinctive feature [spread glottis] refers to the same articulatory configuration as the glottal gesture specified as "wide open". However, there is continued debate as to the appropriate set of features or gestures, and whether these are innate and universal or emergent and language-specific (Mielke 2004). The arguments that follow are structured to go through independent of the particular feature model one adopts, and independent of whether features are viewed as universals, or as language-specific emergent categories.

In many languages, a single feature, either in simple association with a single segment, or in multiple association with a string of segments, is the sole exponent of a morpheme, and hence, associated with meaning in the mental lexicon. A well studied case is found in Isthmus Mixe, a Mixe-Zoquean language of Mexico, where the 3rd person singular is expressed by palatalization of the stem-initial consonant, marking 3rd person possessives on nouns and 3rd person subjects on

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verbs (Dieterman 2008): /pa̱m/ [pa̱m] 'illness' vs. [pʲa̱m] 'her illness' /ka̱:k/ [ka̱:k], 'banana' vs. [kʲa̱:k] 'her banana', etc. The native consonant inventory of Isthmus Mixe includes /p t k ʔ ts ʃ h m n w j/ and all of these occur with secondary palatalization when they are initial in a noun in the 3rd person possessed form. The same feature-sized unit of palatalization has a distinct morphological function in verb-final position: here, the plain vs. palatalized consonant contrast indicates deverbalization, or one of three different types of conjuct clauses. As an example of deverbalization, consider /tu̱:t/ [tu̱:t] / 'to lay eggs' vs. [tu̱:tʲ] 'egg'. Whether one adopts the model of Sagey (1986), where palatalization is represented by the feature [–back], a terminal feature of the DORSAL place node, the model of Hume (1994) where palatalization is represented by [–anterior], a terminal feature of CORONAL, or Articulatory Phonology, in which palatal constriction of the tongue body is an atomic element, one arrives at the same conclusion: a single atomic feature, palatalization, is the sole exponent of multiple morphemes in Isthmus Mixe. As a "prefix", associating with the first segment of the word, it marks 3rd person singluar inflection. As a "suffix", associating with the last segment of the word, it encodes the syntactic category [+noun].

Feature-sized morphemes, referred to as "featural affixes" by Akinlabi (1996, 2011), exist for all feature classes, as illustrated in Table 2.

Where Isthmus Mixe makes use of palatalization, a place feature, other place features (Chaha/Afro-Asiatic/Semitic; McCarthy 1983), single manner features (Terena/Arawakan; Harden 1946; Bendor-Samuel 1960, 1966; Aikhenvald 1999), single laryngeal features (Misantla Totonac/Totonaco-Tepehua; MacKay 1994, 1999), and single tonal features (Tiv/Niger-Congo/Bantoid; Pulleyblank 1986), play similar roles in the morphology of other unrelated languages, as illustrated in Table 2. The fact that any type of feature (place, manner, laryngeal, tone) can be the sole exponent of a morpheme and serve as a meaningful building block in

Language	F-Class	Feature	Meaning	Association
Isthmus Mixe	place	palatalization	3rd p sg	single/initial C
Chaha	place	labialization	3rd p masc sg obj	single/last labial, velar C
Terena	manner	nasalization	1st p poss	multiple/initial
Misantla Totonac	laryngeal	laryngealization	2nd p sg	single/final
Tiv	tone	L H	general past past habitual	single/final syllable single/final syllable

Table 2: Meaningful feature-sized morphemes

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spoken human language suggests that there is nothing intrinsic to features themselves which makes them *obligatorily* meaningless. Features, the smallest indentifiable units of spoken languages, can bear meaning, and do so in many different languages.

However, two aspects of meaningful features like those illustrated in Table 2 might lead one to insist that Hockett was correct in interpreting meaningless formatives as necessary components of linguistic systems. First, though in rare cases, single distinctive features carry grammatical meaning, the historical origins of these features in full-blown segments might lead one to argue that feature-sized morphemes are always "derivative", having origins in segment-sized morphemes. For all examples in Table 2, this is the case. Within the Mixe-Zoquean family, Isthmus Mixe is not the only language with 3rd person singular expressed by palatalization. However, comparative data illustrates that a segmental prefix, *(ʔ)i- is reconstructable for the family (Dieterman 2008: 39). The same is true for verb-final palatalization of consonants (see above), whose historical origins lie in a segmental suffix, *-(h)i (op cit.). Segmental origins clearly underlie the other feature-sized morphemes discussed above. Chaha 3rd person masculine object labialization is cognate with /-u/ in other Semitic languages, and appears to originate from *-u with the same meaning. In Terena and closely related Southern Arawakan languages Guaná, Chané and Kinikinao, the feature-sized nasalization expressing 1sg possessive (which spreads from the beginning of the word until it hits the first stop or fricative) is cognate with /nu-/ in other Arawakan languages, and has developed from 1st p singular proto-Arawak */n-/ (Aikhenvald 1999: 88). In the Totonaco-Tepehua family, Misantla Totonac is just one of several varieties with 2nd person singular subject expressed as laryngealization. In Misantla Totonaco, this feature associates with a final vowel, while in Huehuetla Tepehua, any stop or affricate in the verb stem is laryngealized (Kung 2007: 179). In this case, the historical trajectory appears to be from segmental */-ʔ/, to a floating laryngeal feature of glottal constriction. Finally we have the numerous cases of tone languages, like Tiv, where tones alone are morphemes. In many tone languages there is both synchronic and diachronic evidence for "tonal stability", the maintenance of tone when the segments that tones are associated with are lost (Goldsmith 1976a, 1976b, 1990). All of these historical trajectories make it appear that feature-sized morphemes are aberrations, occurring only as remnants of historically more robust segments, or segment strings, that have undergone phonological reduction over time.

A second argument that the feature-size morphemes in Table 2 are non-canonical relates to their semantics. Unlike the mono-segmental morphemes in languages like Kabardian, feature-size morphemes do not appear to span the full range of possible meanings. Instead, they typically encode grammatical features,

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like the inflectional categories of person, number, case, tense, aspect and mood exemplified here.

However, both of these arguments are weakened somewhat by the existence of feature-sized morphemes in systems of sound symbolism or ideophones ("marked words that depict sensory imagery"; Dingemanse 2011: 25) (Hinton et al. 1994; Dingemanse 2011). In sound symbolism and ideophonic speech, feature-size morphemes appear to arise spontaneously, and are not clearly linked to segmental pre-cursors. In the same systems, features-sized morphemes have non-grammatical meanings, even if these meanings are different from those of the non-sound-symbolic lexicon.

A well studied example is the case of mimetic palatalization in Japanese (Hamano 1986/1998; Mester and Ito 1989). In this class of words, illustrated in (3), the palatalized form is associated with what Hamano (1986) calls a semantic notion of "uncontrolledness", where this includes childishness, cheapness, diversity, excessive energy, immaturity, instability, noisiness, lack of elegance, uncoordinated movement, and/or unreliability, depending on the semantics of the baseform.

(3) Palatalization in Japanese Mimetic Forms

a.	poko-poko	'up and down movement'	plain
b.	pʲoko-pʲoko	'jumping around impudently'	palatalized
c.	kata-kata	'homogeneous hitting sound'	plain
d.	katʲa-katʲa	'non-homogeneous clattering sound'	palatalized
e.	kasa-kasa	'rustling sound, dryness'	plain
f.	kasʲa-kasʲa	'noisy rustling sound of dry objects'	palatalized
g.	pota-pota	'dripping, trickling, drop by drop'	plain
h.	potʲa-potʲa	'dripping in large quantities'	palatalized
i.	zabu-zabu	'splashing'	plain
j.	zʲabu-zʲabu	'splashing indiscriminately'	palatalized
k.	noro-noro	'slow movement'	plain
l.	nʲoro-nʲoro	'(snake's) slow wriggly movement'	palatalized

As Childs (1994: 178) points out in his discussion of African ideophones, one of the properties that sets ideophones apart from others is that their origins are obscure, constituting likely instances of nonce-creation. Unlike the feature-size morphemes in Table 2, there is no clear evidence that palatalization in Japanese mimetics arises from the lenition of an earlier segmental morpheme /i/ or /j/. On

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the contrary, based on typological and experimental evidence, Kochetov and Alderete (Forthcoming) suggest that Japanese mimetic palatalization and many other cases of "expressive palatalization" (Nichols 1971; Ohala 1994) have their origins in the iconic relationship between palatalization and smallness, childishness, and/or affection. Though the notion of "uncontrolledness" in Japanese mimetics is a not a semantic category one would associate with a concrete noun or verb, it certainly is distinct from the grammatical categories expressed by single-feature morphemes in Table 2.

A similar argument can be made for other distinctive features that take part in sound symbolism. For example, in Lahu, a Tibeto-Burman language, the class of verbs with oral vowels can be paired with sound symbolic "vivid adverbials" which have nasalized vowels (Matisoff 1994 [1989]) and a post-posed particle /kàʔ/: under this transform the vowel of *ŋá* 'spread open' is nasalized, and means 'wide open', while *thê* 'straight' with nasalization means 'straight as an arrow'. Here, the feature [+nasal] is associated with vividness or intensity, though, as Matisoff makes clear, the feature is not the reflex of an earlier syllable-final nasal, or any clear historical segmental morpheme. As with the case of Japanese palatalization, a phonological feature directly expresses a non-grammatical semantic feature, and appears to represent an innovation, rather than sparse remains of an earlier segmental morpheme.

Despite the existence of feature-sized morphemes in inflection and sound-symbolic systems, it is rare in spoken languages to find even a single word made up entirely of feature-sized morphemes. The primary impediment to meaningful features is the atomic nature of the features themselves. A feature like [+nasal], which may designate, in articulatory terms, velic aperture with nasal airflow, cannot be realized in isolation: it will surface in combination with a consonant, glide or vowel segment which is specified, minimally for major class features, and typically for place features as well. In Lahu, where [+nasal] is associated with vivid adverbials, it associates with the nuclear vowel of the monosyllabic verb, which itself is a meaningless formative of the verb stem. However, [+nasal] as a lone feature, is not realizable as a speech sound. The same can be said for nearly every distinctive feature, with only a few exceptions. In some models, [spread glottis] and [constricted glottis] can be realized as the simple laryngeal segments /h/ and /ʔ/ without further feature specification; in Articulatory Phonology, a palatal tongue body gesture can be realized as /i/ or /j/. In contrast, the prototypical autosegmental features, tonal features like H and L, demand strings of tone-bearing units for their realization. Because features typically depend on other features for their realization in speech, a system in which multiple features were meaningful would quickly erode, since meaningful and faciliatating instances of features could not be distinguished. Features, by their very nature,

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then, cannot take part in the same kind of syntagmatic combination as segments for the simple reason that, with only a few exceptions, their realization in the speech stream necessarily implicates other features.

Even with this caveat in mind, we might push the idea of meaningful features to the limit, by assuming that 'default' segments could arise to bear meaningful features. As with the pseudo-language considered in (2), let us allow a morphological template to supply major class (C,V) categories and a minimal degree of semantic distinctness in the realization of meaningful elements, as suggested in (4), and consider whether factors other than the intrinsic unpronounceability of features in isolation limit the distribution of meaningful features.

(4) A language with (mostly) mono-featural morphemes
Sample morphemes: [+high] 'go'/ALLATIVE H 'yesterday'/PAST
[+round] 'lie'/LOCATIVE L 'now'/NON-PAST
[+C.G] 'man'/3SM [+nasal] 'one'/DEF
Stem structure (for nouns and verbs): $[C_1\text{-}\ (V)\text{-}\ (X_2)]_{stem}$
lexical lex/gram grammatical
Sample lexeme: [i̯N] 'the man went' (N = a nasal glide)

In (4) distinctive features are associated with lexical and grammatical meanings whose distribution is determined by the position within the stem template. The sample lexeme [i̯N] 'the man went' is composed of four feature-sized morphemes: [+high] 'go' whose default realization in this context is the vowel /i/; [+C.G] 'man' whose default realization is laryngealization of the /i/ vowel (indicated by the under-tilde); H 'PAST', which results in a H-toned syllable; and [+nasal] 'DEFINITE', instantiated by a syllable-final placeless nasal glide. While a simple language with a very small lexicon is easy enough to construct with meaningful features of this kind and default segmental realizations, two related properties of distinctive feature systems limit the number of morphemes to what appears to be under the threshold of usefulness for human language.

The first limitation is due to the size of the feature set. Within some phonological models, like Articulatory Phonology, only eight basic gestures are proposed, making the feature set smaller than the combined inventory of 8 consonants and 5 vowels in Hawaiian (not counting diphthongs and long vowels)! In this model, the atomic gestures are: lip protrusion, lip aperture, tongue tip constriction location, tongue tip constriction degree, tongue body constriction location, tongue body constriction degree, velic aperture, and glottal aperture. Since some of these gestures like tongue body constriction location and constriction degree are necessarily paired, the feature set is actually smaller than it appears.

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While Articulatory Phonology may constitute an extreme, standard distinctive feature systems in generative models are only slightly larger, with between 27–35 features depending on their characterization of clicks, tone systems, and rare contrasts (e.g. labio-dental vs. bilabial nasals in Teke). However, even if we imagine a system of 40 distinctive features, the combinatorics are limited by paradigmatic (segment-internal) factors determined by the nature of speech sounds: a sound specified as [+high] cannot simultaneously be [–high], nor can it be [+low]; a sound specified as [+round] cannot be [–labial], since rounding involves activation of the lips; and if the tongue tip constriction location is at the teeth, it cannot also be simultaneously at the hard palate. In short, distinctive features, or articulatory gestures are not useful meaningful elements in human linguistic systems since they are constrained in combination by intrinsic properties of speech sounds. We can conclude that the primary inhibition to features as primary meaningful elements in speech is that there are too few of them, and that they cannot freely combine with other features in the same way that segments can.

2.3 Emergent meaning via skewed distributional frequencies: a note on phonesthemes

Phonesthemes (Firth 1930), as defined by Bergen (2004), may be viewed as additional instances in which segment-sized parts (or, often, slightly bigger units, like CC-clusters) contribute meaning to utterances, and have psychological reality. Under Bergen's definition, phonesthemes are *form-meaning pairings* that crucially are better attested in the lexicon of a language than would be predicted, all other things being equal (Bergen 2004: 293). An extreme case of this would be, for example, the Swedish word-initial /fn/ cluster, which is associated with pejorative meaning in 100% of the words in which it occurs (Abelin 1999). This notion contrasts with the more general claim that every sound has some iconic association with meaning, a claim that has been much harder to justify for the full range of sounds made use of in human sound systems (Magnus 1998).

An important property of all phonesthemes investigated up to this point that derive from skewed lexical distributions, is that they occupy a particular position in the word, highlighting Firth's original definition of phonesthemes as individual sounds or "initial and final phone groups not ordinarily recognized as having any function" (1930: 184). If, as suggested by studies like Abelin (1999) and Bergen (2004) many initial clusters in Swedish and English have strong associations with particular meanings for native speakers, then we must re-evaluate the notion of sub-morphemic 'meaninglessness'.

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Consider the case of /gl-/ clusters in English, where approximately 60% of the tokens in the Brown Corpus have meanings associated with light or vision, and where Bergen's (2004) priming experiments support the psychological status of phonesthemes in these word-types. The recognition of meaningful word-initial /gl/ suggests that "duality of patterning", in the normal sense, is compromised: though /g/ and /l/ are segments which can combine freely, once combined, they are associated, at least within a probabilistic model of grammar, with a particular meaning, which is emergent from specific distributional properties of the lexicon of English. Since semantic associations of this kind can arise for single segments as well as for clusters, we must accept that the lexicon of a language can compromise duality of patterning when distributions are skewed. Unlike mono-segmental morphemes which are non-probablistic and categorical, weighted semantics of particular segments in particular positions of words might lead one to question whether any instance of a segment in any position is really 'meaningless'.

While this issue can be mentioned only in passing here, parallel problems in the categorical versus probabilistic treatment of segmental contrastiveness is dealt with constructively within the Probabilistic Phonological Relationship Model (Hall 2009). This model precisely quantifies the degree to which two phonological units are predictably distributed in a language. Building on insights from probability and information theory, it could ultimately allow researchers to calculate degrees of predictability of distribution and meaning for segments and clusters in particular contexts.

3 Holistic morphemes

Though the majority of words or morphemes in most languages can be viewed as composites of contrastive segments or features of the language in question, this is not true of all sound-meaning associations. Aberrant sound patterns are often found in the most common expressions, as for example in English in the positive expression [ʔɐ̃ˈhɐ̃] and the negative [ʔɐ̃ˈʔɐ̃]. Notice that though nasalized vowels and contrastive glottal stop do not occur generally in English, in these utterances, nasalization occurs throughout, with the positive/negative contrast indicated by medial [h] vs. medial [ʔ] respectively. Further evidence that the contrast in these words is holistic in nature comes from their common variants, [ʔm̩ ˈhm̩] (positive) and [ʔm̩ ˈʔm̩] (negative), where the nasalized vowels are replaced by a bilabial /m/. However, this segmental description of the variants is clearly flawed when we look at the bigger picture. In the vocalic variants, the mouth is open for

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the entire utterance. In the bilabial variants, the mouth is closed for the entire utterance. But having an open or closed mouth is not a distinctive feature of the English sound system, nor of any other language, as far as phonology has been able to determine. These articulatory routines are holistic, and wreak of function over form: the mouth can be open or close, the velum is lowered as in relaxed breathing, and one 'breathes' to indicate agreement, and stops breath to indicate dissent. There is no clear segmental phonology in these utterances, despite their minimal disyllable word status, iambic foot structure, and intonational melodies.

Holistic utterances of this kind are not limited to English. In Nhanda, a Pama-Nyungan language of Western Australia once spoken in the greater Kalbarri region, the word for 'yes' or general agreement is [ʔe̯ʔe̯], however the Nhanda vowel system is /a,i,u/, with no /e/, and no contrastive vowel laryngealization (cf. [iʔu] 'south') (Blevins 2001). Again, by being forced to analyze words in terms of distinctive segments or features, we lose a critical component of this utterance: it is produced with holistic laryngealization, and (apparently) enough pharyngeal retraction to produce regular vowel lowering.

Nor are holistic utterances limited to discourse functions of agreement or disagreement. In Koasati, a Muskogean language of Louisiana, Kimball (1991: 502–12) devotes an entire chapter to "Interjections". This special class of words and phrases are described as having "aberrant phonology". There are 79 interjections listed, and while these include particles like *é* 'yes' and *ínkõ* 'no', they also include utterances glossed with significant content, like *hé:* 'Go on!', and *xé* 'Bad dog!'. Though in other words, Koasati shows only a three vowel /a,i,o/ system, in interjections the vowel space is expanded with /u/ and /e/. Though vowel length is generally not contrastive, in these utterances, length can be contrastive in final-position, as in *hé:* vs. *xé*. Another expansion of the phonological space in these words involves the consonant system. Outside of this word-class, the full set of contrasting obstruents is /p t c k b f ɬ s/. In interjections, however, one also finds (contrastive) /g/ and /x/: *gâ* cry of surprise used by men vs. *xá:* 'Whew!' (vs. non-interjection *ká:h* 'He says it'). Finally, while the rest of the language makes use of a four-way pitch accent contrast (high, mid, low, and high rising-falling), in interjections the tonal system is also enlarged by the inclusion of a falling tone (*gâ*), which is absent outside of this special class of words.

In English, Nhanda and Koasati, holistic morphemes share certain functional properties. They are high frequency items whose existence seems keyed to a high level of contextual predictability. Contextual predictability can be equated with very low entropy values, which we know independently, can yield high degrees of articulatory reduction (Jurafsky et al. 2001; Bell et al. 2003; Blevins 2005). If this becomes conventionalized, cues for original particulate structure may no longer

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be present, and holistic utterances like the ones noted above can evolve. In other words, phonology can devolve. From forms that respect duality of patterning, holistic non-compositional meaningful utterances can emerge in a natural and comprehensible way. As with Nepali Sign Language, speakers of English, Nhanda and Koasati can shift from holistic to compositional utterances with ease, and can interchange one word type for another, as in common English phone conversations where listeners can be heard saying things like *yes* . . . . *uhuh* . . . *yes* . . . *mhm* . . . . *yup*.

The implications of holistic morphemes for strong versions of duality should be clear. Not all meaningful utterances in spoken languages can be broken down into smaller meaningless parts. A small number may resist decomposition. If this is so, what limits are there on these aberrant word types? How many can a language have? Must their meaning be contextual? Are they structural parallels to the many lexemes of Al-Sayyid Bedouin Sign Language that also appear to resist decomposition? If so, evolution and devolution may both contribute to our understanding of duality of patterning as a statistical universal.

4 Concluding remarks

In the majority of spoken human languages, morphemes can be represented in terms of "small arrangements of a relatively very small stock of distinguishable sounds which are themselves wholly meaningless" (Hockett 1960: 6). However, the meaningless status of segments, or "duality of patterning" at the segmental level, need not be viewed as a necessary feature of spoken language. On the contrary, there exist many languages with mono-segmental morphemes, and even languages where larger words are made up of a small stock of distinguishable sounds which themselves bear meaning. While meaningless segments are the norm, and clearly facilitate generative capacity, yielding, in particular, lexicons of unlimited size, a relatively large segment-inventory with relatively free phonotactics can yield similar generative capacity, even if segments are meaningful. There seems no reason, at present, to rule out grammars of this kind.

The recognition of phonesthemes as psychologically real components of speech based on skewed distributional frequencies in the lexicon compromises Hockett's original example of "duality of patterning" in which the English words *team* /tim/ and *meat* /mit/ were used as illustration. In this example "meaningless" segments, /t/, /i/, and /m/, combine in different ways to produce morphemes with distinct meanings. Hockett's assumption, and that held by most phonologists prior to probabilistic modeling, is that contrastive segments are,

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by definition, meaningless when they constitute subparts of a single recognizable morpheme. However, the work of Abelin (1999), Bergen (2004), Kochetov and Alderete (Forthcoming) and others, highlights the extent to which submorphemic clusters, segments, and even features, can bear meaning that can be intimately tied to language-specific features of the lexicon. Until we explore the overall frequency of segments in particular combination, and the possible psychological reality of this probabilistic knowledge, we cannot, with certainty, exclude the possibility that segments in English words like /tim/ and /mit/ bear scraps of meaning which may not be accessible through native-speaker introspection.

Finally, in the post-autosegmental era of phonology, where it is widely accepted that nearly any individual phonological feature can lead a life of its own, independent of any particular segment, floating freely in a representation, associating multiply, or, as in cases discussed here, listed in the lexicon as a component morpheme with a clearly identifiable meaning, it is useful to ask why so few languages make use of more than a handful of meaningful features. The answer to this question seems to lie not in any requirement that atomic features be meaningless, but rather in the nature of speech itself: the set of contrastive features is small to begin with, due, primarily to perceptual thresholds; and for most features, realization requires obligatory combination with others. (Indeed, the largest vowel and consonant inventories in the world are those that take full advantage of secondary articulations, – nasalized vowels, creaky vowels, breathy vowels, palatalized consonants, labialized consonants, click accompaniments, etc.) At the same time, some feature combinations are illicit. Though relaxation of duality allows feature-sized meaningful elements, the full power of such systems is never made use of due to these practical constraints on how sounds are made.

It has been argued in recent literature on language evolution that both segments (e.g. de Boer 2001) and features (e.g. Mielke 2004) are emergent properties of speech. Under these proposals, the discovery of a relatively young language like Al-Sayyid Bedouin Sign Language, that appears to lack duality of patterning (Sandler et al. 2011) is not surprising, since it is from systems like these that segments and features are claimed to arise. In the context of the discussion above, there is even less reason to be surprised. If the primary role of duality is to create basic lexicons of thousands of morphemes, there is no expectation that all morphemes should respect duality, nor that all elements used in composition should, on their own, lack meaning. Further, once language is viewed in its communicative context, it is easy to understand how seeming 'violations' of duality might arise in particular domains where meaning is, to a great extent, predictable. In sum, though duality of patterning is a common and useful feature of spoken lan-

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guages, it appears to be a statistical tendency rather than an absolute universal. Most morphemes in most languages are composed of smaller meaningless bits of sound. But some are not, and some bits of sound are meaningful. As probabilistic modeling of speech evolves, we may find larger and larger chunks that resist decomposition, and smaller and smaller bits that carry meaning. By dispensing of duality as a necessary feature of all linguistic structures, we will be in a better position to appreciate the implications of future discoveries.

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