Journal of Language Evolution, 2020, 175–183
doi: 10.1093/jole/lzaa003
Advance Access Publication Date: 2 July 2020
Commentary

OXFORD

Biting into evolution of language

M. A. C. (Riny) Huybregts*

Utrecht Institute of Linguistics OTS (UIL-OTS) Trans 10, Utrecht University, 3512 JK Utrecht, The Netherlands

*Corresponding author: m.a.c.huijbregts@uu.nl

1. Introduction

Do changes in subsistence mode ('cultural evolution') induce changes in human biology that shape language? In a recent research article Blasi and colleagues (Blasi et al. 2019) deliver on Hockett's conjecture (Hockett 1985) that 'labiodentals [. . .] are overwhelmingly absent in languages whose speakers live from hunting and gathering' (Blasi et al. 2019). They offer convincing arguments that 'post-Neolithic emergence of overbite and overjet persistence led to reduced effort when producing labiodentals' (Blasi et al. 2019). The change in bite itself is a consequence, in part, of a change in subsistence type from hunting–gathering to production of soft food that demands relatively less extensive tooth wear. The worldwide association between subsistence type and labiodentals, accounting for the relative absence of labiodentals in languages spoken by hunter–gatherers, and the relative increase of labiodentals during the history of Indo-European, matching the spread of agriculture in early Indo-European societies, thus fall into place. Their conclusion '. . . we can no longer take for granted that the diversity of speech has remained stable since the emergence of *Homo sapiens*' (Blasi et al. 2019) may be unsurprisingly correct and not far removed from truism. On this account language is shaped in part by culturally induced changes in human biology. They then continue 'As such, claims of language universals, deep linguistic history, and language evolution cannot rely on a uniformitarian assumption without considering the wider anthropological context of language' (Blasi et al. 2019). But this conclusion is surprisingly incorrect and far removed from any understanding of the basic property of language. The quote includes a reference to Newmeyer (2002), who discusses alternative positions, concluding that 'no firm conclusion is possible, given the speculative nature of the enterprise.' In fact, as will be discussed below, the one case that is relevant for non-uniformitarianism discussed there receives a superior interpretation favoring the contrary position.

The ambiguous use of an undefined term 'language' unavoidably leads to misrepresentation, misunderstanding, and misconception. What may be observationally real for spoken language at a surface level, generally receives a completely different interpretation at a deeper level of analysis, which, furthermore, is often given a higher degree of reality in the sciences. To avoid pointless talking at cross-purposes, we need a more nuanced and encompassing model of the mappings between language 'genotypes–phenotypes' (in the spirit of Lewontin) that makes precise what we mean by 'language' at different levels of analysis (Chomsky 1965, 2005; Lewontin 1974).

2. Sounds, features, and classes

Part of the problem is that Blasi and associates only mention sound segments of human language, specifically discussing the emergence and distribution of some of these, but never define what they mean by language, what is basic and what is not, using the term as in everyday usage. They only say that speech is characterized as the 'chief mode of human communication'. However, communicative use of language, speech or sign, is not the same thing as language or the faculty of language (Chomsky 2013; Berwick and Chomsky 2016; Huybregts 2017). Language does not disappear when speech or sign does. Furthermore, tooth wear is not genetically determined but the lifetime result of a cultural contingency.

Consequently, even despite an accidental absence of labiodental fricatives in language use, all their constitutive elements have been conserved properties of the human phonetic faculty. More generally, the sensorimotor (SM) system, including the modern vocal tract anatomy and the neural and cranial morphologies necessary for the production of articulate speech, was essentially in place long before its recruitment for production or parsing of externalized language (Tattersall 2019).

2.1 Distinctive features

Blasi et al. (2019) discuss the production, distribution, and historic development of labiodental fricative speech segments, but never mention the basic elements (articulators) that compose these segments, and which define the universal human phonetic capacity. They do not appear to be interested in what is basic and what is not. However, while a specific speech sound may be absent in a language, its constitutive elements could still be active elsewhere in the system. There is no logical contradiction in this. And, in turn, this may have consequences for evolutionary claims about language, as in the present case. More specifically, Blasi and associates ignore a century-old consensus view that the basic units of phonological structure are not the speech segments of human language (e.g., labiodental ‘f’ or ‘w’) but rather the distinctive features (e.g., Labial, Coronal, Continuant, Voice, and others) by which motor articulators like tongue, lips, and larynx assemble such sounds (Jakobson, Fant, and Halle 1952; Jakobson and Halle 1971). Distinctive features ‘correspond to controls in the central nervous system which are connected in specific ways to the human motor and auditory systems’ (Halle 1983) and essentially characterize the organization of the phonetic faculty in humans. Therefore, ‘the totality of phonetic features can be said to represent the speech-producing capabilities of the human vocal apparatus’ (Chomsky and Halle 1968), quite independently of cultural background. Phonetic features excite or inhibit articulators and have articulatory and acoustic correlates, for example, the distinctive feature [Labial] distinguishes labial /p/ in English ‘pin’ from dental /t/ in ‘tin’ and velar /k/ in ‘kin’, the feature [Coronal] sets dental /t/ apart from /p/ and /k/, and the feature [Continuant] distinguishes between /t/ and dental fricative /θ/ in English ‘thin’ or between /k/ and velar fricative /x/ in Scottish ‘loch.’

2.2 Natural classes

Crucially, this scientific consensus holds that rules of phonology do not apply randomly to individual sounds or arbitrary collections of these but rather apply specifically to the *natural classes* characterized by one or more distinctive features (Chomsky and Halle 1968; Halle 1983), just as the possible chemical elements and their associated possible chemical reactions and bonds are naturally grouped by the number of electrons to complete each atom’s outer shells. The arbitrary set {f, t, x} contains members with opposite values for every feature and cannot therefore be characterized with a unifying feature value (see Fig. 1). In contrast, the set {p, t, k} is naturally characterized by the feature value ‘non-continuant’ shared by all its members. Systematic sound changes (e.g., Grimm’s Law or Verner’s Law) obey well-formedness conditions on natural classes. Plosives {p, t, k} may naturally change to {f, *θ*, x}. In contrast, since the set {f, t, x} does not constitute a natural class, no phonological rule will apply to just these sounds.

The phonemic voice distinction between velar obstruants /k/ and /g/, accounting for the minimal pair ‘cut’ versus ‘gut’ in English, is missing in Dutch, where /g/ is not phonemic. Still, regressive voicing assimilation applies to the class of *p, t, k* when these consonants precede a voiced plosive to yield their voiced counterparts *b, d, g* as in *kla**p**deur* (‘swinging door’), with /-pd-/ changing to /-**bd**-/; *wi**t**boek* (‘white paper’), with /-tb-/ changing to /-**db**-/; and *za**k**doek* (‘handkerchief’), with /-kd-/ changing to /-**gd**-/. Conversely, English loans in Dutch often preserve their voiced velar stop in word-initial position as in ‘guts’ or ‘game’ but show the same final devoicing of obstruants (*Auslautverhärtung*) in

	p	f	t	θ	k	x
labial	+	+	–	–	–	–
coronal	–	–	+	+	–	–
continuant	–	+	–	+	–	+

Figure 1. Distinctive features and natural classes. The voiceless plosive consonants {**p, t, k**} form a homogeneous subset, a natural class of speech segments that share a common feature value [– continuant]. Similarly, the subset of voiceless fricative consonants {**f, θ, x**} constitutes a natural class characterized by the feature value [+ continuant]. In contrast, the subset of consonants {**f, t, x**}, their feature values marked in red, does not constitute a natural class (cannot be characterized by one or more features shared by all and only its members) and can only be enumerated by a stipulative disjunction, namely [+ continuant, – coronal] OR [– continuant, + coronal]. Rules of grammar apply to natural classes only. Application of one of Grimm’s Laws changed the series of voiceless non-continuants in Indo-European to the corresponding voiceless continuants of Proto-Germanic. For example, **p** > **f** (cf. Latin ***piscis*** > English ***fish***), **t** > **θ** (cf. Latin ***trēs*** > English ***three***), and **k** > **x** > **h** (cf. Latin ***cord-*** > English ***heart***; Latin ***octo*** > English ***eight*** (OE *eahta*), Dutch ***acht***).

the loans *airbag*, *drug*, or *smog* (all ending in /k/) that applies to regular native words like, e.g., *kwab* ('lobe'), /kʊɑp/, or *vod* ('rag'), /vɔt/. Compare their plural counterparts *kwabben,* /kʊɑbə(n)/, and *vodden,* /vɔdə(n)/. These cases again show that phonology works on natural classes, not on individual segments. No rule applies to *p, k* excluding *t* since *p, k* is not a natural class characterized by distinctive features of the phonetic faculty in humans ('universal phonetics'). If rules of phonology were to apply to individual speech sounds, we might expect voicing assimilation *not* to apply to yield velar plosive /g/, and final devoicing in loans *not* to apply to yield /k/. Still, the rules invariably apply to *natural classes* containing sounds that are not part of the systematic sound patterns of the language but are nonetheless members of them with a universal interpretation. These two empirically different cases show that natural classes (features) dictate the distribution of sounds even when these are not phonemic in the language. Natural but non-phonemic sounds are systematically generated by general rules (the first case), and general rules systematically convert non-phonemic sounds in loans to phonemic values of the borrowing language (the second case).

2.3 Opposing views

Some approaches, for example, usage-based learning of language, oppose the view that phonological rules apply to natural classes. Features emerge from usage-based learning, and the latter allows for 'unnatural classes.' Mielke gives numerous examples of 'crazy classes' in section 3.2 of chapter 5 in his book (Mielke 2008). These 'unnatural classes' surely pose some interesting puzzles to be solved by phonological theory. In fact, some of the 'unnatural' cases discussed by Mielke turn out to be perfectly 'natural' under improved analysis. See, for example, Daniel Hall's discussion of Mielke's nasal deletion in Bukusu (Hall 2010). However, from a synchronic point of view it is to be expected that a 'margin of irregularity,' exceptions that result from historical processes, will persist in phonological description. Still 'the existence of exceptions should not prevent the systematic formulation of those regularities that remain' (Chomsky and Halle 1968). Exceptions exist in even the most developed sciences, for example, specific areas of physics. The postulation of attractive gravitating dark matter that does not interact with any type of electromagnetic radiation and the cosmic acceleration of the universe when expansion would be expected to be slowing down are just two cosmological puzzles.

Mielke's analysis questions the idea that distinctive features are 'innate'. Instead, features are emergent properties of language learning. Use of language will define which phonetic features are involved in which rule applications. Since use is wedded to frequency effects and accidental contingencies, diachronic changes may plausibly lead to 'unnatural' phonetic classes. Although not stated in precisely these terms, what the proposal essentially amounts to is that distinctive features are annotations on sound segments indicating rule applicability. Any collection of segments that a rule applies to is a class. There is no principled distinction between natural and unnatural classes. But this merely restates the problem without explaining it and amounts to a mere description of attested sound patterns of an individual language. There is no theory or account of what it means to be 'emergent.' In contrast, the natural classes as grounded in articulator–distinctive feature theory at least have a much more predictive and falsifiable theory of this, namely, features emerge as the 'stable articulator' points in the articulatory gestures.

Furthermore, 'unnatural classes' are not exactly novel phenomena, but could already be accounted for in *The Sound Pattern of English* (SPE) of Chomsky and Halle (1968) by taking them to be combinations of natural classes subsumed under the brace notation for conjunctive ordering. The complications that arise (e.g., through diachronic change) can be assumed to be real and are captured by the brace notation as part of an explanatory theory of *markedness* (as provided, e.g., in chapters 8 and 9 of SPE). Rather than usage-based descriptive accounts of attested sound patterns, markedness theory of possible and impossible sound patterns seems the right place to discuss the marked nature of unnatural classes.

Finally, one could at least envision some dynamical system model whose attractor points are 'emergent properties of language learning' in the sense of Mielke, where the attractor points (like p, t, k) are attractors on the basis of distinctive features of articulatory gestures. For one attempt at modeling a related notion in the area of syntactic features, see Niyogi and Berwick (2009). This still allows for some variation while maintaining a basis set, which has remained essentially fixed, although, of course, the attractor points for articulatory gestures could have evolved over time and are subject to learning effects, for example, possibly as set out in Berwick (1985), but this way of explaining natural classes leads back to distinctive features again—via the notions discussed in Halle and Stevens (1959, 1962) and Stevens and Halle (1967).

3. Labial articulations and dental attrition

3.1 Labiodentals in the world's languages

Crucial to this discussion is that the relevant features [Continuant], distinguishing labiodental /f/ from bilabial

/p/, and [Strident], distinguishing between labiodental /f/ and bilabial /ϕ/, were *already* available as elements of a universal system of distinctive features that make up our phonetic faculty. The feature [Continuant] distinguishes bilabial plosives (p/b) from bilabial (ϕ/β) and labiodental (f/v) fricatives; the feature [Strident] distinguishes between bilabial continuants (ϕ/β) and labiodental continuants (f/v). However, these distinctive features are not restricted to just labial consonants. The feature [Continuant] is a property of dental (θ/ð) and (s/z), dorsal (x/ɣ) and (χ/ʁ) as well as labial (ϕ/β) and (f/v) fricatives, and it distinguishes fricatives from plosives in dental, dorsal, as well as labial consonants; the feature [Strident] distinguishes bilabial from labiodental fricatives, interdental from dental fricatives and velar from uvular fricatives. In short, labiodentals (f/v) share the positively charged feature [Strident] with sibilants (s/z) and uvular fricatives (χ/ʁ), while bilabial fricatives (ϕ/β) share the negatively charged feature [Strident] with interdental (θ/ð) and velar (x/ɣ) fricatives. See Fig. 2 for an overall picture and a clarification of some of the International Phonetic Alphabet (IPA) symbols used here.

Outside the class of labial consonants, the feature [Continuant] was already freely available to discriminate, for example, between /θ/ and /t/ or to distinguish /x/ from /k/. Similarly, the feature [Strident] must have been a factor in setting sibilant /s/ apart from interdental /θ/, or velar /ɣ/ apart from uvular /ʁ/. These sound segments exist independently of labiodentals and probably were

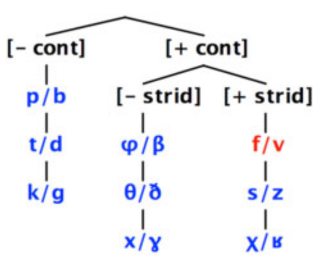

Figure 2. Culturally induced changes in the history of language that leave the initial state of language (UG) unchanged. Note that all relevant features of labiodental fricatives (f/v), *viz.* Continuant and Strident, appear elsewhere in bilabial (top row), dental (middle row), and dorsal (bottom row) fricatives. The alleged emergence of *f/v* in the world's languages after the agricultural revolution did not change the human phonetic space with its attractor points grounded in the distinctive features of articulatory gestures. Use of the already available feature [Strident] was merely facilitated for/extended to labial continuants. Symbols: /ϕ/ as in Ewe *éϕá* ('he polished'), /β/ as in Spanish ***valor*** ('value'), /θ/ as in English ***myth***, /ð/ as in English ***with***, /x/ as in Scottish ***loch*** ('lake'), /ɣ/ as in Greek ***gála*** ('milk'), /χ/ as in Hebrew *mele**ch*** ('king'), /ʁ/ as in French ***r**ester* ('stay').

in use before 'culturally induced' labiodental /f/ could be articulated relatively effortlessly as a result of a change in subsistence type. In fact, strident fricatives, for example, /s/ and /z/, or /χ/ and /ʁ/ occur widely (Ladefoged and Maddieson 1996). Furthermore, Khoisan and Inuit languages generally show dental, alveolar, velar, and glottal fricatives, and clicks with velar fricative release abound in Xóõ (a Tuu language) or Ju|'hoan (a Kx'a language) spoken by hunter-gatherers ('San') of Botswana and Namibia.

Within the class of labial consonants, fricative bilabials do occur widely, while not frequently, in the world's languages (e.g., Bengali, Catalan, Ewe, Itelmen, Maori, Tarifit Berber, Greenlandic). In fact, Ewe even has phonemic stridency oppositions, high/low-intensities at high/low-frequencies, between bilabials /ϕ/, /β/ and labiodentals /f/, /v/, for example, *ɛ̀βɛ̀* ('Ewe') vs. *ɛ̀vɛ̀* ('two'), and *éϕá* ('he polished') versus *éfá* ('he was cold') discussed in Ladefoged (1964). There is no reason to assume that bilabial fricatives have ever been absent from human language on principled grounds. Finally, within the class of labiodental fricatives, Dutch labiodental approximant /ʋ/, as in *wacht* ('guard'), differs from labiodental fricative /v/, as in *vacht* ('fleece'), precisely in the distinctive feature [Strident].

A further consideration is that the articulation of labiodental fricatives is merely facilitated, not exclusively produced, in an overbite configuration, which, in addition, permits articulatory ease both of strident and non-strident labial continuants. Use of the feature [Strident], already available for the articulation of dental and dorsal fricatives, was merely facilitated for/extended to labial continuants in post-Neolithic times, yielding labiodental fricatives.

As a result, the emergence of labiodentals fricative /f/ and /v/ engender no theoretical significance since all of their constitutive distinctive features, in particular [Labial, Continuant, Strident], already are part of the human phonetic faculty, and are attested world-wide in the speech sounds of human language (Ladefoged and Maddieson 1996). Specifically, the feature [Strident] differentiates non-strident bilabial (ϕ/β), interdental (θ/ð), and velar (x/ɣ) fricatives from strident labiodental (f/v), sibilant (s/z), palato-alveolar (š/ž), and uvular (χ/ʁ) fricatives, showing again the primacy of basic units of phonology over the specific speech segments to which they are confined.

Consequently, the constitutive distinctive features of labiodental fricatives /f/ and /v/ are each represented in different segments that very plausibly must all have existed in pre-Neolithic times. Just as no new element with some new number of electrons in its outer shells has ever been chemically created, the set of possible distinctive features has more plausibly remained fixed since pre-Neolithic times, and this part of the human initial state for language at birth (sometimes called 'uniformity in capacity for language' or 'UG') was never modified but has remained deeply conserved.

3.2 Labiodentals in the Neolithic

Suppose someone were to argue that, after all, in fact a feature [Labiodental] is independently motivated as a phonetic primitive of natural language. This would not change the argument given here. The relevant feature would be universally available to children but would get compromised in adult hunter–gatherers for reasons that are not genetic and are therefore irrelevant for the evolution of the human phonetic capacity and its use in spoken language. In fact, throughout the Neolithic children and adolescents of hunter–gatherer populations must have been fully capable of articulating labiodentals before tooth wear became sufficiently substantial to make articulation effortful in adulthood. In hunter–gatherer populations, articulation of labiodentals has *always* been possible for children and adolescents, if not for adults. In other words, the change in mode of subsistence has never created an articulatory option for the human species that was unavailable before. Hence, relevance of subsistence type for evolution of language remains essentially nil. The range of sounds a child learns clearly depends on what she hears, but what is important here is what the child *can* learn, namely any system that is UG-compliant, not what the child actually *does* learn, a specific internal system satisfying UG. Evidently, Zürich German does not determine the human capacity for articulation. Hunter–gatherer children inherited from their parents the exact overbite configuration that makes it possible to articulate labiodentals. It is the basis state of the human organism's sound system at birth explaining what sound patterns are possible and impossible that is relevant here, not the set of accidentally attested sound patterns or language universals in the sense of Greenberg (i.e., descriptive generalizations).

To put the matter in perspective, nineteenth-century Dutch farmers wearing wooden shoes have been shown to develop *osteochondritis dissecans* (Vikatou, Hoogland, and Waters-Rist 2017), a joint disorder that mostly affects foot and knee bones and causes catching and locking in joints during movement. A change from clogs to soft footwear simply avoids the problem. No biologist would seriously want to argue that a culture-induced change in footwear has been a factor in the evolution of bipedal locomotion in modern humans.

One wonders whether an unequivocally biological example would also work. One familiar example of a new surface trait, a phenotype that appears without 'deeper' evolutionary change is of course the notion of environmentally determined gene expression (Thompson 2013). In evolutionary ecology and genetics, it is a commonplace that biologists posit this more accurate and nuanced model of environmentally contingent genotypes, where, for example, identical gene(s) determining plant height would lead to tall plants at low altitudes and short ones at higher altitudes. Rather than a unique outcome of development, a genotype 'specifies a norm of reaction, a pattern of different developmental outcomes in different environments' (Lewontin, 2000).

We therefore conclude that the change in bite configuration was a factor exogenous to the language faculty and only led to a slightly different selection from a fixed set of distinctive features for use of an unchanged phonetic faculty, rather than a change in the basic set of distinctive features itself. It was therefore of absolutely no relevance for the evolution of language or language universals since the latter did not evolve at all in this situation.

4. Non-uniformitarian assumptions

Even though this particular argument for a non-uniformitarian basis of language can be discounted, there are perhaps other cases that are relevant. The pros and cons of a uniformitarian thesis for language have been discussed by Newmeyer (2002) but his arguments are inconclusive, and, with one exception, the 'non-uniform' aspects discussed all involve properties that concern externalization of language (morphophonemics, inflection, grammaticalization, word order) and are ancillary to the basic properties of internal language. However, language change should not be confused with the evolution of language because for one thing, their timescales often seem to be completely different. The single exception to all of this is his discussion of the *Subjacency Constraint* on sentences with complex embedding (Chomsky 1973, 1981). Newmeyer's discussion of Kirby and Hurford's argument for the 'non-uniformitarian' origin of subjacency is quite illustrative. In their view, since our ancestors would have used little if any subordination, there would have been little if any need for a strict locality constraint. Subjacency would then have 'evolved' (by genetic assimilation) when communicative need for complex sentences increased over time. But this proposal is definitely wrong. Current generative theories of grammar (Chomsky, Gallego, and Ott 2019) make it quite clear that subjacency is not primitive. Its empirical effects derive from the phase-bound application of a simple combinatorial operation, binary Merge, which takes two objects X, Y already constructed and forms a new object Z (Chomsky 2013; Berwick and Chomsky 2019). Minimal Computation, a general *third factor* principle applied to language (Chomsky 2005), further dictates that neither X nor Y is modified by Merge, and that they appear in Z unordered (Chomsky 2013). As a result, Merge(X, Y) = {X, Y} is essentially set formation, and Merge-based systems are grounded on binary order-free sets, not string concatenation" (Berwick and Chomsky 2019). On these terms the subjacency effects follow more precisely from a strict locality constraint on Merge (the *Phase Impenetrability Condition*) and the strict cyclicity of a *Transfer* operation, which, at the phase level, hands Merge-generated constructs to the meaning and sound systems that interface with language (Chomsky 2007). Only elements at the phase edge will therefore be accessible to further computation on the next phase level, and successive cyclic movement receives a principled explanation. It follows that even simple *bi-phasal* transitive sentences, 'Panthers kill monkeys,' sentences with a verbal and clausal phase, already obey the very same constraint that Kirby and Hurford argue only came into existence when sentences increased in length. This is a contradiction. The phase-based locality principle itself is a general *third factor* principle of least effort (Chomsky 2005) applied to language ('Minimal Computation'). It was already there before language arrived! It follows that the use of longer sentences did not cause the emergence of locality constraints through parsing or processing strategies. The emergence of subjacency cannot be taken as an argument against uniformitarianism.

It would perhaps be useful to talk about non-uniformitarian assumptions generally, with 'internal language' serving as an analog of 'genotype' and periphery as 'realized genotype.' For that we need some more nuanced account of explanation for observed variation in the 'form that shows'—what is observed from language to language. In biology at least, as per Lewontin's classic genotype–phenotype picture (Lewontin 1974), there are at least four distinct mappings from genotype to phenotype, and so there could be change after any one of these mappings. Lewontin discusses epigenetic laws (T1) that transform an array of genotypes into a distribution of phenotypes, laws of natural selection (T2) that transform phenotypes within the span of a generation, epigenetic relations (T3) that predict the distribution of genotypes based on selected phenotypes, and Mendelian genetic rules (T4) that map parental genotypes to an array of genotypes in the next generation. Such account would at least let us have a vocabulary for distinguishing a diachronic type 'surface' change of the sort described by Blasi et al. (2019), that is, a T2 change of phenotype within the span of a generation, from other sorts of changes. Unfortunately, it is this lack of a vocabulary that causes undue confusion. From this it is straightforward to indicate that a change of the sort that Blasi and colleagues describe does not *ineluctably* indicate that the underlying 'genomics' has to change. In fact, T3 mappings predict that there would be no effect on the distribution of genotypes based on selected post-adolescent phenotypes with loss of their overbite/overjet configuration.

5. Internal language: core and periphery

Although the empirical range of the argument is restricted to speech sounds, its major theoretical conclusions concern universals of language and evolution of language. Since the argument turns out to be misguided, a slightly more detailed inquiry into the nature of some of the misunderstandings and confusions may be revealing. Language in communication (speech mostly or sign) is linearly structured, probably a reflex of properties of SM systems that require it for externalization. In fact, sequential order of words or properties of linear distance between them in externalized language do not enter into the computations that construct conceptual–intentional (CI) representations. In contrast, hierarchical structure and concepts of structural distance are essential to the mapping of internal language to the cognitive interfaces (Chomsky 2013; Everaert et al. 2015; Berwick and Chomsky 2016; Huybregts 2017). The linear sequential order that is imposed on the hierarchically structured expressions of internal language thus constitutes an ancillary feature restricted to external language. More precisely, labeled hierarchical structure is a basic trait of the language phenotype that derives from its Basic Property, the uniquely human and domain-specific capacity for recursively generating an unbounded array of hierarchically structured expressions that each receive a systematic and determinate interpretation at the cognitive interface, and may, but need not, additionally be externalized at the SM interface as speech, mostly, or sign (Chomsky 2013; Everaert et al. 2015; Berwick and Chomsky 2016; Huybregts 2017). Furthermore, since no stepwise approach can reach unbounded generation of language (Huybregts 2019), i.e., there is no half-recursion (Berwick and Chomsky 2019), this 'saltational' property of simple recursive computation fits rather naturally with the sudden recent emergence of hierarchical language, an emergent internal system conforming to laws of nature and organism-independent, third-factor principles (Chomsky 2005) for which no external selective pressures seem required (Chomsky 2010, 2013; Berwick and Chomsky 2016; Huybregts 2017).

The primacy of computation over externalization is well motivated on independent grounds. Computation of internal language is simple, universal, and uniform across languages, while external languages are complex, highly diverse, and rapidly changeable. But besides the asymmetry of the mappings to the CI and SM interfaces, with computational efficiency prevailing over ease of communication, there are other considerations (Chomsky 2010, 2013, 2017; Berwick and Chomsky 2016). For externalization of internally generated language, an evolutionarily ancient SM system had to be linked somehow to an evolutionarily novel computational system, allowing for many options, and thereby explaining the complexity, variety/diversity, and changeability of externalized language (Chomsky 2010, 2013, 2017; Berwick and Chomsky 2016). Another result is that language is modality-independent, adopting speech (when possible) or sign (when necessary) for external use (Chomsky 2010, 2013; Berwick and Chomsky 2016). There may be a preferential choice for speech but there is no necessity. Finally, externalization developed later in human evolution, where the deepest human separations occurred subsequent to the emergence of recursive Merge (internal language) but, plausibly, prior to externalized language (Chomsky 2010, 2017; Huybregts 2017).

It has been argued elsewhere that tonal languages may be culturally adaptive in warm, humid climates (Everett, Blasi, and Roberts 2015), or genetically facilitated by low population frequencies of particular derived *ASPM* and *Microcephalin* alleles (Dediu and Ladd 2007). Culturally driven evolutionary change is typically much more rapid than changes driven by small fitness differences in allelic variants and may lead to rapid evolutionary adaptation (Thompson 2013). However, no such changes appear to have applied to UG-based properties such as structure dependence of rules. Cultural evolution did not provide a 'relentless environment' (Thompson 2013) for evolution of basic properties of internal language, and even the one or two cases for genetically based vocal preferences that have been reported (Dediu and Ladd 2007) remain questionable (Berwick and Chomsky 2016) and, moreover, are peripheral to elementary features of language. For the basic property of language, Merge-based computation, no group differences are known and there is no evidence of variation (Chomsky 2010, 2013; Berwick and Chomsky 2016; Huybregts 2017). But, of course, there is variety, diversity, and changeability of externalized language (speech or sign or any other modality). External language changes continuously but there is no indication that internal language, specifically its basic property that yields unbounded generation, has undergone evolutionary change of any significance after its sudden, recent, and abrupt emergence, presumably without external pressures. UG was preserved throughout, and the human phonetic faculty has plausibly remained fixed throughout Neolithic and post-Neolithic times. For all we know, the human faculty of language has plausibly remained unchanged since the emergence of language (or at least since *H. sapiens* left Africa), as already noted by Eric Lenneberg (Lenneberg 1967) and discussed at length in Berwick and Chomsky (2016).

6. Conclusion

The non-uniformitarian argument for language evolution fails at several levels of abstraction: conceptually, theoretically, and empirically. Conceptually, since it essentially deals with processes of externalization ancillary to the basic property of language; theory-internally, since it focuses discussion on speech sounds, rather than on constitutive distinctive features; and empirically, since the contingent conditions of dental attrition show up during one's lifetime, and have *ipso facto* no genetic relevance for the design of language. From these perspectives the argument has no relevance for language universals or evolution of language.

Plausibly, 'changes in human ecology and biology' may have an influence on 'the range and probabilities of speech sounds' (external language). But the ensuing instability of 'diversity of speech' does not necessarily have any relevance for deeper levels of internal language. What happened in this case was something marginal and peripherally connected to language: a minuscule change in articulation facilitated by a change in subsistence type. Nonetheless, while the discussion of this change is misguided, seeking for answers where no problem is found, the results may usefully prompt a reassessment of our view on the nature of 'language evolution, deep linguistic history and language universals,' suggesting constructive integration into a more encompassing account that includes the 'wider anthropological context' of language. We evidently need a more nuanced model of what amounts to genotype–phenotype mapping in the language case. Rather than throwing out the foundation of evolutionary biology, biologists came up with a better picture of genotype–phenotype. Likewise, we could encompass the kinds of findings obtained by Blasi and associates and incorporate them into a more nuanced picture of what underlying language universals are—the initial state—while we can still scientifically contest what that state is. No one doubts that culture can interact with the way language is used, and those interactions can drive language change. On this, all agree. But it is an entirely different matter to infer from this to saying that we know that this changes the initial state of the individual.

Acknowledgements

I wish to express my gratitude to Bob Berwick, Noam Chomsky, Martin Everaert, David Lightfoot, Marc van Oostendorp, Ian Roberts, and Charles Yang for their support and helpful discussion of earlier versions of the manuscript. Special thanks are due to one anonymous reviewer for his valuable comments.

Conflict of interest statement. None declared.

References

Berwick, R. C. (1985) *Locality Principles and the Acquisition of Syntactic Knowledge*. Cambridge, MA: MIT Press.

Berwick, R. C., and Chomsky, N. (2016) *Why Only Us: Language and Evolution*. Cambridge, MA: MIT Press.

—— and —— (2019) 'All or Nothing: No Half-Merge and the Evolution of Syntax', *PLoS Biology*, 17/11: e3000539. 10.1371/journal.pbio.3000539

Blasi, D. E., Moran, S., Moisik, S. R., Widmer, P., Dediu, D., and Bickel, B. (2019) 'Human Sound Systems Are Shaped by post-Neolithic Changes in Bite Configuration', *Science*, 363/6432, eaav3218. 10.1126/science.aav3218

Chomsky, N. (1965) *Aspects of the Theory of Syntax*. Cambridge, MA: MIT Press.

Chomsky, N. (1973) 'Conditions on Transformations', in Anderson S. R., and Kiparsky P. (eds) *A Festschrift for Morris Halle*, pp. 232–86. New York, NY: Holt, Rinehart & Winston.

——(1981) *Lectures on Government and Binding*. Dordrecht: Foris Publications.

——(2005) 'Three Factors in Language Design', *Linguistic Inquiry*, 36/1: 1–22. https://www.jstor.org/stable/4179307

——(2007) 'Approaching UG from below', in Sauerland U., and Gärtner H.-M. (eds) *Interfaces + Recursion = Language*?, pp. 1–29. Berlin: Mouton de Gruyter.

——(2010) 'Some Simple Evo-Devo Theories about Language: How Might They Be True for Language?', in Larson R. K., Déprez V., and Yamakido H. (eds) *The Evolution of Human Language: Biolinguistic Perspectives*, pp. 45–62. Cambridge: Cambridge University Press.

——(2013) 'What Kind of Creatures Are We?' The Dewey Lectures. Lecture I: "What is Language?", *The Journal of Philosophy*, 110/12: 645–62. https://www.jstor.org/stable/43820808

——(2017) 'The Language Capacity: Architecture and Evolution', *Psychonomic Bulletin and Review*, 24/1: 200–3. 10.3758/s13423-016-1078-6

Chomsky, N., Gallego, Á. J., and Ott, D. (2019) '"Generative Grammar and the Faculty of Language: Insights, Questions, and Challenges"', in Gallego Á. J., and Ott, D. (eds) *Generative Syntax: Questions, Crossroads, and Challenges. Catalan Journal of Linguistics Special Issue*, pp. 229–61. https://doi.org/10.5565/rev/catjl.288

Chomsky, N., and and Halle, M. (1968) *The Sound Pattern of English*. New York, NY: Harper and Row.

Dediu, D., and Ladd, D. R. (2007) 'Linguistic Tone is Related to the Population Frequency of the Adaptive Haplogroups of Two Brain Size Genes, ASPM and Microcephalin', *Proceedings of the National Academy of Sciences*, 104/26: 10944–99. 10.1073/pnas.0610848104

Everaert, M. B. H., Huybregts, M. A. C., Chomsky, N., Berwick, R. C., and Bolhuis, J. J. (2015) 'Structures, Not Strings: Linguistics as Part of the Cognitive Sciences', *Trends in Cognitive Sciences*, 19/12: 729–43. 10.1016/j.tics.2015.09.008

Everett, C., Blasi, D. E., and Roberts, S. G. (2015) 'Climate, Vocal Folds, and Tonal Languages: Connecting the Physiological and Geographic Dots', *Proceedings of the National Academy of Sciences*, 112/5: 1322–7. 10.1073/pnas.1417413112

Hall, D. C. (2010) 'Probing the Unnatural', in Van Kampen J., and Nouwen R. (eds) *Linguistics in The Netherlands 2010*, pp. 71–83. Amsterdam: Benjamins.

Halle, M. (1983) 'On Distinctive Features and Their Articulatory Implementation', *Natural Language and Linguistic Theory*, 1/1: 91–105. https://www.jstor.org/stable/4047515

Halle, M., and Stevens, K. N. (1959) 'Analysis by Synthesis', in Wathen-Dunn W., and Woods L. E. (eds) *Proceedings of the Seminar on Speech Compression and Processing*, Vol. II, paper D7. Bedford, MA: Air Force Cambridge Research Laboratories.

—— and —— (1962) 'Speech Recognition: A Model and Program for Research', *IRE Transactions on Information Theory*, IT-8: 155–9.

Hockett, C. F. (1985) 'Distinguished Lecture: F', *American Anthropologist*, 87/2: 263–81. 10.1525/aa.1985.87.2.02a00020

Huybregts, M. A. C. (2017) 'Phonemic Clicks and the Mapping Asymmetry: How Language Emerged and Speech Developed', *Neuroscience and Biobehavioral Review*, 81(Pt B): 279–94. 10.1016/j.neubiorev.2017.01.041

—— (2019) 'Infinite Generation of Language Unreachable from a Stepwise Approach', *Frontiers in Psychology*, 10: 425. 10.3389/fpsyg.2019.00425

Jakobson, R., Fant, G., and Halle, M. (1952) *Preliminaries to Speech Analysis: The Distinctive Features and Their Correlates*. Cambridge, MA: MIT Press.

——, and , and Halle, M. (1971) *Fundamentals of Language*. The Hague: Mouton.

Ladefoged, P. (1964) *A Phonetic Study of West African Languages*. Cambridge: Cambridge University Press.

Ladefoged, P., and Maddieson, I. (1996) *The Sounds of the World's Languages*. Oxford: Blackwell.

Lenneberg, E. H. (1967) *Biological Foundations of Language*. New York, NY: Wiley.

Lewontin, R. C. (1974) *The Genetic Basis of Evolutionary Change*. New York, NY: Columbia University Press.

—— (2000) *The Triple Helix: Gene, Organism, and Environment*. Cambridge, MA: Harvard University Press.

Mielke, J. (2008) *The Emergence of Distinctive Features*. Oxford: Oxford University Press.

Newmeyer, F. J. (2002) 'Uniformitarian Assumptions and Language Evolution Research', in Wray A., (ed.) *The Transition to Language*, pp. 359–75. Oxford: Oxford University Press.

Niyogi, P., and Berwick, R. C. (2009) 'The Proper Treatment of Language Acquisition and Change in a Population Setting', *Proceedings of the National Academy of Sciences*, 106/25: 10124–29. 10.1073/pnas.0903993106

Stevens, K. N., and Halle, M. (1967). 'Remarks on Analysis by Synthesis and Distinctive Features', in Wathen-Dunn W., (ed.) *Models for the Perception of Speech and Visual Form: Proceedings of a Symposium*, pp. 88–102. Cambridge, MA: MIT Press.

Tattersall, I. (2019) 'The Minimalist Program and the Origin of Language: A View from Paleoanthropology', *Frontiers in Psychology*, 10: 677. 10.3389/fpsyg.2019.00677

Thompson, J. (2013) *Relentless Evolution*. Chicago: University of Chicago Press.

Vikatou, I., Hoogland, M. L. P., and Waters-Rist, A. L. (2017) 'Osteochondritis Dissecans of Skeletal Elements of the Foot in a 19th Century Rural Farming Community from The Netherlands', *International Journal of Paleopathology*, 19: 53–63. 10.1016/j.ijpp.2017.09.005