Evolutionary Phonology as Human Behavior

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1. Introduction.

Columbia School Linguistics views itself as a functional approach to language where problems, typically defined in terms of non-random skewings of sounds in the speech stream, are explained in terms of aspects of human behavior.[1] In the realm of phonology, or sound patterns, the Columbia School was ahead of its time in formulating specific hypotheses where both phonetic and non-phonetic factors were assessed with respect to their roles in determining sound patterns (Diver 1974, 1979). For example, Diver (1974) sketches an analysis of final obstruent devoicing, and the relationship between voiced and voiceless consonants more generally, where phonetic substance is central in defining the directionality of the process from voiced to voiceless, and where communicative function is central in defining the position in the utterance where the process occurs. Since the 1970s, similar approaches to phonology have emerged, from Ohala's phonetically-based models with special attention to perception (Ohala 1981, 1990, 1993, 1997), to Bybee's (2001, 2002) usage-based approach, and the more comprehensive framework of Evolutionary Phonology (Blevins 2004a, 2005a, 2006a, 2008, 2009a, 2014, to appear a), where articulatory, perceptual and aerodynamic explanations and non-phonetic explanations combine to explain common and rare sound patterns in the world's languages.[2] In this chapter I compare Columbia School Phonology to Evolutionary Phonology, highlighting similarities and differences between the two approaches. Where Columbia School Phonology grazes the surface of phonological typology, Evolutionary Phonology grounds itself in cross-linguistic common and rare sound patterns. Where Columbia School Phonology suggests simple intuitive phonetic explanations for sound patterns, Evolutionary Phonology refers to detailed empirical work in distinct sub-fields of phonetics. And where Columbia School Phonology proposes usage-based explanations for skewed distributions of sounds, Evolutionary Phonology shows why these are inadequate, and how non-phonetic factors interact in complex ways with over-riding phonetic factors. While language use does play a role in shaping sound patterns, a complex interplay of frequency-based effects (Gahl 2008), predictability effects (Bell et al. 2003, Blevins 2005a), and lexical competition effects (Blevins and Wedel 2009) makes it difficult to isolate usage-based sound patterns that are independent of language-specific phonologies.

This chapter is structured as follows. In section 2 I present an overview of Evolutionary Phonology and note similarities and differences between Evolutionary Phonology and Columbia School Phonology. In section 3 I compare Evolutionary Phonology and Columbia School

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[1] Diver uses the term "skewings", implying that the asymmetries are statistically significant non-chance events. In later work, researchers are more explicit. For example, Dekker and de Jonge (2006) compare phoneme frequencies for a large corpus of Spanish, while Tobin (2011) refers to "non-random phonological distribution" (p.173) and summarizes skewing in the phonology as "…not random but motivated: the frequencies of the phonological units and the ways they combine are determined…." (p.189).

[2] The framework of Evolutionary Phonology referenced here is distinct from "Evolutionary phonology" as referred to in the work of Tobin (2011), where, for example, a possible evolutionary explanation for the preference for CV syllables makes reference to the evolution of mammalian vocalization (Tobin 2011:189).

Phonology in terms of their analyses of specific sound patterns, including asymmetries in sound inventories, phonotactic asymmetries, and asymmetries inherent to specific alternation types. Section 4 summarizes the central differences between the two approaches. While both approaches embrace phonetic and non-phonetic explanations for sound patterns, only Evolutionary Phonology integrates large-scale typological surveys, the wealth of phonetic studies appearing over the past half-century, and more recent computational modeling of language use bearing on contrast, predictability, and frequency.

Throughout this work, Columbia School Phonology is represented primarily by the work of Diver and co-authors, since most of Diver's original suggestions have been continued and elaborated by subsequent researchers, including Tobin (e.g. 1997, 2011) and Dekker and de Jonge (2006). Tobin (2011) provides an updated and comprehensive summary of the model, including its extension to root structure constraints in Hebrew, and higher-level prosody.

2. An Overview of Evolutionary Phonology

Like Columbia School Linguistics, Evolutionary Phonology (Blevins 2004a) defines concrete problems that cry out for explanation. The most general problems concern non-random distributions of sounds in the world's languages which are referred to throughout as "sound patterns". Theories within Evolutionary Phonology are formulated to explain why certain sound patterns have the typological distributions they do, and the language-internal features they do. Leading research questions are shown in (1).

(1) Leading research questions in Evolutionary Phonology

- Why are certain sound patterns extremely common, while others are rare?
- What factors play a role in determining similar sound patterns across languages?
- What explains the striking identity between recurrent context-dependent instances of sound change, recurrent alternation types, and static distributional asymmetries across the world's languages?

Within this framework a great deal of progress has been made by isolating recurrent sound patterns and formulating subtheories to account for cross-linguistic skewings whose frequency and distribution demand explanation. Sound patterns with well-grounded phonetic explanations include: metathesis (Blevins and Garrett 1998, 2004); final obstruent devoicing and other laryngeal neutralizations (Blevins 2004a, 2006a); consonant epenthesis (Blevins 2008); vowel syncope (Blevins 2009a); and properties of voiceless sonorants (Blevins to appear b). Sound patterns with significant non-phonetic structural or lexical components include: final consonant loss (Blevins 2004b); vowel syncope (Blevins 2009a); antigemination (Blevins 2005b); and *t > k and *Kl > Tl sound changes (Blevins and Grawunder 2009), discussed further in section 3.

The focus on explanation of sound patterns, as opposed to mere description, is a feature shared by Evolutionary Phonology and Columbia School Phonology. Diver's (1979) leading research question involves understanding "the skewings in the phonetics" (p.19). Just as typological skewings and features of sound patterns define the questions above, Columbia School Phonology also focuses on explanations for asymmetric distributions: "…It is the attempt to come to an understanding of these skewings that leads to the formulation of theories… *A theory, therefore, is a solution to a problem and a phonology is a particular instance of a theory*" (Diver 1979:20).

However, the kinds of explanation made use of in Evolutionary Phonology are more diverse than those referred to in Columbia School Phonology. When two languages show similar sound patterns, whether those be patterns involving basic sound inventory, phonotactics, or alternations, Evolutionary Phonology considers a wide range of potential sources of similarity, as outlined in (2). Two languages may share a sound pattern due to shared inheritance from a mother tongue (2a). Though this type of explanation is not discussed explicitly within Columbia School Phonology, it does seem to be implicit in historical work, e.g. Diver & Huffman (2012). A second explanation for similar sound patterns is parallel evolution (2b): a pattern like final obstruent devoicing may develop in unrelated languages due to similar phonetic forces in these languages. Parallel evolution is a central aspect of CSP, and involves "phonetic substance" (Diver 1974), though the specific phonetic hypotheses proposed are generally unsupported by instrumental or experimental work in the phonetic sciences (see below).[3]

(2) Types of explanation for similar sound patterns

a. inheritance from a shared mother tongue
b. parallel evolution in the form of parallel phonetically motivated sound change (where "phonetic" = based on aspects of speech perception & production)
c. non-phonetic speaker-internal constraints, including: general cognitive mechanisms (memory, analogical reasoning, category formation); potential phonological (non-phonetic) universals; and usage-based effects (frequency effects; predictability effects; competition/contrast effects; effects of feedback loops in the course of language acquisition)
d. speaker-external factors including: language contact, prescriptivism, literacy, second language acquisition
e. chance

A third set of factors considered in Evolutionary Phonology is non-phonetic constraints (2c), including general cognitive processes, potential phonological universals, and usage-based effects. While the Columbia School also considers non-phonetic constraints, these are divided into two orientations, with the second rarely supported by empirical studies: those related to language as a communicative system (e.g. meaning, information content), and general aspects of human behavior (the difficulty of complex motor tasks; laziness).[4] Evolutionary Phonology also considers speaker-external forces in explaining similar sound patterns (2d). The most obvious case is language contact, where

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[3] A reviewer notes that Diver viewed the phonetic evidence needed for his hypotheses as being so obvious as not to require instrumental support.

[4] One reason why Columbia School Linguistics may be overlooked in the majority of work on phonological theory over the past 50 years is that is does not consider phonological universals as potential explanations for recurrent sound patterns. While Evolutionary Phonology might start with the observation that antigemination exists as a recurrent sound pattern (Blevins 2005b), and then explore the hypothesis that this is due to the universal Obligatory Contour Principle, hence engaging in a debate with phonologists who argue strongly for phonological universals, this is not a common starting point for the Columbia School. I emphasize "starting point", since, in the end, most explanations based on phonological universals are abandoned in Evolutionary Phonology. One exception in the Columbia School is the work Davis (2006) on the phoneme. The starting point for this work is that phonemes are universal phonological units; the conclusion, however, is that they are not necessary in Columbia School analyses.

areal sound patterns suggest lateral influence of one language on the next via speaker-to-speaker contact (Blevins to appear a). However literacy, second language learning, and prescriptivism must also be considered, and may play a bigger role than expected in the maintenance of what might otherwise be viewed as rare or defunct sound patterns (Blevins 2006b). As far as I am aware, there is no work in the Columbia School where explanations for sound patterns are offered based on these kinds of factors.

Finally, there is always the possibility that two sound patterns in different languages that appear similar have arisen purely by chance, or that the skewed distribution of a pattern within a particular language is due to chance (2e). While general work in the Columbia School framework (e.g. Sabar 2015) takes care to rule out chance, this kind of argumentation is lacking in phonological analyses.

Evolutionary Phonology also differs from the Columbia School framework in offering a basic typology of sound change, illustrated in (3).

(3) A general typology of sound change in Evolutionary Phonology, S = speaker, L = listener

i. CHANGE: The phonetic signal is misperceived by the listener due to: acoustic similarities between the utterance and the perceived utterance and/or biases of the human perceptual system.
S says [anpa] L hears [ampa]

ii. CHANCE: The phonetic signal is accurately perceived by the listener but is intrinsically phonologically ambiguous. The listener associates a phonological form with the utterance which differs from the phonological form in the speaker's grammar.
S says [ʔa̰ʔ] for /aʔ/ L hears [ʔa̰ʔ], thinks /ʔa/

iii. CHOICE: Multiple phonetic variants of a single phonological form are accurately perceived by the listener. The listener (a) acquires a proto-type or best exemplar which differs from that of the speaker; and/or (b) associates a phonological form with the set of variants which differs from the phonological form in the speaker's grammar.
S says [tuʔəlaŋ], [tuʔᵊlaŋ], [tuʔlaŋ] for /tuʔəlaŋ/
L hears [tuʔlaŋ], [tuʔᵊlaŋ], [tuʔəlaŋ], and assumes / tuʔlaŋ /

The CCC-model allows identification of CHANGE (3i), based primarily in perceptual/acoustic similarity; CHANCE (3ii), where long-domain phonetic features result in reanalysis[5]; and CHOICE (3iii), where articulatory variation along the hyper-to-hypo-articulation continuum leads to phonological renalysis. In Columbia School Phonology, there is no typology of phonetically based sound change. Most sound patterns are attributed to articulatory (3iii) rather than perceptual factors.[6]

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[5] The label 'CHANCE' has no relationship to the common English meaning of *chance* or 'chance' as it is used in probability theory. It is simply a label for one source of sound change within this typology. In retrospect, better terms for CHANGE, CHANCE and CHOICE would be PERCEPTUAL BIAS, LOCALIZATION and VARIATION respectively.

[6] For example, in Diver (1979) phonotactics are explained in terms of favoring sames and disfavoring differents, where the categories are "stable" ("the articulatory organ employed in the production of the sound is relatively stationary during excitation of the resonant cavity") and "mobile" ("the articulatory is necessarily in motion during sound production"). Or, to take another example, in Tobin's (2011) comprehensive summary, there are more than a dozen articulatory principles, but only a single acoustic one (pp.171-173). Finally, in a paper devoted wholly to sound change, Diver and Huffman (2012) attribute aspiration in the history of Germanic to "a special expenditure of energy that leads to an increase in the amplitude of sound waves" under stress accent (p.5), while deaspiration or lack of aspiration in sT clusters or environments of Grassmann's Law are explained in terms of avoidance of a "succession of two lavish consumers of the air supply in a row." For a modern treatment of Verner's Law wholly consistent with the principles of explanation proposed by Diver, see Garrett and Hale (1993).

A final difference between Evolutionary Phonology and Columbia School Phonology involves the nature and level of detail ascribed to structural principles involved in usage-based explanations. Within Evolutionary Phonology at least two general properties have been hypothesized to play a role in the form and content of sound patterns or skewed distributions of sound waves. One is Structural Analogy (4), and the other is Lexical Character Displacement (5), a consequence of lexical competition.

(4) Structural Analogy (Blevins 2004a:153-55, 246-48, 297-99; Blevins 2009a)

> In the course of language acquisition, the existence of a (non-ambiguous) phonological contrast between A and B will result in more instances of sound change involving shifts of ambiguous elements to A or B than if no contrast between A and B existed.

(5) Lexical Character Displacement (Blevins and Wedel, 2009)

> Lexical character displacement occurs when differences among similar words whose syntagmatic distributions overlap are accentuated, while the same differences may be minimized or lost where syntagmatic distributions do not overlap. Lexical character displacement is based on the principle that, to coexist in a stable environment, two competing words must occupy distinct phonetic niches.

Both principles refer to ambiguity and contrast, and are grounded in speech perception and categorization. As these are not central to Columbia School Phonology, there is no clear parallel to either principle. As noted earlier, alternatives are quite general. Within Columbia School Phonology, for example, initial position is seen as a position of maximum contrast, while final position is not, and therefore favors neutralization; also general is the avoidance of merger via chain shift (Diver and Huffman 2012:8-9); or the inference that "a disfavoring... represents a difficulty in a learning process" (Diver 1979:8).

From this brief overview it may seem that the differences between Evolutionary Phonology and Columbia School Phonology far outweigh the similarities. However, in contrast to other approaches, the two frameworks have a great deal in common, as summarized in (6). Given these commonalities, it is possible, in essence, to improve and update some of the proposed explanations offered in Columbia School Phonology from the perspective of Evolutionary Phonology. This is what I pursue in section 3.

(6) Evolutionary Phonology & Columbia School phonology in contrast to other approaches

- Many recurrent sound patterns are explained by common pathways of change.
- There are multi-causal explanations
- Explanations may be grounded in phonetics, aspects of language use, or other
- Sound pattern frequency is addressed
- Testable hypotheses are proposed

- Phonetic naturalness and probabilities associated with particular pathways of change replace phonological markedness.
- As a consequence of all of the above, there is little left of ‘Universal Grammar’ in the generative sense of this term: recurrent patterns emerge from the form and content of human communication. Phonologies are language-specific and learned.

3. Evolutionary Phonology and the Columbia School: “Le bon Dieu est dans le détail”

While Evolutionary Phonology and Columbia School Phonology share an interest in explaining sound patterns, the data to be explained as well as the explanations differ greatly in detail, and in the extent to which typology and modern phonetic science are integrated into holistic explanations (Blevins 2014). In this section I look at three different kinds of sounds patterns or skewings of the speech signal, as Diver referred to them: skewings in phoneme inventories; skewings in phonotactics or sound sequences; and skewings in alternation types.

3.1 Segment inventories: The high frequency of coronal sounds.

It is commonly noted that coronal sounds, made with the front part of the tongue, are more frequent, language-internally and cross-linguistically, than sounds made with other articulators. Cross-linguistic surveys like Maddieson (1984) lend support to coronals being a preferred place of articulation for stop consonants. Coronal consonants have also been claimed to be “special” in other ways: they more readily undergo assimilation; they may be epenthetic consonants; and they may fail to show dissimilatory effects where other consonants do (Paradis and Prunet 1991). Diver (1979:12) focuses on coronal frequency and suggests a simple explanation:

> “…as among lips, apex of the tongue and dorsum, it is apparent that the apex is the most adroit of the three. It is not surprising then that, as has often been remarked, the apical sounds are generally more frequent than others.” (Diver 1979:12)

While one might accept without substantial evidence that the apex of the tongue is the most adroit articulator, there is no evidence offered that where coronals are preferred sounds in languages, they are always apical. What proportion of the world’s coronal sounds are apical and what proportion are laminal, using the blade of the tounge? In Maddieson (1984), arguably one of the most detailed analyses of phoneme inventories to date, there is no distinction between apical and laminal noted in descriptions. For general “t”-sounds (voiceless, unaspirated, oral coronal stops), the breakdown is: 72 voiceless dental plosives (including Russian, French, Spanish, Kurdish); 135 voiceless dental/alveolar plosives (including Greek, German, Lithuanian, Bengali, Japanese). For some of these, subsequent studies show laminal, not apical articulations: for example Spanish /t/ and /d/ are dento-alveolar laminals (Martínez-Celdrán et al. 2003). So, while 207 of the 451 languages contain some kind of voiceless, unaspirated, unglottalized “t”-sound, for the majority of these, the precise place of articulation and apical vs. laminal status of the articulation is not provided. Without these details, Diver’s impression that “apical sounds are more frequent than others” has little empirical basis, undermining the status of the generalization he is attempting to explain.[7]

[7] Compare Diver’s repetition of this claimed fact to the textbook description of Eohippus, an extinct ungulate, being “the size of a small Fox Terrier”. As illuminated in Stephen Jay Gould’s essay “The Case of the Creeping Fox Terrier Clone”, the fox terrier is about half the size of Eohippus (Gould 1992). Verify that your data is correct before offering an explanation for it.

Within Evolutionary Phonology, the claimed "special status" of coronals is questioned on multiple grounds (Blevins 2004a:125-29), and new explanations are offered for patterns that pose difficulty for the simple articulatory account above. A first observation is that there are languages with "t"-gaps, suggesting that coronal (apical) sounds can not be the universally unmarked place of articulation for stops.

As argued by Blust (2004), at least five distinct instances of *t > k sound change have occurred in the Austronesian language family, as evidenced by Hawaiian, Samoan, Luangiua, Gomen, Dehu and Iaai. Interestingly, in all of the languages, there was a /k/-gap prior to the sound change. On this basis, Blevins (2004a:122-25) proposes a hypothesis based on acoustic/perceptual similarities of /t/ and /k/ in contrast to /p/: [k] and [t] have higher amplitude stop bursts than [p]. The hypothesis is that *t > k begins as free variation within an enlarged phonological space created by the loss of /k/.[8] In the course of language acquisition, [t] and [k] are grouped together perceptually, in contrast to [p], based on higher amplitude bursts. Since [k]-bursts are strongest, they are the "best" exemplars of the "strong-burst" category, and evolve from *t. This hypothesis has both phonetic and structural components: acoustic/perceptual similarity plays a role in speaker-categorization of [t] and [k] as the same category, as opposed to [p] which is different. However, this categorization is only possible given a particular structural property, or starting point, namely that the language has a /k/ gap in terms of its contrastive sound inventory. While overall, coronal/apical sounds might be more frequent than others, a preference for apicals based in articulation goes only so far in explaining the full set of asymmetries in sound distribution in systems of phonological contrast. Velars can be preferred segment types, but only under very specific conditions, like those found in earlier stages of Hawaiian and other languages that have undergone a *t > k sound change.

Even more striking are the rare languages that appear to lack coronal sounds altogether. One of these is Northwest Mekeo (Blevins 2009b), with consonants /p/, /k/, /β/, /g/, /m/, /ŋ/. Examination of the synchronic phonology of this language allows us to ask another question: in addition to articulatory ease, are there other factors that could play a role in the high frequency of coronals in phoneme inventories? Although Northwest Mekeo has no contrastive coronals, it does have surface coronals that are allophones of the basic consonants just listed. These include: /g/, pronounced as [dz^{j}]/_i; /ŋ/ pronounced as [n]/i; and a [j]-insertion process in /ia/ sequences (in other dialects, this glide is strengthened to a sibilant). Coronals in Northwest Mekeo are also found in loan words and in baby talk. In this case, there are multiple sources of coronals in a language that lacks them: coronals occur as a consequence of coarticulation, when velars are palatalized or in palatal contexts; they may also occur as a consequence of glide-interpolation and glide strengthening. And since so many languages have coronals, loans words may be a primary source of coronals in a language. In sum, it may be the case that the strong preference for coronals (and possibly apicals) cross-linguistically is related to ease of articulation, but it must also be acknowledged that other factors, arguably perceptual, can result in their elimination in small sound inventories in preference to dorsals. And, coronal (or apical) sounds may be frequent for other reasons as well. In particular, there are multiple phonetic pathways to them from other sounds, especially in languages with palatal vowels like /i/, yielding velar palatalization and glide-epenthesis via coarticulatory and perceptual processes.

In this discussion, I purposely avoid the term "unmarked" when speaking of coronal place of articulation since markedness plays no active role in Columbia School or Evolutionary Phonology. For a general discussion of problem inherent in the terms "marked" and "unmarked" in linguistic theory, see Haspelmath (2006).

[8] This kind of variation could be compared with the 'sloppy phonemes' of Pirahã described by Everett (1985).

In sum, whether or not coronal (or apical) sounds are preferred due to the adroitness of the tongue tip as articulator is an open question. In contrast, there is no question that languages without contrastive coronals exist, and that languages can move from a state with coronals to one without them. Diver's attempt to explain the distribution of (apical) coronal sounds in terms of a single dimension, articulatory ease, is overly simplistic and is at a loss to explain languages without coronal stops, those without any coronals at all, and those, like Spanish and French in which /t/ and /d/ are laminal, but still show high frequency and other "special" coronal properties.

Since Columbia School Linguistics and Evolutionary Phonology are both interested in explaining asymmetries in sound distribution, the criticism here is not in the attempt at explanation, but in the nature of the details to be explained. A wider set of facts, taking into account the potential non-apical status of many of the world's coronal consonants, rare languages that have lost coronal stops, and the rarest languages with no contrastive coronals at all, might result in explanations incorporating perceptual confusion, perceptual contrast, pathways of evolution, and language contact, in addition to ease of articulation.

3.2 Phonotactics: Explaining TL-gaps.

Sticking with the general theme of tip-of-the tongue sounds, consider another purported generalization that Diver (1979), along with many others, has tried to explain. Unlike the first asymmetry, this one is not statable at the level of sound inventory or basic contrast. Rather, it concerns a sequence of sounds that is claimed to be cross-linguistically avoided or dispreferred. The sequence is Tl- where T is /t,d/ and /l/ is a lateral liquid. In Diver's words (1979:10) "one of the classic examples of phonotactic skewing is the absence of the cluster *tl*- in English and in many other languages."[9] Diver's suggestion is that this skewing is best understood in terms of general properties of clusters in English. On the basis of English monosyllables, Diver comes up with two generalizations: stops prefer to cluster with /ɹ/ over /l/; fricatives prefer to cluster with /l/ over /ɹ/. On this basis, he proposes an articulatory distinction between these four classes of sounds where the stops /p,t,k,b,d,g/ and the liquid /ɹ/ are "mobile" articulations and the fricatives /f,s/ as well as the liquid /l/ are "stable" articulations. In addition to this novel articulatory classification he proposes a hypothesis based on these facts alone: combinations of sames (e.g. stable + stable or mobile + mobile) are favored, while combinations of differents are disfavored (stable + mobile or mobile + stable). Further disfavoring comes when the already disfavored "differents" involve the same articulator: "The strongest disfavorings, the zeros, occur where it is exactly the same musculature that has to be brought under control, the apex in both elements of *tl, dl*…" (Diver and Davis 2012:307).[10]

While most phonologists agree that the absence of /tl/ and /dl/ clusters in some languages that otherwise allow oral stop plus liquid should be explained, the range of facts is more complex than simple prohibition of these clusters. As detailed by Blevins and Grawunder (2009) there are varieties of English as well as German that, in contrast to the standard language, show /tl/ and /dl/, where Standard English and Standard German have /kl/ and /gl/ respectively. In both cases, there is good evidence of a sound change by which initial *kl > tl and *gl > dl. Since there are varieties of English (e.g. Yorkshire, Lancashire) with /tl/ and /dl/ that differ minimally from neighboring varieties of

[9] For a general theoretical discussion of phonotactics and co-occurence constraints within the Columbia School framework, see Diver and Davis (2012).

[10] This explanatory model is challenged by Davis in Diver and Davis (2012:306, fn.3). However, the "mobile" vs. "stabile" dichotomy is included in the list of principles replacing traditional phonetic and phonemic categories in Tobin (2011:172).

English that do not have these clusters, the explanation is unlikely to be a general constraint on articulations like the one proposed above by Diver. Indeed, any attempt to explain Tl gaps in one variety of English or German must have some explanation for their tolerance in other varieties, with the best theory also able to explain why *Kl > Tl sound changes occur where they do.

The Evolutionary Phonology proposal of Blevins and Grawunder (2009) attempts to explain both aspects of sound pattern distribution. First, broad typological surveys show that /tl/ and /dl/ are not cross-linguistically disfavored: within Indo-European *Tl clusters are reconstructed for many subgroups, including Romance, Celtic, and Balto-Slavic. Second, the Kl > Tl sound change is shown to have both articulatory and acoustic/perceptual factors. Kl > Tl can result from co-articulation, with the coronal articulation of /l/ anticipated at the start of the cluster. At the same time, there is ample evidence that [kl]/[tl] and [gl]/[dl] are highly confusable and perceptually similar. This perceptual similarity can yield a Kl > Tl sound change, and may also be responsible for the many Tl > Kl sound changes known from the literature, including those in Latin, Lithuanian, Slavic, and Romani (Blevins and Grawunder 2009). Finally, the study of *kl > tl sound change reveals a striking asymmetry: this sound change is attested only in languages with /tl/ gaps! An explanation for this skewed distribution is also proposed by Blevins and Grawunder (2009). In languages without a /kl/ vs. /tl/ contrast, more coarticulation can occur in /kl/ clusters, resulting in [tl]-like tokens. In addition, perceptual assimilation will lead speakers of languages without /tl/ to hear [tl] as /kl/. These factors allow the sound change to sneak into the language without homogeneity across speakers: while some speakers are pronouncing [tl] for /kl/, other continue to pronounce [kl], but hear [tl] as [kl], and still others have advanced to pronouncing [tl] for /tl/, hearing [kl] as [tl].

As with the discussion of phoneme inventories in 3.1, the difference between the Evolutionary Phonology approach to /Tl/ gaps and the Columbia School Linguistics approach to /Tl/ gaps lies in the details. Typological studies reveal that /Tl/ clusters are not as disfavored as formerly believed, while dialect surveys reveal /Tl/ (vs. /Kl) dialects, and historical studies reveal a skewed distribution of *Kl > Tl sound changes. Modern phonetic studies of acoustic properties of these clusters and perceptual confusion of Kl and Tl clusters provide the foundation for a comprehensive explanation of both the general distribution of these clusters as well as the shifts of Kl > Tl and Tl > Kl. Again, it is likely that with this more comprehensive set of typological and phonetic facts, a Columbia School phonologist might well have moved towards a more complex explanation, leaving behind the undermotivated notions of mobile and stabile articulations.

3.3 Neutralization: where substance matters.

A bold statement in Diver's (1974) paper, "Substance and Value in Linguistic Analysis" is that his research group has seemingly solved the central problem of accounting for the nature and direction of sound patterns involving neutralization:

> Research done at Columbia University *has established quite clearly exactly* what the substantive features are that produce the difference in frequency occurrence, of which we see the extreme case in German. … In producing *t*, the apex of the tongue is used…In producing *d*, two articulators must be controlled, the apex and also the glottis. As we all know, it is more difficult to learn to do two things at once, than to learn to do one thing at a time… Hence the difference in frequency, standing in relation to the difference in phonetic substance… But…why should this preference be realized so much more clearly in final position of the word than elsewhere? …the first sound generally bears a much greater communicative burden than does the last…Therefore a much smaller investment in distinctness is required at the end of the word than at the beginning, and it is not pure chance that places the "position of neutralization" at the end. (Diver 1974:12) [Italics: JB]

In this discussion Diver adopts Trubetzkoy's (1939) original account of final obstruent devoicing as neutralization to the unmarked: since /d/ has something that /t/ does not, an articulation at the glottis, it is more difficult to produce. To this general directional principle, Diver adds a functional explanation for the position of neutralization: devoicing occurs at the end of the word in German because sounds at the end of words have less of a functional load than those at the beginning.[11]

Here again, matters of fact are of the utmost importance. While phonological notions of voiceless vs. voiced might lead one to believe that laryngeal neutralization results in articulations in which the glottis is not activated, phonetic descriptions of neutralized segments paint a different picture (Blevins 2004a, 2006). Where laryngeal neutralization occurs, final obstruents may be "checked" and unreleased and produced with constricted glottis (e.g. Korean, Cantonese), or they may be "aspirated" and released, and produced with spread glottis (e.g. Turkish, Yucatec Mayan), as detailed in Vaux and Samuels (2005). Since glottalization and aspiration involve active laryngeal articulations, the neutralization of a laryngeal contrast to an unreleased voiceless glottalized series or a released aspirated series cannot be explained in terms of Diver's suggestion above. One laryngeal mechanism is replaced with another, but the glottis is still an active articulator. Indeed, this is the analysis proposed by Iverson (1997) and Iverson and Salmons (2007) for German, supported by phonetic analysis.

Diver's attempt to explain the position of neutralization in terms of word-based communicative force also meets with empirical problems very quickly when more data is examined.[12] As summarized in Steriade (1999) and Blevins (2004a:92-100), patterns of laryngeal feature neutralization depend, to a great extent, on how the feature in question is phonetically realized. Release features like post-aspiration and ejection tend to be neutralized when release, or a transition into a vowel-like sound is absent. In contrast, onset closure features like pre-aspiration and pre-glottalization tend to be neutralized when a preceding vowel or vowel-like transition into the segment is absent. So, while obstruent voicing or voice-onset-time contrasts are neutralized word-finally in German, in Yurok, the contrast between glottalized sonorants and plain sonorants is neutralized to the plain series in *word-initial position*. It is not only the phonological status of glottalized sounds as "marked" members of a contrast that matters here, but the recognition of contexts that facilitate the phonetic realization of sonorant glottalization. Word-initial position is a poor position for phonetic realization of this class of sounds. Sound patterns cannot be understood without understanding the acoustic/perceptual images they project onto the human mind.

In this example, both of the asymmetries that Diver intends to explain are inaccurate generalizations based on incomplete data. The content of laryngeal neutralization is more variable than was thought: neutralization of oral stops in word-final position can involve simple devoicing, but can also involve additive process of final glottalization or final aspiration. And while the association of German devoicing with final position is clearly linked to phonetic properties phrase-ends within Evolutionary Phonology (Blevins 2006a), positions of neutralization in exceptionless sound patterns do not generally align with information content, but with fine details of phonetic realization, occurring in word-initial position as well.

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[11] Diver's model makes an interesting, but as far as I know, unsupported prediction: that languages where roots are consistently word-final, like Navajo, will be less likely to have phonological word-final neutralization processes than languages with word-initial roots, like Turkish. In addition, though neutralization of laryngeal features may occur at word edges or syllable edges, Diver's analysis does not scale-down to the syllable level, since syllables, unlike words, are not obvious communicative units. However, as is well known, there are many languages with syllable-final neutralization processes. See Blevins (2006a) for a discussion of trajectories of phonologization from phrase to word to syllable.

[12] The same is true of Tobin's (2011:173) more nuanced principle: "The differences in the higher communicative force of utterance-initial versus the lower communicative force of utterance-medial versus utterance-final positions also will affect the choice of more adroit versus less adroit… articulators, and phonemes requiring one, two, or three sets of articulators."

It should be clear from this example that within Evolutionary Phonology, as in Columbia School Phonology, substance matters. Patterns of laryngeal neutralization are intimately tied to the phonetic nature of the laryngeal gesture at both the articulatory and perceptual level. Processes of final devoicing are seen to follow from common non-release of stops, as well as common laryngeal spreading and closing gestures at phrase-boundaries. Phrase-final lengthening may also contribute, given the common association between longer duration and voicelessness. Within Evolutionary Phonology, it is substance that also predicts the position of neutralization. Pre-glottalized sonorants neutralize word-initially because the cues for this phonological contrast are typically found in the vowel preceding the glottalized sonorant. The contrast between plain and glottalized sonorants is weak in word-initial position, where there is no preceding vowel, and so, subject to neutralization (Blevins 2004a, 2006).

Is there a role for functional load or in Diver's term "communicative burden" in Evolutionary Phonology? There is, but not in the simple notion of one part of the word having a greater communicative burden than another. In Evolutionary Phonology lexical contrast and lexical competition can give rise to aberrant sound patterns, as summarized in the statement of Lexical Character Displacement in (5) (Blevins and Wedel 2009). Where two words are similar and compete lexically in the sense of occupying the same distributional niche, that competition can enhance small differences, or inhibit sound change that would neutralize the minimal contrast. Within this model there are two major predictions. First, rare phonological contrasts, like three degrees of length, are expected exactly where they are the sole exponents of contrast between two words within a paradigm. Second, where two minimally distinct forms compete, a pattern of inhibited sound change may be observed. For example, by final-vowel shortening, the contrast between long and short vowels is neutralized in Banoni, except when that contrast is necessary for disambiguation of lexical items that are in lexical competition, like *tama* 'father' and *tama:* 'my father'. In this case, the vowel length contrast is maintained.

4. Concluding remarks.

Evolutionary Phonology and Columbia School Phonology both seek explanations to asymmetries in sound distribution. By comparing specific Columbia School Phonology analyses to Evolutionary Phonology explanations, differences between the two approaches are easier to identify. Evolutionary Phonology identifies recurrent sound patterns by broad-based typological studies of the world's languages, and includes, in this identification, fine phonetic details, since, again and again, such details appear to play an important role in understanding the frequency and distribution of these sound patterns. Broad-based typological studies and fine-grained phonetic detail have not played a major role in Columbia School Phonology.

Evolutionary Phonology also attempts to engage with proponents of Universal Grammar. While one might question the status of many phonological universals and dispense with markedness constraints, Generative Phonology, and its constraint-based successors have been highly successful in identifying skewed distributions of the speech signal that cry out for explanation, including: the Obligatory Contour Principle for tonal representations (Leben 1973); Autosegmental Phonology as a constraint system (Goldsmith 1976); common segmental alternation types (Kenstowicz and Kisseberth 1979); antigemination (McCarthy 1986); and predictable stress patterns (Hayes 1995). Where Evolutionary Phonology revisits many of these sound patterns, and engages in constructive debate with proponents of markedness, Columbia School Phonology seems disengaged from this parallel world.[13]

[13] Exceptions include Tobin (2000) and Tobin (2009).

A final difference between the two approaches relates to human behavior. Within Evolutionary Phonology there is emphasis on certain aspects of human behavior: humans are very good at pattern-extraction, generalization, category formation, analogy and lexical learning. Given these general cognitive strengths, the default assumption is that language-specific phonologies are learned, and that there is no need for principles of universal grammar specific to phonological knowledge. It is unclear to me how seriously these same principles are taken in the Columbia School. Since reference is made to some things being "easier to learn" than others, and since Diver (1979:8) explicitly states that "a disfavoring... represents a difficulty in a learning process", it seems that the two frameworks have distinct notions of phonological learning. Within Evolutionary Phonology, sound patterns change due to "imperfect" learning, but "easy" and "hard" are not used to describe the learning process. On the contrary, all natural language phonologies are learned quickly and easily by healthy human infants in healthy social environments, including even the most extreme or unusual sound patterns like the 100+ consonant systems of the Khoi languages, the initial CCCCC-clusters of Georgian, and the alternations between voiced and (inaudible) voiceless vowels in Blackfoot and Oneida (Gick et al. 2012). Where imperfect learning occurs, it is typically due to one of the phonetic sources of sound change in (3), where similar sounds are confusable, long-domain features are subject to realignment, and variability along the hypo-to-hyperarticulation continuum seeds exemplar-based category shifts. The notion that phonological learning is all "easy" then, appears to distinguish Evolutionary Phonology from the Columbia School.

The three differences just mentioned, however, seem minor in comparison to the similarities listed in (6). Like Columbia School Phonology, Evolutionary Phonology attempts to explain sound patterns in relation to human articulation, perception and general cognition, and, in doing so, to capture the essence of phonology as human behavior.

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