GRIMM'S LAW AS A RESPONSE TO FUNCTIONAL ASYMMETRY

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1. INTRODUCTION

Guided by principles such as those of economy and symmetry, both major schools of modern phonology (structuralist and generativist) have tended to distinguish too sharply between the paradigmatic and syntagmatic functions of phonological features. In addition, both types of phonology have tended to undervalue the functions of features which could be classified as having syntagmatic functions only. In structural phonology such features were regarded as merely allophonic; in generative phonology they were classified as purely redundant. Redundancy, however, performs the essential function of insurance in human speech (Fry 1977: 75-89)—synchronically, it offsets all types of what is called NOISE in communication theory (Cherry 1966); diachronically, it permits orderly changes from one phonological stage to another. Redundancy, in other words, helps us solve what Weinreich *et al.* (1968) called the *transition problem* in historical linguistics. Finally, the fact is that phonological features normally have both syntagmatic and paradigmatic functions, and that it is not always obvious which of these two functions is primary and which is secondary.

Let us take, for example, the functions of aspiration in Modern English. This feature is generally regarded as a typically syntagmatic one, since aspiration occurs according to the principles of complementary distribution (in syllable onsets) or free variation (in syllable codas). However, aspiration is obligatory on any so-called voiceless plosive which is the first (or only) consonant in the onset of a stressed syllable. This means that aspiration performs a paradigmatic function in the onsets of English syllables, since the delayed voice onset time (VOT) of aspirated plosives has been shown to be a major perceptual cue for the so-called voiceless plosive onsets of Modern English (Lisker & Abramson 1964). When we examine the so-called voiceless plosives in syllable codas we find that they tend to have longer periods of closure and stronger (noise burst) releases of closure than do their so-called voiced coda counterparts (Fry 1979). If we combine the phonetic cues from both onsets and codas, it becomes apparent that the paradigmatic contrast between /p t k/ and /b d g/ is more a matter of

Fortis/Lenis than of Voiceless/Voiced *in stressed syllables* of Modern English.

Here we can compare the similarly complex functions of vowel duration in stressed syllables of Modern English. In such syllables, vowel length can be regarded as having a paradigmatic function in that the FREE vowels (of *seat, cooed,* etc.) tend to be intrinsically longer than the CHECKED vowels (of *sit, could,* etc.) (Wells 1982: 119). However, the actual durations of vowels also vary considerably according to certain syntagmatic factors. These length-conditioning factors are both segmental—especially the voicing (Chen 1970) and manner of following consonants, as well as the height of the vowel itself; and suprasegmental—location in the intonation pattern and degree of stress (Cruttenden 1986: 2). We must therefore conclude that vowel length has both paradigmatic and syntagmatic functions in Modern English. Moreover, experimental work has shown that such vowel length differences are important for communication of both segmental and suprasegmental information. Classifying vowel length as merely allophonic, or conditioned, or redundant therefore merely hinders our understanding of the true functions of this phonological feature in Modern English. In fact, it is very difficult to demonstrate that any one of the phonetic differences which 'implement' the Free/Checked distinction in English vowels is the sole phonemic and conditioning one while all the others are allophonic and conditioned (Compare Hockett 1955: 173-5). Various distinctions have been proposed as the basic *emic* one. These include Tenser/Laxer, Longer/Shorter, more Diphthongal/more Monophthongal, more Peripheral/more Central, etc., but there is no general agreement as to which of these phonetic features is more basic. For example, in their famous SPE, Chomsky & Halle (1968: 54, 178-223) propose that all the free vowels of Modern English are underlyingly tense monophthongs, but this analysis has continued to be controversial (Durand 1990: 128-33).

It therefore seems to me that we should attempt to move beyond such impasses in modern phonology, by trying to identify the *actual* functions which phonetic features perform in phonological systems. In this paper, I will attempt to bypass such roadblocks by classifying phonological features simultaneously in two ways, i.e., phonetically and functionally. My most basic phonetic classification will be binary, and based on the SOURCE/FILTER distinction which has proven its worth in the field of experimental phonetics (See for example Fant 1960 and Lieberman 1977: 31-45.) My most basic functional classification will be based on Dik's (1989: 387-8) binary distinction between DISTINCTIVE function and CHARAC-

TERIZING function for prosodic features. I will assume that Dik's distinctive function for prosodic features is equivalent to the classical PARADIGMATIC function for segmental features, and that his characterizing function for prosodic features is equivalent to the classical SYNTAGMATIC function for segmental features.

I will therefore use the superordinate or cover term VERTICAL for *distinctive* prosodic functions and for *paradigmatic* segmental functions. Similarly, I will use the term HORIZONTAL for *characterizing* prosodic functions and *syntagmatic* segmental functions. The intersecting of these two binary divisions provides us with a classificatory matrix containing four cells, as shown in Table 1.

Table 1: a 2 x 2 classification of phonological features

	VERTICAL functions	HORIZONTAL functions
SOURCE features	**Tones** Compare Dik's (1989: 387) DISTINCTIVE function for tonemes.	**Intonations** Compare Dik's (1989: 388) CHARACTERIZING function for Characteristic Accent Positions (CAPs).
FILTER features	**Segmentals** Note the typically PARADIGMATIC functions of place and manner features.	**Harmonies** Note the typically SYNTAGMATIC functions of such phenomena as vowel harmony.

However, as I have indicated in my discussions of plosive aspiration and vowel length above, a phonological feature can simultaneously possess both vertical and horizontal functions which are approximately equal. Such a duality of functions suggests that we should expand our classification into a 2 x 3 matrix containing six cells, as shown in Table 2.

Table 2: a 2 x 3 classification of phonological features

	Vertical functions PRIMARY	Functions more equal	Horizontal functions PRIMARY
SOURCE features	**Tones**	**Accentual features** Stress accent or pitch accent	**Intonations**
FILTER features	**Segmentals**	**Secondary articulations** e.g., palatalization or pharyngealization	**Harmonies**

Our classificatory table could be further expanded into a 3 x 3 matrix containing nine cells. This is because certain phonological features can be classified as both source and filter features. The most obvious feature of this type is length, since the lengthening of any segment requires a sustaining of both its source (whether periodic voicing or aperiodic noise or both) and its filter (i.e., supralaryngeal articulatory configuration). Another phonological feature which may involve both source and filter is the so-called tension or tenseness feature, as Catford (1977: 199-208) meticulously explains. Such features as length (and some instances of so-called tension) therefore possess a double duality—a *phonetic* duality because they involve both source and filter, and a *functional* duality because their functions seem equally vertical and horizontal. It is noteworthy that both tension and length have been associated with the Free/Checked distinction in English vowels. This double duality helps explain the perennial controversy surrounding the analysis of this distinction in English phonology.

2. TENSIONS BETWEEN HORIZONTAL AND VERTICAL FUNCTIONS

The horizontal (i.e., syntagmatic) functions of phonological features are just as important as their vertical (i.e., paradigmatic) functions in human speech. This is because speech is in fact 'a time-compressing system' of communication (Lieberman 1977: 120). What is meant by time-compression here is that human speech sounds can be perceived at about three times the rate of non-speech sounds. To be specific, about 20 to 30 segmental phonemes can be perceived per second in human speech, whereas human beings can perceive only 7 to 9 non-speech sounds per second (Miller 1956). This apparent paradox is resolved by recognizing that the smallest unit of speech encoding and decoding is the syllable rather than the segmental phoneme. In other words, humans can perceive a CV or a CVC syllable in the same time that it takes them to perceive a V syllable. The fact that the number of segments in a CVC syllable is three times the number in a V syllable therefore explains why humans can perceive speech sounds about three times as fast as non-speech sounds.

However, speech communication must pay a price for its 'triple' rate of transmission in CVC syllables. This is because CVC syllables impose an extra burden of segmental ordering, since they require both the encoder (speaker) and the decoder (hearer) of the syllable to distinguish C1VC2 from its reverse order of C2VC1 (e.g., *pat* from *tap*, *cap* from *pack*, etc.). This ordering problem is reduced by the horizontal functions of phonological features. For example, in the English words cited above the feature of (stronger) aspiration helps distinguish the onset allophones of the phonemes /p t k/ from their coda allophones.

Moreover, such reductions in the ordering problem by means of positional allophony lead in turn to tensions between the horizontal and vertical functions of phonological features. This is because the horizontal functions of a feature tend to undermine its vertical functions by *reducing* phonetic similarity between allophones of the *same* phoneme, while simultaneously *increasing* phonetic similarity between allophones of *different* phonemes. Tensions of this type therefore tend to produce sound changes of the split-plus-merger type. This split-plus-merger type of chain shift is exactly what we find in the First Germanic Consonant Shift, referred to hereunder as Grimm's Law. It therefore seems that tensions between the horizontal and vertical functions of features can be used to motivate many sound changes which have usually been classified as unconditioned changes.

Tensions between these two types of functions are minimal in CV languages (i.e., those with single onset consonants and no coda consonants), since the order of segments is so highly predictable. However, as explained above, such tensions are greater in CVC languages (i.e., those with single coda consonants) and they are even greater in languages with consonant clusters. The fact that we reconstruct Proto-Indo-European (PIE) with consonant clusters in both onset and coda of the syllable means that tensions between horizontal and vertical functions must have been very high in that proto-language. Such tensions could have led to positional neutralizations of aspiration (as in Grassmann's Law for Sanskrit and Ancient Greek) and even to the regrouping of earlier horizontal (syntagmatic) allophones into later vertical (paradigmatic) phonemes, as in Grimm's Law producing Common Germanic.

3. GRIMM'S LAW AS A RESOLUTION OF FUNCTIONAL TENSIONS

In trying to explain such typologically rare sound changes as the devoicing of word-initial voiced stops in Grimm's Law, we can avoid controversial appeals to teleology (Hock 1991: 164-6) simply by recognizing that the primary function of aspiration on Proto-Germanic voiceless plosives was allophonic (i.e., syntagmatic or horizontal) rather than phonemic (i.e., paradigmatic or vertical). Only the unconditioned (i.e., aspirated) allophones [$*p^h$ $*t^h$ $*k^h$] of the Proto-Germanic voiceless plosives shifted to voiceless fricatives in Common Germanic; the conditioned (i.e., unaspirated) allophones [*p *t *k], which occurred only after obstruents in Proto-Germanic (Hock 1991: 39), remained unshifted in Common Germanic.

This split in the Common Germanic reflexes of the Proto-Germanic voiceless plosives automatically changed the function of voicing in unaspirated stops from a vertical (phonemic) one to a horizontal (allophonic) one, because the unaspirated voiceless stops [p t k] were now left in complementary distribution with the unaspirated voiced stops [b d g]. To be specific, the voiceless stops [p t k] now occurred only after (voiceless) obstruents while the voiced stops [b d g] occurred elsewhere. In addition, the principle of phonetic similarity of allophones was satisfied by the fact that [p t k] were now more similar to [b d g] than they were to [Φ θ x], the most probable voiceless fricative reflexes of Proto-Germanic [*p^h *t^h *k^h] in this transitional stage between Proto-Germanic and Common Germanic. The unaspirated voiced stops [b d g] then naturally devoiced, thereby increasing the phonetic similarity of allophones and giving the expected unmarked voicing (i.e., voicelessness) to this newly merged set of Common Germanic stop phonemes /p t k/.

It is therefore possible to trace functional changes in the reflexes of Proto-Germanic plosives through five distinctly different functional stages from Proto-Germanic to Modern English. These five functionally different stages are as follows:

(1) Proto-Germanic,
(2) Pre-Germanic,
(3) Common Germanic,
(4) Old English,
(5) Modern English.

The functional differences between the five stages are displayed in the following schematic diagrams. Each diagram contains four cells. Thin lines between cells indicate a vertical (i.e., phonemic) functional difference; thick lines between cells indicate a horizontal (i.e., allophonic) functional difference. Principal allophones of phonemes are enclosed in diagonal brackets while conditioned allophones are shown in square brackets. Arrows indicate directions of sound changes.

In stage 1, Proto-Germanic, aspiration has a horizontal (i.e., allophonic) function on voiceless stops. However, on voiced stops aspiration has a vertical (i.e., phonemic) function. It also has a different phonetic realization on voiced stops, where it produces murmur or breathy voice rather than a delay of VOT (voice onset time). This phonetic difference is indicated here by writing the voiceless aspirates with a following voiceless [h] but the voiced aspirates with a following voiced [ɦ].

Stage 1: Proto-Germanic,
with functions of aspiration asymmetrical for plosives

[p t k]	$/p^h\ t^h\ k^h/$ →	→ to voiceless fricatives
/b d g/	$/b^{\text{ɦ}}\ d^{\text{ɦ}}\ g^{\text{ɦ}}/$→	→ to voiced fricatives?

Stage 2, here called Pre-Germanic, represents the transitional stage between Proto-Germanic and Common Germanic. In this Pre-Germanic stage the voiceless aspirated *allophones* of Proto-Germanic have become voiceless fricatives. If we accept Hock's (1991: 595-609) careful compilation of evidence, it is also very likely that the voiced aspirate *phonemes* of Proto-Germanic have shifted in parallel to give a corresponding set of voiced fricatives. These changes have left the two sets of unaspirated stops in a situation of complementary distribution and of relatively greater phonetic similarity (as compared with the new fricatives). We can therefore assert that the function of voicing has become horizontal (i.e., allophonic) on plosives but vertical (i.e., phonemic) on fricatives. The voiceless plosives can be regarded as conditioned allophones of the voiced plosives, since the former occur only after voiceless obstruents.

Stage 2: Pre-Germanic,
with functions of voicing asymmetrical for obstruents

[p t k]	/Φθx/
↑ /b d g/ ↑	/βðɣ/

This transitional stage seems typologically unusual in that it has two series of fricative phonemes but only one series of plosive phonemes (Compare Hock 1991: 604). It is even more typologically unusual in that the principal allophones of its single plosive series are voiced rather than voiceless. The system responded by devoicing the voiced plosive allophones to produce stage 3, Common Germanic.

Stage 3: Common Germanic,
with functions of manner asymmetrical for obstruents

/p t k/	/Φθx/ or /fθh-x/
[b d g]	← ← /βðɣ/

In this third stage we find that the [± Continuant] feature of manner has a vertical (i.e., phonemic) function in voiceless obstruents but a horizontal (i.e., allophonic) function in voiced obstruents. Some of the voiced fricatives have begun to change to voiced plosives, perhaps in complex patterns of free variation and complementary distribution in different dialects. I agree with Hock (1991: 602) that this change probably happened earliest after homorganic nasals, where the oral cavity stoppage feature of the nasal would persist into the following voiced obstruent, so that [-mβ], [nð] and [-ŋɣ] would become [-mb], [-nd] and [-ŋg] respectively.

In stage 4, Old English, it is the feature of voicing which shows an asymmetry of function. In this stage the function of voicing is vertical (i.e., phonemic) on plosives but horizontal (i.e., allophonic) on fricatives. The voiceless fricative phonemes /f θ x/ have voiced fricative allophones [v ð ɣ] and, where Verner's Law has applied, also voiced plosive morphophonemic alternations [b d g] (Compare Hock 1991: 602). For example, the voiceless fricative /θ/ at the end of the verb in *hit sēaþ* 'it boiled' has a voiced allophone [ð] in the infinitive *sēoþan* 'to boil' and a voiced plosive morphophonemic alternation /d/ in the past participle *soden* 'boiled', as shown in Table 3.

Stage 4: Old English,
with functions of voicing asymmetrical for obstruents

/p t k/	↓ /f θ h-x/ ↓
/b d g/	[v ð ɣ]

Stage 5, Modern English, represents the first symmetry of the four-part schema. Each of the four previous stages was asymmetrical in that the functions of one phonological feature were opposed (i.e., vertical versus horizontal). In stage 1, Proto-Germanic, the functions of aspiration were asymmetrical for plosives. In stage 2, Pre-Germanic, the functions of voicing were asymmetrical for obstruents. In stage 3, Common Germanic, the functions of manner (i.e., plosive vs. fricative or ± continuant) were asymmetrical for obstruents. In stage 4, Old English, the functions of voicing were again asymmetrical for obstruents, but in this stage horizontal for fricatives rather than for plosives. In stage 5, Modern English, the functions of voicing have become more or less symmetrical, because the language has now acquired some minimal pairs for voicing of fricatives, even though the functional load for voicing is still lower for fricatives than it is for plosives.

Table 3: Reflexes of PIE Apical Plosives in five Stages of Germanic

Stage 1 Proto-Germanic	[t]=/tʰ/ *ster *rekʰt	/d/ *drew *ed-	/dʱ/ *dʱur- *wadʱ-	/tʰ/ *seutʰ- *bʱatʰ
Stage 2 Pre-Germanic	[t] = *ster *reçt	/d/ *drew *ed-	/ð/ *ður- *wað-	*seuθ- /θ/ *suθén *βaθ
			VL	
Stage 3 Common Germanic	/t/ *ster *reçt *trew *et	[d] *dur-	/ð/ *wæð *suðén	/θ/ *séuθon *βæθ
Stage 4 Old English	/t/ *steorra, riht* *trēow, etan*	/d/ *soden* *duru weddian*	[ð] *sēoþan* *baþian*	/θ/ *bæþ*
Stage 5 Modern English	/t/ *star, right* *tree, eat*	/d/ *sodden* *door, wed*	/ð/ *seethe, bathe*	/θ/ *bath*

NOTES: Principal allophones in slashes /-/: conditioned allophones in square brackets [-]. Equal signs (=) between allophones of the same phoneme. VL indicates (first part of) Verner's Law.

However, this does not imply that we should expect a long period of stability for the functions of voicing in the obstruents of English. For example, the vertical function of voicing in plosives is already being undermined in stressed syllables by the 'new' vertical function of aspiration, especially in the onsets of such syllables, as described in section 1 above.

Stage 5: Modern English, with functions of all features more symmetrical

/p t k/	/f θ h/
/b d g/	/v ð -/

4. CONCLUSIONS

In his chapter on prosodic features, Dik (1989: 379-99) outlines the functions of suprasegmental features in phonology; in this paper I attempt to apply two analogous functions to segmental features of consonants. Dik's DISTINCTIVE function for *prosodic* features compares with the PARADIGMATIC function of *segmental* features; his CHARACTERISTIC function for *prosodic* features parallels the SYNTAGMATIC function of *segmental* features. The same phonetic feature may have a mainly distinctive-type function in one language (e.g., voicing of obstruents in English) but a mainly characteristic-type function in another (e.g., voicing of obstruents in Micmac: Hewson 1982); in some other languages the two functions are more equal (e.g., voicing of obstruents in German and Russian). Tensions between these two types of functions may provide explanations of some so-called 'unconditioned' sound changes. In particular, they may help us explain consonantal chain shifts, such as Grimm's law.

Tensions between these two types of functions are minimal in CV languages (i.e., those with single onset consonants only), since the order of phonological segments is so highly predictable. However, such tensions are greater in CVC languages (i.e., those with coda consonants) and even greater in languages with consonant clusters. In such languages, the positional allophones of consonants play important roles in the ordering of phonological constituents, in both the production and perception of speech. However, such increased syntagmatic or characteristic-type functions of a phonological feature (e.g., *etic* aspiration) tend to undermine its paradigmatic or distinctive-type function, by *reducing* phonetic similarity between allophones of the *same* phoneme and by *increasing* phonetic similarity between allophones of *different* phonemes. The fact that we reconstruct Proto-Indo-European (PIE) with consonant clusters in both onset and coda of the syllable means that tensions between the above two functions must have been high in that proto-language. Such interactional tension apparently led to positional neutralizations of aspiration (as in Grassmann's Law for Sanskrit and Ancient Greek) and even to the regrouping of earlier syntagmatic allophones into later paradigmatic phonemes (as in Grimm's Law for Common Germanic).

A careful reconstruction of Grimm's Law indicates that voiceless aspiration performed only a syntagmatic or characteristic-type (i.e., allophonic) function in Proto-Germanic. Only the unconditioned (i.e., aspirated) allophones [$*p^h$ $*t^h$ $*k^h$] of the Proto-Germanic voiceless stops shifted to voiceless fricatives in Common Germanic; the conditioned (i.e., unaspirated) allophones [*p *t *k] remained unshifted. This split automatically changed the function of voicing in unaspirated stops from a paradigmatic or distinctive-type *emic* one to a syntagmatic or characteristic-type *etic* one, since voiced and voiceless unaspirated stops were now found only in complementary distribution. The (unaspirated) voiced stops then naturally devoiced, thereby increasing the phonetic similarity of allophones and giving the expected unmarked voicing to this newly merged set of Common German stop phonemes /p t k/.

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