

## The phonetics and phonologization of Verner's law

### 1. Verner's law

1.1 According to Verner's law (1877), the Germanic voiceless fricatives [f, θ, χ, s] became voiced fricatives [β, ð, γ, z] when adjacent to a voiced sonorant, *except*:

- a) In initial position
- b) Immediately following the lexical accent

### 2. Outline

2.1 The issues addressed in this paper are:

- a) What is the nature of the fricative voicing?
- b) Why did only the fricatives voice, and not also the stops?
- c) How do we account for the exceptions to voicing?
- d) How did Verner's law become phonologized?

2.2 This analysis of Verner's law follows an approach to historical phonology where sound change is analyzed as being primarily rooted in phonetics – i.e. in articulation and perception. Sound change itself occurs when the listener's perception leads to a reanalysis of the speaker's articulation (Ohala 1993).

### 3. Voicing

3.1 Some analyses of Verner's law have pointed out that the voicing of fricatives is an instance of lenition.<sup>1</sup> With regard to the mechanism of voicing lenition, there are two main approaches.

3.2 One key characteristic of lenition is a decrease in duration. Based on articulatory data showing that voiced obstruents are shorter than voiceless obstruents (Lisker 1957, Crystal/House 1982, 1988), and perceptual data showing that shortening of voiceless obstruents leads to the percept of voiced obstruents (Lisker 1957, Cole/Cooper 1975), it has been suggested that voicing lenition occurs when the speaker misinterprets the shortened duration of a segment as intended voicing (Lavoie 2001, Blevins 2004).

3.3 Another key characteristic of lenition is the 'reduction in constriction degree', caused by an imprecision and undershoot of the articulatory target (Kirchner

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<sup>1</sup> d'Alquen 1988, Garrett/Hale 1993, Ramers 1994, 1999, Iverson/Salmons 2003.

2001, 2004). Since the reduced segment will have more in common with its neighboring segments, undershoot is a type of coarticulation. It has been suggested that in the immediate vicinity of voiced sonorants, voiceless obstruents will undergo voicing through laryngeal coarticulation (Westbury/Keating 1988, Kirchner 2001).

#### **4. Germanic voicing of obstruents**

- 4.1 In Germanic, only voiceless fricatives undergo voicing. Voiceless stops remain as such.
- 4.2 An account focusing primarily on duration and perception cannot without additional stipulations account for why voiceless stops are not affected by lenition. Additionally, Stevens et al. (1992) have shown that fricative duration has a very minor impact on the perception of voicing.
- 4.3 In terms of articulation, voiceless fricatives differ from voiceless stops in being produced with a larger glottal spread (Hirose/Niimi 1987, Vaux 1998, Stevens 1998) and higher longitudinal tension of the vocal folds (Löfqvist et al. 1989).
- 4.4 A sonorant with 'modal' voicing is produced with a narrow glottal spread and little vocal fold tension (Hewlett/Beck 2006). As a result, there is a greater distance in the laryngeal settings between a sonorant and a voiceless fricative than between a sonorant and a voiceless stop. As such, the laryngeal settings for voiceless fricatives are susceptible to undershoot in this position. Since voiced fricatives are produced with a smaller glottal spread and less longitudinal tension of the vocal folds (Löfqvist et al. 1989, Stevens 1998), undershooting these targets in a fricative can lead to voicing.
- 4.5 Relevant to the question of why only fricatives underwent voicing is the fact that Germanic had no voicing distinction in fricatives, but did in stops: /b d g – p t k/ (Vennemann 1984). If there were any voicing coarticulation for stops as well, a reanalysis of this articulation as intentional voicing would lead to voicing neutralization. Gurevich (2004) finds in a cross-linguistic study that lenition very rarely leads to positional neutralization, thus concluding that lenition is phonologically constrained.
- 4.6 It is well known that phonetic coarticulation tends to be greater along non-contrastive dimensions, the classic example being that a language with few vowels has more vowel-to-vowel coarticulation than a language with many vowels (Manuel 1999).
- 4.7 Both the speaker and the listener are therefore willing to give more leeway in terms of voicing to the articulation of fricatives than stops, since fricative voicing has no contrastive value, and can easily be factored out in the perceptual analysis.

## **5. Directionality**

- 5.1 For any coarticulation analysis, the direction of coarticulation is important. With respect to Verner's law, the relevant articulations are those which allow or inhibit voicing in an obstruent. As pointed out in Löfqvist et al. (1989), this is to a large extent determined by the cricothyroid muscle, which determines the longitudinal tension of the vocal folds.
- 5.2 In studies of sequences of vowels and fricatives, it has been observed that voiceless fricatives are affected by the voicing of a preceding sonorant more than by a following sonorant (Stevens et al. 1992, Hoole 1999). In a vowel-fricative-vowel sequence, then, the laryngeal settings leading to voicing seem to be carried over from the vowel into the fricative, rather than being anticipated by the following vowel.
- 5.3 The longitudinal tension of the vocal folds is also responsible for raising the pitch of a sonorant (Atkinson 1978, Löfqvist et al. 1989, Stevens 1998, Hewlett/Beck 2006). Hyman (2007) shows that there is an observable asymmetry in pitch spreading in the world's languages in that it as a rule is carry-over and not anticipatory, concluding that other things being equal, there is a "tendency of tone targets to be realized late". As is also well known, the vocal fold tension of voiceless obstruents is also commonly carried over into a following vowel, leading to a rise in the pitch (Löfqvist et al. 1989).
- 5.4 In conclusion, it appears as if the laryngeal articulation largely responsible for the presence or absence of voicing by its nature is more prone to be lagging than anticipated. These observations can be supported by clinical experiments showing that the cricothyroid muscle is in fact the slowest intrinsic laryngeal muscle, needing 30-45ms to reduce its tension by half (van Lunteren/Strohl 1988).

## **6. Exceptions to voicing**

- 6.1 As mentioned in 1.1, the voicing of fricatives in Germanic is inhibited in initial position and immediately following the lexical accent.
- 6.2 The initial position commonly escapes lenition (Kirchner 2001), and there are several factors working together to ensure this for Germanic.
- 6.3 First, given the lagging effect of voicing described above, there would be no preceding voiced sonorant whose voicing would lag over into an initial fricative. Second, the initial consonant of a word is commonly lengthened and strengthened (Fougeron/Keating 1997), and these articulations are antagonistic to lenition. Finally, the initial segment of a word carries a heavy functional load in word recognition (Kirchner 2004, Smith 2005), and is

therefore less likely to undergo changes than other segments (Nooteboom 1981).

- 6.4 The other exception to fricative voicing occurs immediately after the lexical accent. As an illustration, \*/maφá/ will undergo voicing to \*/maβá/, whereas in \*/máφa/, where the sonorant preceding the fricative /φ/ carries the lexical accent, no voicing to \*\*/máβa/ will occur.
- 6.5 An important underlying assumption is that the Germanic free accent was primarily characterized by a high pitch (cf. e.g. Meillet 1970). As pointed out in 5.3, high pitch is produced by increasing the longitudinal tension of the vocal folds.
- 6.6 As first pointed out in Halle/Stevens 1971, this laryngeal specification is shared by high pitched sonorants and voiceless obstruents. Since a Germanic accented vowel and the immediately following voiceless fricative are both produced with high longitudinal tension of the vocal folds, coarticulation between the two is less likely to lead to any change in the voicing quality of the fricative.

## **7. Phonologization of Verner's law**

- 7.1 A voicing coarticulation of /φ/ as described above in 4 would lead to a partially voiced /β̞φ/. Its eventual phonological pronunciation /β/ is the result of at least two important factors.
- 7.2 First, it is a descriptive fact that the phonologization of an original phonetic coarticulation brings with it a clarification and enhancement of the quality that has been interpreted as intentional (cf. Hyman 1976, Ohala 1993). Second, and more important in our case, the perceptual experiments in Stevens et al. 1992 show that the primary cue for phonological voicing in fricatives is the presence and duration of vocal fold vibration in the *onset* of the fricative, meaning that /β̞φ/ would naturally be perceived as a phonological /β/.
- 7.3 Another question is why this coarticulation was phonologized at all. Since the quality of the voiceless fricatives would be predictable from the pitch of the preceding sonorant, it would be expected that the listener would factor out the phonetic voicing in his own phonological analysis (Ohala 1993). The primary cause for phonologization is the familiar 'loss of the conditioning environment'. Since the conditioning environment for Verner's law in Germanic is the location of the free accent, it follows that the most probable reason for the phonologization of Verner's law is the Germanic relocation of the accent to the initial syllable.

- 7.4 Cross-linguistic correlates of stress generally include pitch, duration and strengthening, meaning that a stressed syllable tends to have a higher pitch, be longer, and have more clearly articulated segments.<sup>2</sup> These articulations are also commonly present in initial syllables, independent of the stress placement (Fougeron/Keating 1997, Ladd 2001, Barnes 2006), which can lead the listener to reanalyze the input as having initial stress. These facts are clearly paramount in accounting for the disproportionally high amount of languages with initial stress (cf. Hyman 1977, Gordon 2002).
- 7.5 Taking Proto-Germanic to be a natural language, some or all of these correlates were probably associated with initial syllables, causing a reanalysis to initial stress.
- 7.6 When a Germanic speaker utters \*/máƿa/ and \*/maβ̥wá/, the listener would by the stress reanalysis hear \*/máƿa/ and \*/máβ̥wá/ with a fixed initial stress. To the listener, there is no longer any conditioning environment for the difference in voicing, and will consequently assume that the distinction is intended by the speaker. Through the phonologization process (7.2), the listener will internalize the distinction as a voicing contrast \*/máƿa/ vs. \*/máβa/, giving the outcome of Verner's law.

## 8. Typology of Verner's law

- 8.1 By Verner's law, the pitch in effect determines the voicing quality of a following fricative. As pointed out by Calabrese/Halle (1998) and Petrova (2004), this contradicts Hyman and Schuh's generalization that 'tone does not affect consonants' (1974, Hyman 1975).
- 8.2 There are several languages, though, that behave like Proto-Germanic in that the presence or absence of the lexical accent or a high pitch directly determines the voicing quality of a following obstruent: Jingpho (Matisoff 1973, Maddieson 1974, 1976), Sireniki (Hammerich 1955), Wuyi (Yip 1995), Yabem (Poser 1981, Hansson 2004), and to some extent English and German (Ramers 1994).
- 8.3 Since these languages are geographically spread and unrelated to each other, it suggests that they are independent developments, thus supporting the naturalness of Verner's law in Germanic.

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<sup>2</sup> Fry 1958, de Jong 1995, Sluijter/van Heuven 1996, Steriade 2007.

## 9. Conclusion

This paper has outlined the underlying phonetic basis for the implementation, scope, and phonologization of Verner's law. In summary, I have argued for the following:

- Implementation: Verner's law is a case of lenition through coarticulation.
- Scope: The coarticulation affects voiceless fricatives due to their extreme laryngeal settings and non-contrastiveness in voicing. Fricatives following a high pitched sonorant remain voiceless by the shared articulation of vocal fold tension.
- Phonologization: The coarticulatory voicing is phonologized as a result of accent retraction, after which the listener cannot attribute the voicing to any other predictable phonetic source.

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## References

- d'Alquen, R. J. E. 1988. *Germanic accent, grammatical change and the laws of unaccented syllables*. New York.
- Atkinson, J. 1978. Correlation analysis of the physiological factors controlling fundamental voice frequency. *The journal of the acoustical society of America* 63:211-222.
- Barnes, J. 2006. *Strength and weakness at the interface. Positional neutralization in phonetics and phonology*. New York.
- Blevins, J. 2004. *Evolutionary phonology. The emergence of sound patterns*. Cambridge.
- Calabrese, A./Halle, M. 1998. Grimm's and Verner's laws: A new perspective. In Jasanoff, J./Melchert, H. C./Oliver, L. (ed.) *Mír curad. Studies in honor of Calvert Watkins*, pp. 47-62. Innsbruck.
- Cole, R. A./Cooper, W. E. 1975. Perception of voicing in English affricates and fricatives. *The journal of the acoustical society of America* 58:1280-1287.
- Crystal, T. H./House, A. S. 1982. Segmental durations in connected speech signals: preliminary results. *The journal of the acoustical society of America* 72:705-716.
- Crystal, T. H./House, A. S. 1988. Segmental durations in connected speech signals: current results. *The journal of the acoustical society of America* 83:1553-1573.
- Fougeron, C./Keating, P. A. 1997. Articulatory strengthening at edges of prosodic domains. *The journal of the acoustical society of America* 101:3728-3740.
- Fry, D. B. 1958. Experiments in the perception of stress. *Language speech* 1:126-152.
- Garrett, A./Hale, M. 1993. The phonetics and phonology of Grimm's and Verner's laws. LSA handout.
- Gordon, M. 2002. A factorial typology of quantity-insensitive stress. *Natural language and linguistic theory* 20:491-552.

- Gurevich, N. 2004. *Lenition and contrast. The functional consequences of certain phonetically conditioned sound changes*. New York.
- Halle, M./Stevens, K. 1971. A note on laryngeal features. *Quarterly progress report. MIT research laboratory of electronics* 101:198-213.
- Hammerich, L. L. 1955. Die germanische und die hochdeutsche Lautverschiebung. I. Wie entsteht die germanische Lautverschiebung? *Beiträge zur Geschichte der deutschen Sprache und Literatur* 77:1-29.
- Hansson, G. Ó. 2004. Tone and voicing agreement in Yabem. In Chand, V./Kelleher, A./Rodríguez, A. J./Schmeiser, B. (ed.) *WCCFL 23. Proceedings of the 23<sup>rd</sup> West coast conference on formal linguistics*, pp. 318-331. Somerville.
- Hewlett, N./Beck, J. 2006. *An introduction to the science of phonetics*. Mahwah, NJ.
- Hirose, H./Niimi, S. 1987. The relationship between glottal opening and the transglottal pressure differences during consonant production. In Baer, T./Sasaki, C./Harris, K. S. (ed.) *Laryngeal function in phonation and respiration*, pp. 381-390. Boston.
- Hoole, P. 1999. Techniques for investigating laryngeal articulation. Section A. In Hardcastle, W. J./Hewlett, N. (ed.) *Coarticulation. Theory, data and techniques*, pp. 294-300. Cambridge.
- Hyman, L. M. 1975. *Phonology. Theory and analysis*. New York.
- Hyman, L. M. 1976. Phonologization. In Juillard, A. (ed.) *Linguistic studies offered to Joseph Greenberg*, pp. 407-418. Saratoga.
- Hyman, L. M. 1977. On the nature of linguistic stress. In Hyman, L. M. (ed.) *Studies in stress and accent*, pp. 37-82. Los Angeles.
- Hyman, L. M. 2007. Universals of tone rules: 30 years later. In Riad, T./Gussenhoven, C. (ed.) *Tones and tunes. Volume 1: typological studies in word and sentence prosody*, pp. 1-34. New York.
- Hyman, L. M./Schuh, R. G. 1974. Universals of tone rules: evidence from West Africa. *Linguistic inquiry* 5:81-115.
- Iverson, G. K./Salmons, J. C. 2003. Laryngeal enhancement in early Germanic. *Phonology* 20:43-74.
- de Jong, K. J. 1995. The supraglottal articulation of prominence in English: Linguistic stress as localized hyperarticulation. *The journal of the acoustical society of America* 97:491-504.
- Kirchner, R. 2001. *An effort based approach to consonant lenition*. New York.
- Kirchner, R. 2004. Consonant lenition. In Hayes, B./Kirchner, R./Steriade, D. (ed.) *Phonetically based phonology*, pp. 313-345. Cambridge.
- Ladd, D. R. 2001. Intonation. In Haspelmath, M./König, E./Oesterreicher, W./Raibe, W. (ed.) *Language typology and language universals*, pp. 1380-1390. New York.
- Lavoie, L. M. 2001. *Consonant strength. Phonological patterns and phonetic manifestations*. New York.
- Lisker, L. 1957. Closure duration and the intervocalic voiced-voiceless distinction in English. *Language* 33:42-49.
- Löfqvist, A./Baer, T., McGarr, N. S./Story, R. S. 1989. The cricothyroid muscle in voicing control. *The journal of the acoustical society of America* 85:1314-1321.
- van Lunteren, E./Strohl, K. P. 1988. Striated respiratory muscles of the upper airways. In Mathew, O. P./Sant'Ambrogio, G. (ed.) *Respiratory function of the upper airway*, pp. 87-123. New York.
- Maddieson, I. 1974. A note on tone and consonants. *UCLA working papers in phonetics* 27:18-27.

- Maddieson, I. 1976. A further note on tone and consonants. *UCLA working papers in phonetics* 33:131-159.
- Manuel, S. Y. 1999. Cross-language studies: relating language-particular coarticulation patterns to other language-particular facts. In Hardcastle, W. J./Hewlett, N. (ed.) *Coarticulation. Theory, data and techniques*, pp. 179-198. Cambridge.
- Matisoff, J. A. 1973. Tonogenesis in Southeast Asia. In Hyman, L. M. (ed.) *Consonant types & tone*, pp. 71-95. Los Angeles.
- Meillet, A. 1970. *General characteristics of the Germanic languages*. Tuscaloosa.
- Nooteboom, S. G. 1981. Lexical retrieval from fragments of spoken words: beginnings vs endings. *Journal of phonetics* 9:407-424.
- Ohala, J. 1993. The phonetics of sound change. In Jones, C. (ed.) *Historical linguistics: Problems and perspectives*, pp. 237-278. New York.
- Petrova, O. 2004. The role of perceptual contrast in Verner's law. In Curzan, A./Emmons, K. (ed.) *Studies in the history of the English language II*, pp. 371-408.
- Poser, W. J. On the directionality of the tone-voice correlation. *Linguistic inquiry* 12:483-488.
- Ramers, K. H. 1994. Verners Gesetz: Ein Beispiel für die Interdependenz segmentaler und prosodischer Faktoren des Lautwandels. *Sprachwissenschaft* 19:271-306.
- Ramers, K. H. 1999. *Historische Veränderungen prosodischer Strukturen*. Tübingen.
- Sluijter, A. M. C./van Heuven, V. J. 1996. Spectral balance as an acoustic correlate of linguistic stress. *The journal of the acoustical society of America* 100:2471-2485.
- Smith, J. L. 2005. *Phonological augmentation in prominent positions*. New York.
- Steriade, D. 2007. 24.964 'Topics in phonology' handout, September 15<sup>th</sup>. MIT.
- Stevens, K. N. 1998. *Acoustic phonetics*. Cambridge, MA.
- Stevens, K. N./Blumstein, S. E./Glicksman, L./Burton, M./Kurowski, K. 1992. Acoustic and perceptual characteristics of voicing in fricatives and fricative clusters. *The journal of the acoustical society of America* 91:2979-3000.
- Vaux, B. 1998. The laryngeal specifications of fricatives. *Linguistic inquiry* 29:497-511.
- Vennemann, T. 1984. Hochgermanisch und Niedergermanisch. Die Verzweigungstheorie der germanisch-deutschen Lautverschiebungen. *Beiträge zur Geschichte der deutschen Sprache und Literatur* 106:1-45.
- Verner, K. 1877. Eine ausnahme der ersten lautverschiebung. *Zeitschrift für vergleichende Sprachforschung* 23:97-130.
- Westbury, J. R./Keating, P. A. 1986. On the naturalness of stop consonant voicing. *Linguistics* 22:145-166.
- Yip, M. 1995. Tone in East Asian languages. In Goldsmith, J. A. (ed.) *The handbook of phonological theory*, pp. 476-494. Cambridge, MA.