Comments on privative versus binary features

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This note is concerned with the implications for phonetic implementation of privative, or unary, phonological feature specifications. By phonetic implementation is meant the process of converting symbolic feature values into continuous values along phonetic (articulatory and/or acoustic) parameters. By privative or unary phonological feature specification is meant the limitation on features that they may have only one value (a positive, or plus, value). Privative features cannot take on a "minus" value, and thus there is no minus value that can be seen by the grammar or referred to by rules or constraints. Under privativity, then, phonetic implementation is limited to the implementation of positive feature specifications and cannot refer to negative values.

In at least some work on phonetic implementation, much use is made of traditional minus values of features to effect particular phonetic results.[1] The rise of privative theories presents a challenge to those phoneticians who have assumed and made use of full binary specifications. I will first comment generally on how phoneticians make use of feature values, and then consider whether and how privative features could be accommodated. All of this discussion will be couched in articulatory terms, since standard phonological features and most work in phonetic implementation are articulatory in nature.

The phonetic interpretation of a feature F can be viewed as generating continuous time functions along some set of phonetic parameters $P_1 \ldots P_n$. The feature specifications [+F] and [-F] each mean a specific, limited, range of possible values on P, one restricted so that it is clearly distinct from values seen for [+F] in the same context. The unspecified value, or [0F], means little or no restriction on possible values of F on P. In common practice, the plus value of a feature F is taken to indicate some specific articulation, and the minus value of that feature is taken to indicate the contrary gesture. For example, [+round] indicates lip protrusion, while [-round] may indicate lip spreading; [+nasal] indicates velum lowering, while [-nasal] indicates velum raising. Under this kind of phonetic interpretation, the minus value of the feature has as much meaning and impact as does the plus value.

In such a situation, there is no practical impediment to the use of privative features. Whatever interpretation results from [-F] in the binary system would pertain to [0F] in the unary system. There might be some objection that such an interpretation violates the spirit of privativity and its "no negative specifications" basis. In response it could be suggested that privative features are re-interpreted as binary before phonetic implementation.

The issue is not so simple, however. Some phoneticians rely on the distinction between [-F] and [0F], that is, the ternary power of underspecified binary features. While [+F] indicates a specific articulation and [-F] indicates an opposite, specific, articulation, [0F] indicates that there is no articulation specified. With [0F], the articulator in question

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[1]Such work does not include Browman and Goldstein (e.g. 1989), whose gestural specifications are always unary; nor Pierrehumbert and Beckman (1988) and other work on intonation where the representations are two tonal units which can be construed as privative specifications of tonal features High and Low.

has no specific demands placed upon it by the segment in question. That articulator's activity is instead determined passively, by the context. Consider two examples of this from my own work.

First, in a brief discussion of vowel nasalization in English (Keating 1990a) I suggested that oral sonorants be unspecified for [nasal], while [-nasal] be reserved for oral obstruents, especially voiceless ones. (Nasal sonorants of course are [+nasal].) Whereas oral obstruents show velum raising, oral sonorants show context-dependent nasality; for example, a vowel between an obstruent and a nasal is transitionally nasalized. A crucial distinction is thus made between the phonetic interpretations of [-nasal] and [0nasal] within a single language, English. Second, I have suggested that languages differ in this same respect. This difference can be seen phonetically in the phenomenon of vowel-to-vowel coarticulation. (Vowel-to-vowel coarticulation refers to the mutual influence of one vowel on another, at least at their edges, across an intervening consonant; it can be thought of as a generalized phonetic precursor of harmony.) A language in which consonants bear contrastive secondary tongue body articulations will use the feature [back] for consonants, with repercussions on coarticulation. The degree of vowel-to-vowel coarticulation depends on how uninvolved the tongue is in making an intervening consonant. A [-back] or [+back] specification on a consonant will block or limit vowel-to-vowel coarticulation. In contrast, a language without any specification for [back] on consonants will show more extensive vowel-to-vowel coarticulation. Thus English shows much more vowel-to-vowel coarticulation than do various Slavic languages (Ohman 1966, Keating 1988, Choi and Keating 1991). The analysis of this phenomenon has been that a specified value ([+back] or [-back]) on consonants makes the values for [back] on vowels non-adjacent, and that coarticulation depends on adjacency of specifications. A similar analysis of consonant-to-consonant coarticulation in Marshallese is offered by John Choi in his 1992 dissertation. In her 1990 dissertation and her 1993 conference presentation, Abby Cohn develops these points with respect to the feature [nasal]. The point here is that [-back] and [0back] are taken to have very different phonetic consequences.

We have then a paradox. The phonological proposal for unary features is that [-F] is collapsed with [0F] because [-F] seems to be invisible. If it is invisible phonologically, it cannot then be visible later on to block phonetic interactions.

It seems to me that there is an alternative approach which can coexist with privative features, one in which [-F] is not referred to. This alternative comes from considering where the [-F] values in the examples above come from. The value [-nasal] comes from the values for other features ([sonorant], perhaps [voice]). The value [-back] for consonants comes from the system of consonant contrasts in a language: in a language with [+back] consonants, [-back] also carries information. Strictly speaking, then, [-F] specifications are a handy encapsulation of information which is available elsewhere in segment specifications. This information can be constructed in the phonetics as part of the phonetic implementation of [0F], rather than be handed over to the phonetics by the phonology. After all, if only the phonetics cares about this distinction, then the phonology should not encode it. Instead, phonetic interpretation can be made to depend more on the paradigmatic context.

In this light, let us revisit the examples given above. In the case of English sonorant nasalization, [+nasal] means a narrow range of open velum positions, while [0nasal] can depend on other features: for [-voice] segments (which will all be obstruents) it means a narrow range of closed velum positions, and otherwise it means a wide range of possible velum positions. Abby Cohn has shown that when the cross-language situation is considered, things are not so simple, but let us assume that the analysis could be developed more generally. In the case of blocking coarticulatory interactions, [+back] means a

constriction behind the hard palate, while [0back] must be interpreted in a language-specific manner. In a language with [+back] consonants, [0back] means constriction in the hard palate region. In a language with no [back] specifications for consonants, there is no specific constriction or constriction location associated with the tongue body for consonants.

In sum, it would fall to the language-specific phonetic system to determine the phonetic interpretation of unspecified feature values.

A different sort of case is presented by the feature [voice]. The marked value [+voice] clearly refers to a set of articulations which allow vocal cord vibration. Unlike with [nasal], [round], and [back], however, the minus value of [voice] does not refer to any single specific gesture contrary to that for [+voice]. Instead, [-voice] indicates any gesture sufficient to prevent voicing (generally glottal spreading or constriction, but potentially perhaps certain supralaryngeal maneuvers as well). On its face, this makes [voice] look like a better candidate for a privative treatment, as proposed by e.g. Mester and Ito (1989, section 5), Cho (1990), and Lombardi (1991).

Nonetheless, a role for the distinction between [-voice] and [0voice] exists in the analysis of near-neutralization of voicing in final obstruents, a phenomenon discussed most convincingly by Port & Crawford (1989). The claim in this and other studies is that final obstruent devoicing in, for example, German, is not completely neutralizing; that is, derived [-voice] obstruents are not physically identical to underlying [-voice] obstruents. Rather, there are slight phonetic differences between them, differences which are highly variable across speakers and studies. As these and other researchers have noted, the lack of physical identity indicates that the output of a devoicing rule cannot be identical with an underlying [-voice] specification, at least not if that output is the sole input to phonetic interpretation of these different obstruent classes. In previous work (Keating 1984) I've hinted at an analysis of this phenomenon based on markedness that can be seen as relying on a difference between [-voice] and [0voice]. Let me spell this out here. First, as in current discussion of devoicing under privative theories, devoicing can be seen as the deletion or delinking of a [+voice] specification, resulting in [0voice]. Second, unlike in privative theories, there are underlying [-voice] obstruents. The output of devoicing thus remains distinct from underlying voicelessness. Phonetically, underlying [-voice] is interpreted by voicing-preventing gestures. [0voice] is interpreted as default or neutral settings, with variable results, as discussed by Westbury & Keating (1986).

This analysis, then, relies on ternary-powered voicing specifications in surface representation. It accounts for the phonetiic difference between devoiced and underlying-voiceless obstruents by giving them different representations. It accounts for the variability in devoiced obstruents by letting them be interpreted by a variable phonetic mechanism. In contrast, under privative voicing with no [-voice] value available, the [0voice] output of devoicing must be like the underlying voiceless specification. Here again is our paradox: the phonology may not distinguish between devoiced and voiceless obstruents, but if they are collapsed phonologically, then phonetic interpretation will see no difference between them. At the same time, the kind of solution offered for the cases above will not carry over to this one. Here, there is no other information from other features that could be used to distinguish the two kinds of voiceless obstruents.

Nonetheless, even in this case there are alternative approaches compatible with privative voicing. The more traditional one is to find a way to get extra information into a representation before devoicing, the deletion of a voicing specification, occurs. If there is other distinguishing information in the representations, then devoicing will not be neutralizing even phonologically, and phonetic implementation will preserve the indicated

distinction. Such a way is the redundant feature values of Stevens et al.'s (1986) "enhancing" features, by which non-contrastive feature values are introduced into representations to bolster underlying contrasts. Suppose that enhancing feature values are introduced before devoicing, and that these values are not affected by devoicing. The generally-recognized enhancers of unspecified-voice would be [spread glottis] and [constricted glottis] (see also Keating 1990b). The analysis would be:

1) assign enhancing [spread glottis] to [0voice] obstruents (more precisely, assign it to all of them but subject to a co-occurrence restriction against [spread glottis] with [+voice];

2) delete [+voice].

The outputs of these rules are distinct laryngeally, but non-distinct re [voice], since both are [0voice].

The less traditional alternative is to regard devoicing as a phonetic, rather than a phonological, rule. Pierrehumbert (1990) outlines such an account, noting that devoiced obstruents are not referred to by later phonological rules; that is, nothing hinges on doing devoicing in the phonology. Putting her analysis into privative terms, Pierrehumbert suggests that phonetic implementation of voicing proceed as follows: [0voice] (underlying voiceless) obstruents are implemented with voicing-suppressing gestures, while [+voice] obstruents are implemented in a context-dependent fashion. Non-final [+voice] obstruents are implemented with voicing-permitting articulations, while final [+voice] obstruents are implemented weakly. Thus the phonological structural condition is preserved in the phonetic rule, but the phonological structural change is reformulated as a different phonetic implementation. In effect, it preserves the phonetic origin of devoicing process (Ohala 1983, Westbury & Keating 1986) as the synchronic devoicing mechanism, giving German simply a more extreme version of what we see phonetically in English (e.g. Veatch 1990).

In conclusion, I hope to have shown that there is quite a range of options for phonetic implementation, any or all of which could be used to pare down surface representations to privative feature specifications and yet still accomplish phonetic implementation with appropriate details.

References

Browman, C. and Goldstein, L. (1989). Articulatory gestures as phonological units. *Phonology* 6, 201-252.

Cho, Y. Y. (1990). A typology of voicing assimilation. *WCCFL* 9.

Choi, J.-D. (1992) Phonetic underspecification and target interpolation: An acoustic study of Marshallese vowel allophony. UCLA Ph.D. dissertation. [UCLA Working Papers in Phonetics 82]

Choi, J.-D. and Keating, P. (1991). Vowel-to-vowel coarticulation in three Slavic languages. *UCLA Working Papers in Phonetics* 81, 78-86.

Cohn, A. (1990). *Phonetic and Phonological Rules of Nasalization.* UCLA Ph.D. dissertation. [UCLA Working Papers in Phonetics 76]

Cohn, A. (1993). Privative features: consequences for an adequate theory of phonetic implementation. Presentation at the Phonetics-Phonology workshop, Ohio State U., August 1993.

Keating, P. (1984). Phonetic and phonological representation of stop consonant voicing. *Language* 60, 286-319.

Keating, P. (1988). Underspecification in phonetics. *Phonology* 5, 275-292.

Keating, P. (1990a). The window model of coarticulation: articulatory evidence. In J. Kingston and M.E. Beckman (eds.), *Papers in Laboratory Phonology I: Between the Grammar and the Physics of Speech*.. Cambridge: Cambridge University Press, 451-470.

Keating, P. (1990b). Phonetic representations in a generative grammar. *J. of Phonetics* 18, 321-334.

Lombardi, L. (1991). *Laruyngeal features and laryngeal neutralization.* Ph. D. dissertation, U. Mass/Amherst.

Mester, R. A. and Itô, J. (1989). Feature predictability and underspecification: palatal prosody in Japanese Memetics. *Language* 65, 258-293.

Öhman, S. (1966). Coarticulation in VCV utterances: spectrographic measurements. *JASA* 39, 151-168.

Pierrehumbert, J. (1990). Phonological and phonetic representation. *J. Phonetics* 18, 375-394.

Pierrehumbert, J. and Beckman, M. (1988). *Japanese Tone Structure.* Cambridge: MIT Press.

Port, R. and P. Crawford (1989). Incomplete neutralization and pragmatics in German. *J. Phonetics* 17, 257-282.

Ohala, J. (1983). The origin of sound patterns in vocal tract constraints. In P.F. MacNeilage (ed.), *The Production of Speech*.. New York: Springer-Verlag.

Stevens, K.N., S.J. Keyser, and H. Kawasaki (1986). Toward a phonetic and phonological theory of redundant features. In *Invariance and Variability in Speech Processes*, J.S. Perkell and D.H. Klatt (eds.). Hillsdale, N.J.:Lawrence Erlbaum Associates.

Veatch, T. (1989). Word-final devoicing of fricatives in English. Annual meeting of the LSA, December 1989, Washington DC.

Westbury, J.R. and P. A. Keating (1986). On the naturalness of stop consonant voicing. *J. Linguistics* 22, 145-166.