N Clements, 18 octobre 2006

The feature [strident]

1. Main sources

Jakobson, Fant & Halle 1952, 23-26; Chomsky & Halle 1968, 329; Stevens 1983, 249-51.

2. Overview

This widely-accepted feature was originally proposed by Jakobson, Fant & Halle (1952, 23-6) and has been maintained in most feature theories ever since, including that of Chomsky & Halle (1968). It is maintained notably by K.N. Stevens and his colleagues. Occasional attempts to eliminate this feature have not been widely followed. Good reviews of the use of this feature to describe fricative contrasts are provided by Keating (1988, 4-7) and especially Hall (1997, 141-3); for its use in affricates, see LaCharité (1993, 36-42), Rubach (1994), Clements (1999), Kim (2001) and Kehrein (2002).

3. Phonological use

This feature is restricted to obstruents, where it has two main uses:

A. To distinguish sibilant fricatives such as [s z ʃ ʒ] from nonsibilant fricatives such as [θ ð ç ʝ];

B. To distinguish sibilant stops such as [ts dz tʃ dʒ] from nonsibilant stops such as [t d c ɟ].

Both uses were recognized in PSA (= *Preliminaries to Speech Analysis*). In contrast, SPE (= *Sound Pattern of English*) recognized only the first, proposing a short-lived feature [+delayed release] to distinguish affricates from nonaffricate stops. SPE also used [+strident] to distinguish strident liquids from nonstrident (ordinary) liquids, as in Czech *řada* 'row' vs. *rada* 'council'. However, since these two sounds are also distinguished by the feature obstruent / sonorant (SPE, 302), the strident liquids can just as well be treated as a type of fricative.

Autosegmental phonology also rejected use B, distinguishing affricates from nonaffricates by the use of contour segments (Clements & Keyser 1983), contour features (Sagey 1990), or simultaneous specifications for [stop] and [continuant] (Lombardi 1990). However, the more recent literature has rallied once again around the use of [strident], resurrecting use B which is now widely accepted (see references above).

A further issue is whether [strident] should also characterize noncoronal sounds. Both PSA and SPE used it to distinguish "noisy" from "mellow" fricatives at labial and dorsal places of articulation as well: labial, where it distinguishes strident [f v] from nonstrident [ɸ β], and dorsal, where it distinguishes strident (uvular) [χ ʁ] from nonstrident (velar) [x ɣ]. However, as little evidence has been found for recognizing a natural class of strident sounds at all these places of articulation, including such diverse sounds as [f s ʃ χ], the almost universally accepted view at present is that [+strident] is restricted to coronal sounds (i.e. sibilants), for which reason it is sometimes also called [+sibilant]. One exception is Halle (1995, 6), who states: "The feature [strident] serves to distinguish bilabial from labiodental continuants in Ewe ... It is not clear whether [strident] can also be distinctive for Dorsal obstruents...". However, even if it were used to distinguish labial fricatives, [strident] cannot distinguish labiodental from bilabial

approximants in African languages such as Kresh, Gbeya, and Mbum, in which bilabial /w/ contrasts with a labiodental flap. Apparently, then, some other feature is required to distinguish bilabial from labiodental sounds. See Nartey (1982) for acoustic arguments against the extension of [+strident} to labials, and Blumstein (1991), Utman & Blumstein (1994) for discussion of the acoustics of [+strident] in labials and coronals.

4. Phonetic definition

Historically, [+strident] as a Jakobsonian feature has tended to be defined in acoustic terms. This is true even in SPE, where we read:

> Strident sounds are marked acoustically by greater noisiness than their nonstrident counterparts. When the airstream passes over a surface, a certain amount of turbulence will be generated depending on the nature of the surface, the rate of flow, and the angle of incidence. A rougher surface, a faster rate of flow, and an angle of incidence closer to ninety degrees will all contribute to greater stridency. (p. 329)

(A similar definition is given by Halle 1992). These accounts remain close to the ordinary-language meaning of "strident", which one dictionary defines as "loud, harsh, grating, or shrill" (*AHCD*, 3rd ed.). They do not suggest a quantal boundary between strident and nonstrident sounds, since "greater noisiness" is a matter of degree.

The current definition of [strident] is based on Stevens (1983, 249-251; 1985, 244-6; 1998, 249), who gives the most complete account. We paraphrase his definition as follows:

> *articulatory*: [+strident] consonants are produced by directing a rapid airstream against an obstacle placed downstream from the constriction. In [-strident] sounds, the airstream is directed in such a way as to avoid impinging on an obstacle.
>
> *acoustic*: In [+strident] sounds, the amplitude of the noise in high-frequency regions exceeds the spectral amplitude of an adjacent vowel in the same frequency region. Thus as we proceed from a strident consonant to a vowel, there is a fall in the amplitude of the spectrum at high frequencies. In [-strident] sounds we have the reverse relationship: thus, as we proceed from a nonstrident consonant to a vowel there is a rise in high-frequency amplitude. (See Stevens 1983, Fig. 11-2)
>
> *perception*: Perceptual experiments show that anterior coronal fricative consonants are heard as [+strident] if the high-frequency amplitude falls into the following vowel, and as [-strident] if the high-frequency energy rises. (See Stevens 1985, Fig. 16.1)

Stevens points out that from the point of view of auditory psychophysics and physiology, a rise in amplitude gives a response that is qualitatively different from a fall in amplitude. Furthermore, from the point of view of physics, noise generated by an airstream impinging on an obstacle is qualitatively different from noise that involves no obstacle. Thus this definition appears to establish a categorical distinction between strident and nonstrident sounds.

It will be noted that this rather broad definition is potentially applicable not only to coronal sounds (sibilants) but also to noncoronal sounds. If [strident] is only contrastive in coronals, this fact does not follow from the phonetic definition itself and must be stated separately.

A technical problem comes from the fact that in some spectra of the English nonstrident fricative /θ/ (Stevens 1983, Fig. 11-2), the noise amplitude of the fricative is actually higher than the spectral amplitude of the vowel at high frequencies (around 4.5 KHz), contrary to the definition. However, the noise amplitude is still much lower than either that of /s/ or of the highest amplitudes of the vowel. This problem could be solved by building some minimal amplitude condition into the definition: strident sounds must after all be perceived as "noisy", implying high noise amplitude.

The above definition is an example of a *contextual* feature definition, in the sense of Clements & Ridouane (2006). That is, rather than referring to absolute values, it is based on a comparison with properties of neighboring sounds. In the case of [+strident] sounds, there will usually be a vowel somewhere in the context of the consonant to permit comparison. In English, strident /s/ and nonstrident /θ/ rarely contrast when they are not adjacent to vowels; an exception is *eights* [eits] vs. *eighth* [eitθ], where the contrast seems easily perceived even though the fricatives are not adjacent to the vowel. Presumably, the intervening /t/ does not impede comparison.

Enhancement

A main use of [+strident] as an enhancing feature is to enhance the feature [+continuant] in coronal fricatives, making them less like stops. The contrast /s t/, for example, appears to be auditorily more robust than the contrast /θ t/, and such contrasts are more widely found across languages (Clements, in press).

A second use is to enhance the feature [-anterior] in stops. This is supported by the crosslinguistic preference for contrasts like / t tʃ/ with [+strident] /tʃ/ over /t c/ with nonstrident /c/ (Clements, in press).

Another possible enhancing use of [+strident], which needs study, is to enhance the feature [spread glottis] in aspirated vs plain stop contrasts. In a number of languages, including Nepali, certain aspirates are realized with heavy but phonologically redundant affrication. Similarly, palatalized stops are sometimes realized with redundant strident affrication.

The negative value [-strident] is used to enhance [-continuant] in stop vs. fricative contrasts: thus /t s/ is a better contrast than /ts s/ (Stevens & Keyser 1989, 93).

Can [strident] itself be enhanced? Keyser & Stevens (2001) suggest that articulator-free features (roughly, "manner features") cannot be enhanced. Though they include [strident] among these features, a case can be made that [strident] is a [coronal] dependent (Clements 2001, 109-114), in which case it would not fall under this restriction. Keating (1991, 45) suggests that [+strident] is enhanced by the specific tongue blade and tongue body configurations that help achieve its acoustic target. Keyser & Stevens (2006) themselves later suggest thatat least the negative value [-strident] may be enhanced by tongue backing in English, where the tongue backing and consequent lowering of F2 in /θ ð/ help to distinguish these sounds from /f v/ on the one hand (Harris 1958), /t d/ and (in nasalizing contexts, Manuel 1995) /n/ on the other.

[+strident]: a quantal feature?

Clements & Ridouane (2006) suggest the following 4-point protocol for quantal feature definitions:

1. A quantal feature definition identifies an articulatory continuum associated with one or more acoustic discontinuities, and specifies the range within this continuum that corresponds to relatively stable regions in the related acoustic output. The range is the articulatory definition of the feature, and the associated output is the acoustic definition.
2. A quantal feature definition identifies the stable region in terms specific enough to distinguish it from other regions, yet general enough to apply to all articulations within this region, allowing for observed crosslinguistic variation.
3. It must effectively distinguish segments bearing this feature (e.g. /s/) from otherwise similar segments that do not (e.g. /θ/).
4. Finally, it must identify the classes of sounds in which the definition holds. This will usually be the class in which the feature is at least potentially distinctive

The proposed definition of [+strident] appears to satisfy the last three points quite well. It is not fully clear whether it also satisfies the first. That is, can we identify an articulatory continuum between /s/ and /θ/, or between /ts/ and /t/, that corresponds to two stable regions separated by an unstable region in the acoustic output? On the other hand, the perceptual experiments described in Stevens (1985) may provide good support for a quantal interpretation at the perceptual level.

Other questions

- Are both values of [strident] quantal?

  In Stevens' perceptual experiments, both values of [strident] are symmetrical: [+strident] corresponds to a drop in amplitude from the consonant to the vowel, and [-strident] corresponds to a rise. Acoustically, both values may correspond to stable articulatory regions, though this requires further study.

- Do the correlates of [strident] vary according to the class of sounds in question (for example, stops vs. continuants, voiceless vs voiced sounds, plain vs aspirated sounds)?

  This question also requires further study.

- To what degree do the acoustic correlates of [strident] vary according to the phonological context, style, speaker, or language? In what contexts, if any, do the defining features temd to disappear through the effect of weakening or overlap?

  This question also requires further study.

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