Ken Stevens and linguistic phonetics

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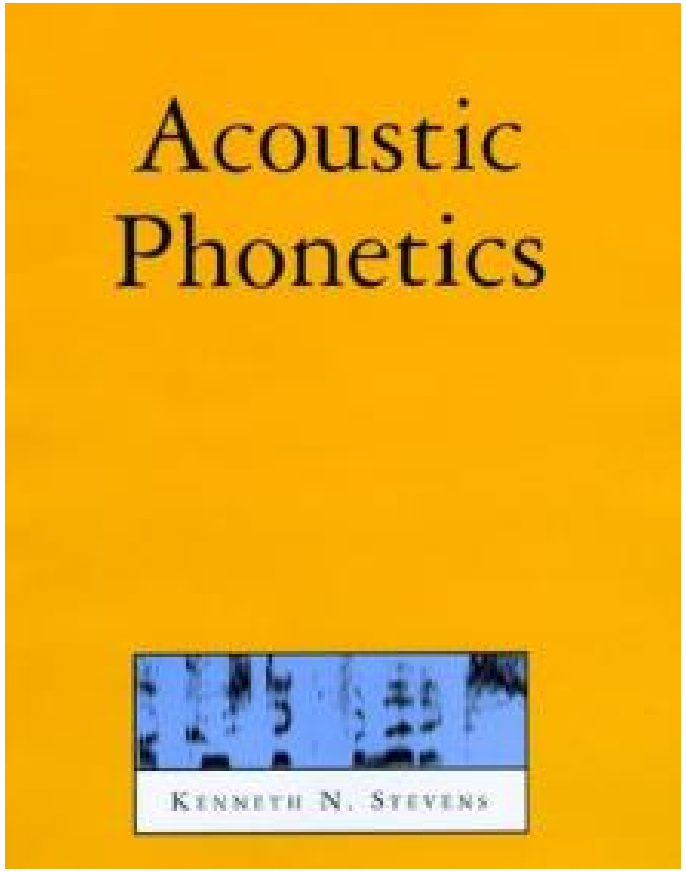
Acoustical Society of America -- May 20, 2015

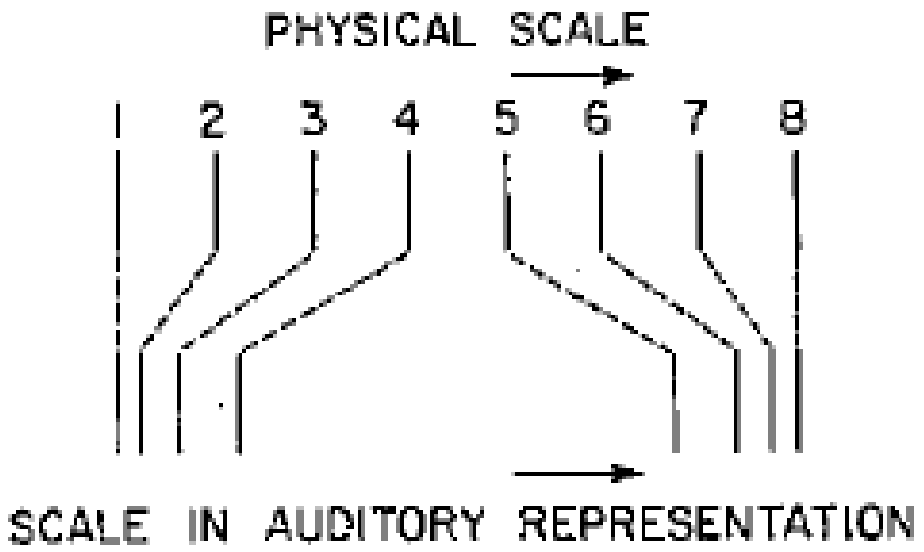
Celebration of Kenneth N. Stevens' Contributions to Speech Communication

1998 book



Quantal Nature of Speech (1972, 1989)

- Language-specific discrete categories already well-known in speech perception
- Extend this from experience-based effects to general auditory-processing non-linearities:
  - Extend even further, from acoustic-auditory relations to production-acoustic relations



(Stevens 1981)

Explaining phonemic typologies

- Quantal non-linearities --> feature values/categories
- Favored categories --> inventory constraints
- Beautifully worked out in 1989 paper in *Language* (the journal of the Linguistic Society of America) with Jay Keyser

PRIMARY FEATURES AND THEIR ENHANCEMENT IN CONSONANTS

KENNETH N. STEVENS AND SAMUEL JAY KEYSER
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Why are these 10 consonants so common across languages?

SEGMENT	IN MADDIESON
/m/	94
/k/	89
/j/	85
/p/	83
/n/	82
/s/	77
/t/	75
/w/	75
/l/	68
/h/	64

TABLE 1. List of the ten most frequently-occurring consonants in languages surveyed by Maddieson 1984.

Feature set:

VOCALIC	NONVOCALIC
high	sonorant
low	continuant
back	coronal
round	strident
nasal	consonantal
spread glottis	anterior
constricted glottis	lateral
	distributed
	voice

primary features for consonants

We argue that the consonant segments that are most prevalent in language are those that are distinguished from one another by the most salient features, i.e. by the primary features. The remaining, or secondary, features for the preferred segments are selected so as to enhance the strength with which the primary features are implemented, and thereby to maximize the perceptual contrast between the segments.

3 features, 8 consonant types:

	CONTINUANT	SONORANT	CORONAL	SEGMENT TYPE
(1)	+	+	+	J
(2)	+	+	−	W
(3)	+	−	+	S
(4)	+	−	−	F,H
(5)	−	+	+	N,L
(6)	−	+	−	M
(7)	−	−	+	T
(8)	−	−	−	P,K

TABLE 3. Three primary features and their combinations.

	CONTINUANT	SONORANT	CORONAL	ANTERIOR	SEGMENT TYPE
(4a)	+	−	−	+	F
(4b)	+	−	−	−	X,H
(8a)	−	−	−	+	P
(8b)	−	−	−	−	K,ʔ

TABLE 4. Combinations of primary features for which the feature [anterior] is salient.

Keyser & Stevens 1994: overall organization of features to define various classes

Phonology **11** (1994) 207–236

*Feature geometry and the vocal tract**

Samuel Jay Keyser
Kenneth N. Stevens
Massachusetts Institute of Technology

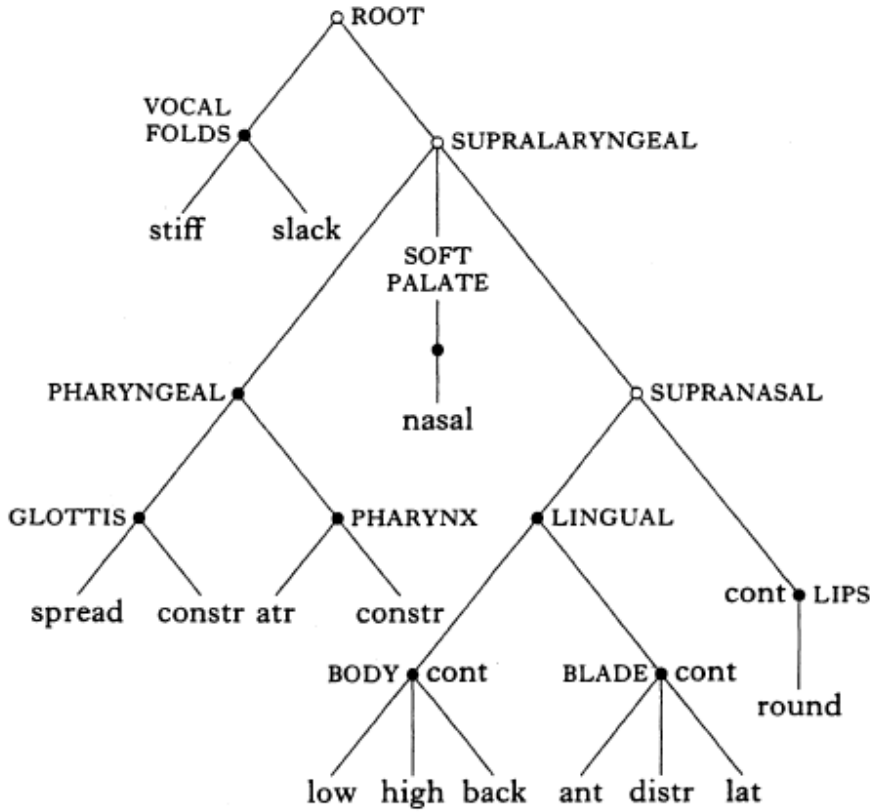
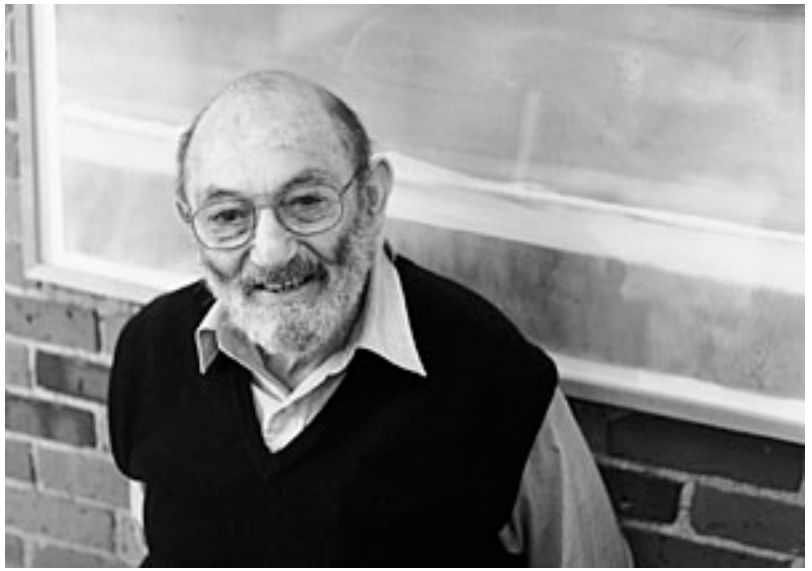


Figure 6
Tree of Fig. 5 with terminal features added. The feature [continuant] is added on nodes where this feature can be active. Nodes that can serve as dominant nodes are represented by open circles. Abbreviations are: constr = constricted; atr = advanced tongue root; ant = anterior; distr = distributed; lat = lateral; cont = continuant

Linguist collaborators:
Sheila Blumstein, Morris Halle, Jay Keyser



Phonetic correlates of distinctive features

- In work with Blumstein and Halle, Ken provided acoustic correlates of features for place of articulation, laryngeal, and nasalization contrasts.
- Original impetus from Jakobson, Fant & Halle (1951):
  - “a distinctive feature cannot be identified without recourse to its specific property”
  - “the invariance of the minimal distinctions can be separated from the redundant features that are conditioned by the adjacent phonemes in the sequence”

Early papers with Blumstein: 1978, 1979

perception:

Invariant cues for place of articulation in stop consonants

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(Received 1 February 1978; revised 18 July 1978)

production:

Acoustic invariance in speech production: Evidence from measurements of the spectral characteristics of stop consonants

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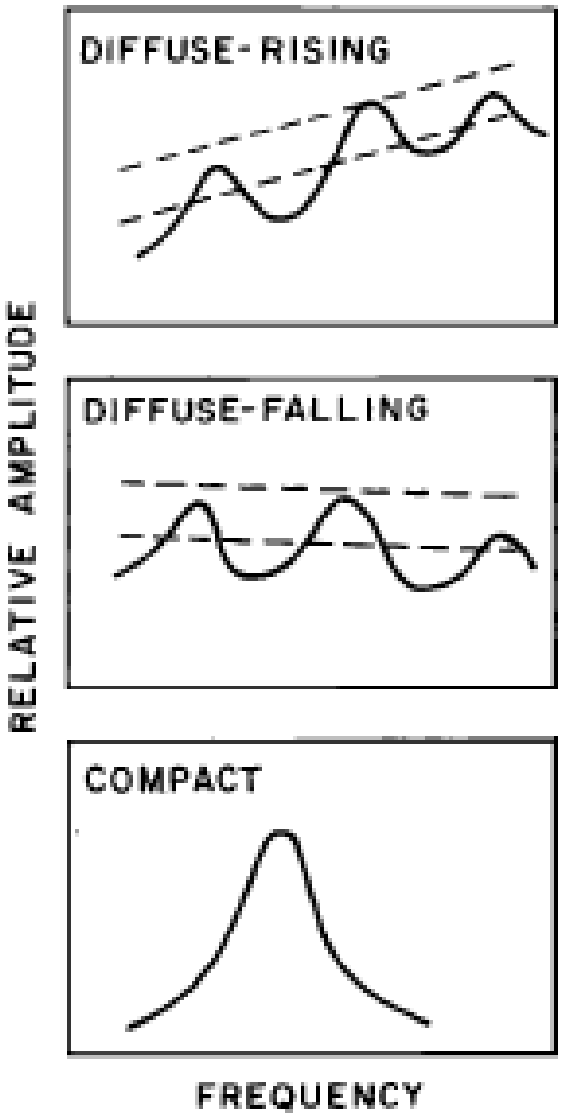
1978: “integrated acoustic properties”
1979: categories of release spectra

- “the auditory system samples the short-term spectrum at stimulus onset for a stop consonant”
- “the spectrum sampled at onset is more likely to provide a context-independent indication of the consonantal place of articulation than are the trajectories of the formants”



Stevens (1977), *Phonetica*:
"Physics of laryngeal behavior and larynx modes"

Two dimensions of vocal fold control that provide phonetic categories and features:

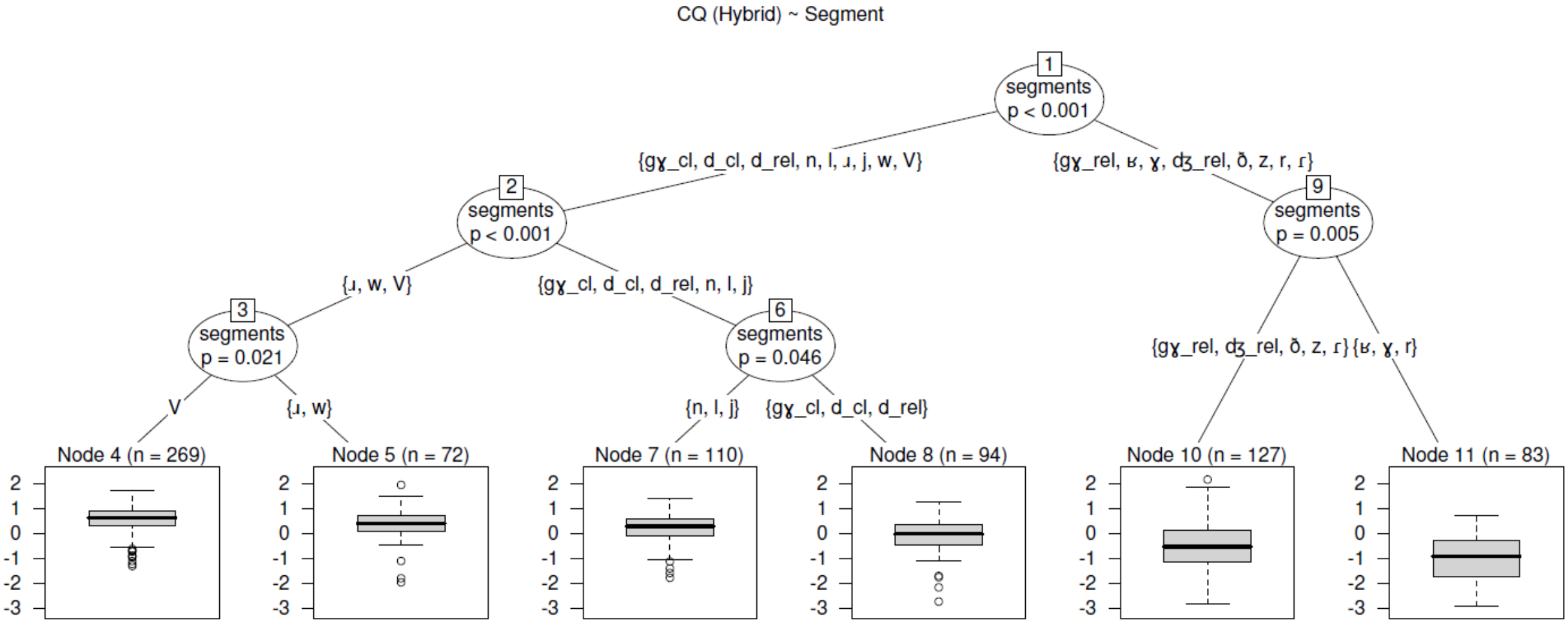
- spacing between the vocal folds (spread/constricted)
- stiffness and mass of each fold (stiff/slack)
    - stiffened vocal folds require a larger transglottal pressure drop for vibration and thus can help prevent voicing
    - slacker/thicker folds allow a smaller drop, so help promote voicing

E.g. for stop consonants

Table II. Phonetic categories associated with different ways of producing vocal-fold stiffness-slackness and with various types of abduction-adduction of the glottis for obstruent consonants. The examples given are the labial stop consonant categories

	Stiff vocal folds (raised larynx)	Slack vocal folds (lowered larynx)
Spread arytenoids	ph	bh
Neutral glottal position	p	b
Constricted glottis	p'	ɓ

Risdal et al. (in progress): Electroglottographic evidence for less-constricted glottis when voicing is difficult

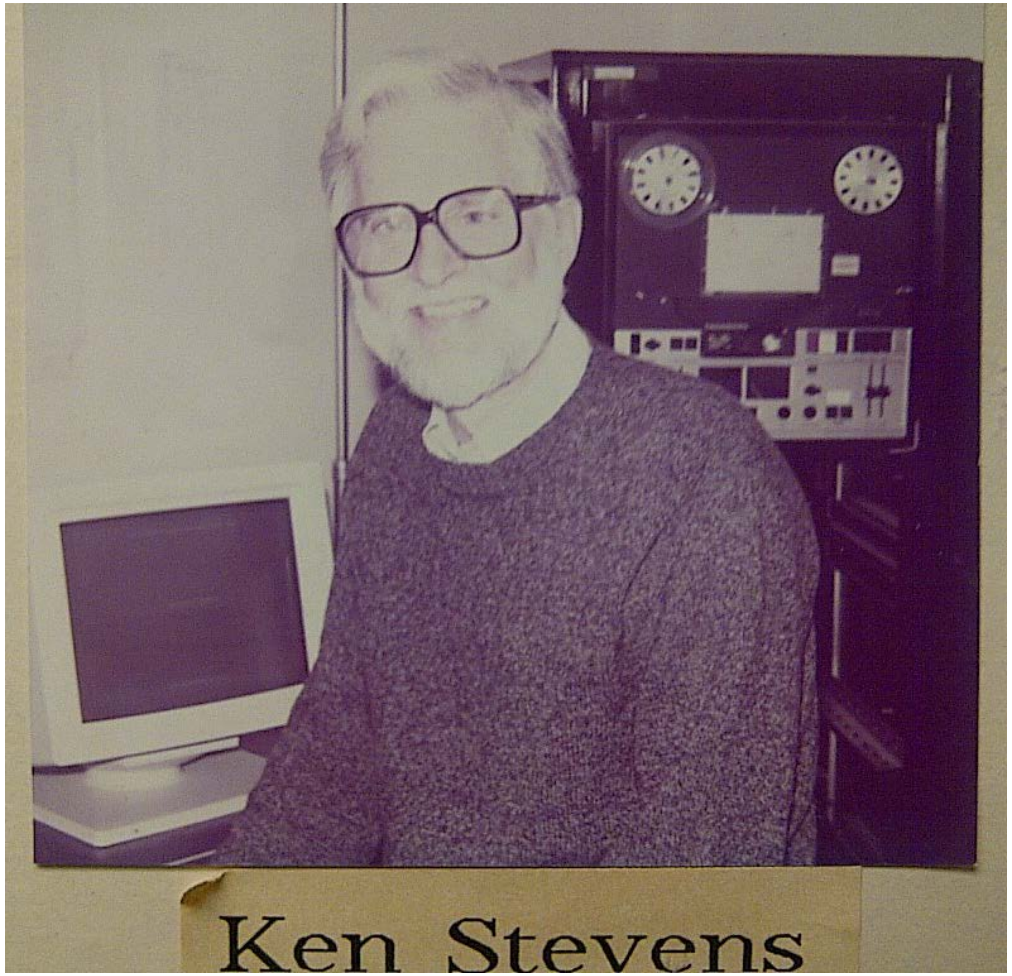


Conclusions

- Ken's Quantal Theory provided linguists with a basis for expecting discrete categories from physical continua
- Ken's sustained and creative work on acoustic correlates of phonetic features has informed not only feature theory, but also phonetic typology
- Ken's importance to linguistics, as an engineer interested in language sound systems and eager to work with phoneticians and phonologists, cannot be overestimated, and is a legacy continued by many of his students.

Thank you, Ken!

probably 1971, by John Ohala



at UCLA in 1988