

*When phonetics is not enough:*  
Syllable parsing and laryngeally-complex nuclei

Benjamin Macaulay

The Graduate Center, CUNY

---

PHONOLOGY FORUM 2016: CONFERENCE ON THE SYLLABLE

JANUARY 14, 2016

THE GRADUATE CENTER, CUNY

# Roadmap

---

1. Approaches to sonority
2. Laryngeally-complex nuclei
3. Preliminary data from Danish
4. Implications for models of sonority

# 1. Approaches to sonority

---

# Introduction

---

The sonority hierarchy has long been a source of controversy in phonology.

Inquiry into the nature of sonority and the quest to explain recurring sound patterns that appear to draw from the sonority hierarchy highlight the contrast between the theoretical assumptions of scholars in the field.

There are two main approaches to sonority and its status in the synchrony for the purposes of this talk:

1. Those that treat sonority as a primarily **phonological** phenomenon
2. Those that treat sonority as a primarily **phonetic** phenomenon

# Approaches

---

The sonority scale is traditionally evidenced by patterns such as the availability of segments as syllable nuclei, the well-formedness of clusters, asymmetries in syllabification, the output of phonological rules at syllable boundaries, stress systems etc. (Whitney 1865, Vennemann 1988...)

Approaches to sonority from a **phonetic** standpoint attempt to match the resulting hierarchy to quantifiable phonetic properties.

If a single phonetic correlate can be found for the full span of the hierarchy, then sonority need not be phonological in basis: listeners can access this phonetic correlate directly. The above sound patterns can emerge without reference to arbitrary phonological structure.

# Approaches

---

Many phonetic correlates for sonority have been proposed (Parker 2002:44-48 and citations within):

- acoustic (F1, formant/harmonic structure...),
- articulatory (jaw displacement, sustainability...)
- aerodynamic (unimpeded air flow, non-turbulence...)
- perceptual (perceptual robustness, salience, perceived loudness...)

One case to focus on: Parker 2002, found that the sonority hierarchy correlated with **intensity**, from experiments with English and Spanish speakers.

# Approaches

---

**Phonological** approaches to sonority are those that believe that phonological structure is necessary to explain the recurring sound patterns that have evidenced the sonority hierarchy.

Some scholars have proposed specific sonority values for phonological categories, which are to be referenced by algorithms that govern phonological rules and constraints (Vennemann 1988, Gómez et al. 2014).

- For example, “onset clusters must rise by X amount of sonority”, “there must be a difference of X sonority over the syllable boundary”...

# Approaches

---

Some take this logic further, and point to...

- the ability for speakers to generalize the sonority hierarchy to environments unattested in their native language (Berent et al. 2007)
- evidence of differences in processing rising vs. falling sonority onset clusters at birth (Gomez et al. 2014)

...as reason to believe that the sonority hierarchy is *innate*.



# Goal

---

This talk aims to investigate the nature of sonority as phonetic vs. phonological in a sonority-based pattern: syllable parsing.

The Sonority Sequencing Principle (SSP) demands that a syllable's nucleus be a sonority peak, and that clusters in the syllable margin rise in sonority in the direction of the nucleus.

- In phonetic models, the phonetic correlate peaks at the syllable nucleus and falls at syllable boundaries. Thus, syllable boundaries are predicted by minima of this correlate. Similarly, syllable shapes that fail to conform to this pattern are deemed ill-formed under phonological models.

This talk introduces a type of SSP violation, whereby there is a drop in sonority *within the nucleus*. This pattern is a problem both for models of sonority that are wholly phonetic or phonological in nature.

## 2. Laryngeally-complex nuclei

---

# Laryngeally-complex nuclei

---

Laryngeally-complex nuclei (LCN) are syllable nuclei that are 'interrupted' by what appears to be a laryngeal segment [ʔ h].

These nuclei are still considered to be single syllables by speakers.

[ʔ h] are generally considered to be of lower sonority than vowels.

- Phonetic correlates such as intensity (Parker 2002)
- Found in syllable margins, so of lower sonority in phonological models too.

Both phonetic/phonological models predict that LCN are to be parsed as disyllables  $V_1.HV_1$  (where H is a laryngeal segment)

LCN are found in a variety of languages...

# LCN in Oto-Manguean

---

Macaulay & Salmons 1995 describe CVʔCV forms in Chalcatongo Mixtec that often surface with a copy vowel [CV<sub>1</sub>ʔ<sup>V1</sup>CV]

- Copy vowel has same quality as preceding vowel
- Copy vowel is short in duration
- If glottal stop is a segment /ʔ/, it is the only licit coda, and only first of disyllable can have coda!

# LCN in Oto-Manguean

---

Copala Trique (Longacre 1952, Silverman 1997)

- Contrast between LCN and disyllable
- Disyllable undergoes final lengthening but not LCN
- LCN have the same tonal distribution as monosyllables
- LCN copy vowels but not second syll. of disyllable deleted under compounding rules
- Onset of LCN can be voiceless obstruent or fortis nasal, otherwise only found as onsets of final syllables

# LCN in Oto-Manguean

---

Coatzospan Mixtec (Gerfen & Baker 2005)

- Glottal element of LCN survives in whistle speech (like suprasegmentals)
- Production study: 49% of tokens had a drop of over 6dB at LCN glottal element
- Perception study: a dip of 4.1dB will be perceived as LCN 50% of the time

# LCN in Yuhup

---

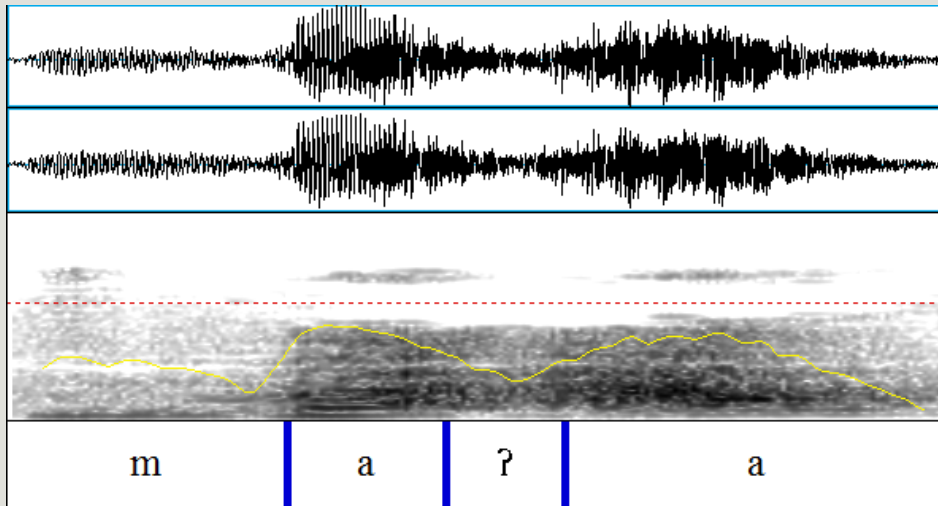
Yuhup (Lopes & Parker 1999; Nadahup, Brazil)

- Morphemes generally monosyllabic, all known exceptions are of the type  $CV_1HV_2C$ ,  $H = \{ʔ h\}$ ,  $V_1 = V_2$
- Counted as single syllables in language games (p.328)
- Duration of  $V_1 + V_2$  less than non-LCN nucleus

# LCN in Vietnamese

Vietnamese has a register complex system: each syllable is specified for one of six registers distinguished by tonal height, tone contour, phonation, duration...

*ngã* tone: high concave tone with interrupting glottal stop (Brunelle 2009), noticeable dip in intensity:



Spectrogram of *mã* 'code' with interrupting glottal stop. From *Learn Vietnamese with Annie*





# LCN in Danish

---

Danish has a phonetic category called *stød*

- Suprasegmentally-assigned, sensitive to morphology (Basbøll 1985)
- Presence (and attachment site?) contrast lexical items
- Can surface as glottal stop, creaky voice, nothing
- Can appear on any syllable that has either a long vowel or a vowel + sonorant (including non-fricated /ð/)
- Koefoed 1958 and *Det Danske Ordbog* (ordnet.dk) list minimal pairs of monosyllables that contrast in *stød* attachment site:
  - *mil* /mi<sup>?</sup>l/ 'mile' vs. *mild* /mil<sup>?</sup>/ 'mild'
  - *fugl* /fu<sup>?</sup>l/ 'bird' vs. *fuld* /ful<sup>?</sup>/ 'drunk'
- Speakers consider these monosyllables
- Noticeable dip in intensity during *stød*, often moreso than at syllable boundaries

# LCN in Danish

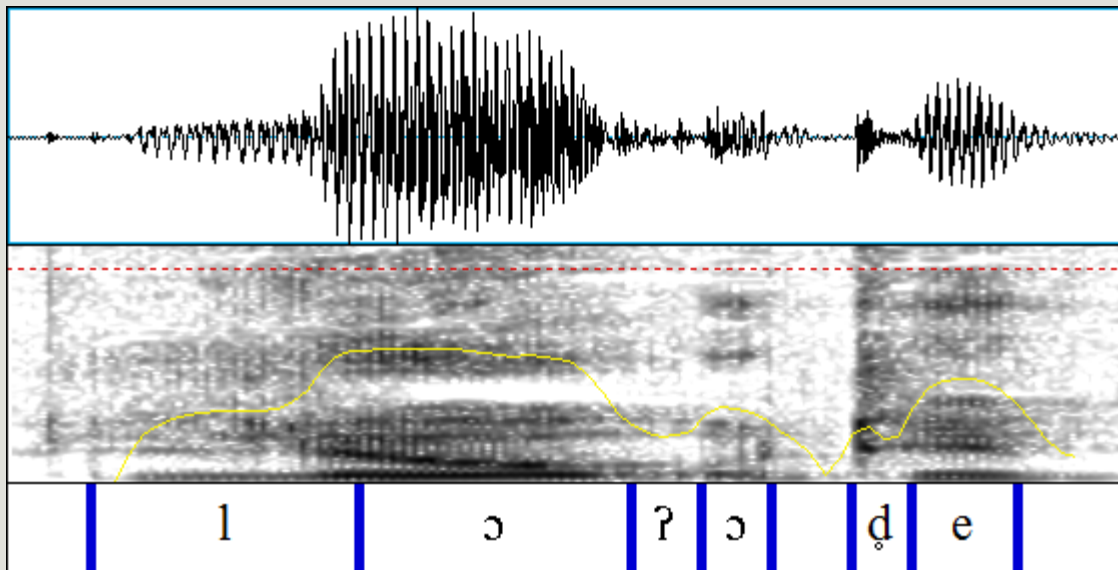
Ex.: Token of *lå det* /lɔ:ʔ de/ (“it lay...”) from running speech

Intensity: max. 78.1dB -> min. 59.78dB -> max. 65.72dB

1<sup>st</sup> vocoid

stød

2<sup>nd</sup> vocoid



# LCN in Danish

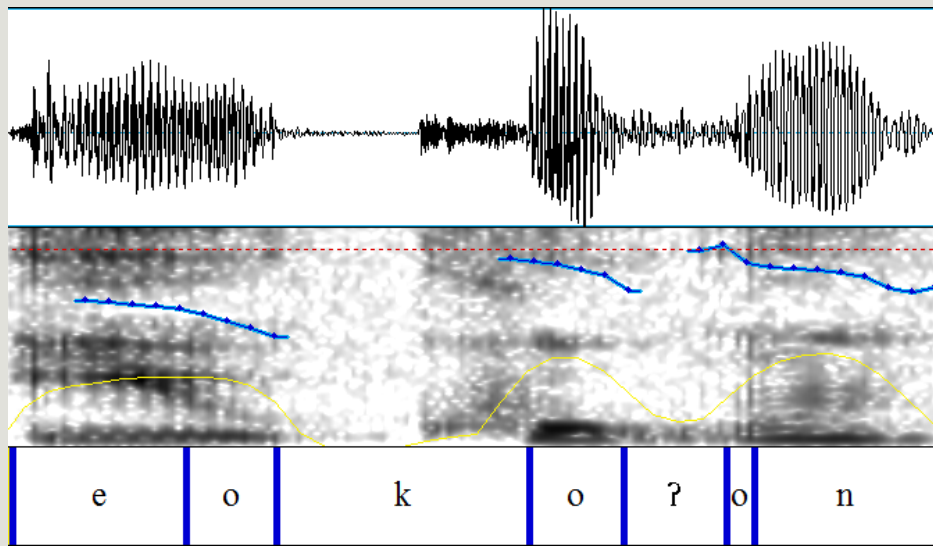
Ex.: Token of *-con* /koʔn/ in *cand.oecon* “Master of Economics” from running speech

Intensity: max. 69.42dB -> min. 55.61dB -> max. 70.70dB

1<sup>st</sup> vocoid

stød

2<sup>nd</sup> vocoid



## 3. Preliminary data from Danish

---

# Materials

---

Recordings of Danish speaker (n=1) reading aloud from newspaper articles.

- Female speaker from southern Jutland, speaking in Standard Danish (*rigsdansk*)
- No special instruction given

This talk describes data from one article:

- “Professoren satte ægteskabet på økonomiske formler”, *Politiken*, Dec. 28, 2015
- (=“The Professor Put Marriage through Economic Formulas”)
- 862 words

Recording 5min 34s

# Materials

---

## Professoren satte ægteskabet på økono\*miske for\*maler

Økonomi 28. decem\*ber 2015 KL. 21.44

Økonomi-professor Michael Svarer skrev\* en afhan\*dling, hvor ægteskabsmarkedet blev udsat for almindelige økono\*miske teori\*er.

OVERVISMAND. 44-å\*rige Michael Svarer er ny økono\*misk overvismand fra årsskiftet. Foto: Jan Dagø (arkiv)

Thomas Flensburg, Journalist

De færreste professorer i økonomi bliver kendt uden for en snæ\*ver kreds af fagfæ\*ller. Endnu færre bliver kendt i offentlige\*den i en ung al\*der, men Michael Svarer var dårligt fyldt 30 år, før han fik sig et navn som skilsmisseforskeren.

I sin ph.d.-afhan\*dling fra 2001 udsætter Michael Svarer »ægteskabsmarkedet« for økono\*miske teori\*er og statistiske form\*ler for at undersøge, om vi opfører os rationelt på markedet for pardan\*else. Det gør vi.

Singler søger mod by\*erne, hvor der så opstå\*r et stort udbud af potentie\*lle partnere. Når vi så har dannet par, har vi en tendens til at søge mod forstæderne, hvor fristelserne er færre. Michael Svarer kunne i en senere artikel påvise, at raten for skil\*smisses er størst blandt de par, som bliver boende midt i by\*ers fristelser.

Selv kommer Michael Svarer, 44, fra den bedre stillede de\*1 af Aarhus, hvor faderen var sparekassedirektør og moderen fuldmægtig. Han blev student fra Aarhus Katedralskole i 1990 og kunne syv år senere kalde sig cand.oeco\*n. fra Aarhus Universitet. Fra næste å\*r er han ny\* økono\*misk overvismand.

Michael Svarer lever på mange måder selv op til sine egne teori\*er om ægteskabsmarkedet. Han mødte sin senere ægtefælle på universitets kollegium.

»Vi er jævnaldrende, har samme uddannelsesmæssige og sociale baggrund«, siger Michael Svarer.

LÆ\*S OGSÅ Folkepensio\*nsal\*der bliver hævet til 68 år for folk under 53 år

De to flyttede fra kolle\*giet til en lejlighed i by\*en og fortsatte til forstæ\*derne, i takt med at bør\*nene kom til. De bor fortsat i Aarhus-forstaden Risskov, hvor der er gode tilbud til bør\*nene i form af skov, strand og skoler. Par\*ret har fået to piger og en dreng, men Michael Svarer oplevede sidste år den store sorg at miste sin ældste datter, som havde været handikappet fra fødslen....



# Materials

---

Of 862 words, 66 audible examples of *stød*

By environment:

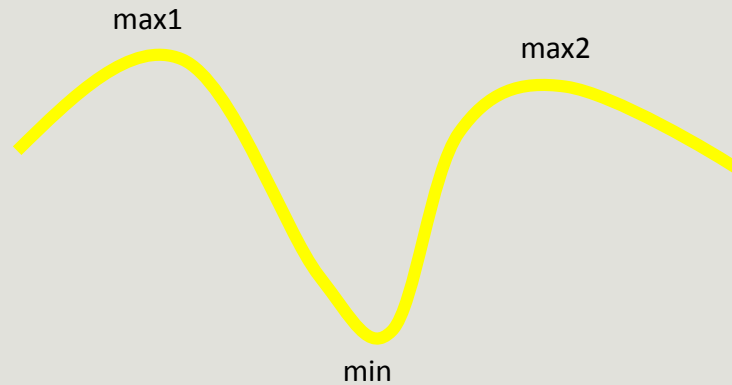
- 11 were unambiguously within monosyllables (✓)
- 50 were ambiguously at syllable boundaries
- 5 were ambiguously at word boundaries or adjacent to stops (✗)

Praat (Boesma & Weenik 2013) was used to track intensity maxima and minima.

# Data

---

Measured the intensity minimum of the *stød* and the maxima preceding and following

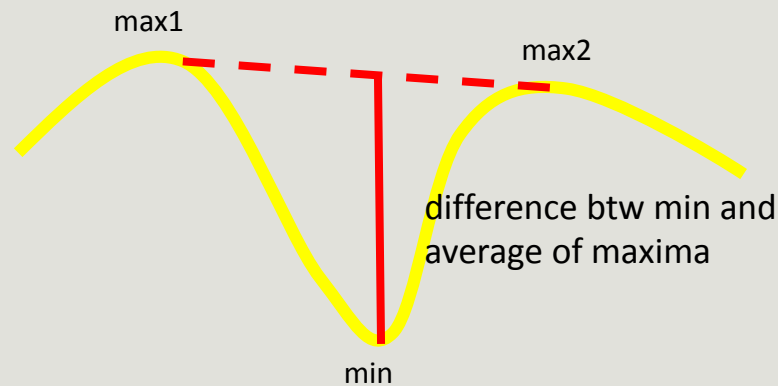




# Data

---

Measured the intensity minimum of the *stød* and the maxima preceding and following



From there, calculated the drop in intensity of the minimum from the mean of the two maxima

# Results

---

All 66 perceived *stød* had intensity minima. Drops ranged from 1.836 dB to 27.463 dB

Environment	Mean drop in intensity	
Unambiguously monosyllabic (n=11)	14.191 dB	$\sigma = 5.25$
Ambiguously at syll. boundary (n=50)	10.933 dB	$\sigma = 5.33$
Ambiguously at word boundary (n=5)	22.536 dB	$\sigma = 3.21$
Combined	12.327 dB	$\sigma = 6.04$

## 4 – Implications for models of sonority

---

# Implications

---

Both syllable boundaries and *stød* in Danish have noticeable dips in intensity.

However, as *stød* may occur within a syllable nucleus, drops in intensity due to *stød* are not parsed as syllable boundaries by Danish speakers, while others are.

# Implications

---

Given our assumptions:

1. The sonority of segments correlates with intensity (phonetic)
2. Well-formed syllables peak in sonority at the nucleus (phonological)

...any model whereby syllables represent sonority peaks is violated by LCN patterns like Danish *stød*.

How can *stød* fail to cause Danish speakers to perceive a syllable boundary?

# Analysis

---

How can *stød* fail to cause Danish speakers to perceive a syllable boundary?

Phonological facts about Danish:

## 1. Active phonology

- *Stød* can appear, disappear or move due to morphological rules
- *økonomi* 'economy' -> *økonono'misk* 'economic'
- *pæ'n* 'nice' -> *pæne* 'nice-pl'
- *hvid'* 'white' + *skægget* 'bearded' = *hvidskæ'gget* 'white-bearded'

## 2. Surface variation

- There were six tokens of *økonono'misk*, with drops of 2.93, 3.89, 6.74, 7.57, 9.16 and 12.50 dB.
- Some speakers do not use *stød*, and those who do can vary between tokens with glottal stops, creaky voice or nothing

# Analysis

---

Phonetically, Danish *stød* and other LCN are predicted to be parsed as disyllables.

However, Danish (and the other LCN languages) have *active phonology* that suggests that the domain of LCN are single syllables.

This suggests a compromise between phonetic and phonological approaches to sonority:

Patterns such as syllable parsing can be influenced by learned, language-specific phonology even if sonority is fully recoverable from the phonetic properties of speech sounds (and not innate phonological knowledge).

# References

---

- Basbøll, Hans (1985). "Stød in Modern Danish," in *Folia Linguistica*, Vol. 19, pp. 1-50.
- Berent, Iris, Donca Steriade, Tracy Lennertz and Vered Vaknin (2007). "What we know about what we have never heard: Evidence from perceptual illusions." *Cognition*, Vol. 104, pp. 591-630.
- Boersma, Paul and David Weenik (2013). *Praat: doing phonetics by computer*. Computer program. Version 5.3.51, retrieved 2 June 2013 from <http://www.praat.org/>
- Brunelle, Marc (2009). "Tone perception in Northern and Southern Vietnamese." *Journal of Phonetics*, Vol. 37, Issue 1 (Jan. 2009), pp. 79-96.
- Dell, François and Mohamed Elmedlaoui (1985). "Syllabic consonants and syllabification in Imdlawn Tashlhiyt Berber." In *Journal of African Languages and Linguistics*, Vol. 7, pp.105-130.
- Gerfen, Chip and Kirk Baker (2005). "The production and perception of laryngealized vowels in Coatzospan Mixtec," *Journal of Phonetics*, Vol. 33, pp. 311-334.
- Gómez, D.M., I. Berent, S. Benavides-Varela, R.A.H. Bion, L. Cattarossi, M. Nespor and J. Mehler (2014). "Language universals at birth." Proceedings of the National Academy of Sciences.
- Koefoed, Hans Anton (1958). *Teach Yourself Danish*. London: English Universities Press.
- Longacre, R. (1952). "Five phonemic pitch levels in Trique," *Acta Linguistica*, Vol. 7, pp. 62-82.
- Lopes, Aurise B. and Stephen G. Parker (1999). "Aspects of Yuhup Phonology." *International Journal of Linguistics*, Vol. 65, No. 3 (Jul. 1999), pp. 324-342.
- Macaulay, Monica and Joseph C. Salmons (1995). "The phonology of glottalization in Mixtec." *International Journal of American Linguistics*, Vol. 61, No. 1 (Jan. 1995), pp. 38-61.
- Nguyễn, Văn Lợi and Jerold A. Edmonson (1998). "Tones and voice quality in modern northern Vietnamese: Instrumental case studies." *Mon-Khmer Studies*, Vol. 28, No. 1, pp. 1-18.
- Parker, Stephen G. (2002). *Quantifying the Sonority Hierarchy*. Diss. Ph.D. U. Mass. Amherst.
- Silverman, Daniel (1997). "Laryngeal complexity in Otomanguean vowels," *Phonology*, Vol. 14, pp. 235-261.
- Vennemann, Theo (1988). *Preference laws for syllable structure and the explanation of sound change: With special reference to German, Germanic, Italian and Latin*. Berlin: Mouton de Gruyter.
- Whitney, William Dwight (1865). "The Relation of Consonant and Vowel," in *Oriental and Linguistic Studies*, New York: Scribner, Armstrong and Company, pp.277-300.



*Thank you!*

*Please ask questions!*

---