From aerodynamically constrained sound sequences to sound change:

Examples from English, Spanish and Italian

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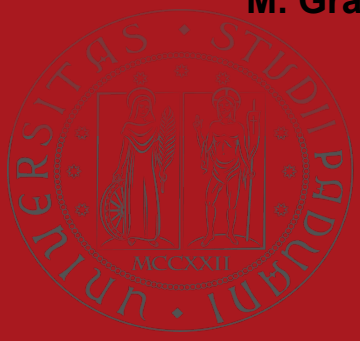

UNIVERSITÀ DEGLI STUDI DI PADOVA

Presentation based on:

- Variations in Pronunciation: A study of nasal + fricative sequences
  - Invited paper at: *Empirical Methods in Phonology*, Berkeley, 20-23 May 2004
  - Published as "Coarticulatory nasalization and phonological developments: data from Italian and English nasal-fricative sequences", in M.-J. Solé; P.S. Beddor, and M. Ohala (eds) (2007), *Experimental Approaches to Phonology, OXFORD: Oxford University Press, p.*155-174.

Outline

- Introduction
- Vowel Nasalization, Nasal C loss, Stop Epenthesis in Italian and English
  - Experiment
  - Results and Discussion

Sources of sound change

Two well-recognized components:

- Phonetic variation in the speech signal (due to coarticulation)
- Listener's perceptual mechanisms (processing of the variation)

What is not well understood….

- How is the perception of coarticulated speech influenced by language-specific coarticulatory patterns?

May explain different outcomes of the same sound sequence

About speech variation

- Essential component of speech
- Sources for speech variation
  - universal factors governing speech production and perception
- Use of empirical methods is important to address phonological questions and study speech variation

Aim of this presentation:

- Show how universal factors governing speech production and perception create:
  - the conditions for variation leading to sound change

  due to:
  - incompatibility of sound sequences

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Common sound changes involving VNC_F clusters

- Sequences involving VNC_F (where F = voiceless fricative) have given rise to sound changes in many languages across the world.
- The same changes are also found in Italian and English

Some examples from Italian and English

Vowel Nasalization and Nasal Loss

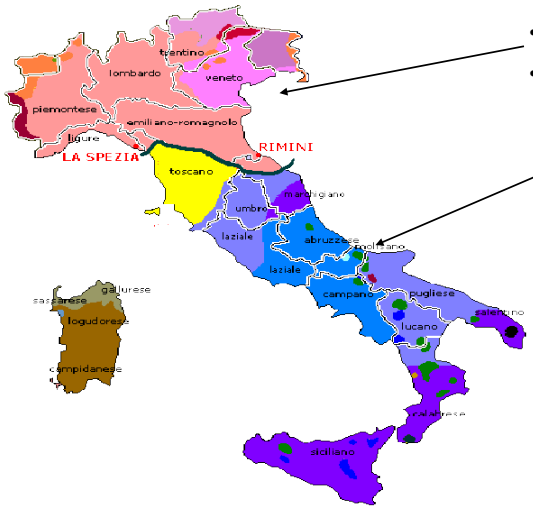
Lat. *dens, dentis* > French /dã/ 'tooth'
mens, mensis > Italian /mese/ 'month'

Germ. *Gans* English *goose*

Stop Epenthesis

Engl. *Thompson* > Thom + son
Bentson > Ben + son

The Italian language today



- Velar /n/ in NC sequences
- Nasalized vowel and no nasal C?

- /n/ assimilates to C in NC sequences
- fricative C is affricated after /n, r, l/

Orthog.	Pron.
penso	/'pentso/
borsa	/'bortsa/
salsa	/'saltsa/

Are Nasal Loss and Stop Epenthesis two outcomes of the same phenomenon?

- For their production, VNC_F sequences impose severe articulatory and aerodynamic constraints on the speech organs

→ create conditions for sound change

Production of VNC_F clusters

- Antangonistic articulatory and aerodynamic constraints in VNC_F
  - for N: Velum is open; Oral pressure is low; Nasal flow is high
  - for C_F: Velum must be sealed to allow the necessary pressure build-up for the C; Oral pressure must be high

→ opposite articulatory and areodynamic requirements bleed coarticulation

Questions

- How does the production of VNC_F sequences create the conditions for sound change?
- Why do we have different outcomes in different languages?

The present study

- Comparison of production strategies for VNC_F in:
  - Northern + Central Italian
  - American English (West Coast)

Hypothesis

- Different coarticulatory patterns of VNC_F will account for:
  - Vowel nasalization processes in Northern Italian
  - Stop epenthesis in Central Italian & Am. Eng.

Speech Material

Italian:

- 12 /nf, ns, nS/ words + 4 /nts/ words + 16 control
- Preceding V contexts: [i], [e], [a] ([o])
- Carrier sentence; 5 readings per speaker
- 3 Northern It. speakers; 2 Central It. Speakers

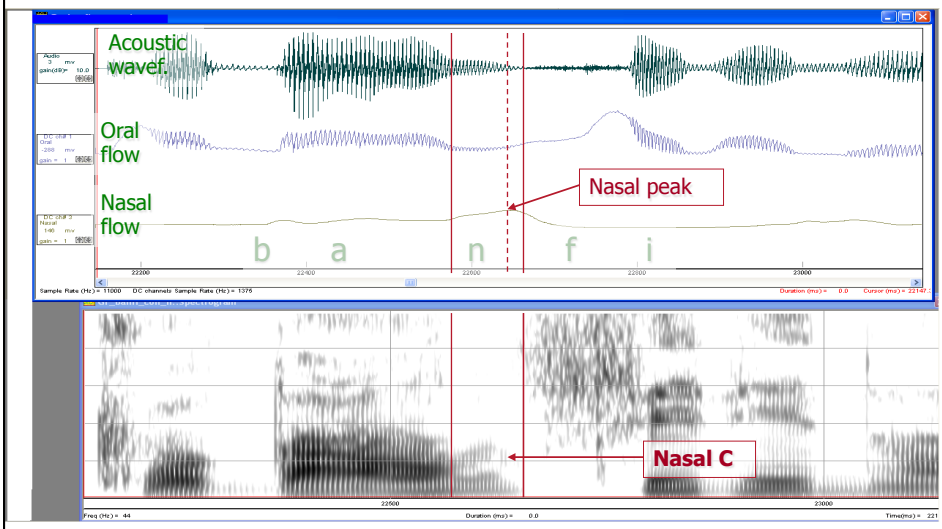
English:

- 14 /nf, ns, nS, nth/ words + 2 /nts/ words + 16 control
- Preceding V contexts: [ɪ], [ɛ], [æ],[A]
- Carrier sentence; 5 readings per speaker
- 3 Am. English speakers

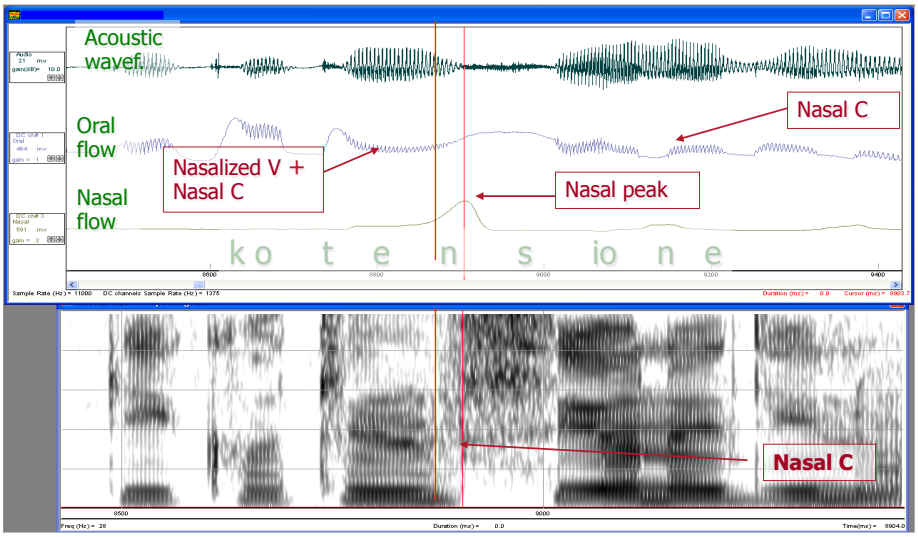
Data Analysis

- Nasal flow, oral flow, acoustic data
- Measures of:
  - acoustic duration of Vs and Cs
  - duration of nasal flow
- Configuration of oral and nasal flow

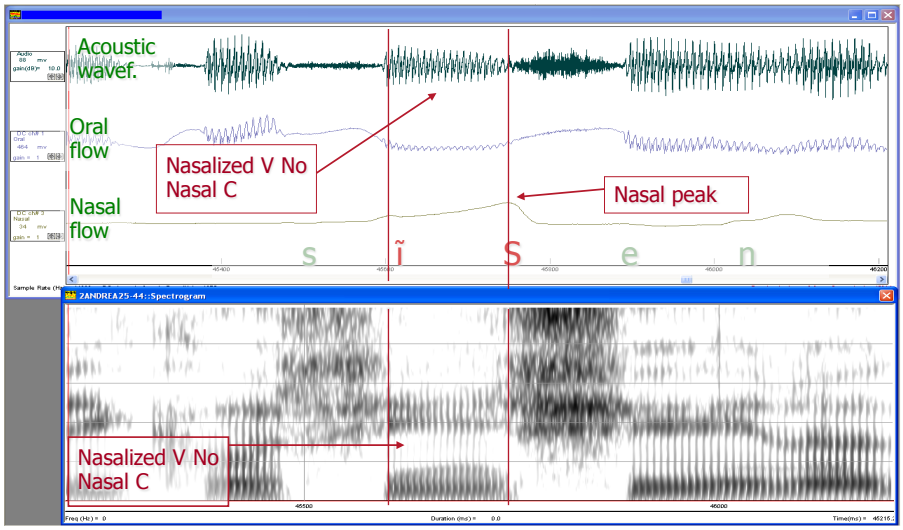
Variability in Northern Italian
1) Clear Nasal C before Fricative



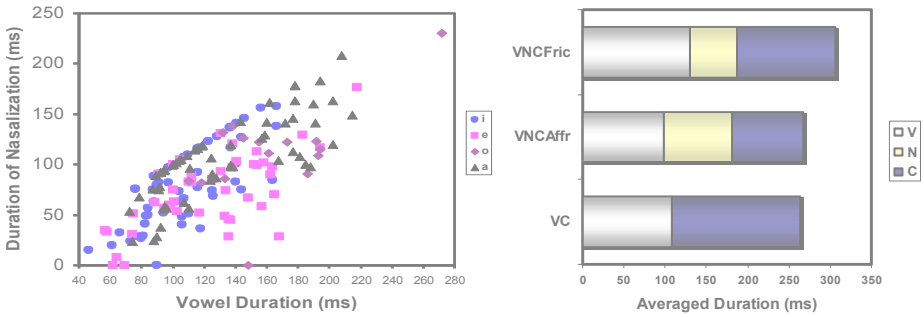
Variability in Northern Italian
2) Disruption of Nasal C by Fricative



Variability in Northern Italian
3) Nasalized V no Nasal C



N.I.: Analysis of duration of V, N, C

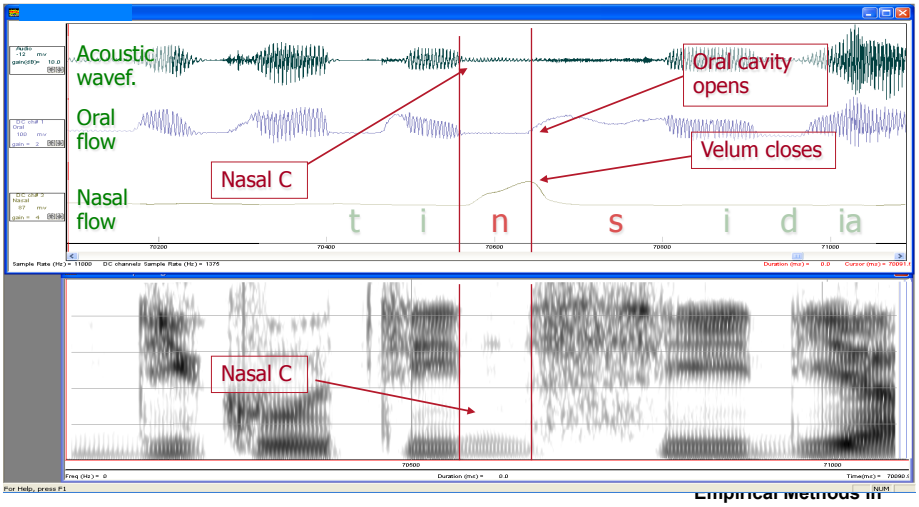


- Correlation between V duration and nasalization
- Longer Vs and shorter Ns in VNC_{fric} than in VNC_{affr} and control

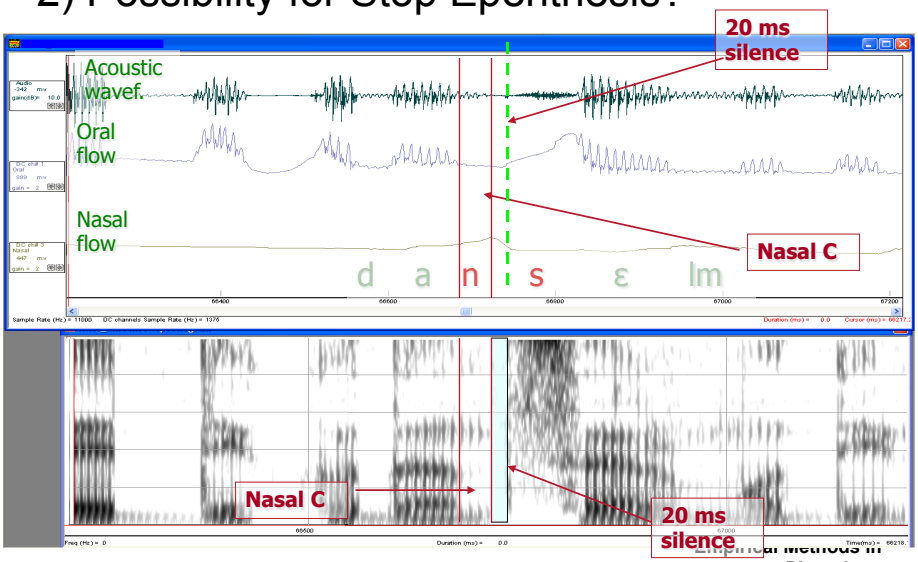
N. Italian: Analysis of configurations

- Clear nasal C in 31% cases
- Anticipation of velic closure leading to disruptive nasality in 62% cases
- No nasal C in 7% cases
  - i_S most favorable context

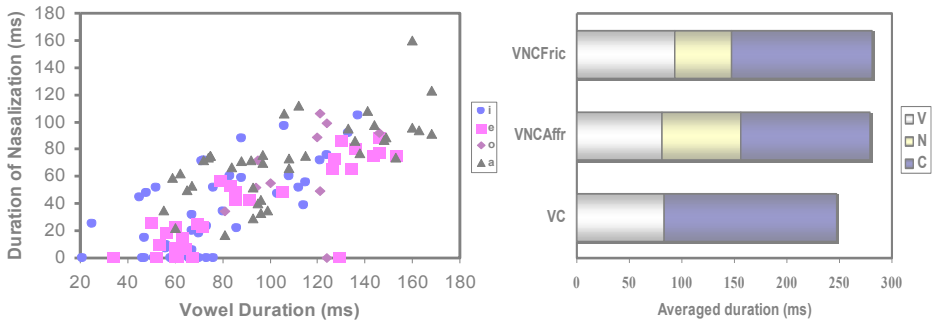
Variability in Central Italian
1) Clear Nasal C in _Fric context



Variability in Central Italian
2) Possibility for Stop Epenthesis?



C.I.: Analysis of duration of V, N, C



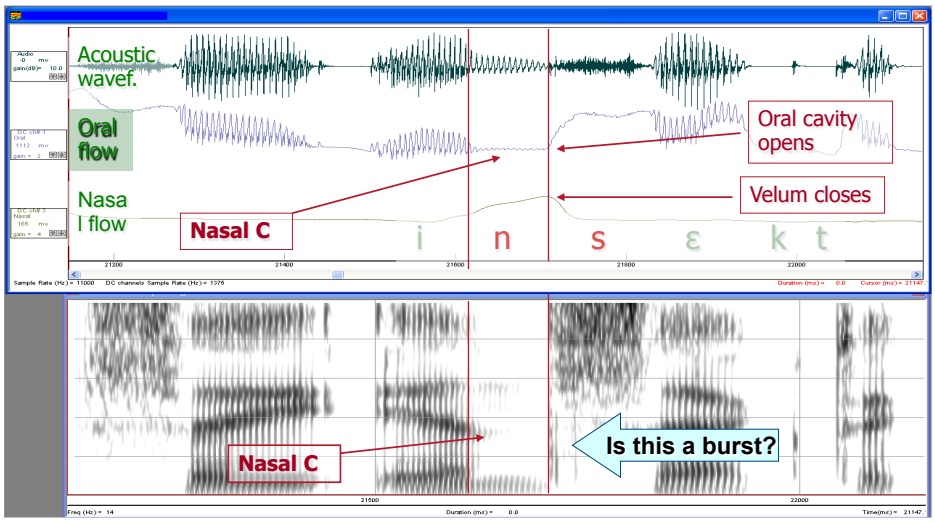
- Direct relation between V duration and nasalization
- Vs less nasalized than in N.I.
- Duration of Fricative in VNC_{fric} approaches duration of Affricate in VNC_{affr}

C. Italian: Analysis of configurations

- No anticipation of velic closure for F leading to disruptive nasality
- Delay in opening oral cavity with silent period before F in 17% cases (one spkr)
  - **Av. Dur.:** 18 ms
  - **Contexts: /_s** 12% **/_f** 5%
- Opening of oral cavity for frication more abrupt

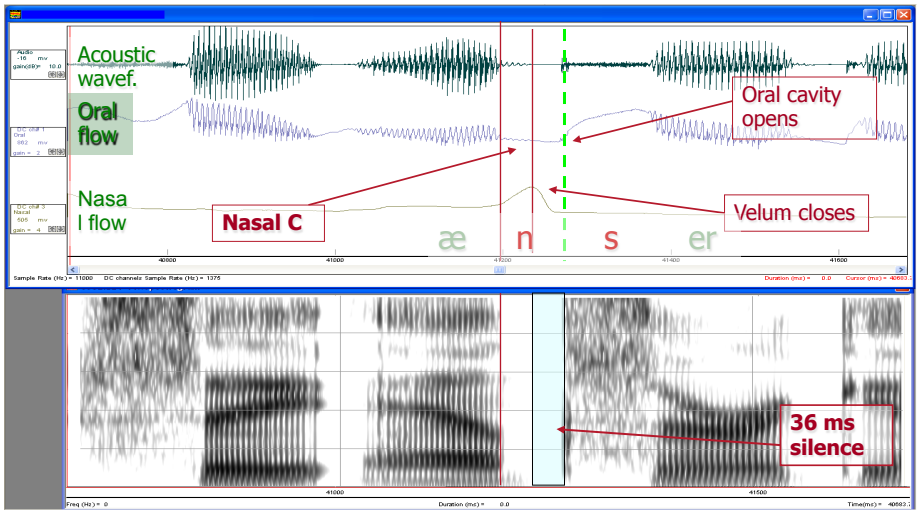
Variability in American English

1) Clear Nasal C in _Fric context

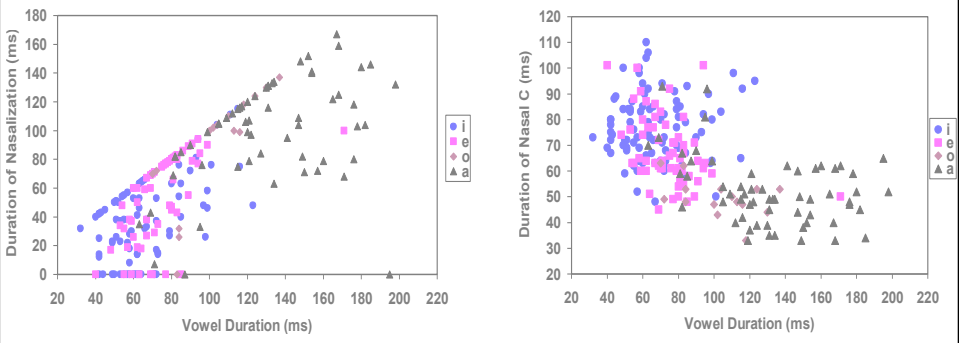


Variability in American English

2) Stop epenthesis



A.E.: Analysis of duration of V, N, C



- Direct relation between V duration and nasalization
- Tendency for shorter Vs to be followed by longer NC

Am. English: Analysis of configurations

- Silent period before the fricative in **43%**
  - **Av. Dur.: 29 ms**
  - Dur > 30 ms: **40%**
  - Favored contexts: **low Vs**
- Pattern of oral cavity opening similar to C.I. (fast rising of frication)

General Results: Italian

- Extensive vowel nasalization process in N.I.
  - Associated with longer nasalized Vs and shorter Frics
  - Some evidence of Nasal C loss in /i_S/ contexts
- Evidence of stop epenthesis in C.I.
  - /nts/ associated with:
    - Shorter duration of fricative
    - Abrupt rise of frication noise
  - /mpf/ pronunciation not found because it violates phonotactics of Italian

General Results: English

- Stop epenthesis is quite frequent in A.E.
  - Favored context: low vowels
  - Articulatory and areodynamic patterns similar to C.I.

Discussion

- Different outcomes of VNC_F Clusters in N.I., C.I. and A.E. due to use of different phonetic and phonological strategies.
  - In N.I.: anticipation of the velic closure required for the oral C in VNC_F
    - Disruption of the perception of the nasal C
    - Condition for perception of longer nasalized vowel
  - In C.I./A.E.: velic closure can be timed at (or slightly after the end of the N)
    - N is maintained
    - Closure after N is perceived as a stop

Preliminary conclusions

- Phonological system of the listener's language is important in processing phonetic variability (through perception)
- The data provide partial support to the claim that Northern and Southern Italian have different rhythms