Problems in the interpretation of the data related to nasality

Jacqueline Vaissière
Angélique Amelot
Problems in the interpretation of the data related to nasality

**Introduction**

difficulty of assembling the wealth of available data on nasality into a coherent whole, taking into account all of the seemingly divergent findings

**EMG, articulatory, aerodynamic, acoustic (and perceptual investigation)**
Problems in the interpretation of the data related to nasality

Sources?
Problems in the interpretation of the data related to nasality

Sources?

confronting data published in the literature (Beddor, Bell-Berti, Benguerel, Clumeck, Ohala, Vaissière, to cite a few), Ph. D. dissertations about nasality (Amelot, Cohn, Delvaux, Krakow, and Rossato)

A set of new data (ongoing research by students at our laboratory).

Available “old” data (X-ray micro-beam)
A) On some discrepancies that can be explained in part
   - A1) instrumentation-dependent results ???
Problems in the interpretation of the data related to nasality

A) On some discrepancies that can be explained in part
   - A1) instrumentation-dependent results

   More anticipation than carry-over
   More carry-over than anticipation
When two instrumentations comparison possible
EMG-based studies [9][6] therefore tend to conclude to a large anticipation, as do fiberscopic studies [1]. Aerodynamic data generally report more extensive carry-over than anticipatory [4][8].
Suppression LP durant le phonème qui précède une **consonne nasale** et un temps avant la pause.

1) **EMG** = more anticipation, for sure
Suppression of LP precedes velar movements, of course

Suppression LP durant le phonème qui précède une **consonne nasale** et un temps avant la pause

1) **EMG** = more anticipation, for sure
2) nasograph; opening of the VP much after lowering start
And movement precedes VP opening, easy to understand!

2) nasograph; opening of the VP much after lowering start
4) EMA less anticipation than fiberscope
Good correlation between fiberscope and EMA, for the same speaker

4) EMA less anticipation than fiberscope
In CVC, the velum is lower during V than C

So the intrinsic lower value of the velum during V is (mis) taken as anticipatory (Bell-Berti)

Still caution needed, due to lower position of velum for V (as compared to C)
Problems start with aerodynamics???

2) **fiberscopic and aerodynamic**: mvt much before airflow
• Going back to aerodynamics pb later …

• Acoustics is also a problem …

• later
Agreement: nasal airflow and acoustic nasalization

5) Aero and acoustics: agreement or not

C’est bon

Aerodynamics

Acoustics

Nasal airflow durant /b/

Presence of formants during /b/

Contextually nasalized /b/
Problems in the interpretation of the data related to nasality

A) On some discrepancies that can be explained in part
   - A1) instrumentation-dependent results
   - A2) acoustic cues to nasalisation, airflow, and microbeam
Remark: nasalisation cues easier on /i/ than /a/

But very difficult to work from acoustics only

Acoustically contextually nasalized /i/
Acoustic nasalisation not seen during fricative?
Agreement: nasal airflow and acoustic nasalization

[pãdãlfɛstival] « Pendant le festival »

aerodynamics

No nasal airflow durant / ã/

acoustics

No much cues to nasalisation

Aerodynamically and acoustically oralized nasal vowel
Agreement: nasal airflow and acoustic nasalization

No nasal airflow during /d/

Presence of formants during /d/

Aerodynamically and acoustically nasalized oral stop
Agreement: nasal airflow and acoustic nasalization

[A&dA&lfEstival] « Pendant le festival »

Nasal airflow / ã/

Aerodynamically and Acoustically nasalized nasal vowel

Reduction of energy in the region of the first formant for the second vowel
suppression of the activity of the levator palatini

descent of the velum

Perception difficult when aerodynamic data
But very difficult to work from acoustic only

Acoustically contextually nasalized /i/

And also from acoustics: depend on the window
no nasal airflow but acoustic nasalization

Aerodynamics

No anticipation of nasal airflow before N in coda

Acoustics

Cues to nasalisation

Agreement difficult to check

Acoustically nasalized oral vowel without nasal airflow
Size of the whole gesture in “tend” and “tent” similar
Beddor (longer in “tend”)
• unexplained

very different Vaissière

X-ray and acoustics
tongue microbeam
About the same tongue gesture
About the same tongue gesture

But different velar movement

Velum pellet

Microbeam

Tongue

English
About the same tongue gesture
But very different velum movement

Same timing of velar lowering a /l/ offset

Velum starts to rise again after /n/ onset in /lend/ 
but before in /lent/

More rapid velar lowering and tongue lowering in the case of lent versus lend
What to conclude? What do you mean by « nasalized »?

- Phonologically oral or nasal +-
- Contextually nasalized
  - Articulatory +-
    - Movement (fiberscope)
    - Opening (nasograph)
    - Location
  - Aerodynamically +-
  - Acoustically +-
  - Perceptually +-
  - Spontaneous
Problems in the interpretation of the data related to nasality

A) On some discrepancies that can be explained in part
- A1) instrumentation-dependent results
- A2) acoustic cues to nasalization and airflow
- A3) acoustics: distinction between nasal mora and voice decay time?? Not so clear
Difficult to separate acoustic nasal mora and voice decay time
Problems in the interpretation of the data related to nasality

A) On some discrepancies that can be explained in part

- A1) instrumentation-dependent results
- A2) acoustic cues to nasalization and airflow
- A3) acoustics: distinction nasal mora and voice decay time
- A4) aerodynamics: positive or negative airflow with VP close
Pumping effect
Pushing effect

the upward movement of the velum along the pharyngeal wall may create a positive nasal airflow, while the velopharyngeal port may be already closed.
What to conclude?

- Pumping effect: underestimation of anticipation
- Pushing effect: overestimation of carry-over
Problems in the interpretation of the data related to nasality

A) On some discrepancies that can be explained in part
   - A1) instrumentation-dependent results
   - A2) acoustic cues to nasalisation and airflow
   - A3) distinction nasal mora and voice decay time
   - A4) aerodynamics: positive or negative airflow with VP close
   - A5) nasal airflow and airflow resistance
The point of maximal airflow often appears in the next oral phoneme airflow resistance in the oral cavity (while the velum has almost achieved closing).
Point of maximum airflow and airflow resistance
The point of maximal airflow often appears in the next oral phoneme but not always.
Problems in the interpretation of the data related to nasality

A) On some discrepancies that can be explained in part
   - A1) instrumentation-dependent results
   - A2) acoustic cues to nasalisation and airflow
   - A3) distinction nasal mora and voice decay time
   - A4) positive or negative airflow with VP close
   - A5) nasal airflow and airflow resistance

B) Uncontrollable post-pausal raising, prepausal lowering and declination
A) On some discrepancies that can in part be explained

1) post-pausal raising
2) Pre-pausal lowering
3) declination
Speech ready gesture

Microbeam

Vaissière, 1986

Randomness not taken into account
Speech ready gesture

impredictable

fiberscope

Amelot, thesis
A) On some discrepancies that can in part be explained

1) post-pausal raising  
2) Pre-pausal lowering  
3) declination
Strasbourg, data

X-ray data
Strasbourg, data

X-ray data
May the opening (before /a/!!)
Jaw starts to rise
Closing gesture starts
At the vowel beginning!!!

/atu/

Strasbourg, data

X-ray data
Vocal tract already half closed (in the middle of the « acoustic » vowel !!!

Strasbourg, data
Protrusion of the lip starts

Strasbourg, data

X-ray data
Strasbourg, data

X-ray data
Strasbourg, data

Lip continue to round (in anticipation of /u/)

X-ray data
Lip continue to protrude

Strasbourg, data

X-ray data
X-ray data

Strasbourg, data
Lip continues to protrude, they are as protruded as for /u/

X-ray data

Strasbourg, data
Strasbourg, data

X-ray data
X-ray data

Strasbourg, data
X-ray data

Strasbourg, data

Deprotrusion starts
Velum lowers
X-ray data

Strasbourg, data
Strasbourg, data

X-ray data
Lips still very protruded Carry-over; velum low

X-ray data

Strasbourg, data
No-prepausal nasal airflow

Depend on the speaker
Almost none for the female speaker
Very variable for the male speaker
Depend on the speaker
Almost none for the female speaker
Very variable for the male speaker
The fiberscope image shows the sound wave pattern for the letters "o" with the following annotations:

- **Spectrogramme**
- **Signal Acoustique**
- **MVélaire**
- **DANasal**
- **DAOral**
- **F0**
- **Aerodynamics**

The text box states:

\[
\text{Depend on the speaker} \\
\text{Almost none for the female speaker} \\
\text{Very variable for the male speaker}
\]
Depend on the speaker
Almost none for the female speaker
Very variable for the male speaker

Randomness not taken into account
A) On some discrepancies that can in part be explained

1) post-pausal raising
2) Pre-pausal lowering
3) declination
Velar declination along the breath group

Repetition of « men ... men »

Microbeam

Bell-Labs Fujimura Tokyo

Velum pellet

Lip pellet

Tongue tip pellet
Depend on the speaker
Almost none for the female speaker
Very variable for the male speaker

Randomness not taken into account
What to conclude?

• Underestimation of anticipatory lowering
• Overestimation of carry-over
• account the position
• Of the phoneme relatively
to speech ready gesture
to the pause

• AVOID ANY PAUSE!
Problems in the interpretation of the data related to nasality

A) On some discrepancies that can be explained in part:
   - A1) instrumentation-dependent results
   - A2) acoustic cues to nasalisation and airflow
   - A3) distinction nasal mora and voice decay time
   - A4) positive or negative airflow with VP close
   - A5) nasal airflow and airflow resistance

B) Uncontrollable post-pausal raising, prepausal lowering and declination

C) Problem of corpus

-choice of vowels

Low vowels tend to have a lower velum, but have less nasal airflow, more coupling is necessary to perceive them as nasal.
Figure 16. Data on velum height for different vowels obtained with the VeloGraph. Adapted from Kuenzel (1977) with permission.
- Inter-speaker differences

- Different ranking

Rossato, ICP (French)
Fig. 3. Plots of average velar elevation, in arbitrary units as a function of time, for utterance pairs of contrasting vowel quality. Utterances having a medial oral/nasal consonant contrast are at the left; those having a medial nasal/oral consonant contrast are at the right.
Hypothesis?
/a/ as first nasal vowel? (tendency?)

- Stressed: PG+
- Back a: PG+
- Stressed back /a/ = PG++

= Nasal vowel: PG+ (Benguerel, French)

Combinaison of stress and back /a/?

Not enough EMG data (Honda?)
Problems in the interpretation of the data related to nasality

A) On some discrepancies that can be explained in part
   - A1) instrumentation-dependent results
   - A2) acoustic cues to nasalisation and airflow
   - A3) distinction nasal mora and voice decay time
   - A4) positive or negative airflow with VP close
   - A5) nasal airflow and airflow resistance

B) Uncontrollable post-pausal raising, prepausal lowering and declination

C) Problem of corpus
   - choice of vowels
   - onset versus coda consonant

Well-known (Krakow) but often ignored
Onset versus coda nasal

Repetition of « men ... men »

Microbeam
Velum pellet
Lip pellet
Tongue tip pellet
Also X-ray, X-ray microbeam system, IRM, French, Japanese, etc.

Differences in velar height and VP opening
Krakow, English

Onset versus coda: velotrace

Velotrace
Valid for oral consonants also

Time correspondence between the five $\epsilon$ stimuli and the velar height curve of Benguerel et al. (1976a).
Problems in the interpretation of the data related to nasality

A) On some discrepancies that can be explained in part
   - A1) instrumentation-dependent results
   - A2) acoustic cues to nasalisation and airflow
   - A3) distinction nasal mora and voice decay time
   - A4) positive or negative airflow with VP close
   - A5) nasal airflow and airflow resistance

B) Uncontrollable post-pausal raising, prepausal lowering and declination

C) Problem of corpus
   - choice of vowels
   - onset versus coda consonant

D) The language
   - Differences between dialects
Problems in the interpretation of the data related to nasality

A) On some discrepancies that can be explained in part
   - A1) instrumentation-dependent results
   - A2) acoustic cues to nasalisation and airflow
   - A3) distinction nasal mora and voice decay time
   - A4) positive or negative
   - A5) nasal airflow and airflow resistance

B) Uncontrollable post-pausal raising, prepausal lowering and declination

C) Problem of corpus
   - choice of vowels
   - onset versus coda consonant

D) The language

Differences between dialects

Delvaux
Problems in the interpretation of the data related to nasality

A) On some discrepancies that can be explained in part
   - A1) instrumentation-dependent results
   - A2) acoustic cues to nasalisation and airflow
   - A3) distinction nasal mora and voice decay time
   - A4) positive or negative airflow with VP close
   - A5) nasal airflow and airflow resistance

B) Uncontrollable post-pausal raising, prepausal lowering and declination

C) Problem of corpus
   - choice of vowels
   - onset versus coda consonant

D) The language

Differences between dialects
Differences between languages
• No nasal vowels

- Spanish:

- English:

• nasal vowels

- French:

- Portuguese:

Remark: phonological status of nasalisation in PB not so clear (Demolin, Wetzels)
Level of abstraction
• **No nasal vowels**

• **Spanish:** mechanistic anticipation
  
  Ohala, Malécot

• **English:** phonologized anticipation (Solé)

• **nasal vowels**

• **French:** reduced anticipation

• **Portuguese:** anticipation

(Cohn)
French: reduced anticipation as a model ???

Limits according to Cohn
No limits according to Delvaux

Aerodynamics
NAF- during nasal consonant

French

Bosniac

Brkan Altijana Comparaison de la nasalité contextuelle en bosniaque et en français, 2009
Problems in the interpretation of the data related to nasality

A) On some discrepancies that can be explained in part
   - A1) instrumentation-dependent results
   - A2) acoustic cues to nasalisation and airflow
   - A3) distinction nasal mora and voice decay time
   - A4) positive or negative airflow with VP close
   - A5) nasal airflow and airflow resistance

B) Uncontrollable post-pausal raising, prepausal lowering and declination

C) Problem of corpus
   - choice of vowels
   - onset versus coda consonant

D) The language
   - Differences between dialects
   - Differences between languages
   - Alternative explanations
Less coarticulatory nasalisation if nasal counterparts or higher vowels
Problems in the interpretation of the data related to nasality

A) On some discrepancies that can be explained in part
   - A1) instrumentation-dependent results
   - A2) acoustic cues to nasalisation and airflow
   - A3) distinction nasal mora and voice decay time
   - A4) positive or negative airflow with VP close
   - A5) nasal airflow and airflow resistance

B) Uncontrollable post-pausal raising, prepausal lowering and declination

C) Problem of corpus
   - choice of vowels
   - onset versus coda consonant

D) The language

E) The style

Basset et al: no clear tendency in one way or another

More spontaneous speech needed
More than expected

Nasalized /k/

Nasalized /v/

Less than expected

No anticipation

Basset & al, 2001
Problems in the interpretation of the data related to nasality

A) On some discrepancies that can be explained in part
   - A1) instrumentation-dependent results
   - A2) acoustic cues to nasalisation and airflow
   - A3) distinction nasal mora and voice decay time
   - A4) positive or negative airflow with VP close
   - A5) nasal airflow and airflow resistance

B) Uncontrollable post-pausal raising, prepausal lowering and declination

C) Problem of corpus
   - choice of vowels
   - onset versus coda consonant

D) The language

E) The style

F) Speaker effort
What to do?

• Head mounted microphone always used at LPP
Problems in the interpretation of the data related to nasality

A) On some discrepancies that can be explained in part
   - A1) instrumentation-dependent results
   - A2) acoustic cues to nasalisation and airflow
   - A3) distinction nasal mora and voice decay time
   - A4) positive or negative airflow with VP close
   - A5) nasal airflow and airflow resistance

B) Uncontrollable post-pausal raising, prepausal lowering and declination

C) Problem of corpus
   - choice of vowels
   - onset versus coda consonant

D) The language
E) The style
F) Speaker effort
G) Random variations?
[dakɔʁ] « D’accord »

« alors »

Spontaneous

naso airflow

spectrogram
Problems in the interpretation of the data related to nasality

A) On some discrepancies that can be explained in part
   - A1) instrumentation-dependent results
   - A2) acoustic cues to nasalisation and airflow
   - A3) distinction nasal mora and voice decay time
   - A4) positive or negative airflow with VP close
   - A5) nasal airflow and airflow resistance

B) Uncontrollable post-pausal raising, prepausal lowering and declination

C) Problem of corpus
   - choice of vowels
   - onset versus coda consonant

D) The language

E) The style

F) Speaker effort

G) Random variations?

H) Errors

No, the « formants » of the oral cavity cannot be measured in nasalized portions of speech !!! (no, F2 is not a direct indication of tongue back-front position)
Tongue did not move!
Problems in the interpretation of the data related to nasality
• Specify at which level nasalisation has been observed
  – Suppression of LP activity, EMG
    • Not the whole story, Honda, Henderson, PG+
  – Mvt (fiberscope)
    • asymetry
  – Nasograph:
    • when open, how much, when most
  – Microbeam, X-ray
    • Lip, tongue, etc.
  – Aerodynamics
    • But airflow resistance, vocal effort
  – Perception
    Size of the windows
• Specify at which level nasalisation has been observed

• Avoid any pause (difficult)
  – Even when frame
  – #imi#
  – Very variable
  – Less nasalisation visible in first phoneme
  – More nasalisation in the last

  – The final pause acts as a nasal segment in #imi# but not in #ibi#
• Specify at which level nasalisation has been observed
• Avoid any pause (difficult)
• Stress, position in the breath group, relatively to pause, syllable structure
  – As well known
  – But not always taken into account
• Specify at which level nasalisation has been observed
• Avoid any pause (difficult)
• Stress, position in the breath group, relatively to pause, syllable structure play a role
• Intensity
  – Head mounted microphone
• Specify at which level nasalisation has been observed
• Avoid any pause (difficult)
• Stress, position in the breath group, relatively to pause, syllable structure play a role
• Intensity
• Perception very important (not always possible)
  – Aerodynamic data
  – A lot of tubes in the nose
  – need standards
• Specify at which level nasalisation has been observed
• Avoid any pause (difficult)
• Stress, position in the breath group, relatively to pause, syllable structure play a role
• Intensity
• Perception very important (not always possible)
• Multisensor approach useful
  – LPP: invasive and not invasive combined
  – Helps description a lot
  – Plateform June 24th
• Specify at which level nasalisation has been observed
• Avoid any pause (difficult)
• Stress, position in the breath group, relatively to pause, syllable structure play a role
• Intensity
• Perception very important (not always possible)
• Multisensor approach useful

• Need to establish standards at all level
  – how to measure? normalisation
  – what to measure?
  – Share data (after publication) to construct data base (normal and pathological)
Merci de votre attention !