Issues in unifying nasal vowel markedness
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Outline

1. Introduction
2. Issues in vowel quality
3. Issues in nasality quantification
4. Sketching an analysis
5. Conclusion
Phonetically, vowels that are nasalized are more difficult to produce than those that are not nasalized. This is due to the fact that the nasal consonant creates a greater friction, which affects the production of the vowel. The process of nasalization can also affect the quality of the vowel, making it sound more nasalized. This can be observed in languages like French, where the nasalized vowel /ɛ̃/ is used to distinguish between masculine and feminine forms of a word. For example, the word 'fine' can be pronounced as /fiː/ (masc.) or /fin/ (fem.).

The phonetic motivation for this is that nasalized vowels are harder to produce, which makes them more marked. This is supported by the fact that high vowels are more difficult to nasalize than low vowels. Therefore, the use of nasalization to distinguish between masculine and feminine forms of a word is a more efficient way to communicate the gender of a noun, as it is less effortful for the speaker to produce.

[Note: This explanation has been discredited by linguists.]
Introduction

Phonetic grounding not problematic *per se*, but runs the risk of:

- Losing motivation upon further inspection/more sophisticated methodology
- Reduplicating information in the grammar—or at worst, lacking unified principle

Establishment of markedness hierarchies requires much more (and more phonological) evidence, but exceedingly difficult when data seem convoluted

High level of idiosyncrasy in nasal vowel behavior (even just on surface)
Recent issues (phonetics)

- Recent instrumental/experimental findings cast even further doubt:
  - **Imaging**: Significant mismatch among transcribed vowel, acoustic output, and (re)configuration of oral articulators (esp. tongue).
    → How do we define the output vowel’s quality? Input?
  - **Nasal quantification**: Global scores of nasality may require different thresholds for vowels of different heights, and high percentages of nasalization may not always be indicative of a *phonological* process.
    → How do we define the surface vowel’s nasality?

- Attempts to establish a unified phonological theory of nasal vowels must first address these phonetic discrepancies (esp. within a modular approach)
Objectives & outline

- Problematize nasal vowels in phonology (in light of some phonetics-based issues):
  1. Recovering underlying representations from conflicting surface evidence
  2. Distinguishing oral from nasal vowels when nasal coupling is incomplete

- Sketch a preliminary solution as an example of a possible response & evaluate predictions made by its implementation in a stringent framework
Introduction

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Immense body of literature on acoustic effects of nasality: cf. Sh osted et al. 2011 for summary, Baken & Orlikof 2000 for exhaustive list.

Extra resonator introduces additional nasal poles and zeroes which interact with oral vowel structure.

Centralization effect: low vowel F1 lowered (raising perceived), high vowel F1 raised (lowering perceived).

Unclear global F2 effects, but F2 lowering may increase perception of nasality (Delvaux 2009).

Oral articulators can be (and are) reconfigured to shift the acoustic output.
3–way mismatch among: articulatory configuration, acoustic output, and traditional transcription

(1) Transcription of French nasal vowels (minor diacritics removed)

<table>
<thead>
<tr>
<th>Example</th>
<th>Traditional</th>
<th>Acoustic (Carignan 2014)</th>
<th>Articulatory (Delvaux 2012)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>paon</em> ‘peacock’</td>
<td>[ã]</td>
<td>[œ]</td>
<td>[œ]</td>
</tr>
<tr>
<td><em>pain</em> ‘bread’</td>
<td>[ẽ]</td>
<td>[œ]</td>
<td>[œ]</td>
</tr>
<tr>
<td><em>pont</em> ‘bridge’</td>
<td>[õ]</td>
<td>—</td>
<td>[œ]</td>
</tr>
<tr>
<td><em>brun</em> ‘brown’</td>
<td>[œ]</td>
<td>—</td>
<td>[œ]</td>
</tr>
</tbody>
</table>
**Fleshing out French phonology...**

(2) Nasal vowel surface patterns & UR types in French

<table>
<thead>
<tr>
<th>Surface type</th>
<th>Proposed UR</th>
<th>Example (traditional IPA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[(\tilde{V})] (\sim) [V(n)]</td>
<td>/V(n/)</td>
<td>[katal(\tilde{a})] (\sim) [katalan] ‘Catalan (m., f.)’</td>
</tr>
<tr>
<td>[(\tilde{V})] (\sim) [(\tilde{V}C)]</td>
<td>/(\tilde{V}/)</td>
<td>[(\tilde{p}\tilde{e})] (\sim) [(\tilde{p}\tilde{t})] ‘painted (m., f.)’</td>
</tr>
<tr>
<td>[(\tilde{V})]</td>
<td>/(\tilde{V}/)</td>
<td>[m(\tilde{e})] ‘hand’</td>
</tr>
</tbody>
</table>

- NB: further evidence for such input types found in “disjointed” alternations; recall [f\(\tilde{e}\)] \(\sim\) [fin] ‘fine (m., f.)’.
- No (major) quality difference in quality between input types for identical surface vowels; only association of [+nasal] (e.g., /\(\varepsilon\)\(n\), \(\tilde{\varepsilon}/\))
Reanalysis?

(3) Scale and consequences of reanalysis (example: *pain*-type)

<table>
<thead>
<tr>
<th>Type</th>
<th>UR(s)</th>
<th>Phono. output</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>/ɛ̃n, ˜ɛ/</td>
<td>[˜ɛ]</td>
</tr>
<tr>
<td>b.</td>
<td>/ɛ̃n, ˜5/</td>
<td>[˜5]</td>
</tr>
<tr>
<td>c.</td>
<td>/ɛ̃n, ˜ɛ/</td>
<td>[˜ɛ]</td>
</tr>
<tr>
<td>d.</td>
<td>/ɛ̃n(?), ˜ɛ/</td>
<td>[˜ɛ]</td>
</tr>
</tbody>
</table>

- Traditional, “good faith” analysis (a.): alternations provide evidence for more abstract output. “Analogy” links non-alternating identical surface forms and articulatory & acoustic shifts are purely phonetic.
- Middle-of-the-road (b.): no reanalysis of input types, but lowering and centralization occur within phonology.
Reanalysis? (2)

(4) Scale and consequences of reanalysis (example: pain–type)

<table>
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<tr>
<th>Type</th>
<th>UR(s)</th>
<th>Phono. output</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>/ε^n, ê/</td>
<td>[ê]</td>
</tr>
<tr>
<td>b.</td>
<td>/ε^n, ë/</td>
<td>[è]</td>
</tr>
<tr>
<td>c.</td>
<td>/è^n, ë/</td>
<td>[è]</td>
</tr>
<tr>
<td>d.</td>
<td>/è^n(?) , ë /</td>
<td>[è]</td>
</tr>
</tbody>
</table>

- Partial reanalysis (c.): same output (necessarily reflective of phonetic shift) belongs to input vowels of different qualities, in addition to feature association; lowering occurs in /ε^n/ within phonology.
- Total reanalysis (d.): all surface forms come from vowel of same quality (association unclear); either raising occurs in feminine forms ([εn]) or funky allomorphy/suppletion comes into play.
But *which* shifted vowel (between acoustic & articulatory)?

**Trends between form and function:**

- **Contrastive nasality:** increased acoustic salience in vowel space — differences heightened between nasal and oral vowels (e.g. Hindi, French; Shosted et al. 2011, Carignan 2014) → acoustic and/or articulatory identity?

- **Allophonic:** greater acoustic identity between output and oral congener — canceling out acoustic effects of nasalization (American English; Carignan et al. 2011) → acoustic identity?

**Targeting of an articulatory configuration (over its acoustic result)?**
So what?

- Room for debate, but (a.) still seems preferable, despite divergent/abstract phonological output:
  - Alternation such as [f̃] ~ [fin] requires some (potentially dubious) extra legwork, e.g., intermediate representations, 3–to–1 correspondence, and/or “superlowering.”
  - The listener must be able to unpack minor phonetic shifts into internalized abstractions — everything falls apart otherwise.

- In the absence of alternations or in the case of underdescribed languages, recovering phonemes from finer and finer phonetic description will require specific conventions.
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Methods available for modeling nasal intensity and/or duration:

- **Motion detection**: timing of nasalization gestures (e.g., velic lowering)
- **Imaging**: velopharyngeal port opening size at any measured point
- **Acoustic**: formant tracing (appearance of nasal poles/zeroes) & relationship between oral and nasal formants (e.g. Chen 1997)
- **Nasometric**: nasalance at any given point (ratio of nasal to total energy)
- **Aerodynamic**: ratio of nasal to total airflow
Global scores

- The latter two (split-level methods) can provide a global score, with respect to an arbitrary threshold (e.g. “vowel $x$ is 90% nasal if 9/10 of its measured points meet certain criteria”).
- Binary classification requires another threshold (e.g. “vowel $x$ is nasal if it has a global score of 50% or more”).
- Potential shortcoming: not all vowel qualities may have the same threshold for classification
- Two claims with reversed scales in each claim:
  - Articulatory preference: high vowels may require only a very low threshold (vs. a high one for low vowels)
  - Inherent length: low vowels preferred; high rates on high vowels may be accidental
Height & nasal coupling

- Relationship between vowel height and nasality →
  articulatory preference for high nasal vowels:
  - Inherent velic position (independent of nasality) highest for high vowels, lowest for low vowels (e.g., Henderson 1984).
  - Nasal airflow “creeps in” on oral low vowels (e.g., Ohala 1975).
  - Extremely little velic movement necessary for nasality on high vowels, both in aerodynamic terms (e.g., Bell-Berti 1993) and for perception as nasal (House & Stevens 1956, Maeda 1982).
Global threshold may vary according to height: here, high threshold may be < low

Compare nasalization measurements on contrastive nasal vowels: often incomplete or surprisingly low (e.g., Delvaux et al. 2008, Dow 2014)

French dialects with multi-phased nasal vowels (e.g., Delvaux 2006, Clairet 2008)

If complete (or even near-complete) nasalization not necessary, realization of/change to [+nasal] may be reflected in phonetics by different (minimal) scores, according to height
Length issues: background

- Preference of nasality on long vowels, both in diachronic change (e.g. Hajek 1992, 1997) and perceptual effects (e.g., Whalen & Beddor 1989)
- Evidence for inherent length, where low > mid > high → length parameter favoring nasalization on low vowels (Hajek & Maeda 2000)
- Velum as a “sluggish” articulator (Bell-Berti 1993) with diminished control (Shelton et al. 1970) and minimal time to lower (224 to 280 ms (Bell-Berti 1980, Bell-Berti & Krakow 1991, Dalston & Seaver 1990))
Length issues

- Minimal transition period + inherently short length of high vowels → high percentages of nasalization may merely be indicative of phonetic, not phonological nasalization

- In other words: $x\%$ on vowel A not necessarily $= x\%$ on vowel B, as a function of duration

- Multiple rate reading task (Solé 1992): does nasal duration increase with overall duration (phonological) or remain the same (phonetic)?

- Durational information may be worked into measurements...
Phonological representations: in communication with phonetics but based on phonological evidence; can be abstract & substantially transformed by phonetic rules

Oral or nasal? Further work on thresholds and duration needed, especially for contextually nasalized vowels.
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3 major aspects: terms, directionality and members

**Terms:** height? backness? sonority?
→ Sonority: assumption that nasal vowels mirror oral vowels to some degree

**Directionality:** high > low? low > high? ... > central?
→ high > low (i.e., low is never more marked than anything else): no inventory (allophonic & contrastive) in Ruhlen’s (1975) survey excludes low nasal vowels; singleton low nasal vowel inventory possible

**Members:** what distinctions are expected?
→ front vs. back distinction in peripheral (non-low?) vowels: motivated by data in Dow (2014) but findings in Parker (2002) may provide less *ad hoc* support
(5) Nasal Vowel Markedness Hierarchy

<table>
<thead>
<tr>
<th>High central</th>
<th>&gt;</th>
<th>Mid central</th>
<th>&gt;</th>
<th>High back</th>
<th>&gt;</th>
<th>High front</th>
<th>&gt;</th>
<th>Mid back</th>
<th>&gt;</th>
<th>Mid front</th>
<th>&gt;</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>ı</td>
<td>&gt;</td>
<td>ő</td>
<td>&gt;</td>
<td>ũ</td>
<td>&gt;</td>
<td>ɨ</td>
<td>&gt;</td>
<td>ɵ</td>
<td>&gt;</td>
<td>ɨ̃</td>
<td>&gt;</td>
<td>ɛ</td>
</tr>
</tbody>
</table>

An example of each category is given. ‘$x > y$’ = ‘$y$ is never more marked than $x$.’

Predictions in stringency (e.g., de Lacy 2006):

- Impossibility of language without low nasal vowel
- Absence of true raising processes in prosodically prominent positions: troublesome (e.g., Beddor 1982), but requires trustworthy data and analysis
- What to do with minor height shifts (e.g., /˜e/ $\rightarrow$ [˜E])?
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Issues in unifying nasal vowel markedness
Much remains to be done before a unified theory of nasal vowel markedness is feasible.

Issues in nasal vowel classification (stemming from quantification) seem to be most daunting, but parallels may exist in variable or incomplete phonetic indices of other phonological properties (e.g. [voice]).

Though the phonetic aspects of nasal vowels remain complicated, establishing a reliable empirical basis with phonology in mind is key.
I would like to thank:

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