Issues in unifying nasal vowel markedness

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Outline

Introduction

- Phonetic motivation of nasal vowel phenomena in phonology
- Lowering in French /fi^{n}/ → [fɛ̃] ‘fine (masc.)’ (vs. [fin] ‘fine (fem.)’)
  - “Relative markedness of high to mid vowels must drive lowering, supported by greater difficulty in nasal coupling on high vowels”
  - OR: “High nasal vowels are marked because they are harder to nasalize.”
  - [NB: discredited explanation]

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

Outline

Acoustic effects of nasalization

- Immense body of literature on acoustic effects of nasality: cf. Shosted 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)

Example	Traditional	Acoustic (Carignan 2014)	Articulatory (Delvaux 2012)
paon 'peacock'	[ɑ̃]	[ɔ̃]	[ɒ̃]
pain 'bread'	[ɛ̃]	[ɐ̃]	[æ̃]
pont 'bridge'	[ɔ̃]	[õ]	[õ]
brun 'brown'	[œ̃]	—	[Œ̃]

Fleshing out French phonology...

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

Surface type	Proposed UR	Example (traditional IPA)
[$\tilde{V}$] ~ [VN]	/V^n/	[katalɑ̃] ~ [katalan] 'Catalan (m., f.)'
[$\tilde{V}$] ~ [$\tilde{V}$C]	/$\tilde{V}$/	[pɛ̃] ~ [pɛ̃t] 'painted (m., f.)'
[$\tilde{V}$]	/$\tilde{V}$/	[mɛ̃] 'hand'

- NB: further evidence for such input types found in "disjointed" alternations; recall [fɛ̃] ~ [fin] 'fine (m., f.)'.
- No (major) quality difference in quality between input types for identical surface vowels; only association of [+nasal] (e.g., /ε^n, $\tilde{\varepsilon}$/)

Reanalysis?

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

Type	UR(s)	Phono. output
a.	/ɛ^{n}, ɛ̃/	[ɛ̃]
b.	/ɛ^{n}, ɛ̃/	[ɐ̃]
c.	/ɛ^{n}, ɐ̃/	[ɐ̃]
d.	/ɐ^{n}(?), ɐ̃ /	[ɐ̃]

- 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)

Type	UR(s)	Phono. output
a.	/ɛ^{n}, ɛ̃/	[ɛ̃]
b.	/ɛ^{n}, ɛ̃/	[ɐ̃]
c.	/ɛ^{n}, ɐ̃/	[ɐ̃]
d.	/ɐ^{n}(?), ɐ̃ /	[ɐ̃]

- 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 /ɛ^{n}/ within phonology.
- Total reanalysis (d.): all surface forms come from vowel of same quality (association unclear); either raising occurs in feminine forms ([ɛn]) 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 [fɐ̃] ~ [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.

Outline

Methods

- 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).

Height & global scores

- 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...

Summary

- **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.

Outline

Considerations

- 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

High central	>	Mid central	>	High back	>	High front	>	Mid back	>	Mid front	>	Low
ɨ̃	>	ə̃	>	ũ	>	ĩ	>	õ	>	ẽ	>	ã

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., /ẽ/ → [ɛ̃])?

Outline

Conclusion

- 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

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