

## Phonological consequences of high front vowel nasalization in French\*

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### 1. Introduction

(1) The **French paradox**:

- Regressive high vowel nasalization (HVN): new experimental evidence points to a deliberate, phonological process in French.
- High vowel lowering (HVL) transforms  $/\tilde{i}, \tilde{y}/ \rightarrow [\tilde{\epsilon}(\cdot), \tilde{\text{œ}}]$ .
- HVN prefers *only* – while HVL avoids *only* – nasal high vowels.

(2) Input-oriented analyses fail to capture the link between HVN & HVL, while traditional output-oriented analyses struggle with the domain of HVN.

(3) The current analysis uses Łubowicz’s Preservation of Contrast theory (2002, 2012) to propose that the two behave predictably if contrast plays an active role in the grammar: the nasality distinction between  $/\tilde{i}, i(\text{N})/$  is transformed to a height-based one:  $[\tilde{\epsilon}]$  vs.  $[\tilde{i}(\text{N})]$ .

(4) Road map:

- Background: French, phonetic factors
- Experimental study
- Analysis & discussion

### 2. Background

#### 2.1 French

(5) Oral-nasal contrast & distribution in European French:  $/a, \text{ɛ}, e, \text{œ}, \text{ø}, \text{ɔ}, o, i, y, u/$   
vs.  $/\tilde{a}, \tilde{\text{ɛ}}, \tilde{\text{ɔ}}(\cdot), \tilde{\text{œ}}/$

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<i>Context</i>	<i>Oral</i>	<i>Example</i>	<i>Nasal</i>	<i>Example</i>
a. _#	Yes	[pɛ] ‘peace’	Yes	[pɛ̃] ‘bread’
b. _]C	Yes	[a.ti.ʁe] ‘to attract’	Yes	[kɑ̃.ti.te] ‘quantity’
c. _]N	<b>Yes</b>	[ka.naʁ] ‘duck’	<b>Marginal</b>	[ɑ̃.ne.ʒe] ‘snowy’
d. _]C]	Yes	[kɔs.mos] ‘cosmos’	Yes	[ʁe.pɔ̃s] ‘response’
e. _N#	<b>Yes</b>	[ʃɛn] ‘chain’	<b>No</b>	—

(6) Evidence for high nasal vowel lowering (HVL)

<i>Faithful</i>	<i>Unfaithful</i>
a. [peizɑ̃] ~ [peizan]	
b. [sɛʁtɛ̃] ~ [sɛʁtɛn]	e. [fɛ̃] ~ [fin]
c. [bɔ̃] ~ [bɔn]	
d. [ʒɔ̃] ~ [deʒøne]	f. [bʁœ̃] ~ [bʁyn]

(7) Traditional HVL analysis

- Underlying quality deduced from [VN] form (Schane 1968) and analysed as oral vowel + floating [nasal] (Tranel 1992)
- Unfaithful alternations less common but still productive, e.g., [tɛ̃tɛ̃] ‘Tintin’ ~ [tɛ̃tinɔlɔʒ] ‘Tintinologist’ (Paradis & Prunet 2000)
- Markedness of high nasal vowels as synchronic motivation of HNL (cf. José & Auger 2004 for Picard)

(8) Most previous phonetic studies in French find highest rates of regressive coarticulation on high vowels, as well as shortest duration (in msec.)<sup>2</sup>

<i>Study</i>	<i>Method</i>	<i>High</i>	<i>Mid</i>	<i>Low</i>
a. Clumeck 1976	Articulatory	52% (146)	64% (183)	78% (214)
b. Delvaux et al. 2008	Aerodynamic	22% (148)	7% (137)	
c. Dow 2014	Nasometric	75% (77)	34% (86)	24% (99)
d. Montagu 2007	Nasometric	35% (115)	35% (129)	45% (134)
e. Rochet & Rochet 1991	Nasometric	60% (110)	25% (130)	20% (150)
f. Spears 2006	Acoustic	57% (74)	10% (115)	—

... but is it phonological?

<sup>2</sup>Numbers are estimates for Rochet & Rochet 1991 and have been recalculated for Spears 2006 and Dow 2014.

## 2.2 Phonetics

- (9) Aerodynamic (Clarke & Mackiewicz-Krassowska 1977) and acoustic (House & Stevens 1956) factors make high vowels easier to nasalize and are easier to perceive as such (Maeda 1982)
- (10) Articulatory factors: inherently lower velic position may favour low nasal vowels (Bell-Berti 1976), but may also lead to nasal “leakage” in oral contexts & raise their threshold of nasality (Bell-Berti 1973, Chen & Wang 1975)
- (11) Height, duration and nasality:
  - Inherent/average durational scale low > mid > high (cf. Hajek & Maeda 2000 for references), similar to vowel sonority hierarchy (e.g., de Lacy 2006)
  - Historical & perceptual preference for long nasal vowels (Hajek 1997)
  - Lethargy/imprecision of velum (Bell-Berti 1993)
  - *Synthesis*: This interaction may favour low nasal vowels and may artificially inflate percentage of nasality on shorter vowels as a group or in experimental settings
- (12) Translating phonetic data into a phonological framework will then require (a) vowel-specific thresholds and (b) consideration of nasality vs. duration (*à la* Solé 1992)

## 3. Experimental study

- (13) Methodology:
  - **Participants:** 20 native French speakers (Finistère and Somme departments)
  - **Instrumentation:** Glottal Enterprises nasometer (NAS-1 SEP Clinic)
  - **Materials:** Reading list of 3-word expressions (article + noun + adjective):
    - Target vowel: Oral (/a, e, ø, o, i, y, u/) or nasal (/ã, ê, õ, œ/) in pre-nasal (typically /n/) or non-nasal contexts (typically word-final)
    - Examples:
      - a. *le certificat secret* = a#s
      - b. *la partisane sarcastique* = an#s
      - c. *le client secret* = ã#s
    - 2,759 total vowels
  - **Procedure:** Self-paced reading task. List(s) randomized 3 times for each speaker.
  - **Measurements:** Energy of oral and nasal channels of each vowel, 5 msec steps; total duration
  - **Calculations:**
    - Vowel- and speaker-specific *nasal threshold*: mean nasal energy of each oral vowel type in oral contexts + 2*sd*

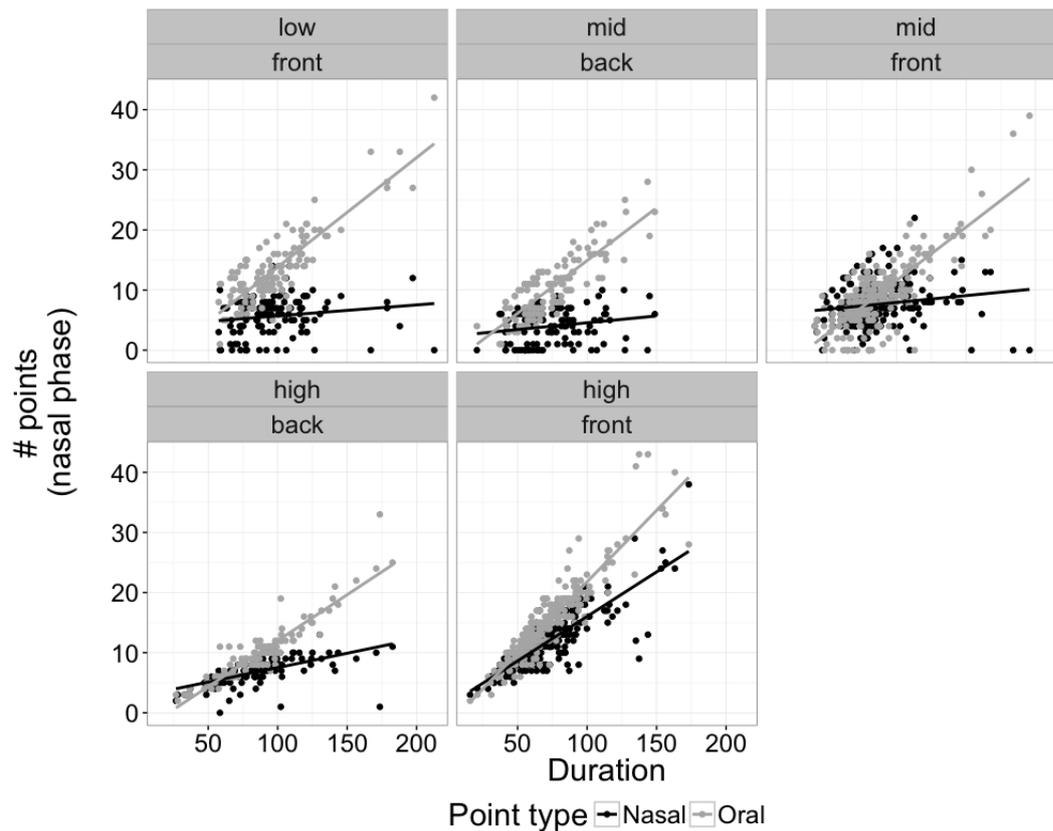
– *Nasal phase*: no. points whose nasal energy > nasal threshold

(14) Results:

a. Low vowels have slightly lower threshold (Pa<sup>2</sup>·s) than mid and high

<i>Vowel</i>	<i>Threshold</i>	<i>sd</i>
/a/	0.015	0.014
/e/	0.021	0.018
/ø/	0.032	0.032
/o/	0.024	0.027
/i/	0.023	0.019
/y/	0.024	0.017
/u/	0.026	0.022

b. Oral and nasal phase duration vs. total duration, by vowel type



(15) Nasal phase duration increases only for high front vowels, suggesting anchorage with respect to V, not N

## 4. Analysis

(16) Competing explanations:

- a. Input-oriented: HVL & HVN both target high vowels, chain shift
- b. Output-oriented, I: HVN applies within permitted range of markedness (here, high nasal vowels least marked), but HVL...?
- c. Output-oriented, II: HVL applies to avoid marked structure (here, high nasal vowels most marked), but HVN...?

(17) Adopted analysis:

- HVL applies because of relative high nasal vowel markedness (supported by typological evidence, cf. Dow 2014), while
- Regressive nasalization seeks to apply to all vowels, but
- Contrast blocks neutralization, but
- HVL creates a small gap for HVN to occur.

### 4.1 PC theory

(18) Overhaul of Optimality Theory giving contrast active role in grammar:

- GEN: Scenario-candidates of (possibly) related or interacting forms, instead of individual candidates
- CON: Addition of PRESERVECONTRAST (PC) constraints preserving distinctions *vis-à-vis* a given property: input-oriented, output-oriented and relational
- EVAL: First pass against PC and markedness; second pass against general faithfulness (if necessary to prevent gratuitous permutations)

(19) Current considerations & potential departures from original PC theory:

- Markedness hierarchy can be stringent, fixed or permutable, but  $*\tilde{u} \gg *i \gg *\tilde{o}, *\tilde{e}, *\tilde{a}$ , etc. – what happens to  $[\tilde{e}]$  happens to  $[\tilde{o}, \tilde{a}]$
- “Docking” occurs early in related pairs, e.g.,  $/V^n/ \rightarrow /V^{\tilde{}}/ =$  nasal input;  $/V^n + \text{FEM.}/ \rightarrow /VN/ =$  oral input
- The *segment* as the locus, not the word: the vowels in  $[\tilde{e}] = [\tilde{e}n] = [\tilde{e}s]$  in terms of (nasal) property

## 4.2 French analysis

(20) Constraints (selected):

### *Markedness*

- a. \*VN : Sequences of oral vowel + nasal consonant are banned.
- b. \*ĩ : Segments with a sonority lesser than or equal to that of high front nasal vowels are banned. (“No high front nasal vowels.”)

### *PC constraints*

- c. PC<sub>IN</sub>(nasal) : For each pair of inputs contrasting in the feature [nasal] that map onto the same output in a scenario, assign a violation mark. (“If inputs are distinct in nasality, they must remain distinct in the output, though not necessarily in terms of the feature [nasal].”)
- d. PC<sub>OUT</sub>(nasal) : For each output that corresponds to two or more inputs contrasting in the feature [nasal], assign a violation mark. (“No outputs ambiguous with respect to nasality.”)
- e. PC<sub>IN</sub>(high) : For each pair of inputs contrasting in the feature [high] that map onto the same output in a scenario, assign a violation mark. (“If inputs are distinct in height, they must remain distinct in the output, though not necessarily in terms of the feature [high].”)
- f. PC<sub>OUT</sub>(high) : For each output that corresponds to two or more inputs contrasting in the feature [high], assign a violation mark. (“No outputs ambiguous with respect to [high].”)

(21) Candidate-scenarios (selected):

- a. Totally faithful. Total contrast in both nasality and height.
- b. Prescriptive French. Lowering of /i<sup>n</sup>/ but no regressive nasalization.
- c. French, as in this study. Lowering of /i<sup>n</sup>/ plus nasalization in /iN/.
- d. Lowering of /i<sup>n</sup>/ and nasalization in all members in hierarchy from /i/ to /a/.
- e. /iN/nasalization feeds lowering.

$$Inputs \left\{ \begin{array}{l} i^n \rightarrow \\ e^n \rightarrow \\ iN \rightarrow \\ eN \rightarrow \end{array} \left| \begin{array}{l} \tilde{i} \\ \tilde{e} \\ iN \\ \varepsilon N \end{array} \right| \left| \begin{array}{l} \tilde{e} \\ \tilde{e} \\ iN \\ \varepsilon N \end{array} \right| \left| \begin{array}{l} \tilde{e} \\ \tilde{e} \\ \tilde{i}N \\ \tilde{e}N \end{array} \right| \left| \begin{array}{l} \tilde{e} \\ \tilde{e} \\ \tilde{i}N \\ \tilde{e}N \end{array} \right| \left| \begin{array}{l} \tilde{e} \\ \tilde{e} \\ \tilde{e}N \\ \tilde{e}N \end{array} \right. \right.$$

(22) Ranking & tableau:

$$*\tilde{u}, PC_{OUT}(nasal) \gg *VN \gg *i, PC_{IN}(nasal), PC_{IN}(high), PC_{OUT}(high)$$

	PC <sub>OUT</sub> (nas)	*VN	*i	PC <sub>IN</sub> (nas)	PC <sub>IN</sub> (high)	PC <sub>OUT</sub> (high)
a.		**!				
b.		**!			* {/e <sup>n</sup> , i <sup>n</sup> /}	* [ $\tilde{e}$ ]
c. $\mathbb{E}$		*	*		* {/e <sup>n</sup> , i <sup>n</sup> /}	* [ $\tilde{e}$ ]
d.	*! [ $\tilde{e}$ ]		*	* {/e, e <sup>n</sup> /}	* {/e <sup>n</sup> , i <sup>n</sup> /}	* [ $\tilde{e}$ ]
e.	*! [ $\tilde{e}$ ]			** {/e, e <sup>n</sup> /} {/i, i <sup>n</sup> /}	** {/e <sup>n</sup> , i <sup>n</sup> /} {/e, i/}	* [ $\tilde{e}$ ]

(23) Consequences of high-ranking PC<sub>OUT</sub>(nasal)...

- If more marked inputs are realized faithfully (e.g., /i<sup>n</sup>/ → [ $\tilde{i}$ ]), neutralization can't occur (i.e., no nasalization in VN)
- If markedness motivates an unfaithful mapping in one instance (e.g., /i<sup>n</sup>/ → [ $\tilde{e}$ ]), a marked output can be favoured elsewhere

## 5. Discussion

- (24) *General scenario*: With a markedness hierarchy for a shareable property P such that A<sup>P</sup> ≫ B<sup>P</sup>, in a language where A and B stand in contrast, A<sup>P</sup> → B<sup>P</sup> in contrastive settings, whereas in assimilatory settings AP → A<sup>P</sup>P and BP remains BP.
- (25) Can other OT approaches achieve the same? Would seem not: this problem requires application of HVN in non-derived environments (cf. NONEUTRALIZATION in Stratal OT, Kiparsky 2008) and some degree of neutralization elsewhere, *contra* systematic approaches such as \*MERGE (Padgett 2003).

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