

Individual variability and contrast in French anticipatory nasal coarticulation

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Coarticulation refers to the temporal overlap of articulatory gestures in the production of successive speech sounds and has been demonstrated to be an actively planned and language-specific behavior ([1], [2]). Phonological contrast is often argued to be an important constraining force on coarticulation ([2]) that avoids conflation of underlyingly distinctive categories with one another (*contrast hypothesis*).

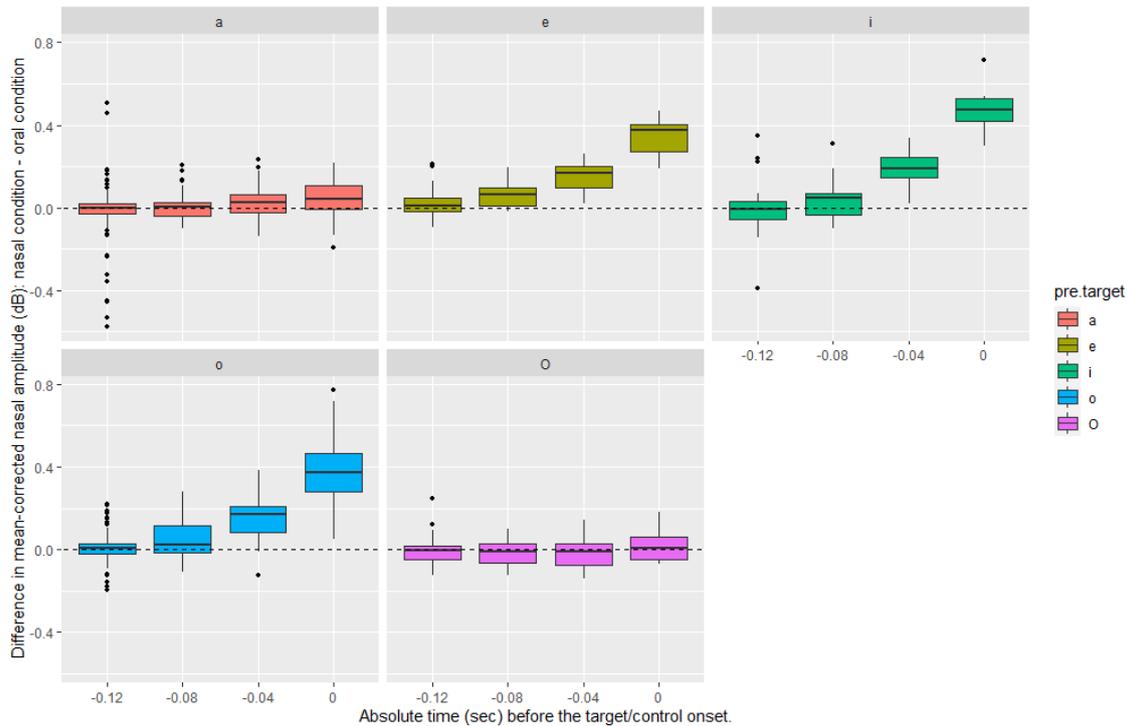
French is of great interest for studying nasal coarticulation specifically because nasality is contrastive for both consonants and vowels ([3]), the latter of which form a rich system that varies along multiple phonetic dimensions, such as nasality, height, backness, and rounding ([4], [5], [6]). Despite methodological differences, previous studies on nasal coarticulation in French provide evidence in favor of the contrast hypothesis, since non-high vowels display more coarticulatory resistance in VN contexts than high vowels, where there is no nasal/oral contrast ([3], [7], [8], [9], [10], [11]). Research also suggests that in general the effect of contrast on the production of coarticulation exhibits considerable individual variability (e.g. [12], [13]) that needs to be accounted for in speech production models ([12]). However, for Northern Metropolitan French (French hereafter) inter/intra-speaker variability is often mentioned but not quantified or reported in detail. This paper thus presents an acoustic study examining individual variability in the magnitude and timing of anticipatory nasal coarticulation in French and how these differences relate to underlying phonological contrasts.

French speakers were recorded at the Institute of Phonetics and Speech Processing (University of Munich) while completing a reading task. We aim to collect data from 30 speakers: here, we present data from 9 speakers for whom analysis is complete. Two sets of stimuli were created: (1) 15 minimal pairs that are contrasted by a nasal/oral consonant, which appears in word-initial, word-medial or word-final position (e.g., **m**ère ~ **p**ère), (2) 12 minimal pairs that are contrasted by a nasal/oral vowel (e.g., **l**ent ~ **l**à). These were embedded in the carrier phrase ‘*Je dis à Cléo X samedi.*’, where X is the target word. Each token was repeated three times. Trials with a prosodic break after *Cléo* were excluded (~14%).

We collected acoustic data with a nasometer. Intensity values in dB were extracted from the nasal channel only and mean-corrected on a token-by-token basis. For each minimal pair, repetitions from the nasal condition (e.g., **m**ot) were matched with repetitions from the oral condition (e.g., **p**eau). We then calculated the difference in nasal amplitude for each matched pair at 4 time points before the target sound (120ms, 80ms, 40ms) as well as at the target sound’s onset (0ms).

Preliminary findings for coarticulation before nasal consonants suggest that coarticulatory timing and magnitude are constrained if the vowel preceding the target nasal is non-high. High vowels, on the other hand, allow for more extensive coarticulatory magnitude and timing (Fig. 1), thereby confirming the inversely proportional relationship between vowel height and anticipatory nasalization as reported in [3] and [11]. This constraining pattern is consistent across speakers regardless of individual differences. These findings are congruent with the contrast hypothesis since nasality only plays a role in contrast formation in the non-high part of the French vowel system.

Figure 1. Difference in anticipatory nasal amplitude between matched nasal/oral pairs grouped by pre-target vowel phoneme (in X-SAMPA). Data from nine speakers of French.



- [1] Whalen, D.H. Coarticulation is largely planned. *Journal of Phonetics*, 18, 3-35, 1990.
- [2] Manuel, S. The role of contrast in limiting vowel-to-vowel coarticulation in different languages. *Journal of the Acoustical Society of America*, 88, 1286-1298, 1990.
- [3] Delvaux, V., Demolin, D., Harmegnies, B., & Soquet, A. The aerodynamics of nasalization in French. *Journal of Phonetics*, 36(4), 578-606, 2008.
- [4] Longchamp, F. Analyse acoustique des voyelles nasales françaises. *Verbum: Revue de Linguistique de l'Université de Nancy II*, 2, 9-54, 1979.
- [5] Fougeron, C., & Smith, C.L. French. *Handbook of the International Phonetic Association*, Cambridge: Cambridge University Press, 78-81, 1999.
- [6] Carignan, C. An acoustic and articulatory examination of the 'oral' in 'nasal': The oral articulations of French nasal vowels are not arbitrary. *Journal of Phonetics*, 46, 23-33, 2014.
- [7] Rochet, A. P., & Rochet, B. L. The effect of vowel height on patterns of assimilation nasality in French and English. *Proceedings of the 12th International Congress of Phonetic Sciences*, (Aix-en-Provence), 3, 54-57, 1991.
- [8] Cohn, A.C. Phonetic and Phonological Rules of Nasalization, *UCLA Working Papers in Phonetics*, 76, 1990.
- [9] Basset, P., Amelot A., Vaissière J., & Roubeau, B. Nasal airflow in French spontaneous speech. *Journal of the International Phonetic Association*, 31(1), 87-99, 2001.
- [10] Spears, A. Nasal coarticulation in the French vowel /i/: a phonetic and phonological study MA thesis, University of North Carolina at Chapel Hill, 2006.
- [11] Dow, M. A phonetic-phonological study of vowel height and nasal coarticulation in French. *Journal of French Language Studies*, 30, 3, 239-274, 2020.
- [12] Grosvald, M. Interspeaker variation in the extent and perception of long-distance vowel-to-vowel coarticulation. *Journal of Phonetics* 37, 2, 173 – 88, 2009
- [13] Zellou, G., & Tamminga, M. Nasal coarticulation changes over time in Philadelphia English. *Journal of Phonetics* 47, 18–35, 2014.