Gradient assimilation in French cross-word nasal+stop sequences

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Recent articulatory studies have shown cross-linguistic variation in the implementation of nasal-to-velar assimilatory patterns with languages differing both in the phonetic implementation (categorical versus gradient) and the factors conditioning this variation. Coda contrast typology may account for some of these between-language differences: in languages like English with larger inventories, assimilation may be categorical or gradient (e.g., Ellis & Hardcastle, 2002). Romance languages allow for particular insights into nasal assimilation typology, since nasal-to-velar assimilation seems to apply categorically, both in languages that have a restricted coda contrast inventory like Spanish (Kochetov & Colantoni, 2010) and Italian (Celata, Calamai, Ricci & Bertini, 2013), and those that allow a wide inventory of codas like Catalan (Recasens & Mira, 2015). Recasens & Mira (2015) hypothesize that Catalan patterns with the other Romance languages because assimilation is categorical within words. Thus, not only coda inventory but also language-specific coarticulatory patterns seem to shape assimilation. If this is the case, we should expect that a language like French, which allows an equally large number of coda consonants as Catalan but does not allow word-internal place assimilation (e.g., Duez, 1995; Darcy, Ramus, Christophe, Kinzler & Dupoux, 2009; e.g., French *samedi* [sam̲d̲i], *[sandi] 'Saturday', *canneberge* [kan̲b̲ɛʁʒ], *[kambɛʁʒ] 'cranberry'), would diverge from the general Romance tendency and allow gradient place assimilation of nasal-to-velar clusters across words.

To test this hypothesis, we conducted an electropalatography (EPG) study. Custom acrylic palates with 62 electrodes were made for 4 female native speakers of French (2 each of European and Québec varieties: E1, E2; Q1, Q2). Target stimuli contained /n/+stop sequences, with stops differing in place ([coronal, velar]) and voicing ([voiceless, voiced]). Four utterances (see (1) overleaf) were read aloud six times in a carrier phrase *C'est une ___* 'That's a…' six times, generating 24 tokens per speaker. The *Articulatory Assistant* software (Wrench, Gibbon, McNeill & Wood, 2002) was used to record, segment, and analyze the data. For each cluster, the presence or absence of coronal (rows 1-4 of the palate) and velar closures (last 2 rows) were measured during the nasal interval. Based on this, all nasal+velar tokens were classified as 'unassimilated' (coronal-only closure [n]), 'categorically assimilated' (velar-only closure, [ŋ]), or 'gradiently assimilated' (coronal closure overlapped by a temporally delayed velar closure, [nn͡ŋ]; see Figure 1). This classification was further confirmed by quantitative measurements of the quotient of electrode activation (Qa and Qp; Fontdevila, Pallarès & Recasens, 1994) taken at the onset, midpoint, and offset of the nasal period in the two targeted regions of the palate.

Results (Table 1) were consistent with our hypothesis: speakers showed neither categorical assimilation (/n/→[ŋ]) nor lack of assimilation (/n/→[n]). Instead, all tokens involved a coronal gesture, albeit partly overlapped by a velar gesture (/n/→[nn͡ŋ]; see Figure 2). Degree of overlap varied across speakers, extending up to half the nasal interval. This gradient place assimilation is in stark contrast to previous findings for other Romance languages. Indeed, in Spanish and Italian, nasals followed by velars were overwhelmingly realized as velar, that is, place assimilation was categorical (Kochetov & Colantoni, 2010; Celata, et al., 2013). In summary, based on new articulatory data for French, the present study demonstrates that, within Romance languages, cross-word assimilation type (categorical versus gradient) is conditioned by coda typology and word-internal assimilation patterns.

(1) Targets: /n/ + /k/   *bonne casquette*   /n/ +/g/   *bonne galette*
                           /bɔn̪kaskɛt/   /bɔn̪galɛt/
                           'good cap'   'good tart'

     Controls: /n/ + /t/   *bonne tablette*   /n/ + /d/   *bonne dentiste*
                            /bɔn̪tablɛt/   /bɔn̪dãtist/
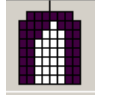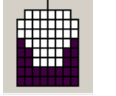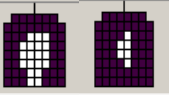   'good shelf'   'good dentist'

Figure 1. Linguopalatal contact types
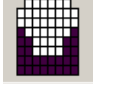
	coronal only	velar only	coronal + overlapped
	[n]	[ŋ]	[nn͡ŋ]
front *back*			

Table 1. Results: realization of /n/ + stop

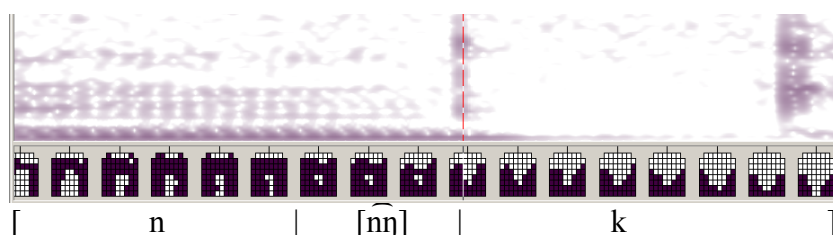| Input	Output	Speaker			
		E1	E2	Q1	Q2
n#k	nk	0%	0%	0%	0%
	nn͡ŋk	100%	100%	100%	100%
	ŋk	0%	0%	0%	0%
n#t	nt	100%	100%	100%	100%

[n | [nn͡ŋ] | k   ]

Figure 2. Sample temporal EPG and spectrogram display for a /n#k/ sequence (speaker E1) with palate images taken at 10ms intervals.

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