

Individual variation in anticipatory nasal coarticulation in German

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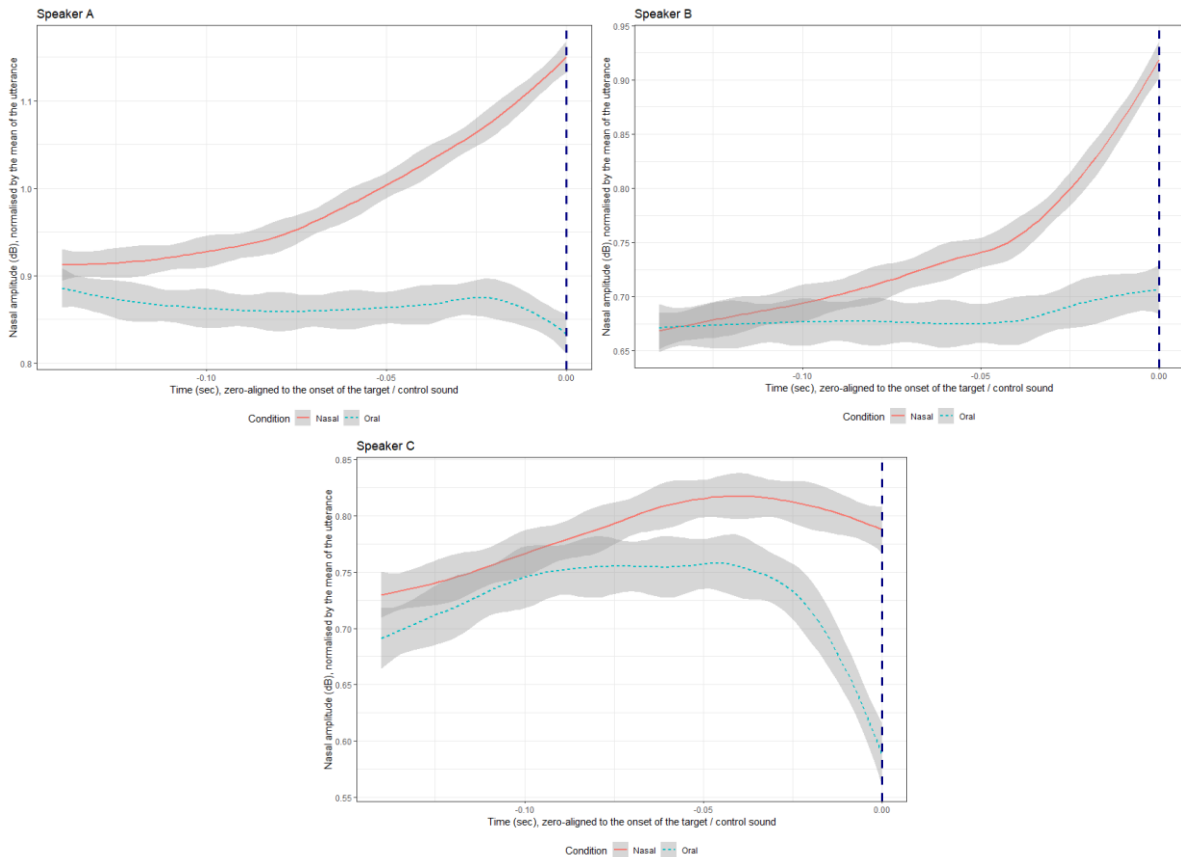
Coarticulation is known to be a language-specific, controlled phenomenon that aids speech comprehension [1, 2, 3], and is proposed to be one of the driving mechanisms behind sound change [4]. For example, anticipatory nasal coarticulation in vowels preceding nasal consonants may eventually lead to the emergence of phonological nasal vowels (i.e. [VÑ] → /Ñ/), which has already taken place in French [5] and is currently ongoing in American English [6]. However, previous research [7, 8] suggests that coarticulatory patterns vary considerably between and within individual speakers. In light of this, we show initial results from a large-scale project investigating the cross-linguistic and inter-speaker dynamics of nasal and labial coarticulation in speech production and perception of French, American English and German. In this presentation, we analyse anticipatory nasal coarticulation in German, as a language with no evidence of a phonologising effect of nasalisation [9]. In particular, we investigate the extent to which individual speakers vary in the temporal extent of coarticulation according to vowel duration, which has been identified in recent work [10] as a potential factor affecting German nasal coarticulation.

Data were collected in laboratory conditions at the Institute of Phonetics and Speech Processing in Munich from 30 speakers of Standard German. Participants read sentences formed from the carrier phrase *Er las Kleo X zweimal vor*, where *X* stands for the target word. Target words consisted of nasal–oral minimal pairs, where the nasal consonant or its oral counterpart appeared in word-initial, word-medial or word-final position (e.g. *Not* / *Tod*, *Leine* / *leite* and *lang* / *Lack* respectively). Speakers read three repetitions of 13 minimal pairs, totalling 78 tokens per speaker. Speech data were obtained using a nasometer, yielding separate nasal and oral acoustic channels. The difference in nasal amplitude between each nasal token and its oral counterpart was measured at three time points (120 ms, 80 ms and 40 ms) preceding the boundary between the vowel and the target sound, as well as at the boundary itself. Word-initial tokens containing a prosodic break between *Kleo* and the target word were excluded.

Findings indicate that for the majority of speakers, the onset of coarticulation is earlier for nasals that follow a phonologically tense vowel or diphthong, with the exception of /ø:/, which patterns with lax vowels. However, acoustic vowel duration does not appear to affect the degree of nasal coarticulation. In addition, the data show a substantial degree of variation between individual speakers in terms of the temporal extent of nasal coarticulation (see Figure 1). Some speakers (e.g. Speaker A in Figure 1) display an early onset of coarticulation, with a gradual increase in nasal amplitude, while for others (e.g. Speaker B), nasal amplitude begins to rise rapidly shortly before the boundary between the vowel and the nasal consonant. For a small minority of speakers (e.g. Speaker C), nasal amplitude does not consistently rise in anticipation of a nasal consonant; rather, it falls before an oral consonant.

Overall, the findings support recent articulatory work that finds that tense vowels exhibit greater nasal coarticulation in German in some contexts [10]. The considerable variation in production of coarticulation between individual speakers also reflects literature on other languages [8]. The results, in combination with future perception data from the same participants alongside similar data for French and American English, will allow us to assess the relationship between coarticulation as an individual production–perception phenomenon and as a language-dependent signal of phonological contrast.

Figure 1. Change in nasal amplitude over time before the onset of the target / control sound for three German speakers, averaged across all tokens. Red solid line = nasal (target) condition; blue dotted line = oral (control) condition; navy dashed line = boundary between the vowel and the target / control sound.



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