The Nasal 'Ash' System in English: how does it get so tense?

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This paper investigates the production of the low front vowel /æ/ which undergoes "tensing" and "raising" (Ferguson, 1972; Labov, 1989) when followed by a nasal consonant in some dialects of English (Labov, Ash and Boberg 2006). Speakers in their early twenties, and life long residents of the province of Newfoundland read a word list which included five tokens of both *hand* and *hat.* All speakers exhibited significantly lower F1 and higher F2 values for the vowel in the word *hand* compared to *hat*. As a way to explain the acoustic differences found in nasal systems, we test the model outlined by Krakow et al. (1988), that such lowering and raising is a result of co-articulation between the vowel and the following nasal consonant. We predict that:

1. If nasal co-articulation is responsible for tensing, then nasality, measured by A1-P0 (Chen 1997, Chen et al. 2007) should be higher in the nasal environment compared oral ones (i.e. elsewhere).
2. (a) Nasality and (b) its concomitant effects on F1 and F2 should be weakest early in the vowel and strongest immediately preceding the nasal consonant. This follows from Cohn's (1993) formulation of co-articulatory nasalization as a phonetically gradient rule as opposed to a categorical phonological one.

All acoustic analyses were conducted using Praat (Boersma and Weenink 2013) at two temporal locations (20% and 80%) into each vowel token. Two-tailed t-tests revealed significantly lower A1-P0 values (more nasality) in the nasal environment for Speaker 1 ($t(18) = 5.5011$, $p < 0.0001$), but not for Speaker 2 ($t(18) = 1.9266$, $p = 0.07$) or Speaker 3, ($t(18) = 0.2687$, $p = 0.79$). This presents a challenge to Hypothesis (1) above suggesting that tensing might not directly related to nasalization.

To test Hypothesis (2), three two-tailed t-tests were run for each speaker to examine the effect of nasality over the course of /æ/. No statistically significant differences were found in A1-P0 across the duration of the vowel for Speaker 1 ($t(8) = 1.008$, $p = 0.34$). However, significant differences were found for F1 ($t(8) = 2.8361$, $p = 0.02$, and for F2 ($t(8) = 16.6312$, $p < 0.0001$), though not in the direction expected if affected by nasalization. Likewise, no significant differences were found in A1-P0 over the duration of /æ/ for Speaker 2 ($t(8) = 0.399$, $p = 0.70$). While a significant difference was found for F2 of Speaker 2 ($t(8) = 3.1884$, $p = 0.01$), and not in the direction expected, no effect was found for F1 ($t(8) = 0.5862$, $p = 0.57$). Finally, for Speaker 3 neither A1-P0 ($t(8) = 1.0342$, $p = 0.33$), F1 ($t(8) = 0.0224$, $p = 0.98$) nor F2 ($t(8) = 1.1659$, $p = 0.0.28$) were significantly different over the course of the vowel. These results suggest that the level of nasality is as high at 20% into the vowel as it is at 80% and that /æ/ was no higher or more fronted 80% into the vowel than at 20%.Taken together, these results run against hypothesis (2).

Two critical findings are discussed. First, some speakers may not have higher levels of nasality for /æ/ in the nasal environment. Therefore, nasalization is not likely responsible for tensing in the speech of these speakers (contra Hypothesis 1). This is consistent with observations of other tensing systems (De Decker and Nycz 2012) where more fronted and raised lingual gestures were found in the nasal environment. Second, speakers who do exhibit higher levels of nasality for /æ/ in the nasal environment, show that co-articulatory nasalization does not apply in a gradient manner (contra Hypothesis 2). Rather, nasalization is applied categorically, affecting the acoustics of the whole vowel. The overall significance of this study reveals two types of nasal systems mediated through either a) lingual specification or b) nasalization. In both sub-systems /æ/-tensing is understood as a categorical, phonological phenomenon, not one driven by phonetic implementation.

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