

Prosodic conditioning of Portuguese subjects' perception of vowel nasality

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ABSTRACT

We examine the sensitivity of Portuguese subjects to a series of prosodic parameters previously shown to condition perception of vowel nasality, hypothesizing that the presence in Portuguese of long, strongly nasal vowels would (i) provoke lower nasality ratings than observed in English and French subjects and (ii) make these insensitive to prosodic parameters under investigation. (i) but not (ii) is confirmed. The results show some language-specificity but subjects were sensitive to all the parameters in question, confirming their robustness.

Keywords: Nasal vowels, perception, Portuguese.

1. INTRODUCTION

In a series of papers [3,4,5], a perceptual basis has been established for the frequently observed diachronic correlation between the development of vowel nasality and a series of prosodic parameters [2], notably (i) the vowel length parameter (vowel nasality develops preferentially in long rather than short vowels; and (ii) the stress parameter (*idem* in stressed rather than unstressed vowels. The perceptual basis of the vowel length parameter was established in [1]. That of the stress parameter was established in [3,4].

All these studies used only English native speakers; however, the generalisability of the results was examined in [5], which compared French and English speakers. French differs from English both in terms of prosodic structure and in having phonemic nasal vowels. It was hypothesized that French speakers would thus be insensitive to the prosodic variables being tested and that they would require a higher degree of nasalization than English subjects to hear a vowel as nasal. The first hypothesis was partially confirmed: the French subjects differed from the English in showing no main effect of stress or vowel length (although vowel length was significant in French for vowels with maximum nasalization, and has also been shown to be salient

for French in a study with different stimuli types [11]). The second prediction was not confirmed. The French and English subjects did not differ significantly in their overall nasality ratings.

The French data thus failed to support our expectation that the presence of phonemically nasal vowels would reduce subjects' sensitivity to the perceptual phenomena which contribute to these vowels' development. However, a stronger test of this prediction may be obtained by examining a language with stronger phonemic vowel nasality than French. In the present study, therefore, similar perceptual tests to those in [5] are applied to native speakers of European Portuguese, which has a larger number of nasal vowels than French, in which nasality has particularly strong phonetic exponence (see section 2) and whose nasal vowels tend to be phonetically long. We hypothesize that these subjects (i) will give generally lower nasality judgements than the earlier subjects; (ii) that they will tend to identify nasality strongly only in long vowels; and (iii) that they will otherwise not respond to any prosodic conditioning effects of stress which are likely to be below the threshold of salience for them.

2. VOWEL NASALITY IN PORTUGUESE

Portuguese has a rich system of nasal vowels, with five nasal monophthongs and a number of diphthongs. The phonological status of both monophthongs and diphthongs has been much debated, but in both the nasalization is very marked [6,8], with (even in the 'monophthongs') a diphthongal movement from oral to nasal, frequently with a nasal consonantal termination. Although Portuguese is not usually described as having phonological vowel length, the diphthongs being analysed as two independent segments, it has been claimed that the nasal vowels should be seen as diphthongal ([6]); they are in any case phonetically long ([8]). They are found in stressed, pre-stressed and, (in the case of diphthongs), post-stressed syllables. Portuguese also has contextual nasalization of vowels, especially after nasal

consonants. Portuguese speakers are sensitive to the existence of vowel nasalization in their language, its degree being one indicator of social/geographical variables.

Apart from the absence of phonological vowel length distinctions, European Portuguese is prosodically closer to English than French. It has significant vowel reduction and was traditionally analysed as a stress-timed language, although recent research suggests that it has elements of both stress- and syllable-timing [7]. It has complex rules of stress assignment in words, resulting in a range of final, penultimate and antepenultimate stresses. Portuguese subjects should thus be able to make readily distinctions between stressed and unstressed syllables in different contexts.

3. EXPERIMENTAL DESIGN.

As described in [3] a series of twenty-four disyllabic synthetic stimuli was created using the HLSYN pseudo-articulatory synthesizer. Nasality was varied using the velopharyngeal port opening (VPO) parameter, specified in mm². The stimuli made up two continua; in one the first vowel varied in its degree of nasality, going from [asa] to [ãsa] in three steps, specified by setting VPO for the first vowel to 0, 16.8 and 36 mm². In the second continuum, it was the vowel in the second syllable whose nasality was so varied, giving an [asa] to [asã] continuum. For both continua, for each degree of VPO, two basic length settings were used, 250 ms and 150 ms; to test the effect of prominence, the relation between the vowels in the two syllables was varied. In the stressed condition, the target vowel (i.e. that whose nasality was being varied, so the first vowel for continuum 1, the second for continuum 2) had a higher intensity than the non-target vowel (sub-glottal pressure of 8.5 vs. 6 cm H₂O), was 100 ms longer than the non-target, and was marked by a major F₀ fall of 55 Hz, while the non-target had level pitch. In the unstressed condition, the non-target vowel was correspondingly louder, longer and pitch prominent. This gives a total of 3 (VPO settings) x 2 (length settings) x 2 (prominence conditions), i.e. 12 stimuli per continuum, so 24 stimuli in all. These were recorded six times in pseudo-random order onto a tape, with an inter-stimulus interval of 3 seconds, the two continua being recorded separately.

Compared to the phonetic norms in Portuguese, the degree of nasality in these stimuli, even those with the largest VPO, is modest and they have no dynamic pattern of nasality increasing through the vowel. Given our hypotheses concerning Portuguese subjects, we therefore predict the following response patterns to the variables in our stimuli: (i) Stimuli with higher VPO settings should be perceived as more nasal than those with lower settings but with overall lower scores than subjects in [3,4] and [5]; (ii) for the same degree of VPO, longer vowels should be perceived as more nasal than shorter vowels; (iii) there will be no effect of stress, given vowels with the same VPO and vowel length.

3.2 Subjects and procedure

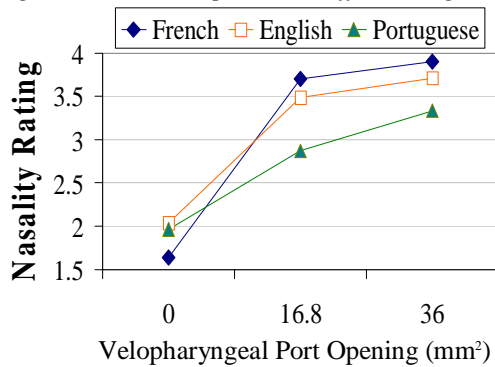
Ten native speakers of European Portuguese were tested. None of them had been trained phonetically, but all were living and working in Oxford. All spoke fluent but accented English. One subject's responses failed to distinguish the continuum end points; these were discarded. Subjects were asked to respond to each stimulus by marking on a pre-prepared sheet how nasalised they considered the target vowel to be, on a scale 1 (least nasal) - 5 (most nasal). Subjects were run in small groups, with an initial short practice session, in which it was established that they were able to perform the task. Running subjects in groups also allowed them time to spend some minutes before the practice session engaged in conversation in Portuguese; this was intended to overcome the danger that their knowledge of and exposure to English would make it less likely that they would carry out the test in the correct language mode [10]; instructions were also given in Portuguese by a native speaker. Each subject heard the stimuli from continuum 1 in one block, followed by those for continuum 2. For each continuum, the first twelve responses in the experiment itself were discarded for each subject, to allow a further familiarization period, leaving five responses to each stimulus (60 responses in all).

The ratings from these were then input to two repeated measures ANOVAs; the first was for the Portuguese subjects only, with dependent variable nasality rating, and within-subjects factors VPO, vowel length, syllable position of nasal vowel (first or second, this variable being used in the analysis of rhythmic effects below) and prominence of nasal vowel (stressed or unstressed); the second

added a cross-linguistic comparison with English and French subjects. Both analyses included planned comparisons between the two prominence conditions, and two- and three-way interactions involving prominence, VPO and syllable position.

4. RESULTS

Figure 1 Overall responses to different degree of VPO



4.1 Velopharyngeal Port Opening

As predicted, the VPO factor is highly significant for the Portuguese subjects, $F[1,4] = 84.694$, $p < .001$, but their nasality ratings are lower than those of the earlier French and English subjects (Figure 1) between whom there was no significant difference [5]. This difference is highly significant in both cases ($F[2,8] = 84.413$, $p < .001$ for French; $F[2, 8] = 12.871$, $p < .01$ for English). Planned comparisons show a highly significant difference between Portuguese and French at all degrees of VPO and between Portuguese and English for all except 0mm^2 . The first of our hypotheses is thus confirmed.

4.2 Length Parameter

Figure 2: Effect of length parameter

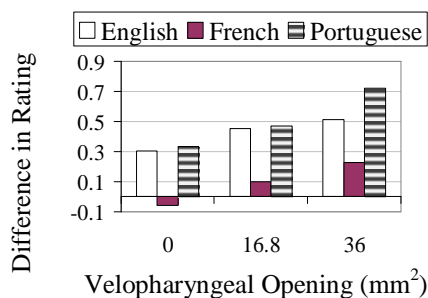


Figure 2 presents the vowel length results for the three languages in terms of the difference in nasality ratings between long and short vowels for each group at each degree of VPO. As predicted, the Portuguese subjects are highly sensitive to the

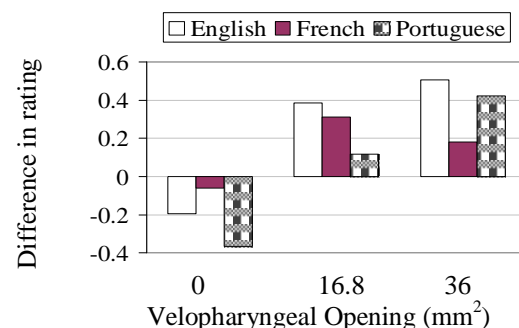
length parameter ($F[1,4] = 85.694$, $p < .001$). Planned comparisons show that the length distinction is highly significant for the two higher values of VPO, though not for the lowest.

The Portuguese subjects' responses are thus indistinguishable from those of the English subjects. They differ from the French subjects ($F[1,4] = 93.77$, $p < .001$) for whom this parameter was only significant at the highest degree of VPO.

4.3 Stress Parameter

Figure 3 shows the results for this parameter in terms of the difference between average nasality ratings for stressed and unstressed syllables. The results are complex. The prediction that stress would not be a significant factor for Portuguese subjects appears to be confirmed in the Analysis of Variance, $F[1,4] = 0.339$, $p > 0.5$. However, the interaction stress*VPO is significant ($F[2,8] = 8.639$, $p < .02$). As Figure 3 shows, the Portuguese subjects (like the English) show a strong tendency to higher nasal ratings on stressed syllables at the highest degree of VPO. Planned comparisons show this distinction to be significant ($p < .05$). However, they show an almost equally strong diametrically opposed tendency, significant at the same level, to higher nasality ratings on unstressed syllables when VPO is set at 0mm^2 . For the intermediate VPO value, there is a weak, non-significant preference for stressed syllables. The opposite and almost equal effects at the two extreme VPO settings thus cancel each other out in the averaging involved in the ANOVA calculation. This disparity between the nasality responses when $VPO = 0\text{mm}^2$ and in other conditions was also observed (non-significantly) for the French and (significantly) for the English subjects and is discussed in section 5.

Figure 3: Effect of Stress Parameter



4. DISCUSSION

In section 1, we predicted that Portuguese subjects would respond less strongly to nasalized vowels than English and French subjects and that, of the two prosodic factors tested here, only vowel length would condition their responses, but that they would be insensitive to the stress parameter. Our first two predictions were entirely supported. The Portuguese subjects gave significantly lower overall nasality ratings than those previously tested, and were highly sensitive to the vowel length parameter, which has now been shown to have a strong effect in English and Portuguese and a weaker one in French (though see [11]). Our final prediction was not straightforwardly confirmed, with the direction of response not entirely consistent. Our Portuguese subjects were sensitive to the stress parameter, but only in the expected direction for the strongest VPO level; at a VPO setting of 0, they gave significantly higher nasality ratings to unstressed syllables. The same pattern was noted for English subjects in [4,5]. As noted there, an explanation may lie in the tendency for subjects to perceive nasality in open synthetic vowels, even when VPO is set to 0 mm² [1,3,4,5]. This impression of nasality may seem perceptually salient in an unstressed vowel, but not a stressed one, where more marked acoustic exponence of nasality is expected. The effect vanishes in vowels with VPO values above a certain threshold.

One caveat concerning these findings concerns the status of our subjects as proficient L2 speakers of English living in England, which may have affected their performance of the test, despite attempts to promote a Portuguese language mode; future research should attempt to replicate the current results using monolingual subjects.

5. CONCLUSION

The experiment reported here tested the hypothesis that the prevalent vowel nasality, associated with phonetic length, of European Portuguese would make speakers of the language (i) relatively insensitive to degrees of vowel nasality that are salient for English and French speakers and (ii) sensitive only to one of two factors previously shown to condition the perception of vowel nasality, the vowel length parameter. The first hypothesis was confirmed, the second rejected. Both of the prosodic parameters (vowel length and stress) under investigation had a significant effect, although that of the vowel length

parameter was indeed the strongest. The overall pattern of results thus supports the robustness of the perceptual conditioning of these parameters, while confirming that there are cross-linguistic differences in their range and implementation.

Two further research areas are suggested by the present results and will be the subject of future investigation. The first concerns the possible value and effect on the perception of vowel nasalization in Portuguese of other parameters, previously identified by [2] to be cross-linguistically important. These focus on different rhythm effects, specifically the interaction between perceived nasalization and the location of stressed and unstressed syllables in the word. The second concerns the specificity of such prosodic conditioning; is it a particular property of vowel nasality, or is this an example of a more general trend for articulatory parameters to be more salient in long vowels and stressed syllables?

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