

Cross-linguistic study of the effect of suprasegmental features conditioning the development of nasal vowels

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ABSTRACT

Certain suprasegmental patterns have been shown to condition the perception of vowel nasality and hence to favour the historical development of nasalised vowels. However, experiments showing this have typically used only anglophone subjects. The present experiment examines whether these effects generalise to speakers of French, a language with significantly different suprasegmental properties from English. We repeated with 10 French subjects perceptual tests already used with English speakers and compared results for the two groups with respect to three parameters known to be potentially salient in conditioning nasal percepts on vowels. Results show that the responses of the French subjects differ significantly from those of the English subjects for all the parameters, and in ways related to the differences between French and English phonology. Nevertheless, both groups showed at least some minimal sensitivity to all the effects studied, so that we are unable to rule out the possibility of their having a universal basis.

1 INTRODUCTION

In previous work [1,2], we have investigated the role of factors known to condition the development of vowel nasality using the techniques of experimental phonology. Hajek [3] showed that in a range of Romance dialects four suprasegmental factors seemed historically to privilege the development of nasal vowels. He named these (i) the Vowel Length parameter, (ii) the Stress parameter, (iii) the Extended Stress parameter and (iv) the Foot (here: Rhythm) parameter. These parameters express, respectively, the preferential nasalisation of (i) long rather than short vowels; (ii) vowels in stressed rather than unstressed syllables; (iii) unstressed vowels in pre-tonic rather than post-tonic position; and (iv) of stressed vowels in oxytonic (weak-strong) rather than paroxytonic (strong-weak) patterns. In [1] and [2] we sought to establish whether these conditioning factors had a perceptual basis, of the type first advocated for diachronic phenomena by Ohala [4]. Evidence of such a basis for the Vowel Length parameter was first provided by Whalen and Beddor [5] in a study using American subjects. In our previous studies we used English subjects. In [1] we confirmed Whalen and Beddor's findings, and found evidence of a perceptual

basis for the Stress parameter. In [2] we further showed a similar perceptual basis for the Rhythm parameter, but not the Extended stress parameter.

However, no inference of universality may be drawn from the experimental studies carried out thus far; they are limited by the shared characteristic that their subjects were native speakers of English. Many perceptual phenomena are known to vary cross-linguistically [see, e.g., 6]. Languages, furthermore, exhibit considerable diversity in their use and realisations of suprasegmental phenomena such as those in question here [7]. There is no *a priori* reason to assume that the previous results hold for any languages other than those which resemble English in at least three relevant respects: English has no phonemically nasal vowels, but does have contextual vowel nasality; English has marked and phonologically contrastive vowel-length differences; English has non-fixed, contrastive stress. In the present study, we have therefore sought to address the empirical question of the effect of native language on the perceptual phenomena investigated in [1,2], and thus to gain an initial insight into the possible universal status of the Vowel Length, Stress and Rhythm parameters. The perceptual tests in [2] were repeated with French-speaking subjects. Their responses were compared to those of the English subjects reported previously, to test the null hypothesis that a change in native language will have no effect on the outcome of the perceptual tests.

2. FRENCH VS. ENGLISH

The use of French subjects permits a harsh test of the null hypothesis. French and English differ both prosodically and segmentally in potentially crucial ways. The phonology of French prosody has been hotly debated, but, observationally, it differs from English in that (i) it has fixed main stress; (ii) this is located on the final syllable of intonation units, whereas English is predominantly trochaic [8]; (iii) secondary stress is variable in both position and realisation [9]. Segmentally, French has in recent times lost the last vestiges of distinctive vowel length, although vowel lengthening is an obligatory allophonic process in certain types of stressed (and therefore final) syllables. Above all, standard French has 3 (or 4) distinctively nasal vowels. These are typically produced with longer durations than oral vowels, and have been analysed as diphthongs, starting with an oral portion followed by a movement to a nasal target [10].

The French subjects could thus present a number of challenges to the null hypothesis. The technique used in [1,2,3] involves subjects making graded judgements of the degree of nasality in vowels; as French phonology uses vowel nasality categorically, French subjects may have difficulty making such judgements. Furthermore, responses to each of Hajek's parameters could be affected by the prosodic structure of French. As stress is non-distinctive, its presence or absence may play a lesser conditioning role on other phenomena than in English. Alternatively the fixed nature of French stress may constrain francophones to attend to stress-related phenomena only if these are situated in phrase-final position; in this case we would observe, relative to the anglophone subjects, a restriction on the stress parameter, but an intensification of the preference for oxytonic patterns in the Rhythm parameter.

3. EXPERIMENTAL DESIGN

3.1 STIMULI

As described in [2] a series of twenty-four disyllabic synthetic stimuli was created using the HLSYN pseudo-articulatory synthesizer. This synthesizer drives an implementation of the KLSYN formant synthesizer using 10 articulatory variables specified by the experimenter. 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 varied, in a similar fashion, 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. Our null hypothesis predicts that all of the factors varied here should impinge on nasality judgments for French subjects as they did for the English subjects in [2]. Specifically (i) stimuli with higher VPO settings should be perceived as more nasal than those with lower

settings; (ii) for the same degree of VPO, longer vowels should be perceived as more nasal than shorter vowels; (iii) for the same VPO and vowel length, stressed vowels should be perceived as more nasal than unstressed vowels; and (iv) final stressed vowels should be perceived as more nasal than non-final stressed vowels of the same length and VPO. It should be noted that, whereas for the English subjects in [2] the two stress patterns synthesized here are normal both in conversational speech and in terms of the patterns found in the lexicon, for the French subjects only the oxytonic pattern has that status. In French, both lexical items and phonological phrases have final stress. This default pattern may, however, be modified under certain pragmatic conditions, such as disambiguation: 'J'ai dit que c'est un pêcheur, pas un pécheur.' Such a pattern will not, therefore, be completely unnatural for the French subjects.

3.2 SUBJECTS AND PROCEDURE

Subjects were ten native speakers of metropolitan French, all staff or students of the Institut de la Communication Parlée in Grenoble. None was a competent speaker of any foreign language, but all had received some phonetic training. They were compared to the subjects described in [2], speakers of British English, all students at Oxford University. Subjects were asked to respond to each stimulus by marking on a pre-prepared sheet how nasalised they considered the first vowel to be, on a scale 1 (least nasal) – 5 (most nasal). Subjects were run individually, or in very small groups, the experiment being preceded by a short practice session. 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, leaving five responses to each stimulus.

The ratings from these were then input to a repeated measures ANOVA, with dependent variable nasality judgement, between-subjects factor language, and within-subjects factors VPO, vowel length, subject, syllable position of nasal vowel (first or second) and prominence of nasal vowel (stressed or unstressed). Further tests were carried out on the results from the French subjects only, matching those for the English subjects reported in [2]. In particular, planned comparisons were made between the two prominence conditions, and the interactions between prominence and VPO, prominence and syllable position, and the three-way interaction prominence*syllable position*VPO.

4. RESULTS

4.1 Velopharyngeal opening

The degree of velopharyngeal opening was highly significant for the French subjects ($F[2,8] = 21.4$, $p < .001$), as for the English ([1,2]); see Figure 1, which shows

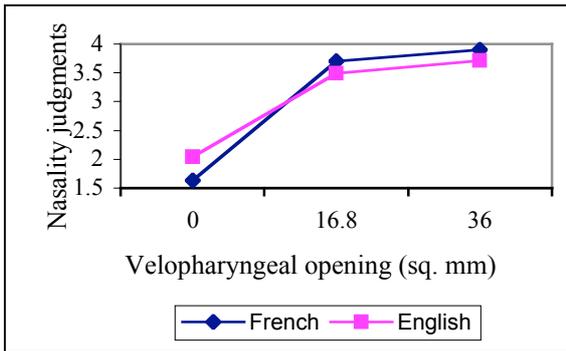


Figure 1: Nasality judgments for both groups

responses against degree of VPO for each language. The French subjects were therefore able to make judgements concerning the relative degree of nasality on vowels.

4.2 Vowel length parameter

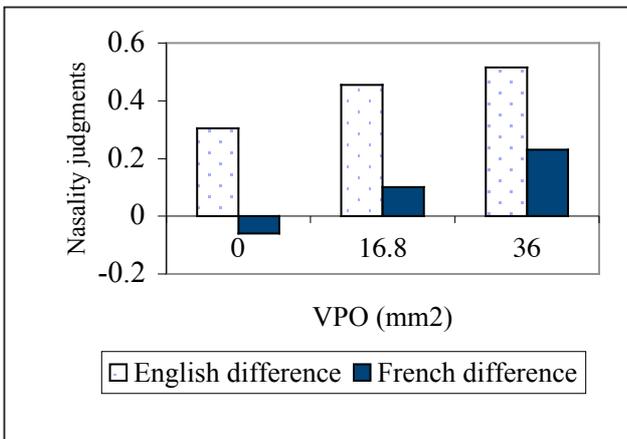


Figure 2: Differences between judgments for long and short vowels

To facilitate cross-linguistic comparisons for this parameter, Figure 2 presents the vowel length results for both languages in terms of the difference in nasality ratings between long and short vowels for each group at each degree of VPO; it thus gives a direct representation of the extent of the effect. This is much smaller in French than English for all VPOs. Analysis of variance shows the two subject groups to be significantly different ($F[1,18] = 5.7, p < .028$). Further analysis of just the French subjects shows that for them the vowel length distinction does not quite reach the .05 level of significance ($p < .01$ for the English subjects). However, planned comparisons of the effect at different VPO levels show a significant distinction at the highest level ($p < .005$). There is thus a marginal effect of vowel length in French.

4.3 Stress parameter

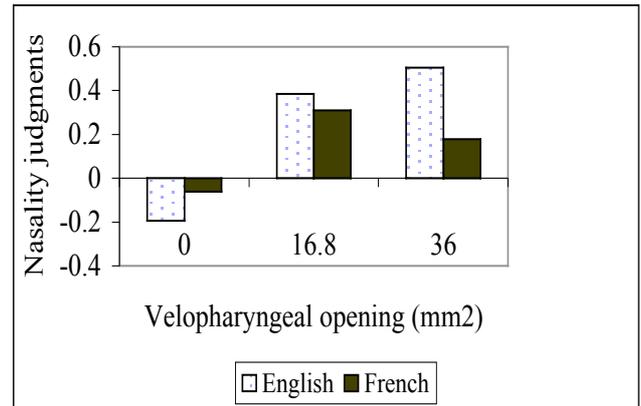


Figure 3: Differences between responses according to stress parameter

In Figure 3, the difference in nasality ratings between stressed and unstressed syllables is given for each group at each degree of VPO. The overall statistical analysis shows that the two groups differ significantly; the stress*language interaction is not significant, but that between stress*language*VPO is highly so ($F[2,17] = 8.1, p < .003$). In English, the main effect was significant ($p < .02$), with significant distinctions at the two higher VPO levels. For the French subjects, the main effect of stress is not significant ($p < .184$), but the stress/VPO interaction is significant ($p < .015$). Planned comparisons show that in French stress is significant only for the intermediate VPO value ($16.8 \text{ mm}^2; p < .022$). However, as noted above, main stress usually only occurs in final position in French, and the possibility arises that the mixing of final and pre-final positions may be a confounding factor here. This interpretation was confirmed by detailed analysis: the stressed/unstressed difference was significant in French only in final position.

4.4 Foot parameter

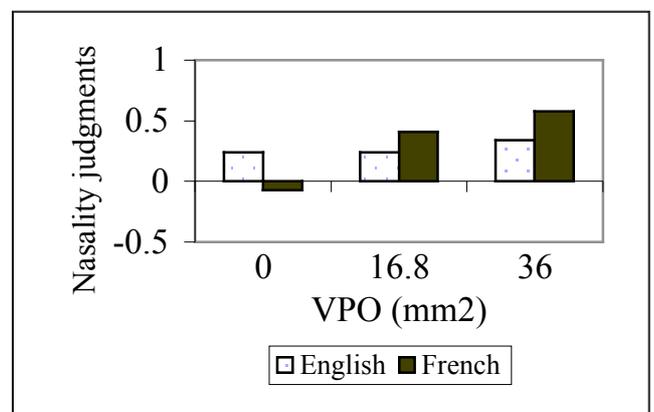


Figure 4: Difference in nasal responses conditioned by Rhythm parameter

As suggested by the above, the French subjects responded

to this parameter more strongly than the English (see Figure 4) except at the VPO setting of 0 mm², at which they showed no effect at all ($p < .05$). For the English subjects the distinction is weakly significant overall, and highly significant at each VPO level ($p < .01$), whereas for the French it reaches significance only for VPO settings of 16.8 mm² ($p < .002$) and 36 mm² ($p < .0002$).

5. DISCUSSION

For the three parameters examined here, the French subjects differ significantly from their English counterparts, while still showing sensitivity to the effects investigated. In each case, the differences may be attributed to subjects' perceptual behaviour being attuned to the role played by the suprasegmental phenomena concerned in their native language. The two groups show particular disparities with respect to the vowel length and stress parameters. The effect of vowel length was highly significant for speakers of English, in which vowel length contributes to phonemic distinctions, but weak in French, where it does not. Future work should investigate whether there are languages in whose phonologies vowel length plays a role so small that their speakers are completely insensitive to this parameter: it will be recalled that French phonology does have non-distinctive lengthening, and that French nasal vowels have been described as long.

The results for the stress parameter require more complex interpretation. The main effect of stress was non-significant, as might be predicted for subjects for whom main stress, being fixed and non-contrastive, is relatively uninformative. However, we found the stress/VPO interaction was significant, as was the stressed/unstressed contrast for the middle degree of VPO, indicating that the subjects do have some sensitivity to this parameter. Furthermore, the results for the Rhythm parameter show that the perception of nasality on stressed syllables is highly conditioned in French by the relative position of those syllables (final vs. penultimate), more so than in English. Indeed, if one focuses only on those positions where main stress may normally be found in each language (either position in English, final in French), there is little difference between the two.

The rhythm parameter was significant in both languages, with, overall, a stronger effect in French. The French subjects' greater preference for oxytones reflects the normal patterning of that language. Non-final stresses in French are either secondary and weak (and these are not normally penultimate) or highly marked. More complex experimentation would be needed to determine whether, in the latter case, nasality is as easily perceived as on stressed final syllables.

6. CONCLUSION

The null hypothesis tested here was that French subjects would not differ from anglophones in their responses to

three factors previously shown to condition the perception of vowel nasality. That hypothesis must be rejected. There are differences, largely attributable to the different phonological patterns of the two languages. However, all of the three factors were shown to have some effect in both languages. The vowel length effect was very weak in French, leaving open the possibility that this may not be of universal applicability, and that a language could be found whose speakers would not respond to this parameter at all. The Stress and Rhythm parameters were salient for both groups of subjects, although they are subject to language-specific variations in implementation.

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