

Nasality of word initial /CV/ syllables produced by a vocal-tract model with the nasal cavity *

☆ Jihyeon Yun (Sophia Univ./Chungnam Natl. Univ.), Takayuki Arai (Sophia Univ.)

1 Introduction

The judgment on the presence or absence of nasality is not always a simple task. This intricacy gives difficulty in studying the Korean “denasalization”, that is, the losing or weakening of nasality and/or nasalance (here indicating perceptual and acoustic aspects, respectively) in “nasal” consonants. In Korean, two nasal phonemes /m/ and /n/ appear in the lexical word-initial position. They tend to be perceived as oral voiced consonants instead of nasal by native speakers of English [1], especially when those are pronounced in the domain-initial position. There arises the question: to what extent are Korean listeners affected by this idiosyncrasy when they hear foreign speech sounds in either phonemic or phonetic level.

In the present study, we produced nasal stimuli with a mechanical bent vocal-tract model containing a nasal cavity with a controllable velopharyngeal (VP) port, and a movable lower lip [2]. (On the nasality of the earlier model, see [3].) The output sounds yield stable nasalance in accordance with the degree of opening of the VP port. This helps us to directly observe the influence of the nasal coupling on nasality.

We examined the power spectra of the sample sounds. Also, the first and second author (a native speaker of Korean and Japanese, respectively) perceptually evaluated those samples. We expected the Korean listener to perceive more as nasal for an isolated syllable with less nasal resonance, than the Japanese listener.

2 Materials and methods

A male Japanese speaker pronounced a sustained /a/ sound. This sound was recorded using a microphone (SONY ECM-MS957) in a sound-proof room at Sophia University. The glottal source was then extracted by [PointProcess: To Sound (phonation)] function on Praat (v.6.0.28).

This extracted sound was played through the

vocal-tract model [2] from a driver unit (TOA TU-750) connected to an audio amplifier (ONKYO MA-500U). While the glottal source was being played, the “lower lip” block of the model was manually manipulated for closure and release of the “oral cavity”. The output signal was again recorded with a digital recorder (marantz PMD661MKII).

In the recording, the degree of rotation controlling the opening of the VP port was modified in equal steps of ten degrees, from 0 to 50. At 0 degree, the VP port was closed. The rotation of the VP port above 50 degrees made unnatural sounds, thus excluded from the recording.

During the operation of the lip movement, the resilience of the springs caused the lower lip block to hit back against the metal parts that provide support at the bottom. Due to this problem, unintended noise was introduced to the sounds some milliseconds after the release of the “oral” emission.

The recorded samples resembled an /aCa/ sequence. We removed the initial vowel before the intervocalic /C/ interval to give an impression of the isolated /Ca/ syllable. Each sound differing in the degree of VP-port rotation was edited to include 30 to 70 ms interval before the clashing noise, in 10 ms steps (Set_30ms to Set_70ms).

3 Perceptual evaluation

The authors of the present study evaluated the six stimuli, from 0 to 50 degrees of VP port opening. Each set consisted of the stimuli with the same degree of VP port opening in five conditions varying in the duration before the clashing noise. Three options were presented for selection: “ba”, “ma” and “else”. Due to the possible inter- and intra-listener variation, we evaluated ten trials per each stimuli.

The degree of the VP port opening affected the perception of nasals, with the partial influence from the duration of the nasal onset. Both of the authors obtained the most consistent result of categorization between /ba/ and /ma/ for Set_60ms which contains 60 ms interval before the clashing noise.

*鼻腔を伴う声道模型の /CV/ 音節における鼻音性. ユン・ジヒョン (上智大/忠南大), 荒井隆行 (上智大・理工).

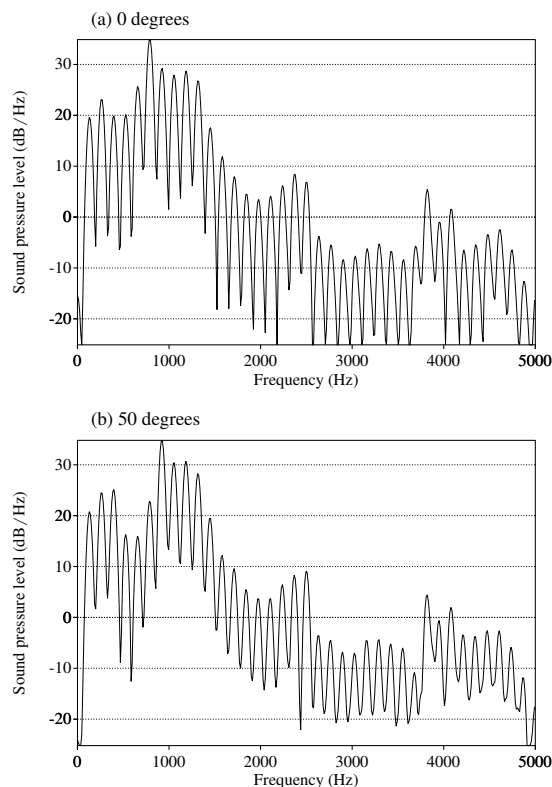


Fig. 1 Power spectra of vowel measured at the midpoint of the /Ca/ stimuli for Set_60ms: VP port rotation at (a) 0 degree, and (b) 50 degrees

For the first author (Rater_Kor), a native speaker of Korean, the perceptual shift from /ba/ to /ma/ was located between the VP port rotation of 20 and 30 degree-stimuli. Rater_Kor judged the stimuli 100 % as /ba/ for the 0 and 10 degrees stimuli of each set, from Set_30ms to Set_70ms. For the second author (Rater_Jpn) whose native language is Japanese, the perceptual boundary of the two syllables was between 10 and 20 degrees.

For the stimuli above 20 degrees, Rater_Jpn only picked /ba/ once. This is contrastive to Rater_Kor who judged nine of ten trials as /ba/ for the stimuli of 30 degrees in Set_30ms and Set_40ms.

4 Spectral analysis

Acoustic analysis was performed on Praat (v.6.0.28). For the inspection of spectrograms and spectra, we analysed the stimuli from Set_60ms. Each stimulus was 410 ms long, of which the initial 60 ms was considered as closure and transition interval of the nasal consonant. For the spectral analysis, we chose the midpoint of the vowel interval to avoid

the collateral noise in the consonant interval.

The effect of nasalization can be observed from Fig. 1. The spectra of vowel interval shows the change in resonance and anti-resonance. The effect was prominent under 1000 Hz especially between the third harmonics (h3) and the sixth (h6).

For the VP opening of 50 degrees, h6 was lowered and h7 was raised in terms of intensity, when compared to 0 degree. From 10 to 50 degree-stimuli, h3 was kept greater in their energy than 0 degree. For 0 and 10 degrees, h2 was greater than h3, while for the rest was the contrary.

5 Discussion

In the present study, the degree of the VP port opening was maintained constant throughout the entire /CV/ syllable of each stimulus. The perception of nasality could be derived from either of the consonant or vowel interval. Further investigation is needed to reveal which part has the prominent effect.

The result of the perceptual evaluation contradicted our prediction, given that the previous research reported the domain-initial nasals of Korean to have weak nasal airflow [1] and short duration. The number of times Rater_Kor perceived /ma/ was less than Rater_Jpn for the stimuli with more than 20 degrees of the VP port opening. A possibility for this unexpected result may be due to the adjustment of the perceptual criterion: Rater_Kor may have used another strategy rather than the thresholds of Korean when evaluating the stimuli. In Korean, the phonetic [ba] is an allophone of /pa/; most of native speakers of Seoul Korean would pronounce /pa/ with longer VOT than Japanese /ba/ in the domain-initial position. In that case, the whole stimulus set of the present study may lack the prototypical non-nasal plosive category of Korean, thus the experimental setting should be modified.

References

- [1] Y. S. Kim, "An acoustic, aerodynamic and perceptual investigation of word-initial denasalization in Korean," PhD diss., University College London, 2011.
- [2] Arai, T., Proc. of INTERSPEECH, 2017.
- [3] Arai, T., Proc. of INTERSPEECH, 1099-1103, 2016.