Quantifying nasalance in Korean *aegyo*

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ABSTRACT

Nasality has historically been a difficult quantity to measure in linguistic studies because it has required expensive and cumbersome equipment. A recent study in language documentation [18] proposed using earbuds to separately measure nasal and oral air intensity for descriptive purposes.

This study extends [18]'s earbud methodology to the field of sociophonetics by using it to measure and operationalize nasalance in the Korean baby talk register, *aegyo*, as a continuous variable. Previous research reports aegyo as associated with the speech of young women, IP-final nasality and following epenthetic nasal consonants. The present study corroborates both structural and social findings: surrounding nasal consonants resulted in a higher degree of nasalance, high vowels had more nasalance than low vowels, and nasalance was greater in the *aegyo* condition particularly for young women. This suggests that both [18]'s earbud methodology and a continuous operationalization of nasalance are meaningful metrics in sociophonetic inquiry.

Keywords: Aegyo, Earbuds, Nasalance, Nasality, Sociophonetics

1. INTRODUCTION

Measuring nasality has traditionally required cumbersome and expensive equipment such as nasometers. Recently, [18] developed an inexpensive, field-friendly and non-invasive method that uses a pair of earbuds to measure the intensity of the airflow separately in the nasal and oral passageways and allows for the calculation of a nasalance score derived from these measures, as shown in (1).

$$(1)\ 100 * \frac{A_{nasal}}{A_{nasal} + A_{oral}}$$

A = intensity in decibels

[18, p. 59]

This method has so far been applied in descriptive linguistics and linguistic documentation in order to determine the presence of phonemically nasal segments in phonological inventories. However, nasality as a subphonemic parameter also represents an important dimension in sociolinguistics, and [18]'s methodology has the potential to inform our understanding of the role it plays in linguistic variation, particularly in the creation of linguistic styles. One area where nasality plays a clear role is in the babytalk registers of Korean, Mandarin, and Japanese [4, 6, 8, 13, 15, 17]. However, due to the various difficulties of measuring nasality in the field, this dimension of these styles has thus far been neglected.

In order to explore the applicability of this method to sociophonetics, specifically to a continuous operationalization of nasality in linguistic styles, we tested [18]'s methodology by applying it to the Korean baby talk register of *aegyo*. *Aegyo* is a particularly apt style to test this on, given that its nasal component also has a name, *kossori* (lit. 'nose sounds') [13]. *Kossori* can manifest as either increased nasalization of the intonation phrase (IP)-final vowel or by the addition of an epenthetic nasal consonant to said vowel. It can also be represented orthographically by the addition of an *ieung*, ㅇ, the Korean symbol for a /ŋ/, as in (2), with the standard version given in (3) [6, 8, 15]. The Korean writing system, Hangul, is an alphabet that is organized into syllable blocks. Thus the relevant character here changes from 자, /tɕa/, to 장, /tɕaŋ/, with the character representing /ŋ/, ㅇ, appearing below the onset vowel grouping.

(2) *Aegyo*-style Script
자기야 잘 장~~~
/tɕakija tɕal **tɕaŋ**/

(3) Standard Script
자기야 잘 자.
/tɕakija tɕal **tɕa**/
'Honey good night.'

[15, p.13]

2. METHODS

2.1. Participants

A total of 114 Korean native speakers were interviewed in their heterosexual romantic couple. Birth year ranged from 1945 to 1999. The age distribution by number of participants per decade is as follows: 1940s: 3; 1950s: 20; 1960s: 32; 1970s: 17; 1980s: 25; 1990s: 17 (MEAN = 1972.1). Region of origin varied but most participants were from the Seoul Capital Area (Capital Area: 68, *Gyeongsang-do*: 27; *Jeolla-do*; *Chungcheong-do*: 6, *Gangwon-do*: 3).

2.2. Stimuli

The stimuli consisted of three short dialogues (dinner invitation, complaining about work, vacation planning), and three open-ended scenarios in which couples were asked to roleplay with one another (requesting, comforting, expressing love).

2.3. Procedure

Recording took place in a private room (a rented room in a study café, a local church, the participants' home, or the researcher's parents-in-law's home) with the researcher present. Recording was done on a pair of Zoom H4n Pros at 44.1 kHz (one recorder per participant) and a pair of low-resistance (32 Ω) earbuds with silicone attachments (Joha JE01) used as microphones. One earbud was placed in the corner of the mouth and one was placed under a nostril to separately record the oral and nasal tracts. A JLab TALK GO Plug & Play USB Microphone was also attached to the laptop used to present the data and used to record the full interaction for use in other research.

The participants were first requested to read the dialogues and then switch roles and do it again. They were then asked to do the roleplays with each partner performing each role once. They were asked to do both of these while speaking "as they usually do." They were then asked to repeat the procedure again while performing *aegyo*.

3. ANALYSIS

3.1. Measurements

The purported location of nasality in *aegyo* is the intonation-phrase (IP)-final syllable (Moon 2013). Accordingly, the participants' speech signals were divided into IPs following K-ToBI [7]. The IPs were then extracted with 100ms on either side to facilitate the calculation of intensity at the edge of the IP, and the amplitude of both the oral and the nasal tracts were normalized to 0db using Adobe Audition (Build 14.4.0.38), following [18]. Vowel duration and intensity values for each tract were then extracted across the IP-final vowel (and any epenthetic nasal consonant following it) using a Praat script and nasalance calculated following the above equation.

3.2. Statistics

Statistical analyses of nasalance were conducted in R [16]. A mixed effects linear regression was calculated using the *lmer()* function of the lmerTest package [9], with nasalance as the dependent variable and the interaction of *preceding segment type* (oral consonant, vocoid, nasal consonant), *vowel duration* (continuous in seconds), *presence of following epenthetic nasal consonant* (yes, no), and *vowel height* (low, mid, high) as independent variables. Additionally, it was suspected that sounds in the 100ms surrounding the IP might influence the amplitude normalization if their amplitude was higher than any sound in the IP itself, so two additional independent variables addressing noise on the edge of each track (i.e., noise from the vocal tract that occurred in the 100ms on the edge of each sound file that was outside of the IP and was larger in amplitude than any sound in the IP itself) were added: *presence of oral-edge noise* (yes, no) and *presence of nasal-edge noise* (yes, no). Additionally, to examine the role of social parameters, we included the three-way interaction between (*performance of) aegyo* (yes, no), continuous *age* (calculated using the Korean system, 2022 - year of birth +1), and *gender (women/men)*. Random intercepts for *participant* and *lemma* were also included. Graphics were generated using the ggplot2 [19] and sjplot [12] packages of R.

4. RESULTS AND DISCUSSION

Table1 displays the computed statistical model.

Factor	Estimate	*p*-value
Intercept	4.833	<0.0001****
Preceding vocoid	1.277	<0.0001****
Preceding nasal cons.	3.075	<0.0001****
Vowel duration	1.188	<0.0001****
Mid vowel	0.585	<0.0001****
High vowel	1.540	<0.0001****
Epenthetic Nasal	2.709	<0.0001****
Aegyo	0.512	<0.0001****
Oral-track Noise	-0.819	<0.0001****
Nasal-track Noise	0.978	<0.0001****
Age	-0.000884	0.933
Men	0.538	0.481
Preceding vocoid * Vowel duration	-0.696	0.022*
Preceding nasal cons. * Vowel duration	-2.015	<0.0001****
Aegyo * Age	-0.0150	<0.0001****
Aegyo * Men	-1.165	<0.0001****
Age * Men	-0.00460	0.752
Aegyo * Age * Men	-0.0197	0.000128***

Table 1: Nasalance linear regression model (nasalance ~ *preceding segment type* * *vowel duration* + *epenthetic nasal consonant* + *vowel height* + *Oral-track noise* + *Nasal track noise* + *aegyo* * *age* * *gender* + (1|*participant*) + (1|*lemma*).

The model revealed a main effect for *preceding segment type* such that IP-final vowels preceded by a vocoid had a nasalance measure that was 1.277% higher than when preceded by an oral consonant (p<0.0001****). Additionally, IP-final vowels preceded by a nasal consonant had a nasalance measure that was 3.075% higher than when preceded by an oral consonant (p<0.0001****). There was also a main effect for *vowel duration* such that for every one second of increase in vowel duration there was a 1.188% increase in nasalance (p<0.0001****).

Figure 1 displays the interaction between *preceding segment type* and *vowel duration*. Here we see the longer a vowel is, the greater its nasalance when preceded by an oral consonant or vocoid. However, when preceded by a nasal consonant the opposite is true: the longer a vowel is, the lower its nasalance.

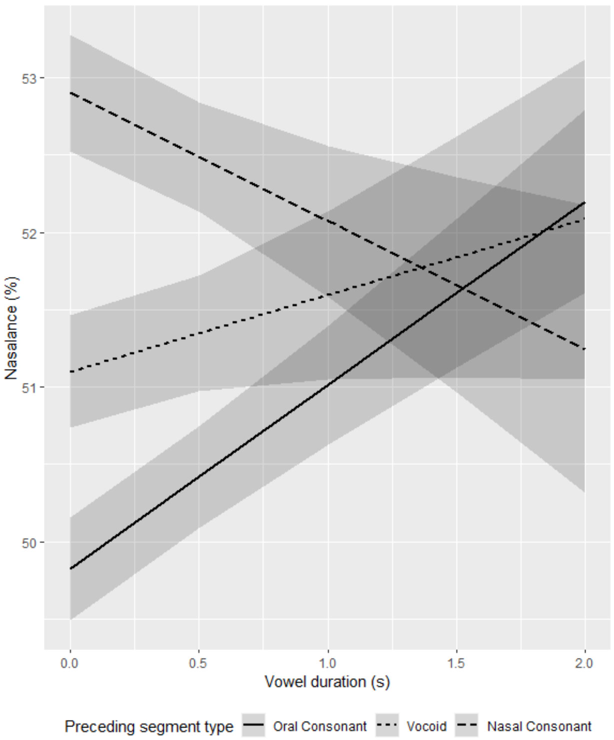

Figure 1: Predicted nasalance by preceding segment type and vowel duration. Shaded areas = 95% confidence interval.

Additionally, the presence of an epenthetic nasal consonant resulted in a 2.709% greater degree of nasalance across the IP-final vowel, as shown in Figure 2 (p<0.0001****).

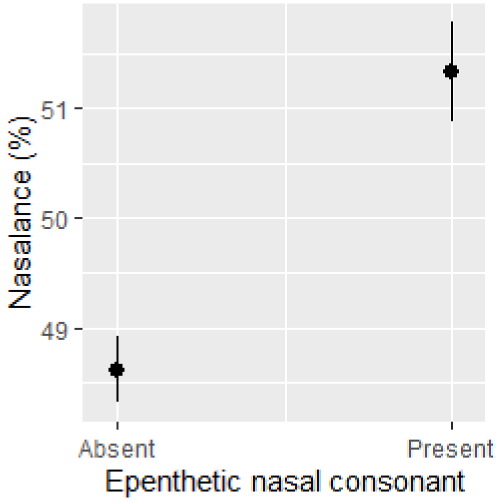

Figure 2: Predicted nasalance by presence of an epenthetic nasal consonant. Bars = 95% confidence interval.

The model also revealed a main effect for vowel height such that mid vowels had a 0.585% greater nasalance (p<0.0001****) and high vowels a 1.540% greater nasalance (p<0.0001****) than the reference low vowels, as illustrated in Figure 3.

Oral-track noise and *nasal-track noise* were also significant. When high amplitude noise was present on the edge of the oral track, the IP-final vowel was predicted to have a 0.512% greater degree of nasalance than when noise was not present (p<0.0001****). Meanwhile, when high amplitude noise was present on the edge of the nasal track, the IP-final vowel was predicted to have a 0.819% lower degree of nasalance than when noise was not present (p<0.0001****).

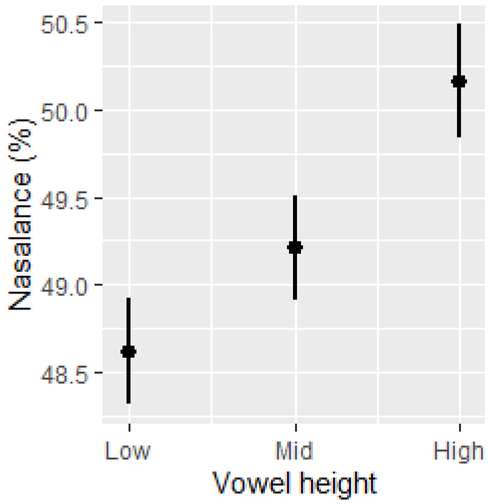

Figure 3: Predicted nasalance by vowel height. Bars = 95% confidence interval.

The findings from the structural factors suggest that the use of [18]'s earbud methodology and the continuous operationalization of nasalance are meaningful metrics in sociophonetic inquiry. The results for *preceding segment type* and *presence of an epenthetic nasal consonant* show that the coarticulation of a nasal consonant with a vowel on either side is reflected in measures of nasalance; the fact that nasalance decreases as a vowel gets longer when preceded by a nasal consonant also shows that this coarticulation gets smaller the further you get from the nasal-consonant vowel boundary. Additionally, low vowels have also been shown to have lower degrees of nasalance than high vowels [3, 11]. However, /u/ has been shown to have lower nasalance than /a/ in Korean [5, 10], and contrary to [11], [2]'s data shows /u/ having similar nasalance to /a/ in English. The authors suggest this is due to the tongue's proximity to the velum in /u/ which dampens velar vibrations and thus the transfer of energy between the oral and nasal tracts. However this should not affect the present data much: /i/ comprised 76.042% of high vowels; /u/ 22.541%, and /ɯ/ 1.416%. This finding also makes phonetic sense, given that low vowels are more sonorous than mid and high vowels, due to their larger aperture for airflow, while the nasal aperture remains relatively constant regardless of vowel height. However, given that the sounds surrounding the IP do have an effect on nasalance values, these should probably not be directly compared to values measured from a nasometer which span a much larger domain than a single IP.

The model also revealed a main effect for *performance of aegyo* such that nasalance was 0.978% greater when *aegyo* was being performed than when it was not (p<0.0001****).

Figure 4 displays the three-way interaction between *performance of aegyo*, *age*, and *gender* (p=0.000128***). Here we see that nasalance decreases sharply the older a woman is when she is performing *aegyo*, but there is little effect for age when she is not. Men also show a slight inverse correlation between age and nasalance but it is actually stronger when they are not performing *aegyo*.

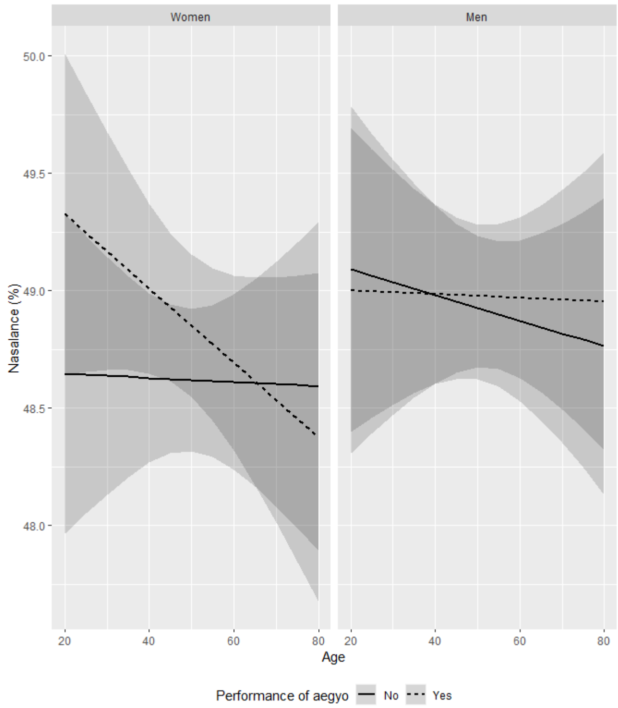

Figure 4: Predicted nasalance by *performance of aegyo*, *age*, and *gender*. Shaded areas = 95% confidence interval.

Like the structural findings, the results from the social factors also argue for the validity of [18]'s earbud methodology and the continuous operationalization of nasalance in variationist studies. *Aegyo*'s association with nasality and with young women is clearly reflected in the nasalance values. We can also see *aegyo*'s effect in the interaction between vowel duration and *preceding segment type*. IP-final vowel lengthening is also associated with *aegyo* [14], so we would expect nasalance and vowel length to increase in tandem when *aegyo* is also a factor, particularly when there is no nasal consonant to influence nasalance values, as suggested by Figure 1.

5. CONCLUSION

The results of this study have shown that continuous nasalance measures obtained using [18]'s earbud methodology follow expected directions in terms of coarticulation with nasal consonants, vowel height, vowel length, style, age and gender. This strongly suggests that this methodology and operationalization can be meaningfully applied to variationist research, opening up the possibility of the exploration of a new dimension of sociophonetic phenomena.

Because most of the nasalance values hovered around 50%, future work should explore alternative normalization methods which may yield more robust results, particularly when measuring more subtle more nasal phenomena.

6. REFERENCES

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