Speaker-Specific Place of Articulation: Idiosyncratic Targets for Japanese Coda Nasal

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1. INTRODUCTION

The long-standing question of whether place targets are necessary for speech gestures has focused primarily on the purportedly "targetless" English schwa [1, 7, 11]. Recent work suggests that English schwa is not placeless or "targetless" after all [3, 4], but rather that schwa may simply be particularly susceptible to coarticulation [2].

A sound also famously purported to be "targetless" is the Japanese coda nasal (henceforth N). Like English schwa, N is susceptible to coarticulation with a following consonant (e.g., aNka, aNta, aNpa; [12, 8]), and has often been called "placeless" ([5, 10]). One x-ray study [6] describes N as having a general dorsal place ('velar or uvular'). However, previous articulatory studies of Japanese N have been inconclusive, being limited to a single subject and lacking quantitative measurement.

A lingual ultrasound study was conducted to test whether N shows evidence of a stable place of articulation.

2. METHOD

2.1 Participants

Seven native speakers of standard Japanese (5 females and 2 males, ranging from early 20s to early 40s) participated in the experiment. The purpose of this experiment was not told. One participant's data was omitted, as her speech was affected by previous temporomandibular joint surgery.

2.2 Materials

All stimuli - *aNa, ahha, akka* - were pseudo words, phonologically and morphologically controlled. They are presented in katakana orthography as in アンア, アッハ, アッカ. The tokens consist of randomized word lists in which each token was repeated 14 times. 10-12 examples of each token were used for the current study.

2.3 Procedure

Recording was conducted in Interdisciplinary Speech Research Laboratory at University of British Columbia. Participants were trained to read all tokens with initial-accent (e.g., a'N.a) at a natural rate.

An Aloka SSD-5000 ultrasound machine was used with a UST-9118 and 180° electronic convex EV probe. Movie clips were recorded into iMovie, and converted to DV files. Still images were extracted at midpoints of consonants and vowels, using Final Cut Express ver. 1.01. Midsagittal tongue contours were produced using EdgeTrak software [9].

2.4 Design

The constriction degree (i.e., peak tongue height; y-axis) and location (i.e., peak tongue position; x-axis) were recorded, in order to compare intervocalic N with (a) flanking /a/ vowels, and (b) the *velar* consonant /k/ and the guttural consonant /h/.

3. RESULTS

3.1 Constriction Degree: N vs. Local Vowel Context

For each participant, N showed a constriction degree greater than that of surrounding /a/ vowels, as in Fig. 1.

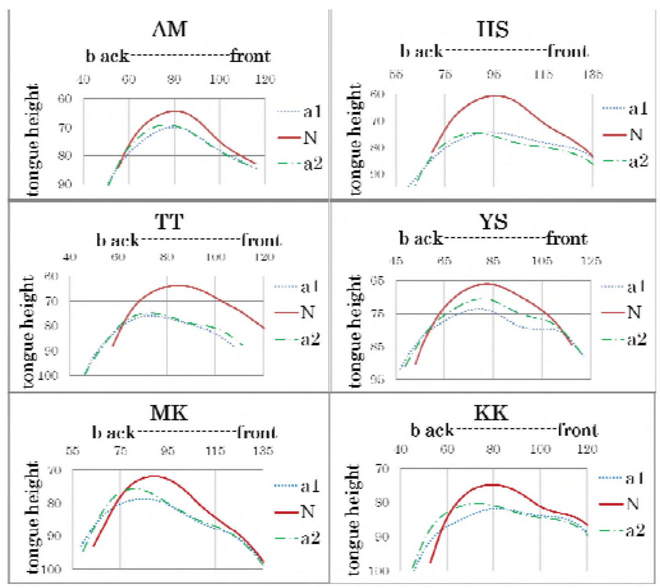

Fig. 1. Tongue Contours of *aNa*. The scale at x/y-axis is in pixels (1 pixel of x is around 0.89mm, 1 pixel of y is around 0.98mm).

3.2 Constriction Location: N vs. /k, h/

The *locations of these tightly constrained constrictions for N varied dramatically across speakers*. As in Fig. 2, the peak location of N for subjects AM and HS is further forward than both /h/ and /k/. TT and YS's N peak location is identical to /k/. MK's peak location of N is between /k/ and /h/. KK's peak location of N is identical to /h/.

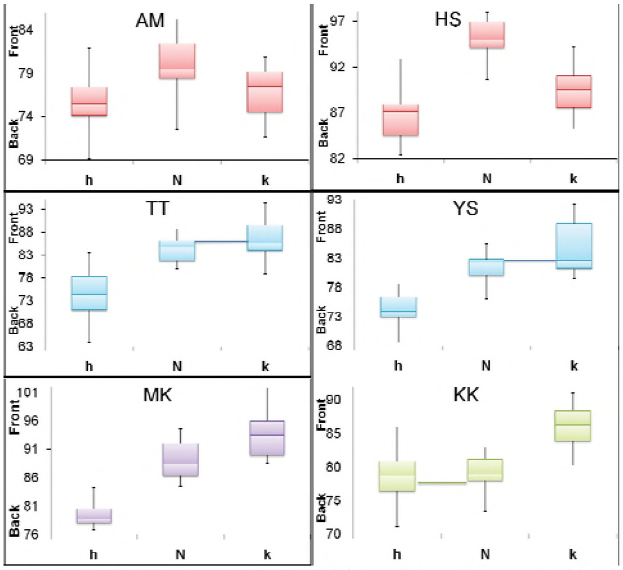

Fig. 2. Peak locations of /h, N, k/ in *ahha*, *aNa*, and *akka*. The scale at y-axis is in pixels (1 pixel is around 0.89mm).

The location of /N/ vs. /k/ or /h/ is confirmed using t-tests, as summarized in Table 1.

Table 1. T-test results (unpaired)

	AM	HS	TT	YS	MK	KK
N vs *h*	**<.01	**<0.01	***<.001	***<.001	***<.001	0.73
N vs *k*	**<.01	**<.01	0.24	0.066	**<.01	***<.001

3.3 Variability of N

N's Standard Deviation (SD) of x values at peak constriction locations was compared with those of /h, k/. As Table 2 shows, SD of N was, on average, less than that of /h/ or /k/.

Table 2. Standard Deviations of consonant location

	AM	HS	TT	YS	MK	KK	AVG
h SD	3.12	5.62	5.29	3.14	2.52	4.19	3.98
N SD	3.84	2.3	3.02	2.84	3.42	3.09	**3.09**
k SD	2.95	2.62	4.6	4.77	4.23	4.6	3.96

The result of f-tests also shows that the variance of N was comparable to that of /k/ for all speakers.

4. DISCUSSION

The above results suggest that N is not targetless, but has a constriction location target that is as stable (within speaker) as /k/, a sound with undisputed consonantal place. Further, places of articulation for N varied individually, ranging from palatal (significantly anterior to /k/) to velar (identical to /k/) to postvelar (significantly between /k/ and /h/) to uvular/upper pharyngeal (identical to /h/). This is illustrated in Table 3.

This high degree of idiosyncrasy in place of articulation accounts for the variability observed across previous single-subject studies. These highly speaker-specific findings for N's constriction location speak in favor of the ontogenetic emergence of place features within individual phonetic/phonological systems.

Table 3. Categorization of peak location

Type of N	Pharyngeal <--> Palatal			Participants
palatal	h	k	**N**	AM, HS
velar	h	k, **N**		TT, YS
postvelar	h	**N**	k	MK
Uvular/ pharyngeal	h, **N**		k	KK

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