

An Electro-palatographic Study of Palatalization in the Japanese Alveolar Nasal

Masaki Tsuzuki*

<Contents>

- | | |
|-----------------|----------------|
| 1. Introduction | 5. Material |
| 2. Attitude | 6. Methodology |
| 3. Survey | 7. Observation |
| 4. Purpose | 8. Conclusion |

<Abstract>

It is widely known that the Japanese alveolar nasal [n] is affected by adjacent vowels in most positions, that is, the variants of the alveolar [n] occur conditionally. The Japanese [n] is palatalized under the influence of vowel [i] or palatal [j]. In the articulation of “に”[ni], for instance, the tip and sides of the tongue make wide contact with the palate. It is interesting to know how palatalization occurs and varies during the production in different contexts. In my presentation, the actual realization of the palatalized alveolar nasal in different contexts is examined and clarified by considering the Electro-palatographic data and examining the articulatory feeling and auditory impression. As a result, palatalized [ɲ] occurs either word-initially- or inter-vocally. [ɲ] in [ni] and “いに”[iɲ] has great palatality. When conditioned by [j], the [ɲ] in “にゃ”[ɲja], “にょ”[ɲjo] and “にゅ”[ɲju] has full palatality. In each sound the average number of contacted electrodes of the Electro-palatograph at maximum tongue-palate contact is 63 or 100% of the total. To summarize the experimental data, articulatory feeling and auditory impression, it can be concluded that the [n] followed by or hemmed in [i], [j] is a palatalized nasal [ɲ].

* Aichi Gakuin University

1. Introduction

Phonetics is a scientific study of speech sounds of human language, which involves the study of actual realization, variants and physical entities of speech sounds. That is, phonetics is the study of the auditory, articulatory and acoustic or physical features and structures of speech sounds. Phonetic study and research are not specific but fundamental to the study of language. This paper is mainly concerned with articulatory, auditory and acoustic approaches of the Japanese palatalized nasal [ɲ].

2. Attitude

2.1. Acoustic phonetics

As recent studies in phonetics or contrastive phonetics have been increasingly concerned with observing the physical attributes of speech sounds, special importance has been attached to the field of acoustic phonetics. Acoustical achievements have become the focus of phonetic studies, and a rapid development of acoustic phonetics and contrastive phonetics followed the improvement in experimental methodology.

Acoustic phonetics clarifies the physical properties and features of speech sounds using oral-aural instruments or an electric apparatus which are specially designed for phonetic investigation. An acoustic evidence which is obtained through experimental methods is a fundamental datum to support the theory of an articulatory transmutation or auditory impression. Phoneticians have been offered reliable evidences through experimental methods. When mechanical limitations, however, are considered, a conflict may concentrate on the difference among acoustic facts, articulatory feeling and auditory impression. Just because investigated evidences are obtained, it does not necessarily determine the sound quality. The prior designator in determining the sound value is still debatable.

It can be said that acoustic phonetics has shown remarkable progress in the development of experimental devices and has played an important role in a great many discoveries about how speech sounds are articulated and perceived.

2.2. The author's attitude

The author's attitude for phonetic study is based on considering not only physical evidence but also the sense impression. Acoustic studies have been carried out using experimental apparatus such as oscilloscope, X-ray cinematograph, laryngoscope, electromyograph, sound spectrograph, electro-palatograph and flow-nasalitygraph, some of which are used in this monograph.

Regarding the attitude of the study, speech sounds are clarified by sense impression of auditory impression and articulatory feeling, and physical evidence of palatographic analysis.

2.3. Sense impression and Physical evidence

Regarding to the attitude of the study of sounds, speech sounds can be clarified by:

- 1) Sense impression of
 - A. Auditory impression
 - e.g. clear [l] dark [ɫ]
 - B. Articulatory feeling
 - e.g. advanced [k̟] retracted [k̠]
- 2) Physical evidence of
 - A. Acoustic Analysis (by using voice)
 - Sound spectrographic Analysis
 - Visi-Pitch Analysis
 - Flow-Nasalitygraphic Analysis
 - B. Palatographic Analysis (by using articulators)
 - Electro-palatographic Analysis

3. Survey

3.1. Korean and Japanese nasals

Korean and Japanese sounds have been studied using different approaches and in different areas of investigation by many phoneticians and linguists, but little study has been made on the Korean and Japanese nasals or on comparisons between the two languages using an electro-palatograph.

One well known investigation, however, was done by Lee, H. (1980:1-47) in which he studied Korean consonants such as plosive, affricate, lateral and nasal. Retroflexion and palatalization in Korean sounds were reported in his paper. His was the first article published in Korea in which electro-palatographic data was featured. In that paper he showed nearly 90 intricate palatograms and clarified the actual realization of those consonants. His observations and data indicate, for example, that the degree of palatalization of [ɲ] in *nyon* “^ㄴ” is greater than that of [ɲ] in *sallya* “^ㄴ” (Lee, H., 1980:37).

In regard to the Japanese nasals, there are five variants: namely, [m], [n], [ɲ], [ŋ] and [ɳ], of which all occur in word-initial positions except [ŋ] and [ɳ]. Among these, in syllable-final positions, [ɳ] and [ŋ] commonly occur. Inter-vocalically, [m], [n], [ɲ], [ŋ] and [ɳ] occur.

3.2. Japanese uvular [ɳ]

Although [ɳ] is generally designated as a “voiced uvular nasal”, (口蓋垂鼻音) in the case of the Japanese [ɳ] the most noticeable feature is that the articulatory manner is slightly different from that of the [ɳ] of the I.P.A. and other nasals. That is, although the uvula assumes a lowered position, and opens the nasal cavity, the closure between the uvula and the back of the tongue is not complete so that air from the lungs can escape through the oral cavity as well as through the nasal cavity. Some phoneticians and linguists use the phonetic symbol [ŋ̞] instead of using [ɳ]. It was Richard Paget, *Human Speech* (1930), who first devised [ŋ̞] for transcribing the uvular nasal.

The description of the articulatory manner of the Japanese uvular [ŋ] has been suggested by Kanehiro (1932:202-206), Onishi (1936:144-149), Sakuma (1963:162-170) and Umeda (1980).

The uvular [ŋ] is similar to nasalized vowels but in the case of the nasalized vowel, the "vowelness" (母音性) is the dominant feature of the sound, whereas the "nasality" (子音性) is the secondary feature. In the case of the uvular [ŋ], the "nasality" is the dominant feature of the sound, and the "vowelness" is the secondary feature (Tsuzuki, 1992). In case of the Japanese uvular [ŋ], it has nasal priority or prior "nasality"

3.3. Nasals in the intervocalic position

In Japanese, [m], [n], [ɲ] and [ŋ] occur in the intervocalic positions. But [ɲ] occurs in the context of "vowel+[ɲ]+[j]", such as, *hanyuu* "はにゅう" [haɲju:]. (In the context of "vowel+[ɲ]+[ɲ]+[j]", [ɲ] also occurs as *hannyuu* "はんにゅう" [haɲɲju:].)

3.4. Japanese nasals in "vowel+[ŋ]+vowel" and "vowel+[n]+vowel"

Nasal [ŋ] by itself in the intervocalic position can form one syllable. Therefore in the word *tan-i* "たんい" (単位) [taŋi], the [ŋ] is a syllabic consonant and the word can be divided into three syllables ([ta-ŋ-i]). The uvular [ŋ] as a syllabic consonant is very common in Japanese. However, in the case of the word *tani* "たに" (谷) [ta-ni], the alveolar nasal [n] can not form one syllable. But the combination of [n] and the vowel [i] (a consonant-vowel sequence) can form one syllable. So there are two syllables in the latter case.

Similarly:

(a)	<i>an-i</i> あんい (安易)	[a-ŋ-i]	versus	<i>ani</i> あに (兄)	[a-ni],
(b)	<i>kan-i</i> かんい (簡易)	[ka-ŋ-i]	versus	<i>kani</i> かに (蟹)	[ka-ni],
(c)	<i>nan-i</i> なんい (難易)	[na-ŋ-i]	versus	<i>nani</i> なに (何)	[na-ni],
(d)	<i>sen-i</i> せんい (繊維)	[se-ŋ-i]	versus	<i>seni</i> せに (背に)	[se-ni],
(e)	<i>han-i</i> はんい (範圍)	[ha-ŋ-i]	versus	<i>hani</i> はに (歯に)	[ha-ni].
(f)	<i>in-i</i> いんい (因位)	[i-ŋ-i]	versus	<i>ini</i> いに (胃に)	[i-ni].

4. Purpose

The specific purpose of this paper is to examine and clarify the actual realization of Japanese palatalized [ɲ] in different contexts by considering the experimental data and examining the articulatory feeling and auditory impression. The specific questions which are addressed here are various articulatory movements of palatalized [ɲ] influenced by adjacent vowel qualities and the articulatory manner of palatalization which occurs and varies during the production in different positions.

The following are the explicit questions:

- (1) How do different vowel qualities influence the articulatory movements of the nasal in the initial, inter-vocalic and final positions?
- (2) How do [s] and [j] influence the articulatory movements of the nasal?
- (3) How do palatalization and retroflexion occur and vary during the production of the nasal in different contexts?

5. Material

The following are the experimental materials which were used for this paper:

A : (1) “に” [ɲi], (2) “いに” [iɲi], (3) “にゃ” [ɲja],
(4) “にょ” [ɲjo], (5) “にゅ” [ɲju].

B : (1) “ね” [ne], (2) “の” [no], (3) “ぬ” [nu], (4) “な” [na],
(5) “えね” [ene], (6) “あな” [ana], (7) “うぬ” [uɲu],
(8) “おの” [ono].

6. Methodology

6.1. Rion's electro-palatograph

As recent studies in phonetics or contrastive phonetics have been increasingly concerned with observing the physical attributes of speech sounds, special importance has been attached to the field of acoustic phonetics. Some of these studies were carried out using experimental apparatus such as oscilloscope, X-ray cinematograph, laryngoscope, electro-myograph, sound spectrograph, electro-palatograph and flow-nasalitygraph. The Rion's electro-palatograph (リオン電極付き人工口蓋) is used in this paper.

6.2 Analization by the use of Electro-palatograph

Full details of the reason for using the electro-palatograph are as follows:

- (1) To observe how and why the tongue movements occur in the different contexts.
- (2) To observe how and where the first complete closure of tongue-palate contact occurs and to calculate the numbers and the percentage of contacted electrodes to the total.
- (3) To observe how and where maximum contact of the tongue and palate occurs and to calculate the numbers and the percentage of contacted electrodes to the total.
- (4) To observe how and where the last complete closure of tongue-palate contact occurs and to calculate the numbers and the percentage of contacted electrodes to the total.
- (5) To compare the numbers of electrodes contacted in the first, the maximum and last complete closure of the tongue and palate.

- (6) To count the succession of frames which have complete closure of the tongue and palate from the first to the last.
- (7) To time the duration of complete closure of the tongue and palate from the beginning to the last.
- (8) To compare the data with that of other variants conditioned by different contexts.
- (9) To graphically show the condition of tongue-palate contacts.
- (10) To observe retroflexion and palatalization.

7. Observation

7.1. Alveolar nasal [n] type

7.1.1. Initial position

In the cases of “네” [ne], “노” [no] and “누” [nu], tongue-palate contact occurs at the first, second and third outer circles. The shape of tongue-palate contact is that of a horseshoe (馬蹄形). In the case of “나” [na], tongue-palate contact occurs at the first, second and third outer circles and at the second inner circle. The average number of contacted electrodes at maximum complete closure of the four sounds ([ne], [na], [no] and [nu]) is 51 or 80.952% of the total. The average succession of complete closures of these four sounds is 19 frames with a duration of 0.296 seconds. The word-initial [n] in these sounds is an alveolar nasal [n].

7.1.2. Inter-vocalic position

In the cases of “네” [ene], “노” [ono] and “누” [unu], tongue-palate contact occurs at the first and second outer circles. The shape of tongue-palate contact is that of a horseshoe. In the case of “나” [ana], tongue-palate contact occurs at the first, second and third outer circles. The average number of contacted electrodes at maximum complete closure of the four sounds ([ene], [ana], [ono] and [unu]) is 38 or 60.317% of the total. The average succession of complete closures of these four sounds is 8 frames with a duration of 0.125 seconds. The intervocalic [n] in these sounds ([ene], [ana], [ono] and [unu]) is an alveolar nasal [n].

7.2. Palatalized nasal [ɲ] type

7.2.1.

In the case of [ɲ] in [ɲi], the tip and sides of the tongue make wide contact with the palate. The [ɲ] in [ɲi] has great palatality and is a palatalized nasal [ɲ]. The maximum tongue-palate contact in [ɲi] has 61 contacted electrodes or 96.825% of the total. Complete closure continues for a succession of 16 frames with a duration of 0.250 seconds.

The average number of contacted electrodes of the three stages (at the first, the maximum and final complete closure) is 52 or 82.539% of the total. Palatalization occurs greatly in [ɲi].

7.2.2.

In the case of [ɲ] in [iɲi], the tip and sides of the tongue make wide contact with the palate. The [ɲ] in [iɲi] has great palatality and is a palatalized nasal [ɲ]. The maximum tongue-palate contact in [iɲi] has 57 contacted electrodes or 90.476% of the total. Complete closure continues for a succession of 9 frames with a duration of 0.140 seconds. The average number of contacted electrodes of the three stages is 48 or 76.190% of the total. Palatalization occurs greatly in [ɲ] conditioned by the adjacent vowel [i] which hems [ɲ] in the combination of [iɲi].

7.2.3.

In the production of [ɲja], [ɲjo] and [ɲjɯ], the front of the tongue is fully raised towards the hard palate, because of the influence of the following palatal [j]. At maximum tongue-palate contact, all parts of the palate are completely contacted. The [ɲ] in [ɲja], [ɲjo] and [ɲjɯ] has full palatality. The succession of frames of complete tongue-palate closure is longer in [ɲjɯ] than in [ɲja] or [ɲjo]. The average of maximum tongue-palate contact of these three sounds is 63 contacted electrodes or 100% of the total. The average number of frames of maximum tongue-palate contact is 22 frames or 0.343 seconds. The three stages (the first, maximum and final complete closure) are seen.

8. Conclusion

Considering the experimental data (by Tsuzuki & others) and examining articulatory feeling and auditory impression, a palatalized nasal is clarified.

Word-initially the Japanese [ɲ] in [ɲi] has great palatality. Inter-vocally the [ɲ] in [iɲi] has great palatality. The Japanese [ɲ] in [ɲja], [ɲjo] and [ɲjɯ] has full palatality.

In regard to palatalization, considering the experimental data, the articulatory feeling and auditory impression, it can be said that palatalized [ɲ] occurs either word-initially or inter-vocally. The results which were obtained in this experiment generally agree with the accounts of Kanehiro (1932:202-206), Onishi (1936:144-149), Sakuma (1963:162-170) and Tsuzuki (1979, 1987, 1987).

Acknowledgments

In bringing out this study, my sincere acknowledgments are due to Ms Janet Mary Bland of Aichi Gakuin Univ., Japan, who has kindly spared so much of her busy time and has given me valuable help in discussing the manuscript of this paper; also to Prof. Hyun Bok Lee of Seoul National Univ., Korea, who was the supervisor of my Dr. Litt. Degree, for his great lectures on Phonetics and his continuous encouragement.

Last but not least, to Prof. Terumichi Horiuchi, for his great help, patience and love.

References

- Hattori, Shiro (1930). 「ン」に就いて、音声の研究、第3号、日本音声学會。
- Hattori, Shiro (1970). 音声学、岩波書店。
- Hattori, Shiro; Yamamoto, Kengo and Fujimura, Yasushi (1956). 母音の鼻音化と鼻音、小林理學研究所報告6卷4号。
- Kanehiro, Masao (1932). 実験英語の音声学、泰文堂。
- Kanehiro, Masao (1934). 日本語の「ン」音の性質に就いて、英語教授研究所主催第10回英語教授研究大會記念論文集。
- Kindaichi, Kyousuke (1963). 国語音韻論、刀江書院、復刻版。
- Lee, Hyun Bok (1980). *A study of Korean Speech Sounds Using Electro-Palatography and Its Application to Speech Pathology*, ソウル大學語學研究所研究論集。
- Lee, Hyun Bok (1989). *Korean Grammar*, Oxford University Press.
- Matsuno, Kazuhiko (1989). *An Electropalatographic Study of Japanese Palatal Sounds*, 日本音声学會會報 第190号、日本音声学會。
- Nihon Onsei Gakkai (1985). *Onseigaku Daijiten, A Dictionary of Phonetics*, 音声学大辭典、日本音声学會、三修社, 6th ed..
- O'Connor, J.D. (1982). *Phonetics*, Penguin Books, Reprinted.
- Onishi, Masayuki (1987). 動的人工口蓋による日本語子音の考察、日本音声学會會報, 第186号、日本音声学會。
- Paget, Richard (1930). *Human Speech*, Harcourt Brace & company.
- Park, Hea Suk and Umeda, Hiroyuki (1978). 韓国語の/r/と日本語のラ行子音、朝鮮學會第29回大會、發表要旨、朝鮮學報。
- Sakuma, Kanae (1963). 日本音声学、風間書房。
- Toyama, Kouichi (1926). 国語の熟音の人工口蓋図形、音声の研究、第2号、日本音声学會。
- Tsuzuki, Masaki (1979). 口蓋垂の調音上の働きについて、日本音声学會會報 第161号。
- Tsuzuki, Masaki (1987). *Various Aspects of the Japanese /r/*, Phonetic Society of Korea, Bulletin No.11-14.
- Umeda, Hiroyuki (1980). *Observation of some Selected Articulation in Korean and Japanese by Use of Dynamic Palatography*, Papers of the 1st International Conference on Korean Studies, The Academy of Korean Studies, Seoul, Korea.
- Umeda, Hiroyuki (1983). 韓国語の音声学的研究、蜷雪出版社。

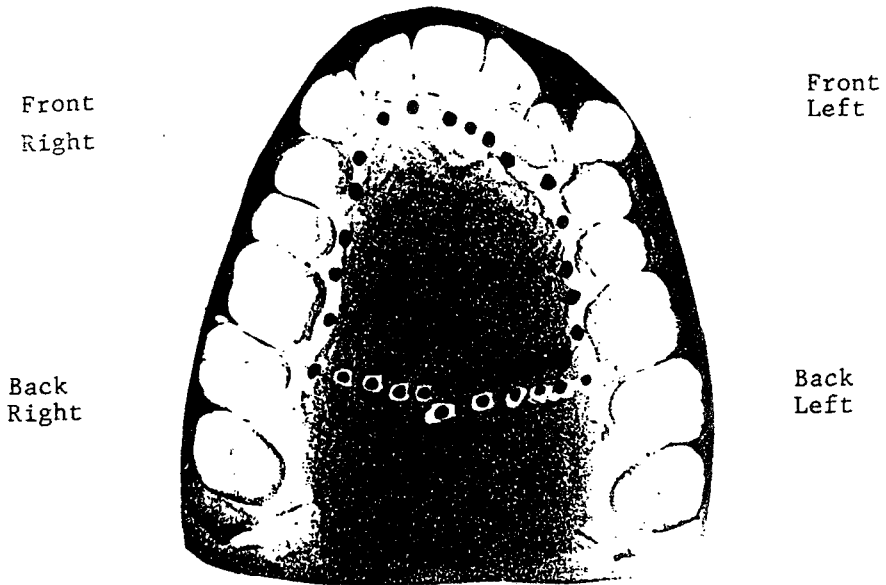


Fig. 1 Dots show the extent of the electro-palatogram in the mouth. (Masaki Tsuzuki)

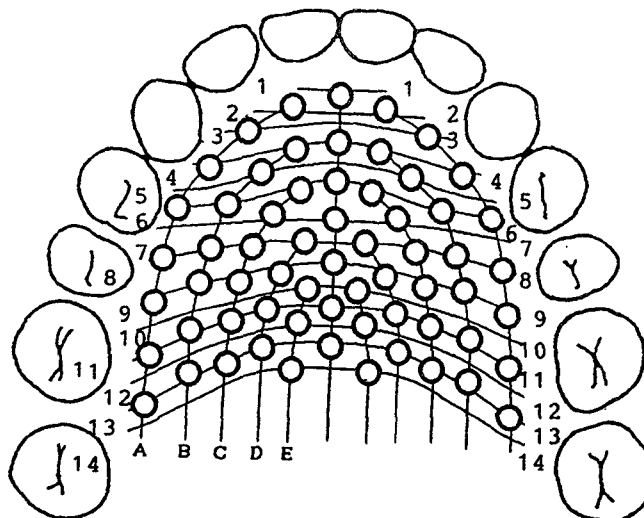


Fig. 2 The diagram of the electro-palatogram.

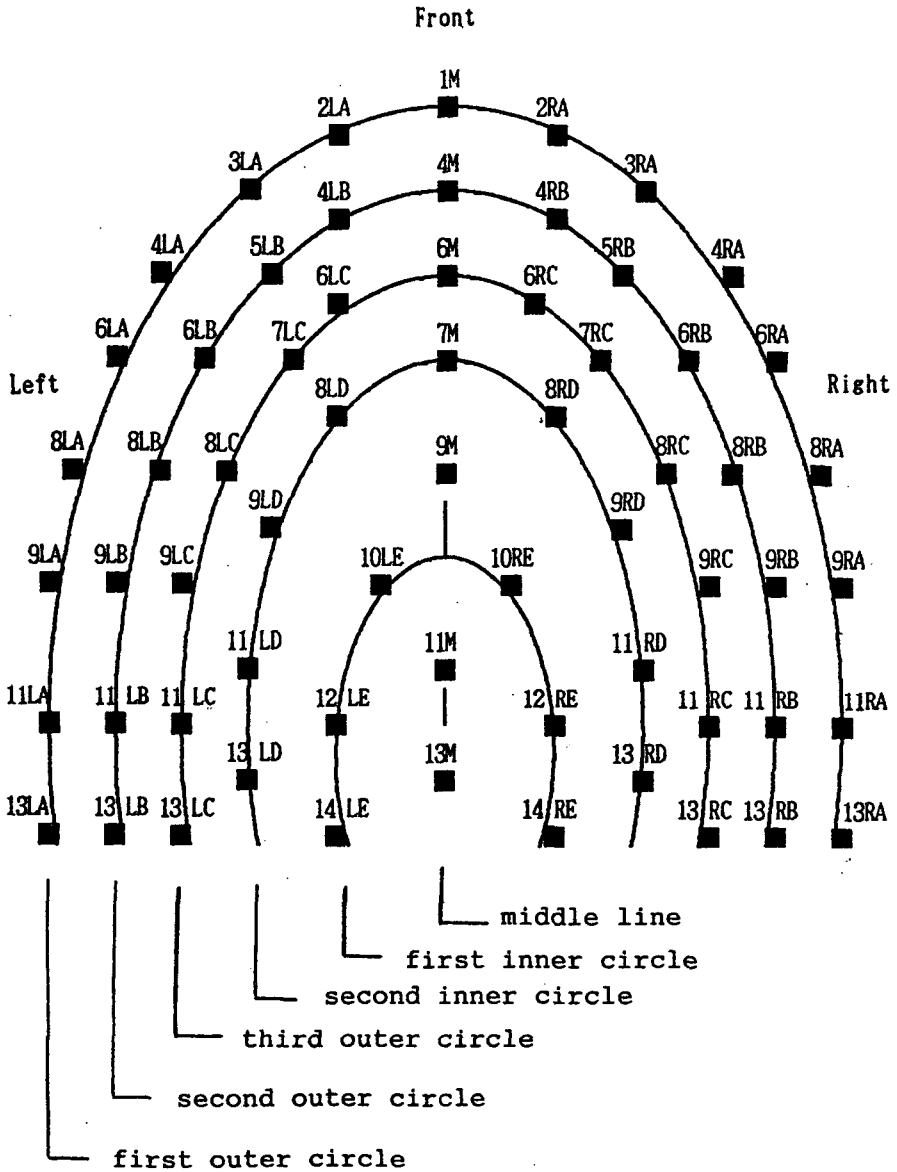


Fig. 3 63 electrodes and their locations

<A-2>

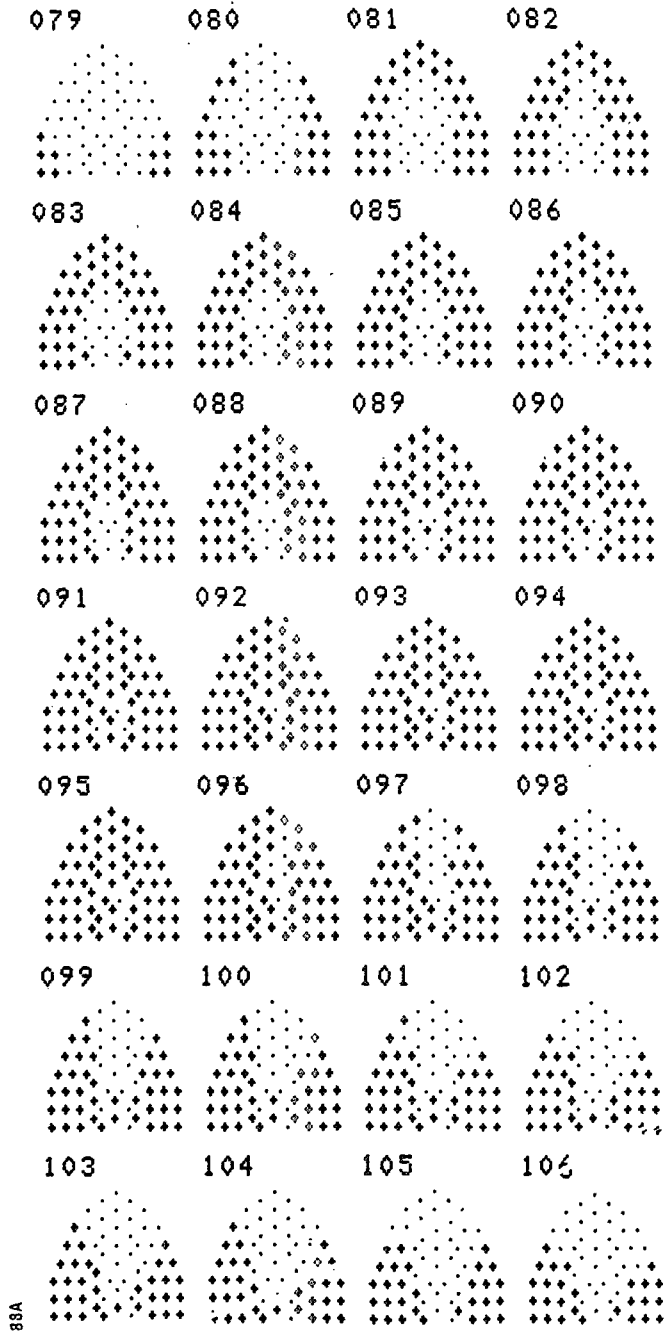


Fig. 4 *ni* “に”[ɲi] (by Tsuzuki)

<A-73>

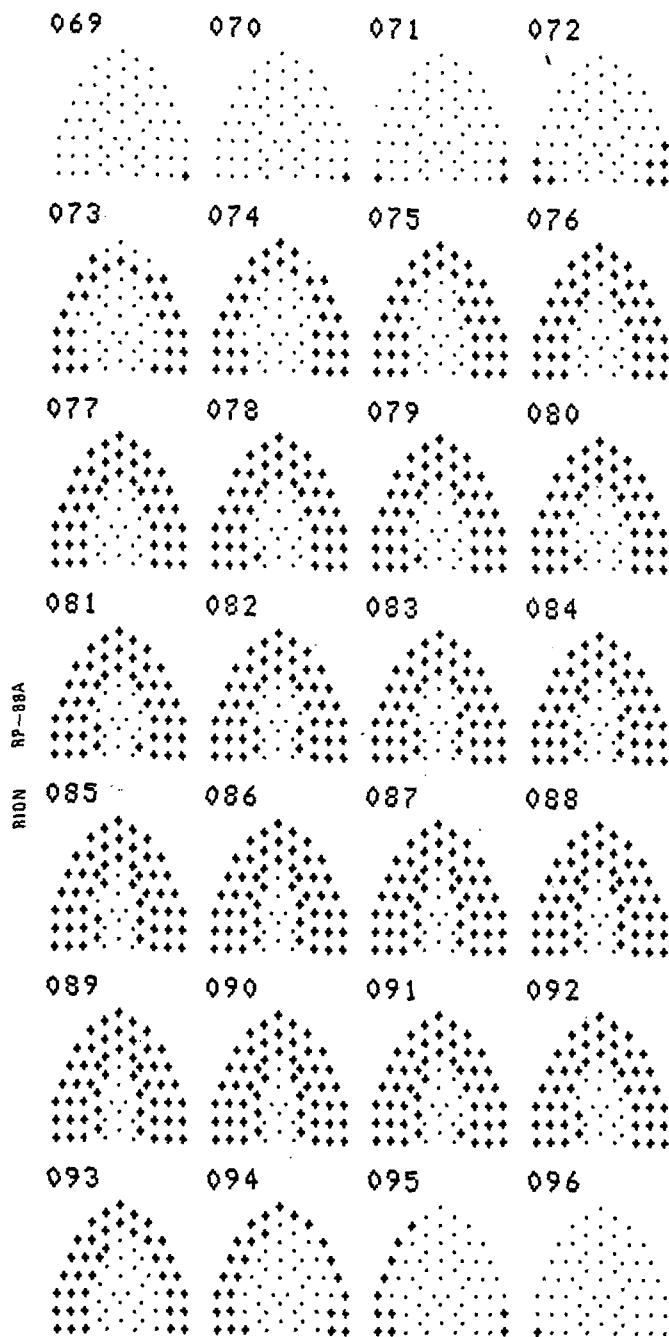


Fig. 5 na “나”[na] (by Tsuzuki)

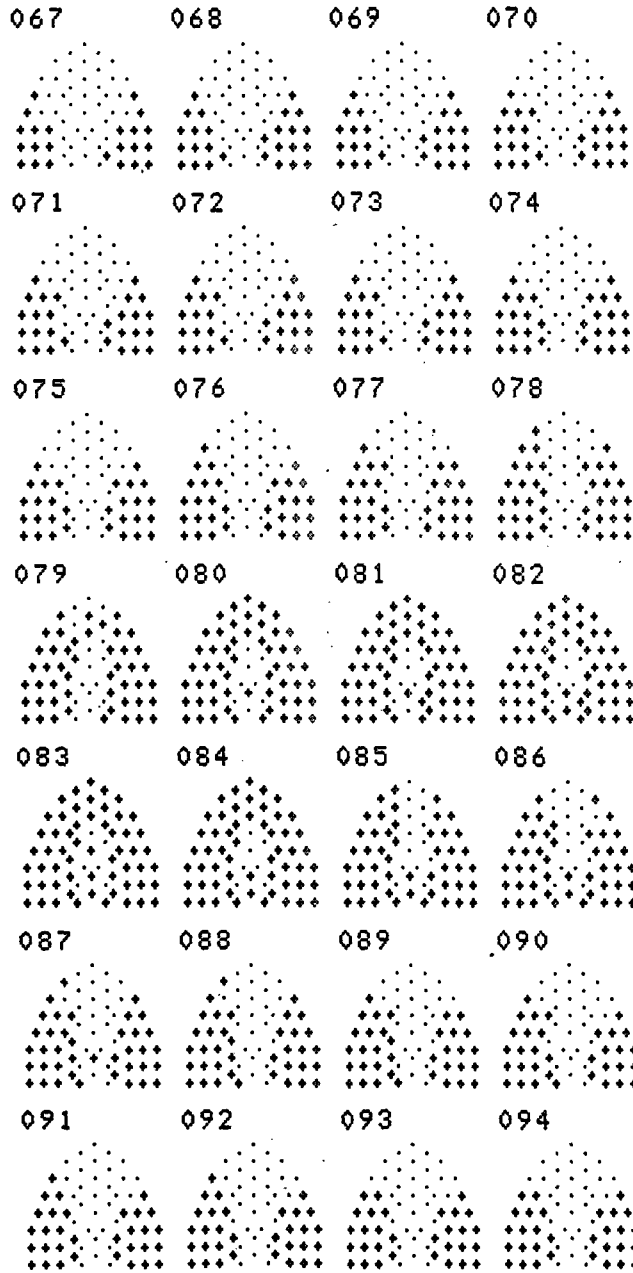


Fig. 6 ini “いに”[iji] (by Tsuzuki)

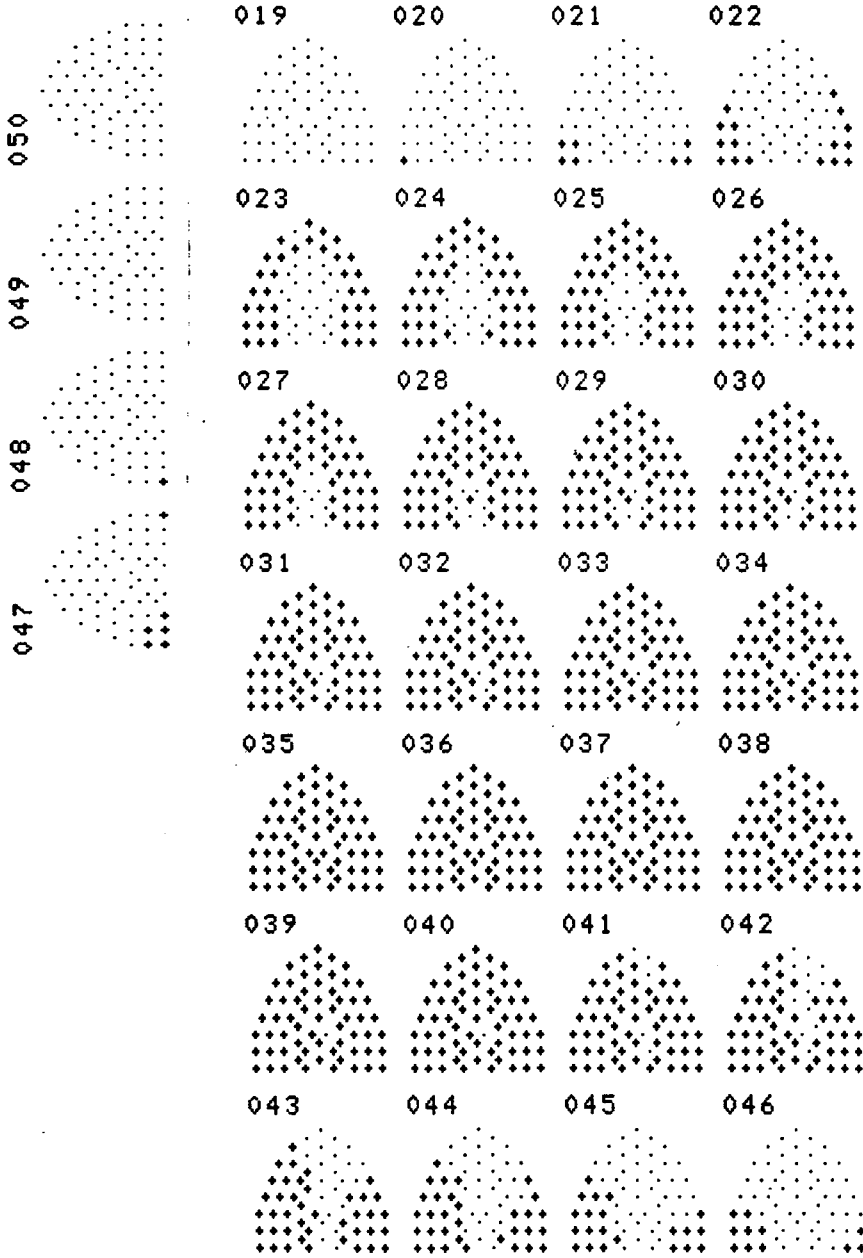


Fig. 7 nya “*냐*” [ɲya] (by Tsuzuki)

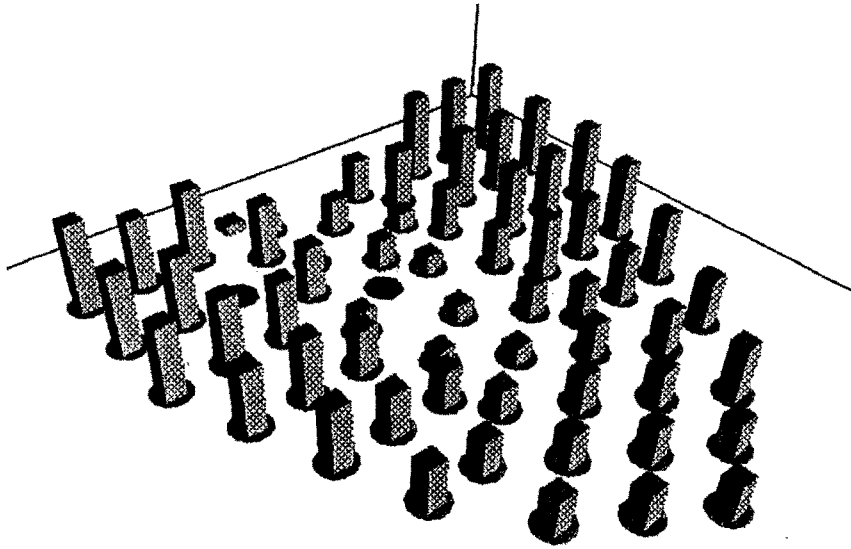


Fig. 8 ni “に” [ɲi] a palatalized nasal (by Tsuzuki)

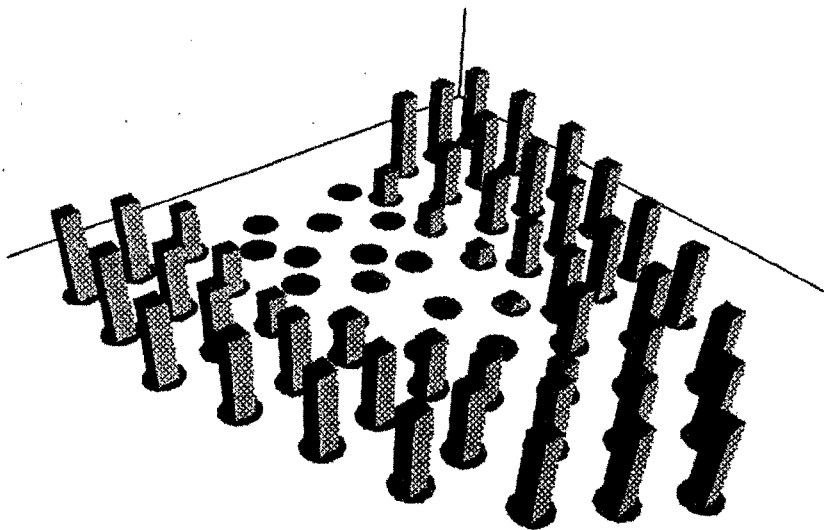


Fig. 9 no “の” [no] an alveolar nasal (by Tsuzuki)

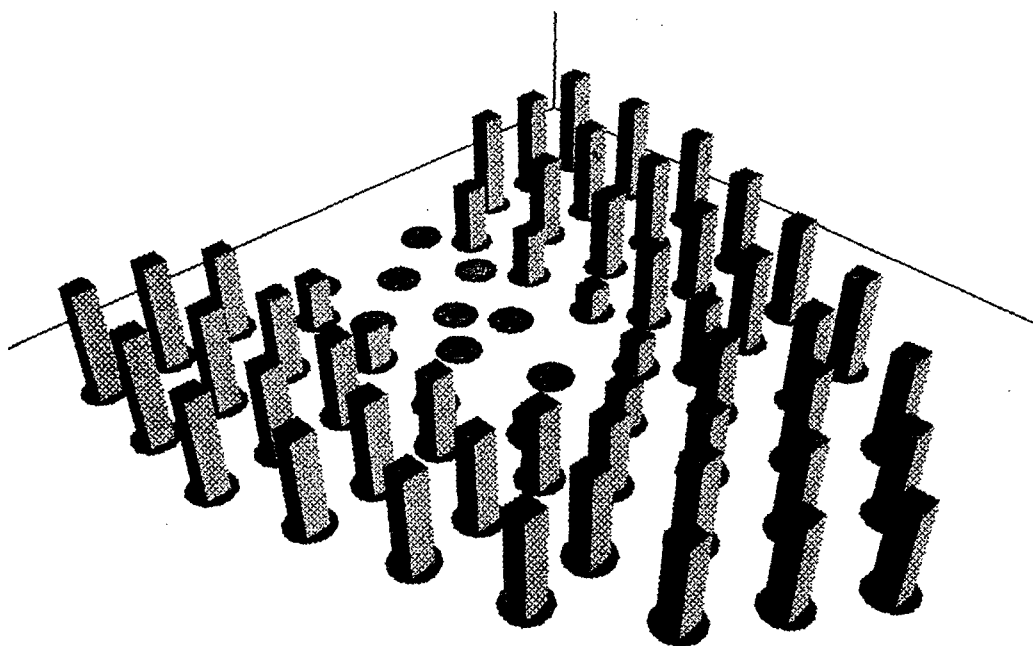


Fig. 10 na “나” [na] an alveolar nasal (by Tsuzuki)

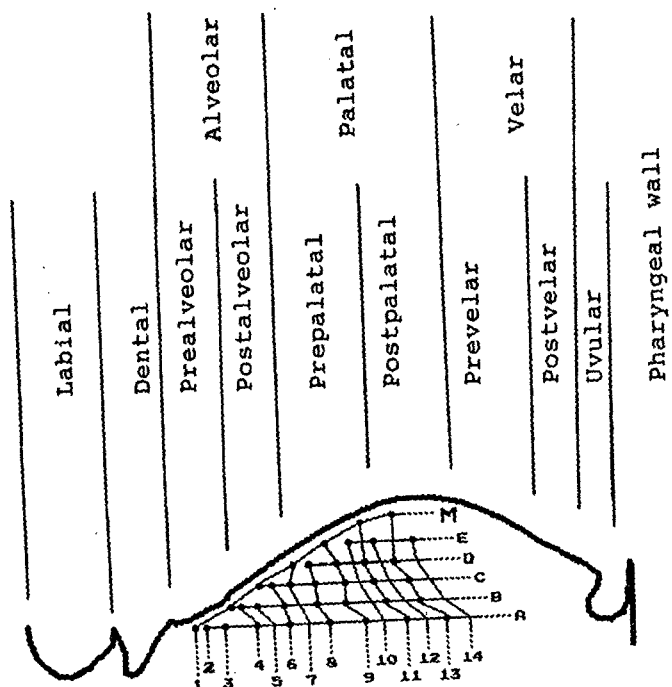


Fig. 11 The correspondence of electrodes of “right sided” to the upper articulatory locations.