ANN.Bull.RILP(1990)No.24, 131-144

ALTERNATION BETWEEN STOP NASAL AND (NASALIZED) FLAP OR LATERAL

Akio Soejima; Hiroshi Imagawa; Shigeru Kiritani

Introduction

This essay is a preliminary report on the alternation between the stop nasal and (nasalized) lateral or flap in some languages, especially in Japanese. Such phenomena in Japanese have never been reported in the literature, as far as we know. But before discussing Japanese, we had better discuss other languages to get some rough impression concerning the linguistic aspects of the subject.

1 Chinese[1)]

In some Chinese dialects, mainly in southern China, (including southern Mandarin dialects), the opposition between /n/ and /l/ has been lost which existed in so-called Ancient Chinese, ca. 6c-10c, the phonemic system of which is reflected in rhyme dictionaries, such as Qieyun, Guangyun and so forth. However, the reflexes of these phonemes in modern Chinese dialects and the environmental conditions of this merger are not uniform. That is, in some dialects these phonemes coalesced into /n/ (e.g. Changsha in Hunan, Chengdu in Sichuan), and in some other dialects into /l/ (e.g. Nanjing in Jiangsu). In some dialects, that coalescence occurred only in syllables without the medial front glide [j] or [ɥ] (e.g. Nanchang in Jiangxi, where [n] and [l] in this context merged into [l]), while in some other dialects this coalescence occurred spontaneously. Although we can also find other conditions in some other dialects, the data given above are enough for our purpose here. Instead of discussing complex geographical distribution of these phenomena or the neutralization of manner of articulation in a nasal context, we will make a few other comments.

Firstly, even if the exact phonetic processes are not clear, this phenomenon is probably related to the denasalization of nasal phonemes, that is, the change of nasal stops into prenasalized stops, e.g. [m] to [^{m}b], [n] to [^{n}d], [ŋ] to [^{ŋ}g] and so on, which is claimed to have occurred during the Tang dynasty in the Chang'an dialect (the capital of the Tang dynasty at that time, which is now Xi'an, Shanxi, northwestern Mandarin dialect).[2)] This denasalization process is reflected in Sino-Japanese as an opposition between Go-on and Kan-on readings except at the velar articulation, since Japanese has no velar nasal in the syllable-initial position. (Table 1: Japanese examples are shown in phonemic representation.)

In fact, rather many dialects through China preserve these prenasalized stops, though under various environmental conditions including the place(s) of the relevant nasal segments, syllables with other than initial nasals, syllables with high and low

Table 1

Gloss	Go-on	Kan-on	place of articulation
horse	ma	ba	labial
tree	moku	boku	labial
male	nan	dan	dental
viscosity	nen	den	dental
day	niti	ditu	alveopalatal (prenasalized fricative)
quite so	nen	zen	alveopalatal (prenasalized fricative)

vowels. But in the dialects without prenasalized dental articulation, that is, "without plosive release on /n/", we can find the tendency that "those dialects are typically also dialects in which *l and *n (in ancient Chinese) have merged, resulting in [l] and [n] as phonetic variants" (e.g. southwestern Mandarin such as spoken in Sichuan, Yunnan or Hubei) (Chan 1987a). This remark of Chan's suggests that at the time of this denasalization processes, at least in some of the dialects that have no prenasalized dental stops now, the phonetic form of /n/ was laterally articulated. The historical process is indicated in the table below.[3)]

Ancient Chinese	m	n	l	ŋ
free variation	m	n ~ l̃	l	ŋ
merger	m	l̃		ŋ
denasalization	^{m}b	l		^{ŋ}g

To summarize, some Chinese dialects appear to have had lateral articulation as the realization of /n/ in the past, and, at a later stage, denasalization seems to have occurred.

Secondly, we can observe a peculiar development in some southern Min dialects, such as Amoy. In this dialect the nasal stops in ancient Chinese developed into prenasalized voiced stops. However, this denasalization was possibly restricted to syllables with oral vowels. Synchronically, nasal stops and prenasalized stops alternate depending on whether the relevant syllable contains an oral vowel or a nasal vowel. Thus, we can conclude that a phonemic opposition between prenasalized stops and pure nasals does not exist, if we postulate the existence of phonemic nasal vowels and oral vowels as is proposed in the usual analysis. However, in this dialect the nasal dental did not develop into prenasalized dental stop [^{n}d] but into the

lateral [l]. Thus, the above-mentioned alternation is transformed into one between the pure nasal [n] and the lateral [l]. Thus, in this dialect we can also expect that formerly there was a lateral articulation of the phoneme /n/, and that at a later stage the denasalization process occurred, so that a phonologically conditioned alternation was brought about.[4)]

2 Indo-Aryan Languages[5)]

In traditional Indian phonetic terms, stops and nasals are grouped together and called contact sounds (sparśas). These contact sounds have been thought to constitute the 5 * 5 phonological system below[6)7)] (dots under characters are used to indicate retroflex articulation in Indian linguistics).

k	kh	g	gh	ṅ
c	ch	j	jh	ñ
ṭ	ṭh	ḍ	ḍh	ṇ
t	th	d	dh	n
p	ph	b	bh	m

In these contact sounds there are two apical articulations: apico-dentals (dentals), the fourth row, and apico-postalveolars (retroflexes), the third row. The latter series are called cerebrals in traditional terms. These retroflex sounds are often articulated as sublamino-prepalatals as well. As to the manner of articulation, these sounds have five series as shown in the table above, that is, (1)voiceless unaspirated, (2)voiceless aspirated, (3)voiced unaspirated, (4)voiced aspirated (breathy)[8)] and (5)nasal. Among these retroflex sounds, voiced sounds tend to have been realized with flapped or lateral articulation since ancient times. So, as early as in the Vedic texts[9)] or the earliest Buddhist texts written in Pali language[10)], we can find both unaspirated and aspirated retroflex laterals corresponding to voiced retroflex stops in classical Sanskrit. However, in these stages these lateral articulations are assumed to be free variants of respective stops and no phonemic contrasts are observed. The retroflex lateral is also found in modern Oriya, Punjabi, Gujarati and Marathi, and is phonemically opposed to the dental lateral.

In some modern Indo-Aryan languages there are retroflex flaps developed from ancient stops (Ghatage 1962 Chap. 6). According to Ghatage, in Oriya and Gujarati,the retroflex flap is an allophone of the retroflex voiced stop in intervocalic positions, and, similarly, in Bengali it is mainly in complementary distribution with /ḍ/. However, in Sindhi and Punjabi, it forms an opposition with the retroflex stops and the dental flap. Furthermore, Hindi has been thought to have both unaspirated and aspirated retroflex flaps.

In the same way (and more interestingly in terms of our present concern), retroflex nasals can alternate with retroflex flaps, especially in intervocalic positions. Thus, Jaiswal (1962 p.40)[11] says "With the growth of flapped retroflex sounds in the post-OIA (Old Indo-Aryan) speeches there may have developed a tendency to make the pure OIA cerebral n also a flapped retroflex. ..... As a matter of fact, it would be more appropriate to consider it (=the retroflex nasal) the nasalised form of ṛ and it should thus be classed with flapped ṛ and ṛh".[12] Furthermore, in some non-Indo-Aryan languages in India (such as Santali, one of the Munda languages) this retroflex nasal flap can be observed.[13]

3 English

In many American English dialects, there is a well-known alternation between [t] or [d] and flap [ɾ]. The typical conditioning environment of this so-called alveolar flapping is after a stressed vowel and before unstressed syllables containing nonnasal syllabic segments. Thus in "metal" or "little" this flapping occurs, while in "mutton" the flapping does not occur, since the relevant dental stop phoneme /t/ is before a nasal syllabic consonant (Ladefoged 1982[2] p.86).[14] According to Ladefoged, the same flapping occurs as the regular pronunciation of the dental nasal /n/, such as in a word like "tanner", (i.e. possibly in the same environments as for the flapping of /t/ and /d/), though he does not discuss the conditions of this nasal phoneme case at all (ibid. p.153). Ladefoged also does not describe whether in this nasal flapping the realized flap is nasalized or not. However, we can assume that the realized flap is possibly nasalized.

Another account of the nasal flap of English in the literature can be found in Harris (1951).[15] Here, nasal flaps are the realization forms of the cluster /nt/. Thus, the opposition between "painting" and "paining" is phonetically realized as the opposition between a nasal flap and a nasal stop.

4 Korean[16]

Korean has only one liquid phoneme, which has two realizations, that is, flaps in intervocalic position and (retroflex) laterals before the initial consonant of a following syllable. (Modern Korean has no syllable-initial or syllable-final consonant clusters, though morphophonemically, there are some syllable-final clusters.) In Korean , as in the Altaic languages, a phonotactic constraint against liquids in word-initial position has existed since the most ancient times we know. Thus, when borrowing foreign words whose initial consonant is [l] or [r], the initial sound was automatically changed into /n/ in Korean, not into one of the three stops, all of which are voiceless in word-initial position (e.g. nampo "lamp", through Japanese "rampu")[17]. This means that at the time of the borrowing, the

most important factor was the voicing and that nasality was neglected. Furthermore, in modern Korean, /n/ in word-initial position is deleted before the high front vowel /i/ or high front glide /j/ and the /n/ derived from /r/ also participates in this alternation. Thus, in morphemes with an initial /r/, /r/ alternates with [n] in word-initial position except before /i/ and /j/, where /r/ alternates with zero (Kōno 1955, pp.380-381). For instance, the Sino-Korean word {rjuk} "six", which had initial /l/ in Chinese (liu in Mandarin), has the allomorphs below (broad transcription is used).

sixty-eight	[yuksipp^{h}al]
five, six, seven, eight	[o:rjukc^{h}ilp^{h}al]

In Korean, there are some other alternations of /n/ and /r/ (ibid. pp.379-380).

1) /n/ is changed into /r/ after and before /r/
2) /r/ is changed into /n/ after and before nasals except /n/
3) syllable-final stops are changed into homorganic nasals before nasals (=/m/ and /n/) and /r/

Rule 2) can be interpreted as nasal assimilation to an adjacent nasal segment. Rule 1) is also the assimilation rule, but in the reverse direction. Rule 3) shows the strong affinity of nasals and /r/. However, what is more important in 3) is that even in the case of a stop followed by /r/ (where there is no nasal), both segments without nasality in the underlying form bear nasality in the surface form, as illustrated below.

thirty-six /sam-sip-rjuk/ > [sam-sim-njuk]

The phonological characteristics of 3) are not clear. However, it is not completely impossible to postulate nasality in the phoneme /r/ at an underlying level.[18]

To summarize, in Indo-Aryan languages and English, there exist nasal flaps developed from nasal phonemes which show a phonologically conditioned alternation with nasals. Korean has an alternation between [n] and [r] whether there are adjacent nasal segments or not. This may suggest the possibility that /r/ itself is specified to be [+nasal] in this language, though we have never observed a nasalized flap as a phonetic realization, nor have such sounds been reported in the literature. In Chinese, we can observe an alternation between [n] and [l], or a complete merger of these phonemes. According to our observation, Chinese speakers sometimes have a nasalized lateral articulation for /n/. We can point out the differences between Indo-Aryan languages or English and Chinese or Korean. Thus, in the former two languages, the alternation occurs with or without nasality. This means there is also a similar alternation involving (voiced) stops. On the other hand, in the latter two languages, stops are not involved in the alternation. In Korean and most of the Chinese dialects, there exist no voiced stops at all.

As in the languages reported above, nasals and laterals or flaps show strong affinities in some languages other than Japanese. As for place of articulation, these laterals and flaps are in most cases apical, or laminal. We do not generally know the diachronic phonetic process by which these laterals or flaps have developed from nasal stops. However, as to where this phonetic alternation leads, Chinese dialectal variation seems to give certain hints, as mentioned above. The conclusion from the Chinese dialectal data is that these alternations, whether freely alternating or phonologically conditioned, can bring about phonemic restructuring, that is, a merger between /n/ and /l/ into one phoneme.

5 Japanese[19)]

In this report Japanese means the modern Tokyo dialect, unless specifically mentioned. The phonemic system of this dialect is indicated in the table below.

Consonant			Semivowel	Vowel				
p	b	m	w		i			u
t	d	n				e		o
s	z	r	j				a	
k	g	h						
Moraic phoneme			Q	N	R	J		

The syllable structure of Japanese is (C)(j)V(R)(J)({Q,N}).

Moraic phonemes, which occur only in syllable-final position, constitute one mora. /Q/ stands before voiceless stops and fricatives and phonetically lengthens a following consonant. /R/ functions to lengthen a preceding vowel. /N/ can stand at any syllable-final position and has at least five realizations; homorganic nasals before stops, (affricates) and nasals such as /b/ , /m/, /d/, /n/, /k/; a uvular nasal before word boundaries; a nasal vowel before any other segment, i.e. fricatives, liquids, semivowels and vowels. The dental nasal phoneme /n/ has been thought to have two phonologically conditioned allophones: a palatalized dental nasal or palatal nasal before the high front vowel /i/ or high front glide /j/, and [n] in any other environment. However, since the phonetic difference between these two allophones has almost nothing to do with the following discussion, we can generally neglect it, and we will use [n] as the cover term for both of these allophones.

In word-initial positions /d/ is realized as [dz] before /u/, as [dʒ] before /i/ and /j/, and before other (= non-high

vowels) as [d]. In intervocalic position, affricates are spirantized, [z] before /u/ and [ʒ] before /i/ and /j/. There is no alternation between voiced stops and flaps as observed in the Indo-Aryan languages or English, though this is sometimes observed in speech errors or sloppy speech. The realization of the phoneme /r/ is somewhat puzzling, for it differs from person to person. In standard pronunciation, this phoneme has a flap articulation. However, before non-high vowels it tends to be articulated as a lateral. Some speakers pronounce it as a lateral exclusively, sometimes as a rather velarized dark [l]. Experimental study using dynamic palatography shows that in intervocalic position its closure is sometimes incomplete.[20] In fact, it is extremely difficult to discriminate flap articulation with nasality from lateral or lateral flap articulation in intervocalic positions.

The sound [n] is derived from two different phonemes; one from the nasal /n/ and the other from the moraic phoneme /N/ before dental stops or dental nasals. For these two phonemes, a lateral or flapped articulation can be observed only in the phoneme /n/, though this type of articulation does not seem to have been reported in the literature. The reason this allophonic variation has never been reported before is unclear; however, we can point out the following.

First, the dental nasal phoneme /n/ has been stable in the history of Japanese and its variation seems to have begun recently, while the voiced stops in Japanese were unstable. For voiced stops were assumed to be prenasalized stops, and a phonetic change to pure voiced stops has occurred in most of Japanese dialects[21]. This is evident from the fact that in some dialects such as the Kōchi dialect in south-western part of Japan, prenasalized voiced stops have been preserved[22], also in some dialects, the word-medial velar voiced stop has changed into a non-nasal stop, while in others it has changed into a pure velar nasal. Thus, it is difficult to explain the opposition between /^{n}d/ and /n/, if we postulate an oral release for /n/.

Second, this allophonic variation is irrelevant to the phonemic system of Japanese in the present state, since it seems to be free, or, rather, its phonological conditions are not clear. Everything we can say with certainty about these phonological conditions is that the nasalized flaps or laterals never occur in word-initial positions. Besides phonological factors, its occurrence also depends on individual speakers, on the speech rate (Figures 1-3)[23], and sometimes even on the speech situation (e.g. with whom or where one speaks).

Consequently, the third reason why the alternation between stops and laterals or flaps under the nasal context seems difficult to observe is an insufficiency of linguistic methods. Field work is usually carried out in linguistics as follows. An Investigator asks his informant to pronounce a prepared word list mainly consisting of basic vocabulary slowly, and, when the linguist can't discriminate such sequences, to pronounce them

repeatedly and more slowly. Then the linguist imitates his informant's pronunciation again and again until the informant says his pronunciation is accurate. Then the investigator writes down the result in some phonetic notation, usually IPA. This method is quite useful when one seeks to determine the phonemic system of a target language. However, when investigating free variation which depends on the speech rate as in our present subject, this method is by no means sufficient, for slow speech rate sometimes prevents the informant from speaking naturally, so that the very point we want to observe sometimes disappears. What is worse, since an informant does not take notice of his pronunciation behavior at all, he has no ability to judge which is his usual phonetic form. When informants pronounce quite naturally, on the other hand, the investigator cannot discriminate speech rapidly pronounced, particularly the small differences between stop articulation and flap or lateral articulation under nasality. This is why experimental research is needed.

Another point regarding the insufficiency of linguistic methods is the structure of the IPA itself. The IPA has independent nasal letters for nasal stops for each place of articulation, such as [m], [n] and so on. However, as for the other manners of articulation, the IPA provides only the diacritical mark [˜] for nasalization. This tends to make one think that nasalized consonants are somewhat marked or unusual, and that the auditory impression always resembles consonants without nasality rather than nasal stops. But this is not the case. From the physiological point of view, the opening of the velo-pharyngeal port at approximant articulations such as laterals seems quite easy, and so does the one in the rapid movement of the tongue during flap articulation.[24] The auditory impression of these lateral or flap sounds with nasality resembles that of stop nasals. For instance, when hearing these sounds in intervocalic position, Japanese speakers usually take them for /n/, not /r/.

Finally, we can suggest some conditions under which the alternation between nasal stops and nasalized laterals or flaps occurs. This observation is based for the most part on our introspection. Examined words were chosen so that the environment in which the relevant /n/ was located may be as exhaustive as possible.[25] When our introspection seemed in doubt, a sonagram was also used. The distinction between flaps and laterals was not so clear, so only distinct cases will be pointed out. As we already mentioned, the alternation depended on many nonlinguistic factors. Therefore, the following statements must be treated as tentative and preliminary hypotheses.

1) Syllable position

We cannot observe this alternation in word-initial position, as already mentioned. It tends to occur in word-final position, and most frequently in bound form at the end of phonological phrases. Typical examples are the genitive postposition {no} for the lateral and the dative postposition {ni} for the flap. Another good example is an interjection indicating hesitation, {ano:}. Some Japanese show the alternation exclusively in these words or

morphemes.

2) Preceding segments

The alternation occurs only after vowels. It does not occur in environments preceded by /n/. In the latter case, the geminate /nn/ seems to prevent the alternation.

3) Vowel length

There are four possibilities, i.e. VnV, V:nV, VnV:, V:nV:. There seems to be a tendency for the alternation to be more frequent in the case where the preceding vowel is short.

4) Height of adjacent vowel

As for adjacent vowel height, we are not sure of the effect at all. However, there seems to be a tendency for syllables with high vowels to have flap articulation more often than lateral articulation, while in syllables with non-high vowels lateral articulation is also common. A following vowel seems to have more influence rather than a preceding one.

5) Accent

We examined only two-mora words. Two-mora words are of three kinds depending on the position of the accentual nucleus. However, the difference between words without a nucleus and with the nucleus on the second mora is realized only when other segments follow, so this case is irrelevant here. We examined two types of pitch patterns. In the words with the nucleus on the first mora, the pitch is falling, while in others it does not fall. Instead, in the latter words, at the initial position of phonological phrases rising can be observed. This difference is illustrated below.

1. nucleus on the first syllable	H(igh)	L(ow)
2. the other two types	L	H

The alternation between stops and laterals or flaps under nasal context is more frequently observed in type 2 than in type 1.

6) Other conditions

The influence of the consonants in the preceding or following syllables is not clear, except that in the case of nVrV, rVnV and the latter consonant in nVnV, the alternation seems to be rather frequent (e.g. {kanarazu} "necessarily", {sira+nai} "not knowing", {banana} "banana").

We cannot say whether morpheme boundary influences this alternation or not. Prenominal modifiers, which are necessarily followed by a noun or noun phrase (i.e. {kono} "this", {sono} "that", {ano} "that") are very often articulated in flap articulation.

The conditions suggested above are not firmly established. Neither are they exhaustive. Furthermore, the conditions mentioned above probably interact one another. However, we do not

know which factors are predominant compared to others or which and which conditions are closely related. We require further study using experimental as well as traditional methodology.[26]

Concluding Remarks

In this essay alternation between stop nasals and (nasalized) lateral or flap in five languages or language families was reported. Of those five languages, Japanese example seems to be introduced for the first time. However, phonetic as well as phonological characteristics are not clear. Further study including physiological and acoustic experiments must be needed.

Notes and References

1) Yan, Jia Hua et al.: Hanyu Fangyan Gaiyao "Outline of Chinese Dialects". Peking: Wenzi Gaige Chubanshe. 25, 30-33, 239-240 and 287-288, 1960.
Zhan, Bu Hui: Xiandai Hanyu Fangyan "Modern Chinese Dialects". Wuhan: Hubei Renmin Chubanshe, 1981.
Chan, Marjorie K. M.: Post-stopped Nasals in Chinese: an Areal Study. UCLA Working Papers in Phonetics 68, 73-119, 1987a.
Chan, Marjorie K. M.: Post-stopped Nasals: an Acoustic Investigation. UCLA Working Papers in Phonetics 68, 120-131, 1987b.

2) Maspero, Henri: Le Dialecte de Tch'ang-Ngan Sous les T'ang. Bulletin de l'Ecole Française d'Extrême Orient 20, 1-124, 1920.
Pulleyblank, Edwin G.: Stages in the Transcription of Indian Words in Chinese from Han to Tang. in Röhrborn, Klaus and W. Veenker (eds.): Sprachen des Buddhismus in Zentralasien. Wiesbaden: Otto Harrassowitz, 73-102, 1983.
Pulleyblank, Edwin G.: Middle Chinese: A Study in Historical Phonology. Vancouver: University of British Columbia Press, 1984.

3) The nasalized lateral postulated here seems to be involved in other types of development, since the historical development from [l̃] to [l] or [n] is not implausible.

4) In Fuzho dialect, syllable-initial /l/ is changed into [n] when preceded nasal finals (Yan et al. 1960, 287-288). However, this alternation in Fuzho dialect seems to be irrelevant to our present discussion.

5) Grierson, Sir George Abraham: Linguistic Survey of India. London, 1903-28.
Ghatage, A. M.: Historical Linguistics and Indo-Aryan Languages. Bombay: University of Bombay, 1962.

6) Allen, S. W.: Phonetics in Ancient India. London Oriental Series 1. Oxford: Oxford Univ. Press, 1953.
Varma, Siddheshwar: Critical Studies in the Phonetic

Observations of Indian Grammarians. London, 1929.
Mishra, Vidhata: A Critical Study of Sanskrit Phonetics. Chowkhamba Sanskrit Studies 83. Varanasi: Chowkhamba Sanskrit Series Office, 1972.

7) This is the interpretation in Indian traditional phonetics and phonology. From modern linguistic analysis, this symmetric system seems unjustified in that the palatal nasal is an allophone of /n/ (Emeneau. M. A.: Nasal Phonemes in Sanskrit. Language 22, 86-93, 1946.), and the velar nasal is also an allophone of /n/ (Ivanov, V. V. and V. N. Toporov: Sanskrit. Languages of Asia and Africa. Moscow: Nauka, 1960.). Aspirated stops are also suspected to be consonant clusters (Pinnow, J.: Sanskrit --Eine Sprache ohne Vokalphoneme ?. Folia Linguistica 3, 255-306, 1969.).

8) Ladefoged, Peter: Preliminaries to Linguistic Phonetics. Chicago: Univ. of Chicago Press, 12-13, 1971.

9) Macdonell, A. A.: Vedic Grammar. Grundriss der Indo-Arischen Philologie und Altertumskunde 1. Band, 4 Heft. Strassburg: Trübner, 32-34, 1910.
Wackernagel, Jakob: Altindische Grammatik. Band 1. Lautlehre. Göttingen: Vandenhoeck&Ruprecht, 255-256, 1896.
Renou, Louis: Grammaire de la Langue Védique. Paris: IAC, 17, 1952.

10) Mayrhofer, Manfred: Handbuch des Pāli. 1. Teil: Grammatik. Heidelberg: Carl Winter Universitätsverlag, 49, 1951.
Hinüber, Oskar von: Das Ältere Mittelindisch im Überblick. Österreichische Akademie der Wissenschaften, Philosophisch-Historische Klasse, Sitzungsberichte 467. Wien: Der Österreichischen Akademie der Wissenschaften, 105-106, 1986.

11) Jaiswal, M. P.: A Linguistic Study of Bundeli (A Dialect of Madhyadeśa). Leiden: E. J. Brill, 1962.

12) In spite of his observation, there is evidence that dental nasals and retroflex nasals merged in Middle Indo-Aryan. See Tagare, G. V.: Historical Grammar of Apabhraṁśa. Poona: Deccan College Post-Graduate and Research Institute, 74, 1948., Bloch, Jules: Indo-Aryan from the Vedas to Modern Times. English edition. revised and translated by A., Master. Paris: Adrien-Maisonneuve, 56-62, 1965.

13) Personal communication with M. Minegishi

14) Ladefoged, P.: A Course in Phonetics. New York: Harcourt Brace Javanovich, 1982[2].

15) Harris, Z.: Methods in Structural Linguistics. Chicago: Univ. of Chicago Press, 92-93, 1951.

16) Lee Ki Moon: The History of the Korean Language (in Korean). 1972[3]. The Japanese translation is used.
Kōno, Rokurō: Chōsengo "Korean Language". in Ichikawa, S. and S. Hattori (eds.): Sekai-Gengo-Gaisetsu "Introduction to World Languages". Tokyo: Kenkyū-sha, 357-439, 1955.
Martin, Samuel E.: Korean Phonemics. Language 27, 519-533, 1951.

17) As for denasalization in Korean Kōno (1955) and Chen, Matthew and H. Clumeck: Denasalization in Korean: A Search for Universals. in Ferguson, Charles A., L. M. Hyman and J. J. Ohala (eds.): Nasalfest: Papers from a Symposium on Nasals and Nasalization. Stanford: Department of Linguistics,

Stanford University, 125-131, 1975. However, this seems to be irrelevant to our present subject.

18) Indeed, this interpretation is not the unique one or the most appropriate one. For this interpretation cannot explain the rule 2). We only want to suggest one possible interpretation.

19) Uemura, Y.: Gendaigo-no Onin "Phonology of Modern Japanese". in I. Nakata (ed.): Kokugoshi "History of Japanese" 2 Oninshi Moji-shi " The History of Phonology and Characters". Tokyo: Taishūkan-shoten, 269-309, 1972.
Jōo, H.: Gendai-Nihongo-no Onin "The Phonology of Modern Japanese. in Ohno, S. and T. Shibata (eds.): Nihongo "The Japanese Language" 5. Onin "Phonetics and Phonology". Tokyo: Iwanami-shoten. 107-145, 1977.

20) Sawashima, M. and S. Kiritani: Electro-palatographic Patterns of Japanese /d/ and /r/ in Intervocalic Positions. Ann. Bull. RILP. 19, 1-6, 1985.

21) Morita, T.: Onin-no Hensen "Historical Phonology" 3. in Ohno, S. and T. Shibata (eds.): Nihongo "The Japanese Language" 5. Onin "Phonetics and Phonology". Tokyo: Iwanami-shoten. 253-280, 1977.

22) Hattori, Shirō: Onseigaku "Phonetics". Tokyo: Iwanami-shoten. 102, 1984[2].

23) Figures 1-3 give data from the soundspectrograph of the utterance /sonna+hanasi+wa+siranai/ "I don't know such a thing.", differing in speech rate: 1. rapid, 2. medium, 3. slow. We can observe that the duration time of /r/ is almost constant through the three speech rates, while that of /n/ becomes shorter as the speech rate increases. That at the most rapid rate is somewhat similar to /r/. It can be interpreted as showing that at the rapid speech rate the articulation of /n/ get approached to that of /r/.

24) On the other hand, nasalized fricatives or trills are difficult, whether voiceless or voiced.

25) The details are as follows. The examined words all had two morae and were either real words or nonsense words of the form CV_1nV_2. Five vowels, /a/, /i/, /u/, /e/, /o/, both short and long (10 kinds in all) were inserted into each vowel position. Then, each set was pronounced with the High+Low and Low+High pitch. Syllable-initial consonants were chosen at random. Thus, the total number of the words examined was $(5*2)^2*2=200$. Each word was pronounced several times at a natural speed and then as fast as possible. Even in the pronunciation of the same word, it happened that sometimes there was a nasal stop, but sometimes it was a flap or lateral.

26) We carried out some experiments using ultrasonic tomography and dynamic palatography. However, the results were not fully convincing, and we will omit reference to them.

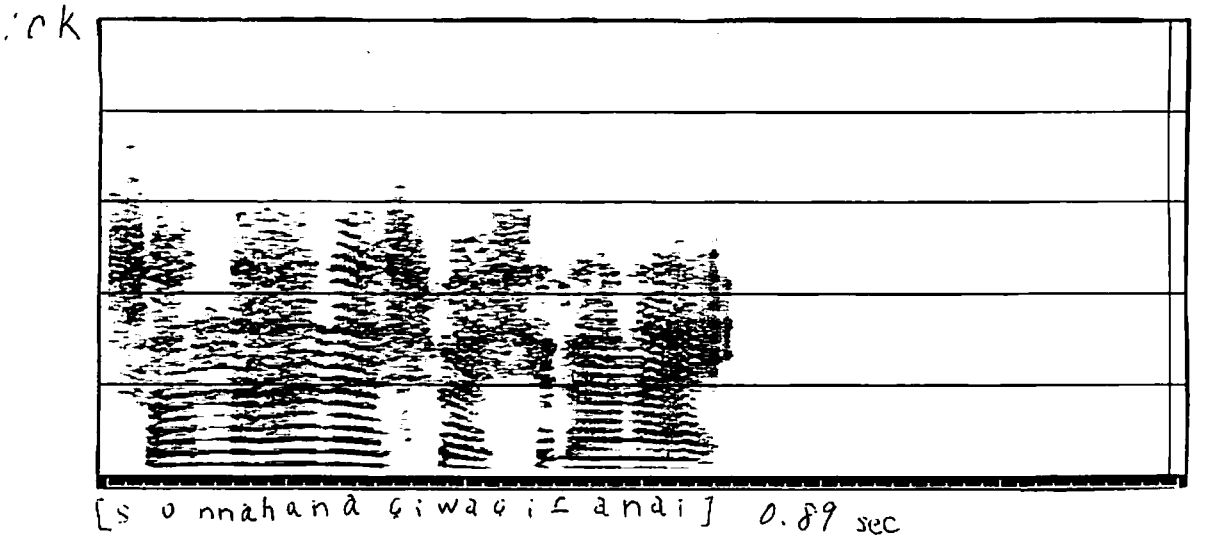

Figure 1 Rapid

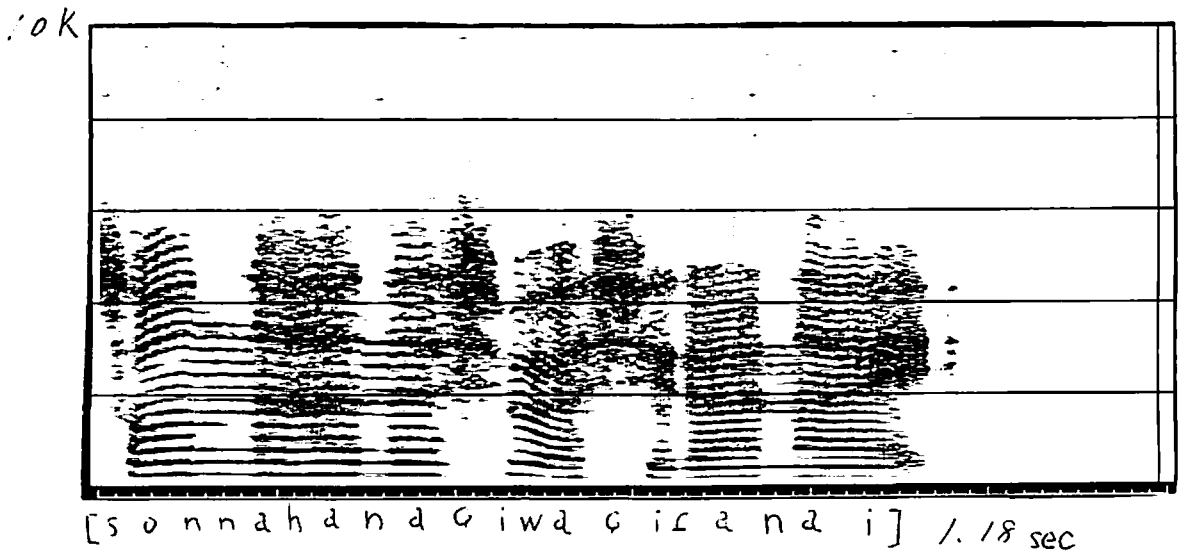

Figure 2 Medium

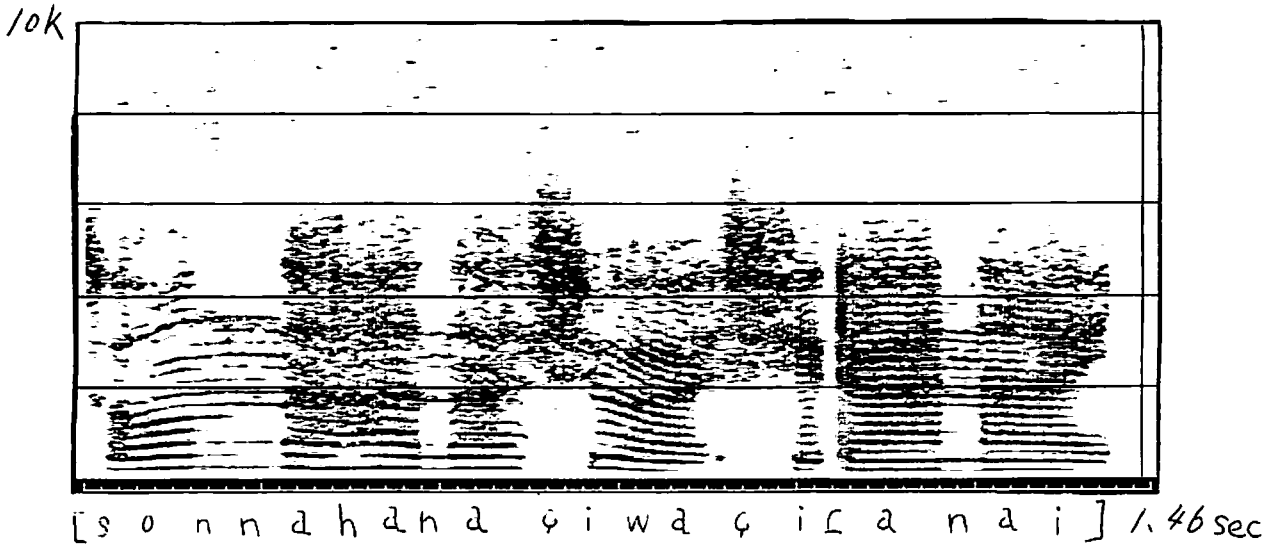

Figure 3 Slow