Perception of Japanese moraic nasal in intervocalic position by Japanese native speakers and Korean learners of Japanese

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ABSTRACT

This study examines the difference in the perception of the Japanese moraic nasal (/ɴ/) by followed by a vowel between Japanese native speakers (JN) and Korean learners of Japanese (KA: advanced learners, KB: beginners). The participants were instructed to identify stimuli by choosing one of two choices (/goseɴeɴ/, /goseːeɴ/).

The results showed that regarding the stimuli in the test word /goseɴeɴ/, the JN judgment rate of /ɴ/ is higher than that of the KB. This means that KB depends on "the degree of closure" more than JN in judgments of /ɴ/. KA's judgment was similar to that of JN. On the other hand, regarding the stimuli on the test word /goseːeɴ/, KA showed the lowest percentage of judgment rate of /ɴ/ among the three groups. They correctly perceived the long vowel part as a vowel ([e]). It indicates that KA did not reach the level of acceptance by JN in terms of the acceptance of vowels as free allophones of /ɴ/ in the intervocalic position.

Keywords: Japanese moraic nasal, perception, degree of closure, variations, learning level

1. INTRODUCTION

Japanese is a language with mora units, generally structured /V/ and /CV/. In addition, there are also the so-called special morae, such as Japanese moraic nasal (hereafter /ɴ/), the geminate consonant, and long vowels. Previous studies have focused on the lengths of special morae. Although /ɴ/ is characterized by being generated as various sounds in contrast to long vowels and geminate consonants, few studies have focused on /ɴ/ sound variations.

In this study, perceptual experiments were conducted with a focus on the variation of /ɴ/. This study includes Korean learners of Japanese, to compare /ɴ/ recognition between native and Korean learners. This study will also investigate the mastery of /ɴ/ by the level of learning.

2. LITERATURE

In general, /ɴ/ is generated as a nasal consonant assimilated to the place of articulation when an obstruent follows. In Japanese phonemes, /ɴ/ has the most conditional allophones. Furthermore, while /ɴ/ is known to be followed by vowels and semi-vowels (/w, j/), the resulting sounds have been considered as nasal vowels (/ã, ĩ, ũ, ẽ, õ/). However, previous studies disagree in regard to the /ɴ/ sounds followed by vowels and semi-vowels in the intervocalic position.

There is a variety of observations about the intervocalic /ɴ/ sounds, which are nasal vowels (e.g. [ẽ]), vowels (e.g. [e]), nasalized approximants (e.g. [ɰ̃]), nasalized fricatives (e.g. [ɣ̃]), voiced velar nasal([ŋ]), and voiced uvular nasal ([ɴ]) ([1], [2], [3], [4], [5], [6], [7], [8], [9], [10]). In the case of the intervocalic /ɴ/ sounds, many variations can be called a "free variant." The cause for such variations has been attributed to individual differences ([9], [11]), speech styles ([5], [7]), and speech rates ([5], [7]). Meanwhile, according to [9], there are no clear regional differences in the articulations of /ɴ/ sounds.

When generated as vowels or nasal vowels, as with words like "/seɴi/ fiber" and "/seːi/ sincerity", they can be confusing even among Japanese native speakers, so it is necessary to judge the words depending on the context ([4], [8]). However, as described above, the intervocalic /ɴ/ is generated not solely as nasal vowels (or vowels) but includes variations such as completely closed nasal stop [ŋ] (or [ɴ]) in the oral cavity, and the intermediates between these two. In order to avoid confusion, it is effective to generate /ɴ/ as a nasal stop, however, this gives the impression that the sounds are being emphasized ([12]). In other words, "the degree of closure (manner of articulation)" is important for the recognition of /ɴ/, while it may make it feel unnatural.

In the Korean language, on the other hand, it is necessary to distinguish clearly the place of articulation (/m, n, ŋ/) on the nasal codas. Furthermore, these nasal codas need to be completely closed in the oral cavity. Thus, regarding the perception of /ɴ/ sounds followed by a vowel, there is the possibility that differences between Japanese native speakers and Korean learners of Japanese may be due to attentiveness toward the degree of closure.

Therefore, this study incorporates native Korean speakers alongside Japanese speakers, as Korean provides a prime example of a language with contrastive phonemes on the nasal coda.

3. METHOD

In Japanese phonology, /ɴ/ and long vowels have been thought of as contrasts. However, there are cases when variations in /ɴ/ obscure phonetic differences between phonemes despite the apparent phonological differences between the two.

Accordingly, this study employs meaningful words that contain "/ɴ/ + vowel (/goseɴeɴ/: five thousand yen)" and add "vowel + vowel (/goseːeɴ/: encouragement)" consisting of five morae. Seven Japanese native speakers (S1, S2, S3, S4, S5, S6, S7) were asked to produce various sounds at the third mora of /goseɴeɴ/ in four speech rates. The four speech rates consist of "A (slow)," "B (normal)," "C (relatively fast)," and "D (fastest)," in order of the rates. Each utterance was measured in length and respectively classified as intended speech rate. Speakers were allowed to practice reading the sentences before recording. While the test words were embedded in carrier sentences when they were recorded, they were omitted from the sounds tested to prevent interference in judgments due to the influence of context ([4], [8]).

The listeners consisted of groups of 30 native speakers of Japanese (JN), 60 native speakers of Korean; 30 beginner learners of Japanese (KB), and 30 advanced learners (KA). KB, in their 20s, studied Japanese for less than one year and majored in Japanese at a Korean university, and 30 KA, also in their 20s, have passed the JLPT Level 1 and studied at a Japanese university for more than one year.

The total number of stimuli is 56 sounds (two test words × seven speakers × four speech rates). The stimuli were randomly ordered, and listeners were asked to listen to each stimulus only once. After being given the instructions, listeners had 10 minutes to practice and become familiar with the process. The perception experiment took about 50 minutes, including breaks. A pause of three seconds was placed between each stimulus. Listeners were asked to choose one of two choices (/goseɴeɴ/ five thousand yen, /goseːeɴ/ encouragement) to identify whether the stimuli are /ɴ/ or the long vowel. Two types of test forms (type1: /goseɴeɴ/ five thousand yen or /goseːeɴ/ encouragement, type2: /goseːeɴ/ encouragement or /goseɴeɴ/ five thousand yen) were prepared to offset any influence that the choice order may have. The choices were written in Japanese. The experiments were conducted in a silent room, with participants left alone for the test duration.

4. ANALYSIS OF STIMULI

We asked three researchers specializing in phonetics or phonology (one Japanese Native speaker, one Korean Native speaker and one English Native speaker) to listen to the stimuli and describe them in IPA. As a result, the stimuli are categorized into three groups as shown in Table 1 ((1) [ẽ], [ĩ], (2) [ɰ̃], and (3) [ɴ]). Only six sounds were described as nasal vowels.

As mentioned in Section 2, some studies ([5], [7]) claimed that the sounds of /ɴ/ vary according to the speech rate. However, there was no obvious consistent correlation found between these sound variations (nasal vowels or [ɰ̃] or [ɴ]) and the speech rate (the length of each stimulus) for the twenty-eight stimuli of /goseɴeɴ/ in this study (r2=-0.082). This result disagrees with the previous studies ([5], [7]). This study shows that the distributions of the stimuli vary across the speaker. Eventually, various sounds with different degrees of closure were collected in this study.

Furthermore, we observed the spectra of the third mora in the test word (/goseɴeɴ/). Regarding nasal vowels ([ẽ], [ĩ]), almost all frequencies keep their energy evenly like in stimulus B from S6 (figure 1). The same tendency was observed in the third mora /e/ of another test word /goseːeɴ/. On the other hand, stimulus B from S4 (figure 2) which was categorized [ɰ̃], shows the sudden decays of certain frequency regions (e.g. around 2,000Hz). These phenomena are called anti-formants. Anti-formants are frequency regions in which the amplitudes of the source signal are attenuated because nasal cavities absorb energy from the sound waves when the oral cavity is closed. This is known as a characteristic of nasal consonants ([13]). Although stimulus D from S2 was described as [ɴ] in figure 3, it displays a spectrum that resembles that of the [ɰ̃] in figure 2. Thus, the results show that while anti-formant possibly contributes to the /ɴ/ recognition, it may not be the only cue for perception.

	[ẽ] or [ĩ]	[ɯ̃]	[ɴ]
S1		A, C, D	B
S2	A, B	C, D	
S3		A, D	B, C
S4			A, B, C, D
S5		A, B	C, D
S6	A, B, D	C	
S7	B	A	C, D

Table1: IPA description of the third mora of /goseɴeɴ/

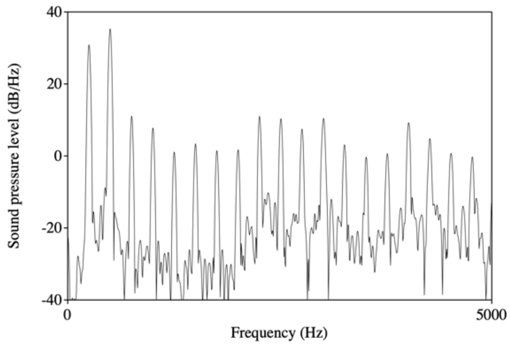

Figure 1: [ẽ] the spectra of the third mora in /goseɴeɴ/

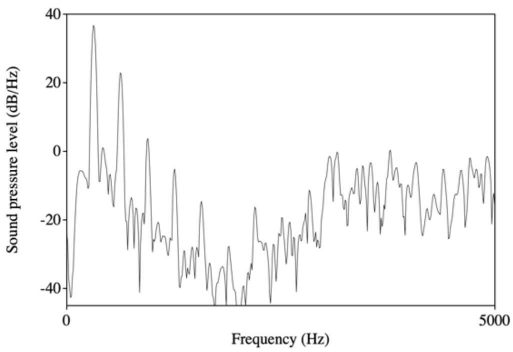

Figure 2: [ɯ̃] the spectra of the third mora in /goseɴeɴ/

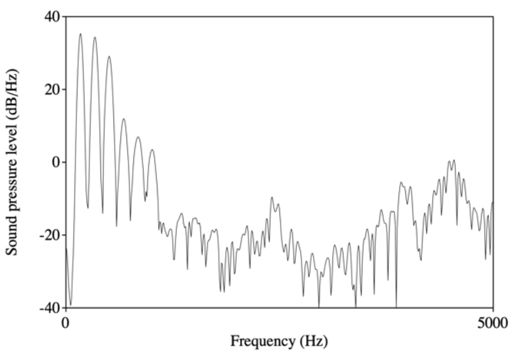

Figure 3: [ɴ] the spectra of the third mora in /goseɴeɴ/

5. RESULTS

5.1 Number of correct answers for test words

Regarding the test word /goseɴeɴ/ (Table 2), JN correctly judged /goseɴeɴ/ in 639 instances out of a total of 840 (seven speakers x four times x thirty listeners), while KB only correctly judged in 496 instances. KA correctly judged /goseɴeɴ/ in 609 instances out of a total of 840 KA showed a tendency similar to JN. Significant differences were found among the three groups (one-way ANOVA (p=0.05), F (2, 2517) =11.206, ***p<0.001***). Multiple comparisons among the three groups were conducted based on the Benjamini-Hochberg method (q=0.017). The correct judgment of JN and KA are significantly higher than that of KB (JN vs. KB: ***p<0.001***, KA vs. KB: ***p<0.001***). There was no significant difference between JN and KA (JN vs. KA: p=0.109).

On the other hand, regarding the test word /gose:eɴ/ (Table 3), significant differences were found among the three groups (one-way ANOVA (p=0.05), F (2, 2517) =12.300, ***p<0.001***). JN correctly judged /gose:eɴ/ in 555 instances out of a total of 840 (seven speakers x four times x thirty listeners). KB and KA correctly judged /gose:eɴ/ in, respectively, 641 and 623 instances out of a total of 840. KA and KB showed similar tendencies, with no significant differences between them (p=0.325). The judgment of JN was significantly lower than that of KB and KA (JN vs. KB: ***p<0.001***, JN vs. KA: ***p<0.001***).

Summarizing these results, the recognition of the two test words as /ɴ/ to the stimuli was higher for JA (924 out of 1680), KA (826 out of 1680), and KB (695 out of 1680), in that order. However, in terms of the seven speaker's intentions for the test words (the original meaning of each word), KA had the highest percentage of correct responses among the three groups.

	/ɴ/	long vowel
JN	**639**	201
KB	**496**	344
KA	**609**	231

Table 2: Recognition of /goseɴeɴ/ (Max 840)

	/ɴ/	long vowel
JN	285	**555**
KB	199	**641**
KA	217	**623**

Table 3: Recognition of /gose:eɴ/ (Max 840)

5.2 Correlation between degree of closure for /ɴ/ and its judgment

In this section, we investigated the difference in the judgment rate for /ɴ/ in the third mora of the test word /goseɴeɴ/ depending on the degree of closure ((1) [ẽ], [ĩ], (2) [ɰ̃], and (3) [ɴ]).

As shown in figure 4, the judgment rate for /ɴ/ approached 100% as the degree of closure for /ɴ/ increased in all groups. However, even for /ɴ/ sounds with insufficient closure ([ẽ], [ĩ], [ɰ̃]), JN had a significantly higher /ɴ/ judgment rate than KB (*p<0.001*). Regarding [ɰ̃], KB had a significantly lower recognition as /ɴ/ than JN and KA (Table 4).

Thus, it indicates that the sensitivity of closure in recognition of /ɴ/ varies depending on the native language and the learning level of the target language.

6. DISCUSSION AND CONCLUSION

In the perception of stimuli of the two test words, JN judged /ɴ/ more frequently than the learners, and judged vowels less frequently than the learners. Particularly, in comparison with KB, JN had higher rates of judgment as /ɴ/ even for sounds with insufficient closure ([ẽ], [ĩ], [ɰ̃]). This means that KB depends on "the degree of closure" more than JN in judgments of /ɴ/. On the other hand, the KA judgment rate had results similar to the JN. However, regarding the stimuli on the test word /goseːeɴ/, KA showed the lowest percentage of judgment rate of /ɴ/ among the three groups. In other words, they correctly judged the stimuli ([goseːeɴ]) as intended /goseːeɴ/, and they correctly perceived the long vowel part as a vowel ([e]). This indicates that KA did not reach the level of acceptance by JN in terms of the acceptance of vowels as free allophones of /ɴ/ in the intervocalic position.

Complete closure makes it easier to recognize stimuli as /ɴ/ for both JN and the learners, while a sound closer to a vowel with no restriction is perceived as /ɴ/ more naturally with the intervocalic position to JN. This result supports the view of [14].

In contrast, the Korean language has three nasal codas (/m, n, ŋ/), which have independent places of articulation, and places of articulation must be strictly maintained to distinguish them. The same opinion has been reported that English speakers do not perceive /ɴ/ like the English nasal coda, according to [15].

In conclusion, we found it more difficult for Korean speakers to recognize /ɴ/, which varies widely depending on "the degree of closure." Furthermore, it indicates that the sensitivity of closure in recognition of /ɴ/ varies depending on the native language and the learning level of the target language.

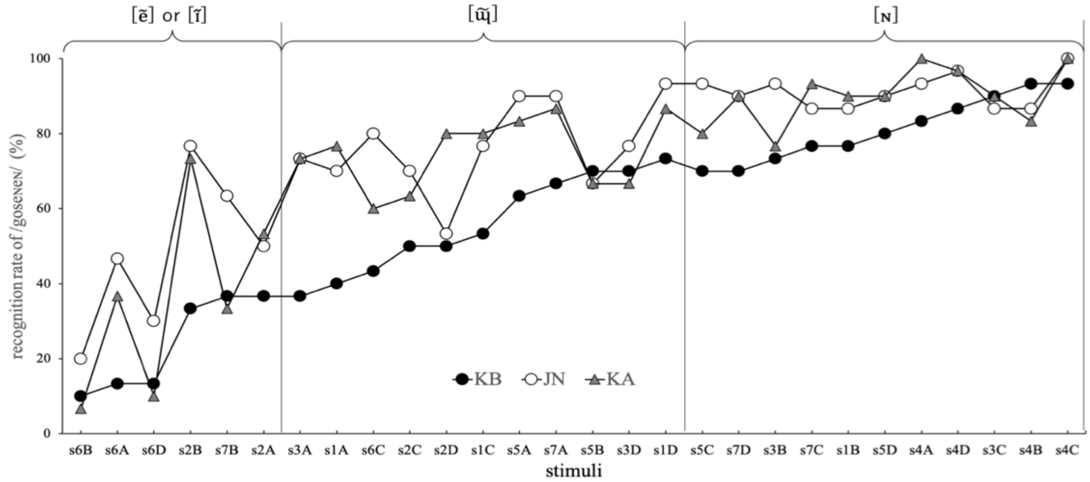

Figure 4: Recognition rates of /ɴ/ for stimuli /goseɴeɴ/ in each classification

	JN	KB	KA	one-way ANOVA (p=0.05)	Benjamini-Hochberg method (q=0.017)		
					JN vs. KB	JN vs. KA	KB vs. KA
[ẽ], [ĩ] (Max 180)	86 (48%)	43 (24%)	64 (36%)	F (1, 537) = 11.600, *p<0.001*	***≤.001***	0.057	0.042
[ɰ̃] (Max 330)	252 (76%)	185 (56%)	247 (75%)	F (1, 987) = 20.530, *p<0.001*	***≤.001***	0.903	***≤.001***
[ɴ] (Max 330)	301(91%)	268 (81%)	296 (90%)	F (1, 987) = 9.423, *p<0.001*	***0.001***	0.932	***≤.001***

Table 4: Comparison between three listener groups in each classification for /ɴ/ sounds

7. ACKNOWLEDGEMENT

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8. REFERNCES

[1] Hattori, S. 1951. *Onseigaku [Phonetics]*, Tokyo, Japan: Iwanami Shoten.

[2] Onuma, Y., K. Otsubo and O. Mizutani. 1979. *Nihongo onseigaku [Japanese Phonetics]*, Kuroshio Shuppan,

[3] Muraki M. and N. Nakaoka, Hatsuon to sokuon: Eigo, chuugokugo washa no baai [The moraic nasal and the geminate consonant: Cases of English native speakers and Chinese native speakers]. 1989. In: Sugito, M. Ed., *Kouza Nihongo to nihongo Kyouiku dai3 kan [Series in Japanese and Teaching Japanese as a Foreign Language: Number 3]*. Meiji Shoin, 139–177.

[4] Kurosaki, N. 2002. A Study of a Nasal Sound Succeeded by a Vowel. *Kanagawa University studies in language* 25, 11-22.

[5] Toki, S. 2006. Gendai no onseigaku/oninron [Phonetics and phonology of modern Japanese]. In: Nitta et. al. (eds), *Nihongo yousetsu [Essentials in Japanese Linguistics]*. Hitsuji Shobo, 129-168.

[6] Vance, T. J. 2008. *The sound of Japanese*. Cambridge University Press.

[7] Saito, S. 2013. *Nihongo onseigaku. (kaichouban) [Japanese Phonetics (Revised Edition)]*. Sanseido.

[8] Uwano, Y. 2014. Fun'iki > funiki no henka kara onitenkan ni tsuite kangaeru [A Thought on the Metathesis from Change of the Sounds between 'Fun'iki' and 'Fuinki'], In: *Hokkaido Hougen Kenkyuukai 40 Shuunen Kinenronbunshuu [Journal for 40th Anniversary of Association of Dialectology in Hokkaido Prefecture]*. Hokkaido Hougen Kenkyuukai, 8-19.

[9] Hashi, M., A. Kodama, T. Miura, S. Daimon, Y. Takakura and R. Hayashi. 2014. Articulatory Variability in Word-Final Japanese Moraic-Nasals: An X-ray Microbeam Study. *Journal of the Phonetic Society of Japan, Vol. 18. Number 2*, 95-105.

[10] Matsui, M. 2018. Nihongo tokusyuhaku onso no youso to kouzou ni tsuite [On the elements and the structures of special moraic phonemes in Japanese], *in Theoretical and Applied Linguistics at Kobe Shoin, Vol. 21*, pp.105-150.

[11] Maekawa, K. 2019. A real-time MRI study of Japanese moraic nasal in utterance-final position. *Proc. 19th ICPhS* Melbourne, 1987-1991.

[12] Sudo, J. 2007. The Japanese Interjection Un: From Its Meanings and Functions to an Analysis of Its Phonetic Features. *Journal of the phonetic Society of Japan. Vol. 11, Number 3*, 94-106.

[13] Fujimura, O. 1962, Analysis of nasal consonants, *J. Acoust. Soc. Am. Vol. 34*, 1865-1875.

[14] Kawakami, S. 1987. Nihongo no iwayuru bionsetu shin no jittai [Fact aoubt the so-caled Japanese Nnasal syllabic consonants]. *The bulletin of the Phonetic Association of Japan.* 185, 18-21.

[15] Nozawa, T. and S. Cheon. 2012. The Identification of Nasals in a Coda Position by Native Speakers of American English, Korean and Japanese. *Journal of the Phonetic Society of Japan.*16:2, 5-14.