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Perceptual Discrimination and Production of the Japanese Nasal 「ん」 Preceding the Bilabial Plosives and Nasal [p, b, m] by Indonesian Learners

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Abstract: *This study examines thoroughly the acquisition of the Japanese moraic nasal 「ん」 preceding bilabial environments ([p, b, m]) among 36 university-level Indonesian students from three academic years. Utilizing a methodology that combines perceptual discrimination tasks with Praat-based acoustic and articulatory duration analysis, this research investigates the interaction between L1 phonotactic constraints and L2 speech execution. The results show a distinctive dissociation between speech perception and production. Perceptually, learners achieved near-ceiling accuracy (98.1%), facilitated by the existence of bilabial nasals in their L1 inventory. Acoustically, however, their production exhibited persistent segmental and temporal deviations. Participants frequently generated overlong durations—exceedingly twice the native speaker baseline—and substituted non-assimilated variants ([n] and [ŋ]) for the target allophone [m], particularly in pre-nasal contexts (e.g., nanmai pronounced as [nanmai]). These production errors stem directly from native Indonesian phonotactic interference and orthographic bias from Romaji transcription. Notably, advanced fourth-year learners showed no significant convergence toward native-like acoustic norms, underscoring that high perceptual discrimination does not automatically yield native-like articulatory control. These findings highlight the necessity of incorporating explicit prosodic and allophonic training into L2 Japanese pedagogical frameworks.*

Keywords: acoustic analysis, L1 phonotactic transfer, Indonesian learners, Japanese phonology, moraic nasal, speech perception and production,

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INTRODUCTION

In Japanese phonology, the moraic nasal 「ん」—phonologically represented as /ɴ/—functions as a "special mora" alongside long vowels and gemination. Native Japanese speakers perceive 「ん」 as a single phonemic unit; however, in actual speech, it exhibits extensive allophonic variation depending on surrounding phonetic environments as stated by Imada 1989 in (Society, 2022); Kubozono & Tanaka 1999 in (Linguistic et al., 2025). Imada (1989) in (Hervé et al., 2025) details these context-conditioned allophones and their occurring conditions: 1) moraic nasal 「ん」 will be pronounced as [m] when followed by a bilabials such as [p, b, m]; 2) moraic nasal 「ん」 will be pronounced as [n] when followed by alveolars such as [t, d, ts, (dz), tʃ, (dʒ), r, n] ; 3) moraic nasal 「ん」 will be pronounced as [ɲ] when followed by an alveo-palatal nasal; 4) moraic nasal 「ん」 will be pronounced as [ŋ] when followed by a velar such as [k, g, ŋ]; 5) moraic nasal 「ん」 will be pronounced as [ɴ] when pronounced independently at the end of a word ; 6) moraic nasal 「ん」 will be pronounced as (ṽ) that assimilates to the following sound when followed by a vowel or semivowel; and 7) moraic nasal 「ん」 will be pronounced as [z̃, ʒ̃] a voiced nasal corresponding to the following sound when followed by a sound from the "sa" or "za" series.

Due to these variations, Kawakami 1987 in (Maekawa, 2023) and Matsui (2017) in (Zahner-Ritter et al., 2022) have conducted research regarding these nasal sounds. Their research became substantial literature for the sound of 「

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ん」. Meanwhile, mastering the allophones of Japanese 「ん」 is notoriously difficult for non-native learners, as stated by (Uchida 1995 in (Pearce et al., 2020) and Nakato 2003 as stated in (Nogita, 2010). Studies show that advanced Chinese learners utilize perceptual strategies distinct from native speakers as mentioned by Uchida 1995 in (Lu & Ren, 2025) and rely on rules that do not apply to native Japanese speakers as shown by Nakato 2003 in (Tsukada, 2025). Furthermore, In a study involving learners of Japanese as a foreign language at the JLPT N2 level from various native backgrounds, Min 2020 in (Takano et al., 2025) confirmed that a defining feature of the nasal 「ん」 is the substitution of intervocalic nasals with either a dental nasal [n] or a velar nasal [ŋ]. The study also reported that the duration of these nasal sounds was shorter. In a study analysing short-phrase readings containing [ɲ], [ŋ], [ɴ], [n], [m], nasal vowels, and semivowels among learners at the JLPT N3 level or higher, Min (2020 in (Nishizawa et al., 2022)) observed that three participants with Indonesian and Javanese backgrounds exhibited an overall tendency to shift nasal vowels to [n] or [ŋ] due to native language interference. Based on the previous studies above, it can be concluded that empirical research focusing on Indonesian learners of Japanese regarding their perception and production of nasal sound 「ん」 remains notably limited. In this study, we focus on the nasal sounds 「ん」 that precede the bilabial plosives and nasals [p, b, m]. Because the nasal sound 「ん」 which precedes [p, b, m] is very common in Indonesian language. Our objective is to obtain a deeper understanding of the actual ability of Indonesian learners of Japanese language to identify and pronounce it.

Indonesian syllables range from simple patterns like Consonant-Vowel (CV) to complex structures containing consonant clusters (CCV or CVCC). The following are the essentials of Chaer (2009) in (Rumalean, 2025) principles of the Indonesian phonology system. Phonetically, the four nasal consonants correspond to the bilabial [m], the alveolar [n], the velar [ŋ], and the palatal [ɲ] . Understanding where these sounds can appear within a word—whether at the beginning (word-initial), middle (word-medial), or end (word-final), except for the palatal [ɲ] —is key to understanding Indonesian sound patterns.

In terms of positional occurrence, the nasal consonants [m], [n], and [ŋ] can freely appear in all three-word positions, but the palatal [ɲ] is the only one excluded in this term. Word-initially, they precede vowels (e.g., *mati*, *nama*, *nganga, nyaring*). Word-medially, they frequently link with other consonants to form clusters, such as [m] before labial sounds for example "simpan", [n] before alveolar sounds for example "nanti", and [ŋ] before velar like "bongkar" or "bangkrut", and the palatal. Word-finally, all three act as standard syllable codas to end words, as seen in "hitam", "bahan", and "abang", these parts are summarize from various parts of Chaer (2009) in (Evizariza, 2025). Furthermore, in Indonesian, grapheme <ng> is pronounced as [ŋ], so the Japanese word 「漫画（manga）」 is pronounced as [maŋa]. If a word is intended to be pronounced [maŋga], it should be written literally as "mangga".

Unlike the other three nasal sounds, the palatal nasal [ɲ] ("ny") has a strictly limited distribution in Indonesian phonology. It naturally occurs at the beginning of words before vowels (e.g., *nyala*) and in the middle of words, where it assimilates with palatal stops like /c/ and /j/ (e.g., *hancur* [haɲcur], janji [jaɲji]) or occurs between vowels (e.g., *banyak* [baɲaʔ]). However, it never appears in the word-final position in native Indonesian words. Thus, while Indonesian phonology flexibly supports most nasal sounds across all positions, it restricts the palatal nasal from ending a word.

This difficulty is closely connected to the phonetic and phonotactic system of Indonesian. Indonesian features four types of nasal sounds: the bilabial nasal [m], the alveolar nasal [n], the velar nasal [ŋ], and the palatal nasal [ɲ]. By reading through the prime principles of Chaer's description of Indonesian phonology as stated in (Ilmiah & Pendidikan, 2023), when the /n/ phoneme is followed by the bilabial plosive /p/, such as /tanpa/ is pronounced [tanpa]. Thus, there is no /n/ phoneme preceding /b/; the phoneme preceding /b/ is always /m/ (e.g., /sembah/ [sembah]). Among alveolar consonants, /n/ followed by /t/ or /d/ becomes [n] (e.g., [nanti], [tunda]), whereas /r/ never follows /n/. Therefore, it is summarized that the foundational rules of Indonesian syllable structures and the positional distribution of its four nasal consonant sounds [m], [n], [ŋ], and [ɲ]. Besides, Indonesian as mentioned clearly by Chaer 2009 in (Rumalean, 2025) and by Akhyarudin, Harahap (2020), uses a syllabic system, so when /n/ is followed by a vowel, it always forms a single syllable and is pronounced as [n]. Specifically, in the VCV pattern, syllables are divided as V.CV (e.g., [ini] is [i.ni]), and in the CVCVC pattern, as CV.CVC (e.g., [tanam] is [ta.nam]) or CVC.CV (eg., [ganti] is [gan.ti]).

Based on these phonotactic differences, Indonesian learners are likely influenced by their L1 when discriminating and pronouncing Japanese special syllables. However, the overall picture of Indonesian learners' acquisition of the Japanese nasal sound 「ん」 remains unclear because of the lack of sufficient research. To address this gap, this paper examines both the perceptual discrimination ability and pronunciation variations of the Japanese nasal 「ん」 that precedes the bilabial plosives and nasals [p, b, m] among Indonesian learners. By clarifying these phonetic characteristics, this study offers significant contributions to both the theoretical field of Japanese

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phonology and the practical domain of Japanese language pedagogy in Indonesia, providing effective teaching strategies for classroom instruction.

METHODS

First, the perceptual discrimination test was conducted using audio recordings of two Japanese Native speakers (one male and one female) reading the list of example sentences shown in Table 1.

Table 1. Sentence Examples

(MN　中級I 第3課)	ジャンプしてください。(janpu)
（MN中級I 第6課）	順番（じゅんばん）が来ました。(junban)
（MN初級I 第4課）	何枚（なんまい）欲しいですか。(nanmai)

The test was administered via *Google Forms*, in which Japanese language learners were randomly presented with four-choice listening comprehension questions. The audio recordings were arranged so that the male narrator spoke first, followed by the female narrator. This method is utilized to mitigate gender bias and allows for the verification of sound on two occasions. It has been adjusted for contextual issues and time and place differences between the researcher and the students as the object of study.

Next, for the pronunciation ability assessment, the writer measured the duration of the sounds in the same sentence examples used in the perceptual discrimination study. The data collection method involved distributing the list of sentence examples and a *Google Drive* link for data submission to the learners. The learners practiced reading the sentences on their own and recorded themselves. They then uploaded their best recording to *Google Drive*. Subsequently, the duration of the geminate consonants was measured using the *Praat* software as shown by (Fujimoto & Funatsu, 2018). Instructions regarding data collection were provided in a video created by the author.

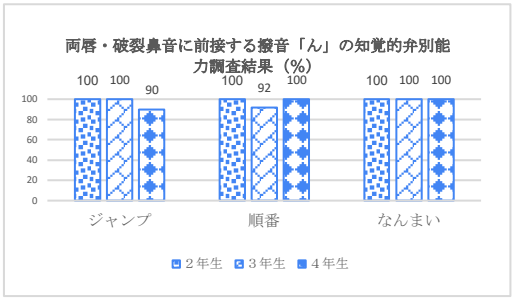
This study focuses on analyzing the perceptual discrimination ability and articulatory variation of the moraic nasal phoneme「ん」among Indonesian learners of Japanese. The sample is limited to 36 university-level Japanese language learners across three academic years—14 second-year, 12 third-year, and 10 fourth-year students—with a maximum proficiency level of *JLPT N3*. Audio stimuli for the perception test are limited to recordings by native Japanese speakers, while target vocabulary is restricted to short phrases and sentences selected from the standard textbook "Nihongo Kananyuumon", "Minna no Nihongo shokyuu I & II" and "Minna no Nihongo chuukyuu I & II" are specific instructional resources. The words selected for this research is the most familiar to Indonesian Learners. High-familiarity terms in this research are those that are included in textbooks used from the early stages, and they are frequently encountered visually or auditorily in everyday life and used consistently in class. In this paper, taking into account the need for familiarity and minimizing environmental influences, words that include special syllables were chosen to be positioned at the beginning of the syllable, and the author created short sentences so that these words would appear at the beginning of the sentences.

Methodologically, acoustic analysis is conducted independently using Praat software. If certain condition happened, the writer will confirm the acoustic analysis with the perceptual evaluation from the expert native speaker. The research design effectively addresses the gap identified in the introduction regarding the limited empirical research on Indonesian phonotactic interference in mastering the Japanese nasal「ん」which precedes the bilabial plosives and nasals [p, b, m]. By integrating cognitive-perceptual analysis via *Google Forms* with acoustic-production analysis, this hybrid approach provides a comprehensive account of L1 phonological transfer patterns. Practically, these findings inform the development of targeted pedagogical strategies tailored to the specific phonetic challenges faced by Indonesian learners.

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RESULT AND DISCUSSION

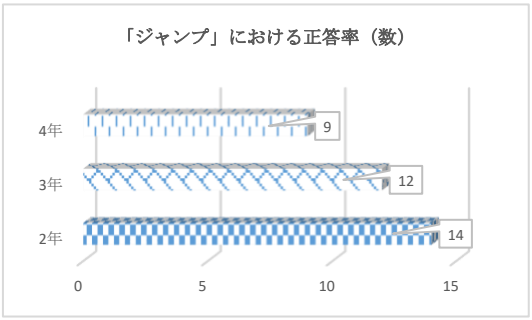
In this section, the writer analyzed the ability of Indonesian learners to perceptually distinguish the Japanese nasal 「ん」, which precedes the bilabial plosives and nasals [p, b, m]. In Japanese, the nasal consonant 「ん」 that precedes the bilabial plosive and nasal sounds [p, b, m] is pronounced as [m]. The results revealed that, among the various alophones of the nasalized consonant 「ん」, the highest correct response rate was preceding the bilabial plosives and nasal [p, b, m]. Since the Indonesian language contains the sound [m], it is believed that distinguishing the nasalized 「ん」 preceding the bilabial plosives and nasals [p, b, m] was not difficult for Indonesian learners. Furthermore, even though the nasalized「ん」preceding the bilabial plosives and nasals [p, b, m] is transcribed as 「ん」in Romanized script, Indonesian learners did not exhibit any mishearing or misreading of these sounds. The words addressed in this paper are「ジャンプ(jump)」,「じゅんばん（junban）」 and「なんまい（nanmai）」; example sentences were created using these words and used in the perceptual discrimination and pronunciation ability surveys.



Graph. 1 Findings on perceptual ability survey in Japanese nasal 「ん」 precedes the bilabial plosives and nasals [p, b, m].

According to the results of the perceptual discrimination test (Graph 1), the correct response rate for the sound [m] in particular reached 98.1%. In ascending order of performance, 「Jump」 scored 97.2%, 「Order （junban）」 scored 97.2%, and「How many （nanmai)」 scored 100%.

Next, we will analyze the perceptual discrimination ability and pronunciation ability for each word. First, this study analyzes the perceptual discrimination ability regarding the nasal sound 「ん」 in the word "Jump". The example sentence used in this paper is 「ジャンプしてください。（Please jump）」. Although participants were asked to choose from four options—「じゃっぷ（Jappu）」,「じゃっむ（Jammu）」,「じゃんぷ（Jump）」, and 「じゃんむ（Janmu）」—it was confirmed that no learners responded with 「じゃっむ（Jammu）」or「じゃんむ（Janmu）」. Furthermore, only one student at 4th year who misheard it as 「じゃっぷ（Jappu）」. These results suggest that the perceptual discrimination of the glide 「ん」preceding the voiceless bilabial plosive [p] in 「じゃんぷ（Jump）」is not particularly difficult for students in their second, third, and fourth years as shown in graph 2 below.

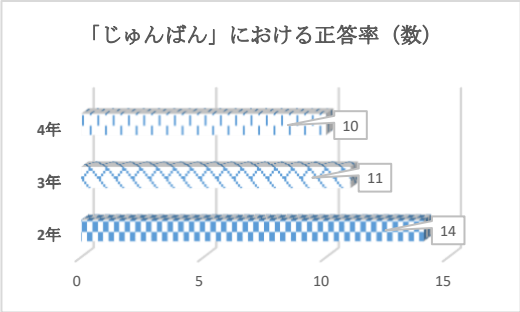


Graph. 2 Finding on perceptual discrimination of the glide 「ん」 preceding bilabial voiceless plosive [p] in「ジャンプ」

Next, is the analysis of the perceptual discrimination ability regarding the nasal 「ん」preceding voiced bilabial [b] in 「じゅんばん（junban）」. In this paper, we use the example sentences In this paper, we used the example sentence "「じゅんばんが来ました（It's my turn）」. The task required participants to choose from four options: 「じゅうばん（jūban）」「じゅんばん（junban）」「じゅばん（juban）」and「じゅうんばん（jūnban）」.

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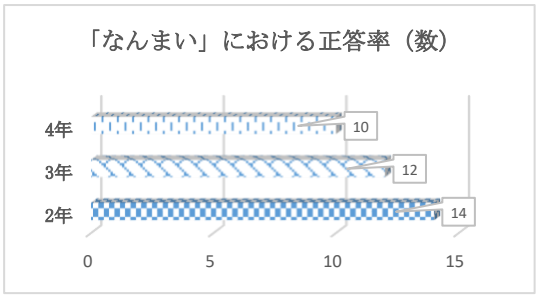
No learners answered 「じゅばん（juban）and only one learner at 3rd year misheard it as 「じゅうばん（jūban）」.



Graph 3. Finding on perceptual discrimination of the glide 「ん」 preceding bilabial voiced plosive [b] in「じゅんばん」

Furthermore, there are two learners at 2nd year who answered 「じゅうんばん（jūnban）」likely did not have a problem with the perceptual discrimination ability regarding the nasal sound 「ん」in 「じゅうんばん（jūnban）」as shown in Graph 3. These results suggest that the perceptual discrimination of the nasal 「ん」in 「じゅんばん（junban）」is not particularly difficult for students in their second, third, and fourth years.

Last finding for perceptual discrimination, we analyze the ability regarding the nasal sound 「ん」preceding the voiced bilabial plosive [m] in 「なんまい（nanmai）」." In this paper, the example sentence used is 「なんまい欲しいですか。（How many (sheets) do you want?）」. Although learners were asked to choose from four options—"「なまい（namai）」「なっまい（nammai）」「なっま（namma）」and「なんまい（nanmai）」—it was confirmed that no learner selected 「なまい（namai）」.



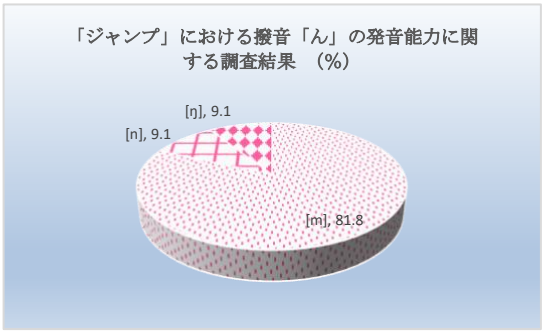
Graph 4. Finding on perceptual ability to discriminate the nasal sound 「ん」preceding bilabial voiced nasal [m] in 「なんまい」.

Furthermore, as Imada (1989) in (Society, 2022) pointed out, it is likely that the learners who responded with 「なっまい（nammai）」and「なっま（namma）」 did not have a problem with their perceptual ability to identify the nasal 「ん」preceding the bilabial voiced nasal [m] because it is pronounced by Japanese native speaker as [mː].

Next, we will analyze the ability to pronounce the plosive sound 「ん」preceding voiceless nasal [p] in the word 「ジャンプ」. For the word 「ジャンプ（jump）」, the average duration for Japanese native speakers was 0.066s, while that for Indonesian learners of Japanese was 0.099s. These results suggest that there is no significant difference between the average durations of native speakers and learners. However, upon closer observation, four learners were found to have durations more than twice as long as those of native speakers. In addition, unlike with 「ジャンプ」three learners mispronounced the word as [zanbu], [zanpu], or [janpo]; these data are not included in the analysis of this study.

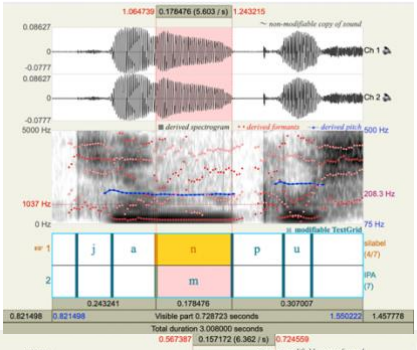
Moreover, the following pronunciation variations of the nasal sound 「ん」in「ジャンプ」were observed: [m], [n], and [ŋ]. Specifically, it was confirmed that learners who pronounced it as [m] were the most numerous in all grade levels. On the other hand, the number of learners who pronounced it as [n] and [ŋ] was in the similar percentage (Graph 5) below.

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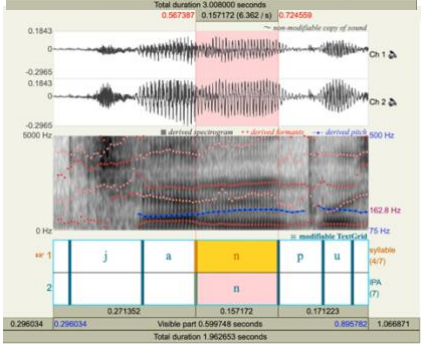


Graph 5. Finding on pronunciation ability of the nasal「ん」preceding bilabial voiceless plosive [p]

In the phonetic analysis, it was confirmed that [m] was the most common variation in the pronunciation of the glide 「ん」 in 「ジャンプ」. Although no issues were observed in the sound quality, the results of the duration observations revealed that some learners pronounced the sound for too long. The following figures show visualizations of these pronunciation data generated using Praat. One representative of the learners who pronounce long [m], [n], and [ŋ]—with durations more than twice as long as those in Japanese Native speaker —are shown in pict 1 for [dʑam:pu], pict 2 for [dʑan:pu], and pict 3 for [dʑaŋ:pu].

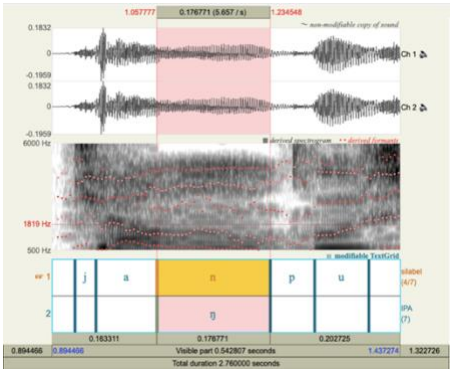


Pict. 1 [dʑam:pu]



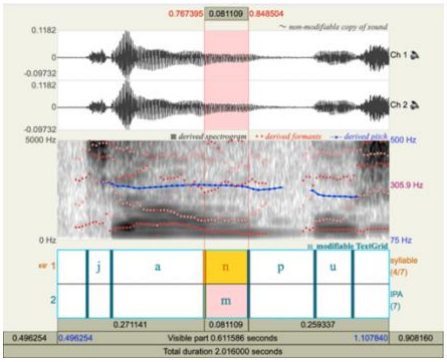
Pict. 2 [dʑan:pu]

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Pict. 3 [dʑaŋːpu]

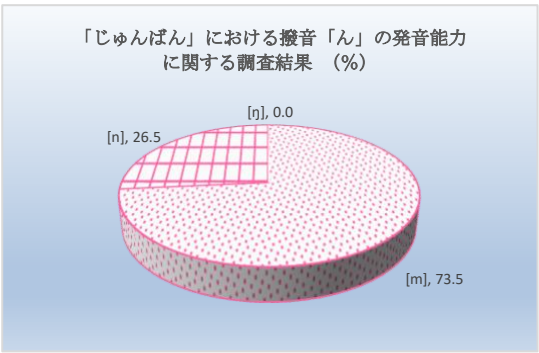
Furthermore, a representative learner who pronounced [dʑampu]—a natural [m] with a duration similar to Japanese Native speaker —is shown in picture 4.



Pict. 4 [dʑampu]

Next, we analyze the duration of the nasal 「ん」 preceding voiced bilabial [b] in the word 「じゅんばん（junban）」. The average duration for the Japanese Native speaker was 0.113s, while that for the Indonesian learners was 0.152s. Specifically, there were three at second-grade students who pronounced the nasal 「ん」 twice as long as the average of the Japanese native speaker. Therefore, the average duration for second graders was 0.177s, which was confirmed to be the longest compared to third and fourth graders. The average duration for third graders was 0.146s, while that for fourth graders was 0.123s, which was closest to the Japanese Native speaker average.

Furthermore, based on observations of sound quality, learners who pronounced the sound as [m] or [n] were present in all grade levels, with those pronouncing it as [m] being the most common (as shown in Graph 6). On the other hand, no learners were found to have pronounced it as [ŋ].

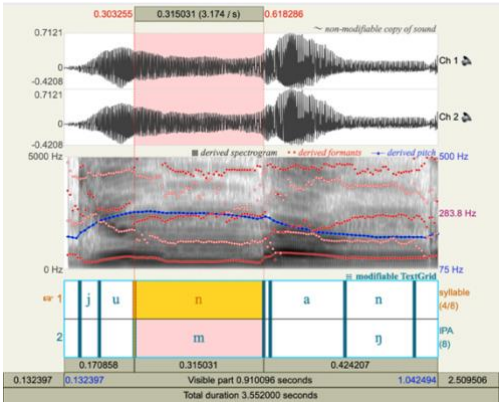


Graph 6. Finding on pronunciation ability of the nasal 「ん」 preceding bilabial voiced plosive [b]

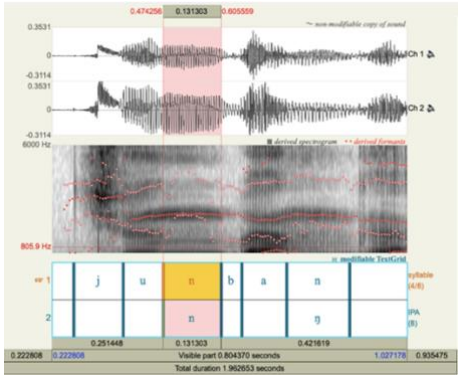
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From Graph 6, it was found that the proportions of variations in the nasal sound 「ん」 preceding bilabial voiced plosive [b] in 「じゅんばん（junban） 」 exhibit pronunciation variations of [m] and [n]. Some learners did not pronounce 「じゅんばん（junban）」 but instead pronounced it as [dʑuwaŋ] or [dʑumaŋ]; these data were excluded from the analysis.

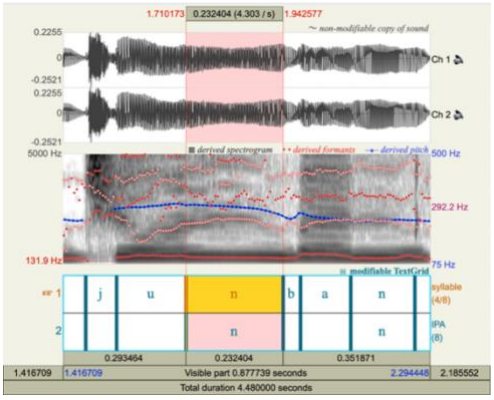
In Indonesian, since the consonant preceding the voiced bilabial plosive [b] is always the phoneme /m/, [m] was frequently observed as a variant of the Japanese nasal 「ん」. Representative examples of the audio data for these pronunciations are shown using *Praat*. Representative audio examples of long [m] and [n] sounds—whose durations are at least twice that of Japanese Native speaker—are shown in pict. 5 for [dʑum:baŋ], pict. 6 for [dʑun:baŋ], and for short varian of nasal 「ん」 such as [dʑunbaŋ] in pict.7.



Pict. 5 [dʑum:baŋ]



Pict. 6 [dʑun:baŋ]

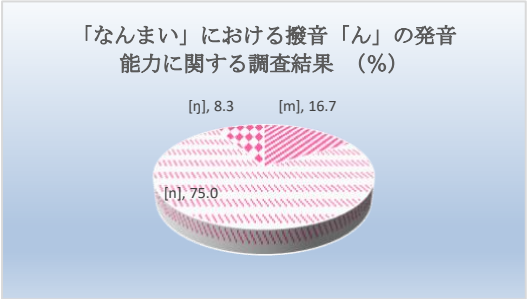


Pict. 7 [dʑunbaŋ]

Next, we analyze the production of the moraic nasal 「ん」 in 「なんまい（nanmai）」. Auditory and spectrographic evaluations confirmed that the Japanese Native speaker produced [nam:ai] with a average duration of [m:] was 0.166s. Similarly, six Indonesian learners realized the target as [nam:ai]. Conversely, three learners—one

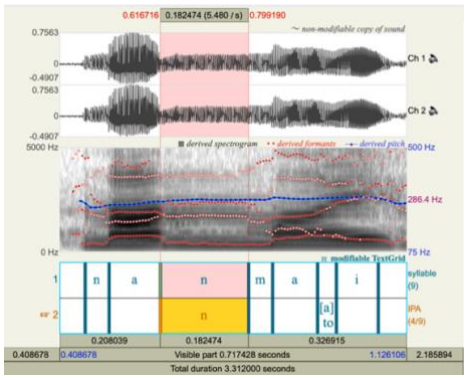
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from each academic year—produced [naŋmai], while the remaining participants yielded [nanmai] or [nan:mai]. Cross-cohort durational comparisons across second- through fourth-year students indicated that third-year learners exhibited the longest average duration (0.132s), compared to second-year (0.117s) and fourth-year learners (0.108 s). The elevation in third-year duration primarily stems from a higher proportion of [nam:ai] realizations. Notably, a substantial number of fourth-year learners articulated the nasal 「ん」 preceding the bilabial voiced nasal [m] in 「なんまい（nanmai）」 as [nanmai], revealing persistent deficiencies in accurate segment production and temporal control despite advanced academic standing. In summary, phonetic analysis demonstrates that [n]-realizations were present across all grade levels and represented the dominant variant. Furthermore, no misreading errors for 「なんまい（nanmai）」 were observed among the participants.

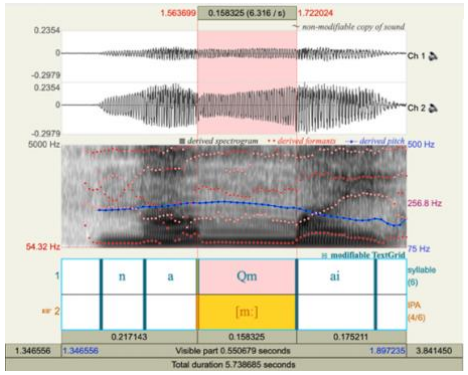


Graph 7. Finding on pronunciation ability of the nasal 「ん」 preceding bilabial voiced nasal [m]

The word 「なんまい」 is transcribed as "nanmai" in Romanization. Because Indonesian phonotactics lack an /n/ onset immediately preceding a bilabial nasal [m], L1 Indonesian learners frequently perceive and produce the Japanese moraic nasal 「ん」 in 「なんまい」 as [n] rather than assimilated [m]. Empirical acoustic analyses confirm that [n] constitutes the primary variant in this phonetic environment. *Praat* spectrographic observations reveal this distribution: Pict. 8 and 9 illustrate representative productions displaying an extended duration of [n] (comparable to Japanese Native speaker) alongside a lengthened [m]. Whereas Pict 10 and 11 exhibit the variants [naŋmai] and [nanmai], respectively.

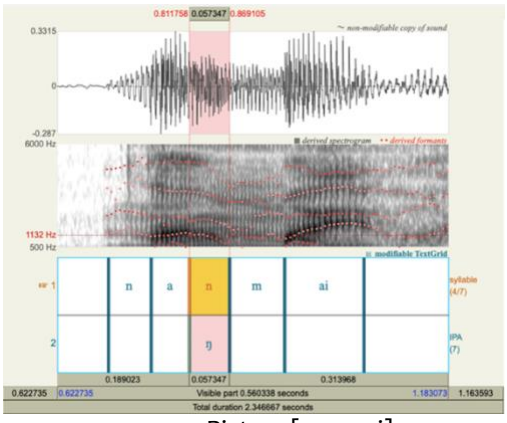


Pict. 8 [nan:mai]

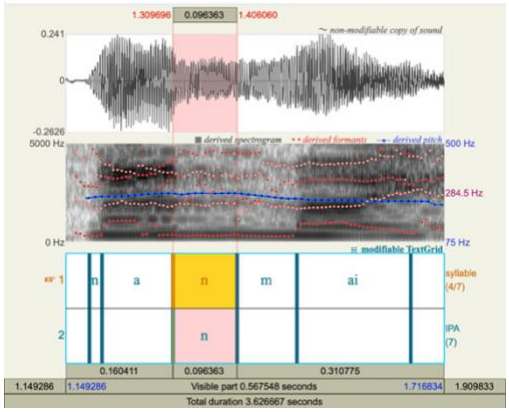


Pict. 9 [nam:ai]

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Pict. 10 [naŋmai]



Pict. 11 [nanmai]

Although learners demonstrated high perceptual accuracy (>98%) for the moraic nasal [before bilabial environments, acoustic analysis reveals a distinct dissociation between auditory perception and articulatory production. While participants accurately identified nasal 「ん」 in listening tasks, their oral production exhibited significant temporal and segmental deviations—such as overlong durations and non-assimilated substitutions ([n] and [ŋ]). This disparity suggests that high perceptual discrimination does not inline with native speakers' phonetic execution, highlighting an underlying mismatch between speech perception and acoustic-articulatory control among L1 Indonesian speakers.

In addition, although the learners were able to identify the nasal sound [m] following the nasal 「ん」 as a long [m] in the perception discrimination survey, they do not have awareness that the nasal 「ん」 preceding the bilabial nasal [m] is pronounced by Japanese native speakers as a long voiced bilabial nasal [m]. Furthermore, these phonetic variations stem directly from native language phonotactic interference and orthographic bias. Because Indonesian phonotactics strictly regulate pre-consonantal nasals (e.g., prohibiting /n/ before /b/ while allowing /n/ before /p/ in words like *tanpa*), learners frequently transfer these L1 structural rules to Japanese. Additionally, relying on *Romaji* orthography (where /n/ is uniformly transcribed as "n") reinforces the substitution of alveolar [n] in environments requiring place-of-articulation assimilation, such as "*nanmai*".

Consequently, explicit instruction integrating both temporal control (mora timing) and context-dependent allophonic rules is essential to correct these persistent L1 transfer patterns.

CONCLUSION

This study investigated the acquisition of the Japanese moraic nasal 「ん」 preceding bilabial environment—specifically [p, b, m]—among university-level Indonesian learners of Japanese across three academic years. By integrating perceptual discrimination tasks with *Praat*-based acoustic and articulatory analysis, the findings demonstrate a clear asymmetry between speech perception and speech production. Perceptually, Indonesian learners (among 2nd grade to 4th grade) exhibited near-ceiling performance, achieving accuracy rates 97.2% and 100%

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across all target items (*janpu*, *junban*, *nanmai*). This high perceptual accuracy indicates that the native Indonesian phonological inventory, which includes the bilabial nasal /m/, facilitates the passive recognition of nasal 「ん」 in bilabial contexts.

In contrast, acoustic and production analyses revealed persistent L1 phonological and phonotactic transfer that distorts both sound duration and segment quality. Acoustically, learners systematically overextended the duration of nasal 「ん」, frequently exceeding twice the duration produced by native Japanese speakers. Articulatorily, while the target allophone [m] predominated, non-native substitutions—specifically the alveolar nasal [n] and velar nasal [ŋ]—recurred consistently across all proficiency levels. This deviation is particularly pronounced in pre-nasal contexts (e.g., *nanmai* pronounced as [nanmai]), driven by native Indonesian syllabification rules and orthographic interference from Romanization. Furthermore, advanced fourth-year learners failed to show significant phonetic native-like convergence, underscoring the inadequacy of current pedagogical instruction in overcoming L1 phonotactic inertia. The findings of this study align with the observations made by Min (2020), which suggest that learners typically pronounce the nasal sound 「ん」 as either [n] or [ŋ]. While Min (2020) did not specify the contexts in which the nasal sound 「ん」 is articulated as [n] or [ŋ], this research aims to elucidate the specific aspects that require attention from both educators and Indonesian learners of Japanese language.

In summary, high perceptual accuracy does not automatically translate into accurate temporal and segmental production of Japanese special mora. Practically, these findings highlight the necessity of targeted phonetic instruction in L2 Japanese curricula—specifically incorporating explicit temporal coaching and pitch/duration monitoring—to remediate L1 transfer among Indonesian learners. Theoretically, this work contributes empirical evidence to cross-linguistic speech research by demonstrating how L1 phonotactic constraints interact with L2 moraic timing mechanisms.

DECLARATION OF GENERATIVE AI

During the preparation of this work the authors used OpenAI's ChatGPT-4o in order to enhance readability and perform grammar checking. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

DECLARATION OF COMPETING INTEREST

All authors declare that they have no conflicts of interest regarding the publication of this paper.

AUTHORSHIP CONTRIBUTION STATEMENT

Writing – review & editing, Writing – original draft, Validation, Conceptualization.

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