The Perception of Japanese Consonant Length by Native Malay Speakers
(Persepsi Kepanjangan Konsonan Bahasa Jepun oleh Penutur Asli Bahasa Melayu)

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ABSTRACT

The present study investigated how the consonant length contrast in Japanese (i.e., word-medial singletons vs. word-medial geminates) was perceived by native Malay speakers according to previous first language (L1) familiarity with such a contrast. The participants were Kedah Malay [KDM (-quantity)] and Kelantan Malay [KLM (+quantity)] speakers who differed in terms of their familiarity with quantity systems. That is, the KDM (-quantity) speakers were unfamiliar with the length contrast, while the KLM (+quantity) speakers were familiar with the length contrast. Neither group had experience with Japanese. Consonant length is contrastive in both Japanese and KLM (+quantity). However, the two languages are different with respect to word position. That is, consonant length in Japanese is only allowed to contrast word-medially, while the length contrast only occurs word-initially in KLM (+quantity). Therefore, we were theoretically interested in observing how the two groups of native Malay speakers, who had different L1 experience with respect to consonant length, perceived the word-medial contrast in Japanese. We tested the degree to which these two Malay groups as well as the control native Japanese (NJ) group perceived the Japanese length contrast by conducting an AXB discrimination task and instructing the participants to respond to 200 trials. The results revealed that the NJ speakers scored the highest accuracy (99%), followed by the KLM (+quantity) (84%) and then KDM (-quantity) (82%) speakers. It appears that the NJ speakers outperformed the two Malay groups. Surprisingly, both Malay groups performed about equally well. There was somehow an additional benefit for the KLM (+quantity) speakers who were exposed to consonant length in their L1, with the clearest effect for the discrimination of alveolar geminates. The results provide some evidence for L1 influence on cross-linguistic geminate perception, albeit without Japanese experience. It is anticipated that the results will also inform pedagogical approaches for developing listening comprehension and communicative proficiency in the Japanese language.

Keywords: Consonant length; length contrast; Japanese; Kedah Malay; Kelantan Malay

ABSTRAK

Kajian ini meneliti bagaimana kontras kepanjangan konsonan dalam bahasa Jepun (iaitu konsonan tunggal berbanding konsonan geminat pada kedudukan tengah perkataan) dipersepsikan oleh penutur asli bahasa Melayu berdasarkan tahap pendedahan awal bahasa ibunda (L1) mereka terhadap kontras tersebut. Peserta kajian terdiri daripada penutur dialek Melayu Kedah [KDM (-kuantiti)] dan Melayu Kelantan [KLM (+kuantiti)] yang berbeza dari segi kelaziman mereka terhadap sistem kuantiti. Secara khususnya, penutur KDM (-kuantiti) tidak terbiasa dengan kontras kepanjangan, manakala penutur KLM (+kuantiti) lazim dengan kontras kepanjangan tersebut. Kedua-dua kumpulan tidak mempunyai sebarang pengalaman berbahasa Jepun. Kepanjangan konsonan bersifat kontrastif dalam kedua-dua bahasa Jepun dan KLM (+kuantiti). Walau bagaimanapun, kedua-dua bahasa ini berbeza dari aspek kedudukan dalam perkataan. Hal ini bermakna, kepanjangan konsonan dalam bahasa Jepun hanya berkontras pada kedudukan tengah perkataan, manakala kontras kepanjangan hanya berlaku pada kedudukan awal perkataan dalam KLM (+kuantiti). Oleh itu, dari sudut teori, kajian ini bertujuan untuk memerhatikan bagaimana

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kedua-dua kumpulan penutur asli bahasa Melayu yang mempunyai pengalaman L1 yang berbeza berkaitan kepanjangan konsonan, mempersepsikan kontras pada kedudukan tengah perkataan dalam bahasa Jepun. Kami menguji tahap persepsi kedua-dua kumpulan bahasa Melayu tersebut serta kumpulan kawalan penutur asli bahasa Jepun (NJ) terhadap kontras kepanjangan bahasa Jepun melalui pelaksanaan tugas diskriminasi AXB. Dalam tugas ini, peserta diarahkan untuk memberikan tindak balas terhadap 200 rangsangan. Dapatan kajian mendedahkan bahawa penutur NJ mencatatkan kadar ketepatan tertinggi (99%), diikuti oleh penutur KLM (+kuantiti) (84%) dan kemudiannya penutur KDM (-kuantiti) (82%). Jelas terbukti bahawa prestasi penutur NJ mengatasi kedua-dua kumpulan penutur bahasa Melayu tersebut. Walau bagaimanapun, satu dapatan yang mengejutkan adalah kedua-dua kumpulan penutur bahasa Melayu menunjukkan tahap prestasi yang hampir sama. Namun begitu, wujud kelebihan tambahan bagi penutur KLM (+kuantiti) yang telah terdedah kepada kepanjangan konsonan dalam L1 mereka, dengan kesan yang paling ketara dapat dilihat pada diskriminasi konsonan gusi panjang. Dapatan ini menyumbangkan bukti untuk pengaruh L1 terhadap persepsi geminat rentas bahasa, walaupun tanpa sebarang pengalaman dengan bahasa Jepun. Hasil kajian ini dijangka dapat memberikan panduan kepada pendekatan pedagogi dalam usaha memperkembangkan kemahiran kefahaman mendengar dan kecekapan komunikatif dalam bahasa Jepun.

Kata kunci: Kepanjangan konsonan; kontras kepanjangan; bahasa Jepun; bahasa Melayu Kedah; bahasa Melayu Kelantan

INTRODUCTION

The present study investigated how word-medial singletons and geminates in Japanese are processed accurately by two groups of native Malay speakers whose native languages are typologically different from Japanese: Kedah Malay [KDM (-quantity)] and Kelantan Malay [KLM (+quantity)]. The speakers of KDM (-quantity) were *unfamiliar* with quantity systems or the length contrast, while the speakers of KLM (+quantity) were *familiar* with quantity systems or the length contrast. Both groups of native Malay speakers did not have any experience learning Japanese. Despite sharing similar roots to the Standard Malay of Malaysia, these speakers are different with respect to *familiarity* with a consonant length contrast [i.e., KDM (-quantity): unfamiliar; KLM (+quantity): familiar]. KLM (+quantity) allows a consonant length contrast, though the word position of the contrast is different from Japanese [i.e., Japanese: word-*medial* position; KLM (+quantity): word-*initial* position].

The main goal of the present study is to assess the perceptual weight of the word-medial consonant length contrast in Japanese via the lens of non-native speakers who have no Japanese learning experience yet differ in terms of L1 experience with consonant length, with the KLM (+quantity) speakers having a potential benefit with the knowledge of the consonant contrast in their L1. Native perception of consonant gemination in KLM (+quantity) has previously been tested for native speakers of this language (Hamzah et al., 2016b, 2019; see also on closely related Pattani Malay, e.g., Abramson, 2003). However, to date, no perceptual studies on foreign languages, such as Japanese, have been conducted for native Malay speakers, except for a previous small-scale study related to the current work (Hamzah et al., 2023).

In KLM (+quantity), the results drawn from a series of perception experiments (Hamzah et al., 2016b, 2019) show that native speakers of KLM (+quantity) manage to distinguish long vs. short consonants in utterance-initial contexts, including words that contain voiceless stops. The perceptual findings lend evidence for closure duration as the most robust acoustic parameter for consonant length in KLM (+quantity). The roles of other non-durational acoustic correlates, such as amplitude and fundamental frequency (F0), are only secondary.

In this study, KLM (+quantity) was compared against KDM (-quantity) in order to examine whether prior L1 experience with/without consonant length can potentially affect the perception

of the length contrast in an unfamiliar language. The results of the study are interpreted within the Perceptual Assimilation Model (PAM) (Best, 1995; Best & Tyler, 2007; see below). This study is a rare extension of the previously reported perceptual findings (e.g., Minagawa & Kiritani, 1996; Tsukada & Hajek, 2023) on the effects of L1 quantity systems on Japanese consonant length. As mentioned earlier, the length contrast for consonants only exists in KLM (+quantity), not in KDM (-quantity), which provides a theoretically significant opportunity to find out the cross-linguistic perceptual differences between the native speakers of these two Malay varieties. We expect that the native KLM (+quantity) speakers would outperform the native KDM (-quantity) speakers, given their previous L1 exposure to the length contrast.

In a similar context, Tsukada et al. (2018a) discovered an interesting pattern among L1 Italian *non-learners* of Japanese who could identify the word-medial contrast in Japanese as successfully as those *learners* of Japanese with other L1 backgrounds (i.e., Australian and Korean). This observation implies that native Italian speakers managed to effectively employ their own native experience with the word-medial contrast in their L1 in perceiving the length contrast in Japanese. As many Asians learn Japanese as a foreign language, including Malaysians, it would be useful to examine whether different native Malay speakers unfamiliar with Japanese differ from other non-native learners of Japanese in terms of their perception of consonant length in Japanese.

The present study is theoretically framed within PAM, originally proposed by Best (1995), along with its extension for second language (L2) learners, PAM-L2 (Best & Tyler, 2007). As the participants in the current study have no experience learning Japanese, their perception of the Japanese length contrast is driven entirely by their native language phonology. PAM is widely considered as the established standard for explaining how inexperienced non-native listeners, such as the target participants in the present study, process unfamiliar foreign speech sounds (see, e.g., Grimaldi et al., 2014; Kogan & Mora, 2022; Tsukada et al., 2014; Tyler et al., 2014). The core principle of PAM is that naïve listeners automatically perceive non-native sounds through the filter of their L1 phonological system. Discrimination accuracy for an unfamiliar contrast, such as Japanese consonant length, depends entirely on how foreign sounds assimilate or map onto the listeners' native categories.

In the case of KDM (-quantity), because the speakers of this Malay variety lack any contrastive consonant length in their L1, PAM predicts they will experience Single-Category Assimilation. That is, they are likely to perceive both the Japanese word-medial singletons and geminates as acceptable variations of the same short native consonant category. Since both length categories map to a single native category, PAM predicts their discrimination accuracy will be poor. As for KLM (+quantity), even though the word position of the length contrast differs between Japanese (word-medial position) and KLM (+quantity) (word-initial position), the KLM (+quantity) speakers possess the phonological feature for consonant length in their L1. Under PAM, they are predicted to exhibit Two-Category Assimilation (i.e., mapping Japanese singletons to their L1 short consonants, and Japanese geminates to their L1 long consonants) or at least Category-Goodness Assimilation (mapping both to one category, but recognising one as a significantly "better" fit, potentially due to robust closure duration cues). PAM predicts this positive transfer will give the KLM (+quantity) group a significant perceptual advantage, leading to high discrimination accuracy.

Based on these predictions, the present study aims to assess the difference between two groups of non-learners of Japanese, i.e., the KDM (-quantity) and KLM (+quantity) speakers, in their perception of the Japanese consonant length contrast. As the KLM (+quantity) speakers had L1 knowledge on consonant length, it is of theoretical interest to investigate whether this particular

L1 experience might boost the KLM (+quantity) speakers' perceptual processing of Japanese consonant length in comparison to the KDM (-quantity) speakers who had no L1 knowledge on consonant length. Accordingly, this study addresses the following main research question:

To what extent does the presence or absence of L1 quantity systems influence native Malay speakers' perception of the Japanese consonant length contrast?

Specific research questions of the current study are outlined below:

1. Do the KLM (+quantity) speakers discriminate the Japanese singleton/geminate contrast more accurately than the KDM (-quantity) speakers, given the difference between two Malay groups in their familiarity with consonant length?
2. Can the sensitivity to word-initial gemination exhibited by the KLM (+quantity) speakers be positively transferred to novel word-medial environments in Japanese?
3. Is length category (i.e., singleton vs. geminate) a factor in native Malay speakers' perception of Japanese consonant length?
4. Is place of articulation (i.e., alveolar vs. velar) a factor in native Malay speakers' perception of Japanese consonant length?

Based on past findings and the predictions by PAM, we have a number of interrelated hypotheses, as detailed below:

H1 Given the additional benefit of L1 familiarity with consonant length, we predict in the first instance that the KLM (+quantity) speakers' discrimination accuracy may exceed that of the KDM (-quantity) speakers.

H2 As the length contrast in word-medial position is relatively less challenging than that in word-initial position, we predict that the KLM (+quantity) speakers, who are familiar with the word-initial contrast in their L1, may discriminate the Japanese word-medial contrast with higher successful rate. That is, the KLM (+quantity) speakers' sensitivity to word-initial gemination may be positively transferred to a novel word-medial context in Japanese.

H3 With regard to the effect of length categories, it is predicted that the two groups of native Malay speakers may perceive the geminate category more successfully given its more robust acoustic characteristics (particularly the closure duration cue) as compared to the singleton category.

H4 As for the effect of place of articulation, it is hypothesised that the length contrast with alveolars may be more discriminable than that with velars, following the findings on this point from past studies (e.g., Hamzah et al., 2023; Tsukada & Hajek, 2022; Tsukada & Yurong, 2023; Tsukada et al., 2025).

The findings drawn from this study may have the potential to contribute significantly to the fields of foreign language teaching and pronunciation instruction in Malaysia where most speakers are multilingual, including native Malay speakers. This is particularly important in the context of tertiary education in which Japanese is usually taught as a foreign language. Besides, examining the extent to which speaker' language backgrounds influence their experience with a L2/foreign language is of considerable importance for both real-life application and classroom practice, particularly within educational contexts that are diverse and global. The present study,

therefore, seeks to generate deeper understanding into the extent to which various L1 backgrounds may influence the cross-language processing of consonant length in Japanese.

LITERATURE REVIEW

CONSONANT LENGTH IN JAPANESE

The Japanese word-medial consonant length contrast is a well-known linguistic feature that is used to distinguish meaning, as previously reported in Kubozono (2013) and Kawahara (2015) (see also Fujisaki et al., 1973; Vance, 2008). The occurrence of the Japanese consonant length contrast in word-medial position potentially facilitates greater perceptual discrimination compared to word-initial contexts (e.g., Tsukada et al., 2018a). For example, the word-medial /k/ in *ika* 以下 'below' is potentially easily distinguished from the word-medial /kk/ in *ikka* 一課 'lesson one'.

Voiced geminates (i.e., prolonged consonants like /bb/, /dd/, and /gg/) usually occur in loanwords in Japanese, such as /gg/ in *baggu* バッグ 'bag'. It was reported (e.g., Hussain & Shinohara, 2019) that closure duration is the primary acoustic marker that distinguishes between Japanese word-medial singletons and geminates, with singletons exhibiting shorter duration than their geminate counterpart (see also Han, 1992; Idemaru & Guion, 2008; Kawahara, 2015). In addition, the preceding vowel length also serves as an auxiliary parameter differentiating Japanese long vs. short consonants, with vowels being phonetically longer before long consonants, unlike in other languages such as Italian (Tsukada & Hajek, 2019). For example, in *sakka* 作家 'author', the first /a/ preceding the long consonant /kk/ is often phonetically lengthened compared to the first /a/ before /k/ in *saka* 坂 'slope'.

MALAY VARIETIES

Standard Malay in Malaysia, according to Asmah Haji Omar (2008), has two varieties which are generally referred to as the schwa variety and the a-variety in relation to a prominent difference in how word-final /a/ is pronounced. The former variety is associated with the central and southern states in Peninsular Malaysia, such as Johor, while the latter is common in the northwestern states of the peninsular, such as Kedah, as well as in East Malaysia (Phoon et al., 2014).

KDM (-quantity) and KLM (+quantity), the target languages in the current study, are part of the Malay varieties in Malaysia. They were chosen for examination in this study because of their distinct phonological characteristics, particularly in their quantity system, as mentioned earlier in the introductory section. KDM (-quantity) speakers are usually found in the northern area of Malaysia, where the state of Kedah is located, while KLM (+quantity) speakers can usually be found in the northeastern part of Malaysia, where the state of Kelantan is located. As illustrated in Figure 1, the two Malay varieties are geographically distant from each other, which is approximately 355 km. Both varieties have close contact with Standard Malay that is used nationwide in Malaysia in both formal and informal contexts (Deterding et al., 2022).

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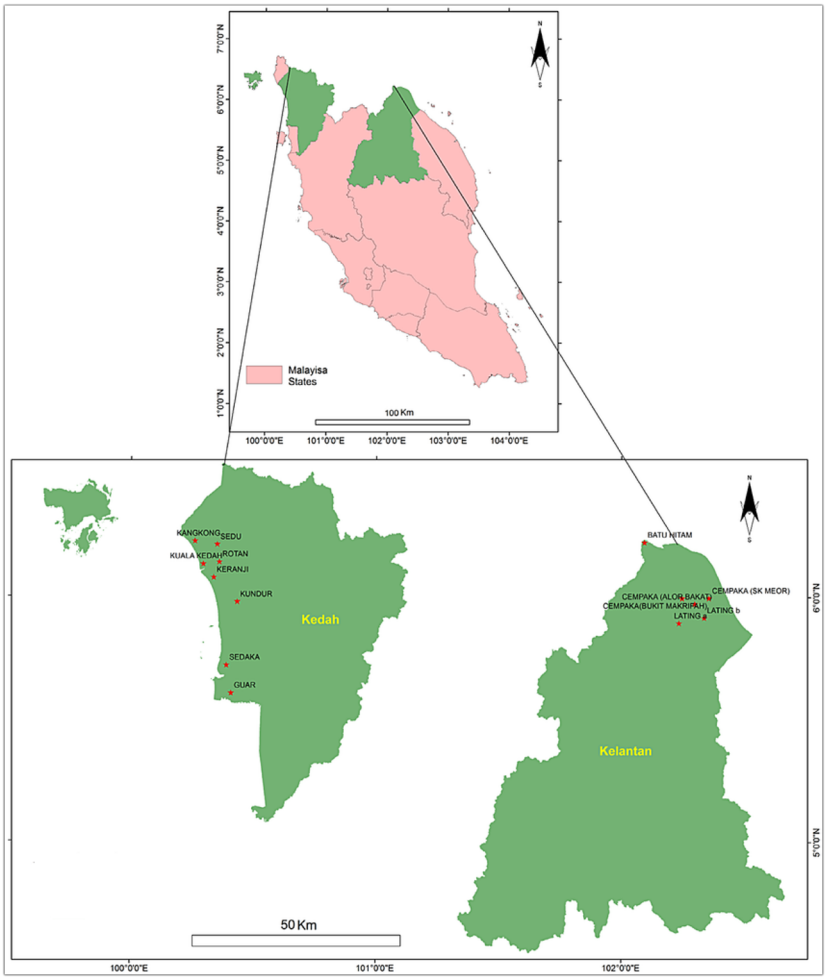

FIGURE 1. Peninsular Malaysia where Kedah and Kelantan are located (Source: Zakikhani et al., 2016)

Drawing from past studies (e.g., Karim, 1965), the consonant inventories for KDM (-quantity) and KLM (+quantity) are presented below in Table 1. There are 18 native consonants in both varieties that are claimed to have full phonemic status. The only difference is the presence of /r/ in KDM (-quantity) which is matched by /ɣ/ in KLM (+quantity).

TABLE 1. Consonant inventories for KDM (-quantity) (upper panel) and KLM (+quantity) (lower panel)

KDM (-quantity)													
	Bilabial		Labio-dental	Alveolar		Post-alveolar		Palatal	Velar		Glottal		
Plosive	p	b		t	d				k	g			
Affricate						tʃ	dʒ						
Nasal		m			n			ɲ		ŋ			
Trill					r								
Fricative				s							h		
Approximant		w						j					
Lateral approximant					l								

KLM (+quantity)													
	Bilabial		Labio-dental	Alveolar		Post-alveolar		Palatal		Velar		Glottal	
Plosive	p	b		t	d					k	g		
Affricate						tʃ	dʒ						
Nasal		m			n			ɲ			ŋ		
Fricative				s							ɣ	h	
Approximant		w						j					
Lateral approximant					l								

CONSONANT LENGTH IN MALAY

In Malay, phonemic consonant length only exists in some of its varieties, such as in KLM (+quantity), but not in KDM (-quantity). Standard Malay and any of its varieties in Malaysia do not allow vowel length contrast. All consonant types in KLM (+quantity) can be geminated, as reported in Hamzah et al. (2011, 2015, 2016a, 2020), such as *tanoh* 'land' vs. *ttanoh* 'outside', and *kabo* 'blurry' vs. *kkabo* 'beetle'. Consonant length in KLM (+quantity) only occurs word-initially, such as *pagi* 'morning' vs. *ppagi* 'early morning', as verified by Karim (1965) and also by Abramson (2003) for the closely related variety of Pattani Malay. This type of consonant length contrast is cross-linguistically uncommon and typologically rare (see, e.g., Frej et al., 2017). That is, word-initial consonant gemination is relatively difficult to perceive by speakers with other language backgrounds, especially for utterance-initial voiceless stop geminates where the acoustic cue of closure duration is absent (e.g., Ridouane & Hallé, 2017). Hamzah et al. (2016a, 2020) reported that, when the word-initial length contrast in KLM (+quantity) is produced in a carrier sentence, closure duration serves as a primary durational cue, while amplitude and F0 play as critical non-durational cues that strengthen consonant gemination in KLM (+quantity).

KDM (-quantity), on the other hand, does not exhibit a consonant length contrast (Asmah Haji Omar, 2008). To date, there are only a few reports on the sounds of KDM (-quantity), and these are mostly with respect to vowel characteristics (e.g., Yusuf et al., 2021; see also Ismail Dahaman et al., 2002). Our KDM (-quantity) participants confirmed that they usually use Standard Malay (the schwa variety) when communicating with native speakers of different Malay varieties, including KLM (+quantity), supporting the notion that the KDM (-quantity) speakers lack the experience with the word-initial contrast in KLM (+quantity). Critically for the current study, being inexperienced with consonant length might potentially cause some difficulties for the KDM (-quantity) speakers to discriminate Japanese singletons and geminates, unlike the KLM (+quantity) speakers who might potentially benefit from their L1 exposure to the singleton/geminate consonant contrast.

RELATED STUDIES ON CROSS-LINGUISTIC GEMINATE PERCEPTION

There is a substantial number of cross-linguistic perception studies on the Japanese word-medial contrast involving non-native L1 speakers of Vietnamese (e.g., Đỗ, 2012, 2015; Tsukada et al., 2025), Korean (e.g., Sonu et al., 2013), Thai (e.g., Ishikawa, 2013), Mongolian (e.g., Le et al., 2010; Liu, 2014; Minagawa & Kiritani, 1996), English (e.g., Darcy et al., 2013; Harada, 2006; Toda, 2007), and Mandarin (e.g., Hung, 2012; Lu et al., 2016; Uchida, 1993). More globally, there is also a substantial number of studies on quantity and length involving speakers from many language backgrounds such as Tashlhiyt Berber (e.g., Hallé et al., 2016, 2023), Finnish (e.g., Porretta & Tucker, 2015), Italian and German (e.g., Altmann et al., 2012; Pešková & Chládková,

in press), Estonian (e.g., Meister & Meister, 2011), and Swedish (e.g., McAllister et al., 2002). For instance, Altmann et al. (2012) investigated two groups of speakers with different L1 and L2 experiences: (1) Italian speakers who were familiar with the *consonant* length contrast, and (2) German speakers who were familiar with the *vowel* length contrast. It was discovered that Italian speakers, who were naïve to German, could successfully perceive the German vowel contrast. However, German speakers, including both with and without Italian learning experiences, performed poorly in the perception of the Italian consonant contrast. These findings led to a conclusion that consonant length is perceptually more challenging than vowel length for non-native speakers, including those who have learning experience of a target language.

The cross-linguistic perception of consonant length in Japanese has been examined across various types of non-native speakers with varied L1 and L2 experiences, as detailed below in Table 2.

TABLE 2. Cross-linguistic findings of Japanese consonant length perception. Colour coding is explained in the text.

Source	Participant/ Language	Type of experiment	Learners of Japanese	Familiar with a length contrast	Length perception accuracy (%)	Effect of length category	Effect of place of articulation
Hamzah et al. (2023)	Kelantan Malay	discrimination	No	Yes	84	No	Yes [A > V]
Tsukada et al. (2018a)	Australian	identification	Yes	No	89	No	Not reported
	Italian		No	Yes	89	No	
	Korean		Yes	Yes	83	Yes [G > S]	
Tsukada et al. (2018b)	American 1	discrimination	Yes	No	93	Yes [G > S]	Not reported
	American 2		No	No	74	Yes [G > S]	
Tsukada & Hajek (2019)	Italian 1	identification	Yes	Yes	96	Yes [S > G]	Not reported
	Italian 2		No	Yes	89	Yes [S > G]	
Tsukada & Hajek (2020)	Italian 1	identification	Yes	Yes	96	Yes [S > G]	Not reported
	Italian 2		No	Yes	90	No	
	Mandarin		Yes	No	86	No	
Tsukada et al. (2020)	Korean 1	discrimination	Yes[1]	Yes	95	No	Not reported
	Korean 2		Yes[2]	Yes	88	No	
	Korean 3		No	Yes	80	No	
Tsukada et al. (2021)	Mongolian	discrimination	No	Yes	86	No	Not reported
	Korean		No	Yes	80	No	
	Mandarin		No	No	69	No	
Tsukada & Hajek (2022)	American 1	discrimination	Yes	No	93	Not reported	Not reported
	American 2		No	No	74	Yes [G > S]	Yes [A > V]
	American 3		No	No	78	Not reported	Not reported
	Argentinian		No	No	80	Yes [G > S]	Yes [A > V]
Tsukada & Hajek (2023)	Italian 1	identification	Yes	Yes	96	No	Not reported
	Italian 2		No	Yes	90	No	
	Mandarin		Yes	No	86	Yes [G > S]	
Tsukada & Yurong (2023)	Mongolian	discrimination	Yes	Yes	96	No	Yes [A > V]
	Mandarin		Yes	No	86	No	Yes [A > V]
Tsukada et al. (2025)	Vietnamese 1	discrimination	Yes[1]	No	91	Not reported	Yes [A > V]
	Vietnamese 2		Yes[2]	No	80		
	Vietnamese 3		No	No	67		

Note. [1] advanced; [2] intermediate; G: Geminate; S: Singleton; A: Alveolar; V: Velar

Note that some studies reported in Table 2 used *identification* tasks to test the speakers' perception, while some others employed *discrimination* tasks (see the third column). Therefore, the results have to be interpreted with caution. Some perceptual studies were cross-examined with other target languages, such as Italian (e.g., Tsukada et al., 2018a). However, in keeping with the scope of the current study, only perception results related to Japanese consonant length are

presented and discussed in this section. The control native Japanese group is not discussed here as this particular group outperformed the other non-native groups across all the studies reported in Table 2.

Based on learning experiences and familiarity with a length contrast (the fourth and fifth columns), four patterns can be observed in Table 2. First, participants who were both *learners* of Japanese and *familiar* with a length contrast (highlighted in red) scored the highest perception accuracies, except for the Korean participants in Tsukada et al. (2018a) who showed the lowest accuracy. It is worth noting that the Korean length contrast is unique: the *phonetic* lengthening of fortis consonants in Korean may result in geminate-like sounds (Kochetov & Kang, 2017). In this context, Korean speakers may associate L1 fortis consonants with Japanese geminates. Second, those who were *learners* of Japanese but *unfamiliar* with a length contrast (highlighted in blue) showed mixed trends: the Australian (Tsukada et al., 2018a) and American (Tsukada et al., 2018b) participants showed higher accuracies, while the Mandarin (Tsukada & Hajek, 2020, 2023; Tsukada & Yurong, 2023) and Vietnamese (Tsukada et al., 2025) speakers showed lower accuracies. Third, participants who were *non-learners* of Japanese but *familiar* with a length contrast (highlighted in yellow), who shared similar characteristics with KLM (+quantity) in the present study in terms of experience with Japanese and familiarity with a length contrast, mostly scored an intermediate level of perception accuracy. For example, the Mongolian speakers (Tsukada et al., 2021) showed high perceptual accuracies despite being non-learners of Japanese. Note that vowel length is contrastive in Mongolian (Iivonen & Harnud, 2005) which may potentially help native speakers of this language perceive the Japanese length contrast, as previously shown by Altmann et al. (2012) for Italians perceiving the length contrast in German. Finally, participants who were both *non-learners* of Japanese and *unfamiliar* with a length contrast (highlighted in green), who resembled the KDM (-quantity) speakers in the current study, usually scored lower, in line with PAM's predictions.

Table 2 (the seventh column) shows the influence of length category (singletons vs. geminates) in which two scenarios emerge. In one scenario, *geminates* are much easier to perceive than singletons, as evident for Korean (Tsukada et al., 2018a), American (Tsukada et al., 2018b), and Mandarin (Tsukada & Hajek, 2023) speakers. In the other scenario, *singletons* are much easier to perceive than geminates, as reported for Italian speakers (Tsukada & Hajek, 2019, 2020). For example, in the first scenario, Tsukada et al. (2018b) reported that the American speakers, albeit being naïve to Japanese, could perceive Japanese word-medial geminates more successfully than their singleton counterparts. In the second scenario, Tsukada and Hajek (2019, 2020) discovered an opposite trend for the Italian speakers who could discriminate Japanese word-medial singletons more accurately than their geminate counterparts. The other groups of speakers were not differentially affected by the length category.

The effect of length category (singletons vs. geminates) reported in Table 2 also shows that the length contrast in Japanese is fuzzier for singletons than for geminates. That is, the length of singletons may potentially be perceived as short or long, but the length of geminates appears to be more easily perceived as long, as evident in Min's (2007) report for Japanese consonant length perception (see also Minagawa & Kiritani, 1996). Conversely, geminates are perceptually challenging for some speakers with other language backgrounds, such as Vietnamese (Đỗ, 2012, 2015), Thai (Ishikawa, 2013), and Mongolian (Liu, 2014). With regard to place of articulation (see the eighth column in Table 2), the effect is evident for some groups, such as Mongolian and Mandarin speakers (Tsukada & Yurong, 2023) who could discriminate tokens with alveolars (95%) slightly more accurately than those with velars (93%), which could potentially be due to the

effects of release bursts and surrounding vowels.

These findings led us to a number of conclusions. The Japanese length contrast is usually perceived more successfully by those with Japanese learning experience than by those without learning experience. However, as evident in Tsukada et al. (2018a, 2021), both groups of participants (i.e., with and without Japanese learning experience) could perceive the Japanese word-medial consonant length contrast with higher accuracy. Note that our participants in the present study were both naïve to Japanese. Second, those without Japanese learning experience could successfully perceive the length contrast that is absent in their L1, as shown in Tsukada et al. (2018b), and Tsukada and Hajek (2022). This observation underscores the need to recruit a diverse group of speakers with different L1 backgrounds, such as the native Malay speakers in the present study. That is, challenging quantity systems, such as the Japanese word-medial contrast, can be processed potentially accurately by speakers with diverse L1 linguistic experiences.

METHOD

PREPARATION OF STIMULI

SPEAKERS

The present study replicated the perceptual experiments employed in prior studies, including Hamzah et al. (2024) and Tsukada and Yurong (2023). A total of six native Japanese speakers (three males and three females) aged between late twenties and early forties were recruited in recording sessions that took place approximately 60 minutes. The speech data were recorded in a professional recording studio at the National Institute of Japanese Language and Linguistics (Tokyo, Japan), ensuring a controlled acoustic environment and high-quality audio capture suitable for the preparation of stimuli for the perceptual experiments. None of these speakers were involved in the experiments. All of them were fluent in standard Japanese. According to the speakers' self-reports, they demonstrated the ability to distinguish between Japanese singletons and geminates based on closure duration. They were either born or spent the majority of their lives in the Kanto region, encompassing the Greater Tokyo Area.

SPEECH MATERIALS

A total of twelve-word pairs in Japanese were employed as experimental stimuli in this study, as shown in Table 3. As indicated by underlining in Table 3, the /(C)VC(C)V/ tokens consisted of either singletons (n = 96) or geminates (n = 96) located in word-medial position. The present study focused exclusively on tokens containing plosives. To be more specific, this study focused solely on voiceless stops (/t, k/), given the limited distribution of geminates with voiced stops in Japanese, as reported in, e.g., Kawahara (2015) and Sano (2019). The average closure durations for word-medial singletons and geminates in Japanese were 96 ms and 262 ms, respectively. The geminate-to-singleton ratios for alveolars (/t/-/tt/) and velars (/k/-/kk/) were comparable, i.e., 2.7 and 2.8, respectively. These ratios are consistent with those observed in prior studies (e.g., Hayes-Harb, 2005: 2.8 for alveolars; 2.7 for velars).

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TABLE 3. Speech materials of the current study

Place of Articulation	Singleton		Geminate	
	Word	Gloss	Word	Gloss
Alveolar	heta	unskilled	hetta	decreased
	kato	transient	katto	cut
	mate	wait	matte	waiting
	oto	sound	otto	husband
	sate	well, then	satte	leaving
	wata	cotton	watta	broke
Velar	ake	open	akke	appalled
	haka	grave	hakka	mint
	ika	below	ikka	lesson one
	kako	past	kakko	parenthesis
	saka	slope	sakka	author
	shike	rough sea	shikke	humidity

PARTICIPANTS

Table 4 summarises the profile of the participants involved in an AXB discrimination task in terms of their L1 background, Japanese learning, and familiarity with a consonant length contrast. A sample size of 10-12 participants per group can be considered sufficient in an AXB discrimination task, supported by standard practices within experimental phonetics (e.g., Best et al., 2010; Singh & Tan, 2021). In an AXB discrimination task, the statistical power is primarily derived from the number of trials per participant, rather than the number of participants alone. As each participant in this study completed 200 unique trials (see below), 10-12 participants is a defensible and historically supported sample size.

TABLE 4. Participants in an AXB discrimination task

Group	L1	Number	Learners of Japanese	Familiar with a length contrast
KDM	Kedah Malay	6m, 6f	No	No
KLM	Kelantan Malay	6m, 6f	No	Yes
NJ	Japanese	2m, 8f	Not applicable	Yes

Note. m: male; f: female

As can be seen in Table 4, the AXB discrimination task in the present study involved three groups of participants. The first group comprised 12 native speakers of KDM (-quantity), including six males and six females, with a mean age of 22.5 years (*sd* = 0.8). The second group comprised 12 native speakers of KLM (+quantity), also equally distributed by gender group (six males and six females), with a mean age of 21.5 years (*sd* = 0.8). The participants in both groups were students at an undergraduate level at Universiti Utara Malaysia, located in Kedah, Malaysia. During the data collection, all participants were residing in Kedah, Malaysia. Participants in the KDM (-quantity) group were born and raised in Kedah and reported native-level fluency in Kedah Malay. In contrast, participants in the KLM (+quantity) group were born and raised in Kelantan and reported native-level fluency in Kelantan Malay. All participants demonstrate proficiency in Standard Malay and also in the English language. They are multilingual, reflective of the fact that Malaysia is a multiracial and multicultural country. Nevertheless, none of the participants had any prior exposure to formal or informal instruction in the Japanese language. The most critical difference between the two groups is that, on one hand, the KDM (-quantity) participants are *unfamiliar* with a consonant length contrast, while on the other hand, the KLM (+quantity)

participants use consonant length contrastively in their language variety (i.e., word-initially) and are therefore *familiar* with a length contrast.

The final group served as a control group and comprised ten native speakers of Japanese (two males, eight females) with a mean age of 21.0 years (*sd* = 0.8). When the data were collected, they were studying at University of Oregon in Eugene, OR, USA. All Japanese-speaking participants were born in Japan and had spent most of their lives residing there prior to participation in the study. During the perception experiments, the participants' mean length of residence in the United States was 0.4 years (*sd* = 0.22). They were not involved in any of the recording sessions. During the experiment, the Japanese-speaking participants reported that they had normal hearing.

PROCEDURE

The perception experiments required the participants to undergo a two-alternative forced choice AXB discrimination task that tested the participants' listening ability to trials coordinated in the A-X-B sequence. The Praat software (Boersma & Weenink, 2019) was employed in the stimulus presentation and in the gathering of perceptual response data. The first (A) and third (B) stimuli in the AXB discrimination task were systematically drawn from a different category of consonant length (i.e., either singleton or geminate). The listeners were instructed to determine whether the intervening stimulus (X) matched A or B. For example, in a trial such as 'saka^{2}'-'saka^{1}'-'sakka^{3}', X ('saka^{1}') matched A in length category, whereas in a trial such as 'oto^{3}'-'otto^{2}'-'otto^{1}', X ('otto^{2}') matched B. Different speakers are shown by the superscript numerals.

During the experiment, the participants completed a total of 200 unique trials, where the initial eight trials served as practice and were excluded from all subsequent analyses. Across all experimental trials, the three stimuli were produced by distinct speakers. Consequently, the acoustic properties of stimulus X were always different from either stimulus A or stimulus B. The experiment systematically tested all possible combinations of AB, namely AAB, ABB, BAA, and BBA, with 48 trials administered for each condition. Feedback was not given throughout the experiment. After every 50 trials, the participants were permitted to take self-paced breaks, if desired. They were instructed to provide a response on each trial and to make a forced-choice response when they were unsure. The participants were permitted to replay each trial as many times as necessary to ensure a confident response. However, once a response was submitted, it could not be modified. For all trials, the interval between stimuli was fixed at 0.5 seconds.

We employed the AXB discrimination task in this study with the aim that the participants attended to the phonetic features relevant for categorising two stimuli that belonged to the same category of length, while minimising the influence of variation within each length category that was acoustically salient yet phonemically unimportant, such as differences in the quality of voice. This was an established procedure to test the perceptual abilities of listeners in real-world listening contexts (see, e.g., Strange & Shafer, 2008). The experimental session was conducted on a university campus in the participants' respective countries. Each participant ran the experiment individually at their own pace, which approximately took 20 to 25 minutes. The stimuli were presented via headphones or loudspeakers connected to a computer, and the participants adjusted the output to their own comfortable listening level. They received compensation for their efforts in completing the task. For statistical analyses and visualisation of data, the R statistical software (version 3.6.0) was employed (R Core Team, 2020).

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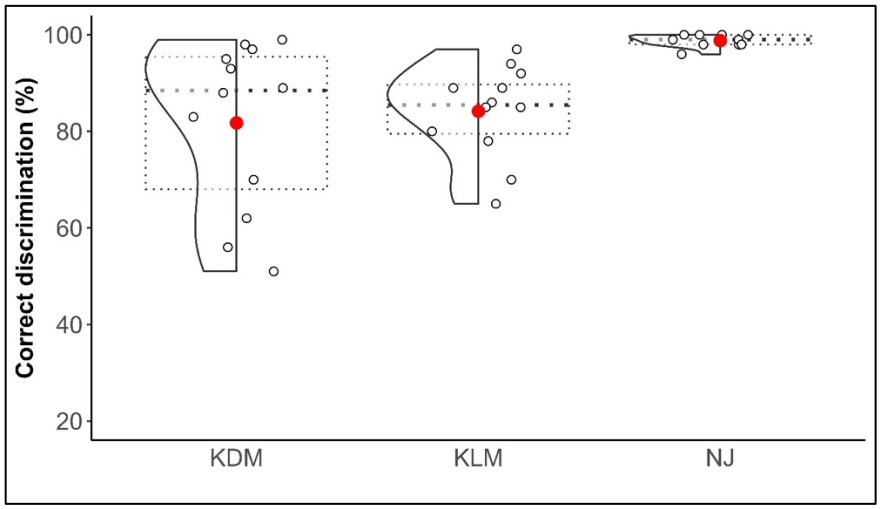
FINDINGS

OVERALL FINDINGS

The overall findings of consonant length perception for all participants are illustrated in Figure 2. The horizontal line within each box represents the median value, while the red circle denotes the mean value. Detailed discrimination accuracy results are given in Table 5.



Note. KDM: Kedah Malay (-quantity); KLM: Kelantan Malay (+quantity); NJ: Native Japanese

FIGURE 2. Overall results of consonant length perception

TABLE 5. Mean percentages of the three groups of participants

	KDM	KLM	NJ
Mean % (SD)	82% (17)	84% (10)	99% (1.3)
Range of mean %	51-99%	65-97%	96-100%
N in native range	3/12 (25%)	1/12 (8%)	NA

It can be seen in Figure 2 that, as expected, the NJ group perceived their own consonant length with the highest accuracy rate, exhibiting minimal inter-individual variability. The results for the native Malay groups were, however, unexpected as both groups generally performed equally well. That is, the KLM (+quantity) speakers, who are *familiar* with a consonant length contrast, did not outperform the KDM (-quantity) speakers, who are *unfamiliar* with the contrast. As shown in Figure 2, both Malay groups showed greater variability in comparison to the NJ group, with the KLM (+quantity) speakers being less variable compared to the KDM (-quantity) speakers. As seen in Table 5, the NJ group reached the highest mean discrimination accuracy (99%, *sd* = 1.3), followed by the KLM (+quantity) speakers (84%, *sd* = 10) and then the KDM (-quantity) speakers (82%, *sd* = 17) which were comparable to each other. The mean percentages for both Malay groups were all above chance, ranging from 51% to 99% for the KDM (-quantity) speakers and 65% to 97% for the KLM (+quantity) speakers. Surprisingly, three KDM (-quantity) participants achieved accuracy scores within the range observed for the NJ group (96%-100%), while one KLM (+quantity) participant achieved this range. A closer inspection into speaker-specific results for the two Malay groups (see the Appendix) revealed that the mean percentages of correct discrimination were all above the chance level at 50%, with only two KDM (-quantity)

participants being just above this level (KDM1 = 51%; KDM5 = 56%).

A one-way analysis of variance (ANOVA) revealed a statistically significant between-group difference in the discrimination of consonant length [$F(2, 31) = 6.5$, $p < .001$]. Results of pairwise multiple comparison *post hoc* analyses indicated that the NJ group demonstrated significantly higher accuracy than the two Malay groups [KDM (-quantity) vs. NJ: $t(11.2) = -3.4$, $p < .05$; KLM (+quantity) vs. NJ: $t(11.5) = -5.3$, $p < .001$]. No statistically significant difference was observed between the two Malay groups ($p = .746$).

LENGTH CATEGORY EFFECT

The results of correct discrimination by length category across all groups of the experiment are exhibited in Figure 3. The lines in the figure indicate the connection of scores for each participant. Table 6 provides the detailed results.

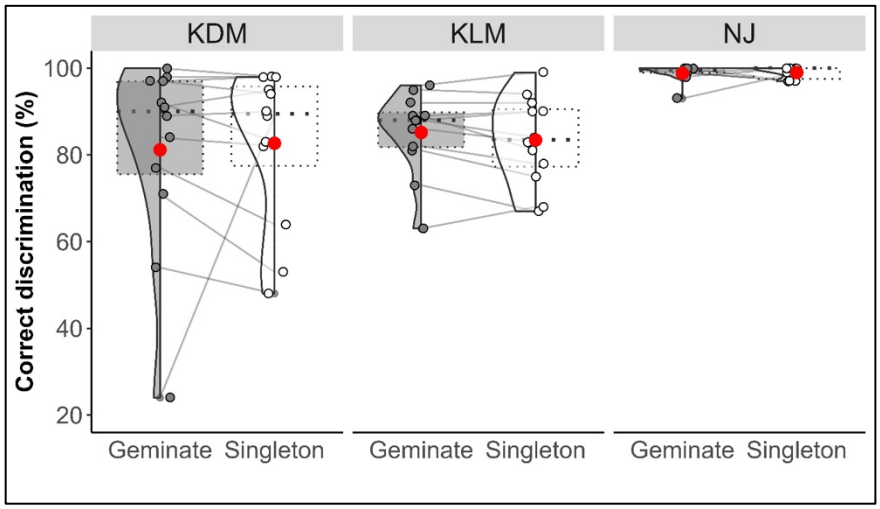


FIGURE 3. Distributions of correct discrimination (%) by length category

TABLE 6. Mean percentages (standard deviations in parentheses) by length category

Group	Geminate	Singleton	*p*-value
KDM	81% (23)	83% (18)	.786
KLM	85% (9)	83% (10)	.751
NJ	99% (2)	99% (1.4)	.974

In these results, we were interested whether the discrimination accuracy was different when the X stimulus in the AXB sequence was a geminate and those in which it was a singleton. Results of a two-way ANOVA with group [KDM (-quantity), KLM (+quantity), NJ] and length (geminate, singleton) as factors revealed a statistically significant main effect of group only [$F(2, 31) = 6.4$, $p < .01$, $\eta_G^2 = .24$]. Specifically, as illustrated in Figure 3, the NJ group consistently demonstrated higher accuracy across the board, surpassing those for the Malay groups. Results of pairwise multiple comparison *post hoc* analyses indicated that all groups are not affected by the length category, as seen in the *p*-values in Table 6 (all *ns*, Bonferroni adjusted).

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A closer examination of the results of *post hoc* tests within the length category (geminate, singleton) revealed a noteworthy finding (see Table 7). Within the geminate category, the mean difference between the KLM (+quantity) group and the NJ group failed to reach significance (p = .06). On the other hand, there was a statistically significant mean difference between the KDM (-quantity) group and the NJ group (p < .01; highlighted in light grey). This result shows that the KLM (+quantity) participants, who are *familiar* with a consonant length contrast, were more perceptive towards Japanese geminates than the KDM (-quantity) participants. Within the singleton category, the result of *post hoc* tests between the KLM (+quantity) group and the NJ group, as well as between the KDM (-quantity) group and the NJ group, was significant (p < .05; highlighted in dark grey), indicating that the two Malay groups were not able to discriminate singletons like the native Japanese participants. Note also the striking variability level of geminate perception for the KDM (-quantity) group, which was the most variable, as evident in Figure 3. This shows that, while some KDM (-quantity) speakers poorly discriminated Japanese geminates, some of them performed even better than the KLM (+quantity) speakers in the discrimination of the geminate category.

TABLE 7. Results of pairwise multiple comparison *post hoc* tests within the length category (geminate, singleton)

Length	Group 1	Group 2	df	Statistic	*p*-value
Geminate	KDM	KLM	62	-0.7282598	.469
Geminate	KDM	NJ	62	-3.0610077	< . 01 **
Geminate	KLM	NJ	62	-2.3666392	.06
Singleton	KDM	KLM	62	-0.1365487	.892
Singleton	KDM	NJ	62	-2.8353379	< .05 *
Singleton	KLM	NJ	62	-2.7051438	< .05 *

PLACE OF ARTICULATION EFFECT

The results of correct discrimination by place of articulation and length category are shown in Figure 4. Table 8 provides the detailed discrimination accuracy results. Our primary interest addressed whether the discrimination accuracy varied for trials when the stimulus X in the AXB sequence differed in both place of articulation and length, concurrently.

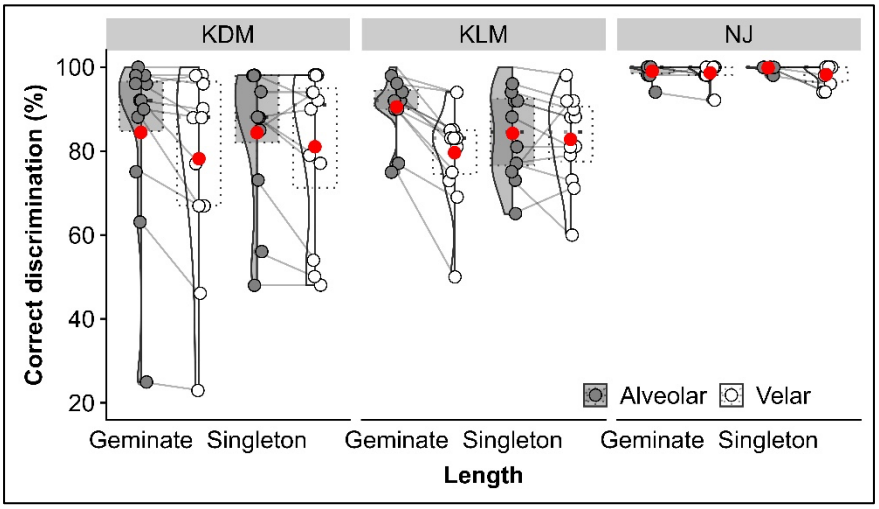

FIGURE 4. Distributions of correct discrimination (%) by place of articulation and length category

TABLE 8. Mean percentages (standard deviations in parentheses) by place of articulation and length category

Group/Length	Alveolar	Velar	*p*-value
KDM			
Geminate	84% (22)	78% (24)	.270
Singleton	84% (17)	81% (20)	.555
KLM			
Geminate	91% (8)	80% (12)	.06
Singleton	84% (11)	83% (11)	.802
NJ			
Geminate	99% (2)	99% (3)	.948
Singleton	100% (0.6)	98% (3)	.796

A three-way ANOVA was conducted, incorporating group [KDM (-quantity), KLM (+quantity), NJ], length (geminate, singleton) and place (alveolar, velar) as factors. The results revealed significant main effects for group [$F(2, 31) = 6.4$, $p < .001$, $\eta_G^2 = .23$] and also place [$F(1, 31) = 23.7$, $p < .001$, $\eta_G^2 = .02$]. Several interactions that included the place of articulation factor attained statistical significance [length x place: $F(1, 31) = 10.2$, $p < .01$, $\eta_G^2 = .005$; group x length x place: $F(2, 31) = 6.0$, $p < .01$, $\eta_G^2 = .007$].

As seen in Figure 4, for the two Malay groups, there were higher mean discrimination accuracies for the alveolar than for the velar tokens almost across the board. For the KLM (+quantity) group, the effect of place was more pronounced for the geminate targets (alveolar: 91%; velar: 80%) than for the singleton targets (alveolar: 84%; velar: 83%). Note that, in the alveolar cell in Table 8 (second column), there is no geminate advantage across all groups, except for the KLM (+quantity) group. Results of *post hoc* pairwise multiple comparisons indicated that, for the KLM (+quantity) group, the mean difference in discrimination accuracy between alveolar geminate and velar geminate tokens approached significance ($p = .06$), as highlighted in grey in Table 8. That is, for the KLM (+quantity) group, alveolar geminates were perceived relatively more easily as compared to velar geminates.

DISCUSSION AND CONCLUSION

The current study explored the perception of Japanese consonant length, a phonemic contrast potentially challenging for non-native speakers, specifically among two groups of native Malay speakers with no prior experience learning Japanese. In contrast to the KDM (-quantity) speakers who lack experience with a length contrast, the KLM (+quantity) speakers' native language utilises consonant length contrastively, albeit exclusively in word-initial position. Therefore, this study aimed to examine whether the KLM (+quantity) speakers can effectively leverage their L1 knowledge to perceive the singleton/geminate consonant contrast in word-medial position, a context unfamiliar in their native language.

Neither group of Malay speakers in this study attained the level of accuracy demonstrated by the NJ speakers in perceiving consonant length in Japanese. This outcome may be attributable to their limited familiarity with the sound structures of word-medial consonant length in Japanese. The discrimination accuracy results for both native Malay groups were surprisingly comparable, in contradiction to our initial hypothesis (H1) of an expected clear differentiation between them. Notably, despite the KLM (+quantity) speakers' ability in perceiving the word-medial length contrast in Japanese, their performance did not surpass that of the KDM (-quantity) speakers, showing that geminates can be perceived well in spite of lack of knowledge in a length contrast

among the KDM (-quantity) speakers. Surprisingly, some KDM (-quantity) speakers reached the native NJ range (96%-100%). In this context, sensitivity to durational information is perhaps sufficient for these participants to discriminate the Japanese length contrast (see, e.g., Cebrian, 2006). Note, however, that the KDM (-quantity) speakers also showed larger variability than the KLM (+quantity) speakers, for reasons which remain unclear.

We predicted earlier (H2) that, given KLM (+quantity) has only word-initial geminates and the speakers of this language are very sensitive to it perceptually, it is possible that they may do even better in word-medial position given the additional pre-consonantal cues available to them. Our results support this hypothesis; the overall score of KLM (+quantity) (84%) was in the same range as the previously noted groups of non-native speakers who were *non-learners* of Japanese but *familiar* with a length contrast, such as Mongolian (86%) and Korean (80%) speakers (Tsukada et al., 2021). More critically, the accuracy shown by the KLM (+quantity) speakers was also comparable to that of learners who were both Japanese *learners* and *familiar* with a length contrast, such as Korean speakers (83%) reported in Tsukada et al. (2018a). As predicted, our findings suggest that the KLM (+quantity) speakers derived some benefit from their prior L1 experience with consonant gemination in spite of lacking experience with the Japanese language. This finding further implies that while L1 experience with consonant length in Malay may confer some advantage, it does not guarantee the level of accuracy similar to that of native Japanese speakers. The observed limitations in transferring geminate contrast knowledge from KLM (+quantity) to Japanese may stem from unique acoustic characteristics of the length contrast in word-initial position in KLM (+quantity) that may not be applicable for the length contrast in word-medial position in Japanese. The potential influence of suprasegmental aspects, including intonation and stress placement, on the perception of consonant length in KLM (+quantity) remains understudied, precluding definitive conclusions at present.

Note, however, that the overall score of the other Malay group, the KDM (-quantity) group, was unexpectedly high (82%), outperforming American (74%; Tsukada et al., 2018b), Mandarin (69%; Tsukada et al., 2021) and Vietnamese (67%; Tsukada et al., 2025) speakers who were also both *non-learners* of Japanese and *unfamiliar* with a length contrast. Furthermore, the accuracy shown by the KDM (-quantity) speakers was approaching those speakers who were Japanese *learners* yet *unfamiliar* with a length contrast, such as Mandarin speakers (86%) reported in Tsukada and Hajek (2020). These observations suggest that unfamiliarity with quantity systems may not be a determining factor in the non-native perception of phonological contrasts.

The present findings for the KDM (-quantity) speakers diverge significantly from those reported by Altmann et al. (2012) who observed difficulties among German speakers naïve to Italian in perceiving the Italian consonant length contrast. This disparity suggests that cross-language geminate perception may be both speaker- and language-specific. Our finding shows that, for some speakers, or potentially some language varieties, lack of prior learning experiences and familiarity with a length contrast may not necessarily hinder successful geminate perception, which holds both theoretical significance (i.e., PAM; see below) and potential pedagogical implications for foreign language instruction. Why the KDM (-quantity) speakers specifically did so relatively well compared to other language speakers, such as German speakers when tested on Italian consonant length, remains unclear and requires further investigation and understanding.

We predicted earlier that both groups of native Malay speakers may be more perceptive to the geminate category as compared to the singleton category; we discovered that the two Malay groups were unaffected by the length category, thus rejecting our hypothesis (H3). Note, however, the KLM (+quantity) participants showed a tendency in discriminating the geminate category,

much like the NJ participants (Table 7). This result is in tandem with Korean, American and Mandarin speakers reported in Tsukada et al. (2018a, 2018b) and Tsukada and Hajek (2023), in which geminates are relatively easier to perceive than singletons. This could be due to the obvious acoustic characteristics of consonant gemination that is generally cross-linguistically not only longer, but also louder and more intense, as empirically established in Japanese consonant length (e.g., Hussein & Shinohara, 2019).

Regarding the effect of place of articulation, it was predicted that consonant length in Japanese would be discriminated by the native Malay speakers with variability. That is, we hypothesised that alveolars would potentially be more discriminable than velars (H4). Our results partially support this hypothesis. A significant place of articulation effect was only observed in the geminate category for the KLM (+quantity) speakers who demonstrated superior discrimination accuracy for Japanese consonant length involving alveolars (91%; see Table 8). This finding is in line with those reported in previous studies (e.g., Hamzah et al., 2023; Tsukada & Hajek, 2022; Tsukada & Yurong, 2023; Tsukada et al., 2025) for participants from various L1 backgrounds including KLM (+quantity) who could also more easily discriminate consonant length contrasts for alveolars than velars. This outcome may be attributable to the distinct acoustic properties of Japanese word-medial alveolars vs. velars, such as differences in adjacent vowel duration, which may exert specific perceptual influences on non-native listeners' processing of consonant gemination.

Theoretically speaking, based on PAM predictions, it was expected that KDM (-quantity) would experience Single-Category Assimilation (i.e., mapping both singletons and geminates to the same L1 sound, resulting in poor discrimination), while KLM (+quantity) would have an advantage. The high overall discrimination scores (84% and 82%) challenge this baseline prediction. Instead of mapping both length categories equally to a native short consonant, the KDM (-quantity) speakers might have experienced Category-Goodness Assimilation. The Japanese word-medial geminates in our experimental stimuli are acoustically robust (i.e., in terms of closure duration and preceding vowel cues). When the KDM (-quantity) speakers heard a Japanese geminate, they likely mapped it to their native singleton category, but they recognised it as a highly "atypical" version of that sound. In this context, they might have relied on raw acoustic sensitivity rather than phonological categorisation to distinguish the Japanese length contrast. PAM predicts that when two sounds map to the same category but differ in "goodness of fit", discrimination accuracy will be high, as evident in our results for the KDM (-quantity) speakers. As for the KLM (+quantity) speakers, while they possess the L1 knowledge of consonant length, it is nonetheless restricted to word-initial position. In this context, PAM relies on how foreign sounds are mapped into native phonotactic constraints. Since the Japanese length contrast occurs word-medially, the KLM (+quantity) speakers seemed to be unable to map the sounds cleanly onto their existing L1 "templates". The mismatch in word position might potentially have blocked direct phonological transfer, bringing their performance down to the same level as the KDM (-quantity) group. These speculations, of course, warrant further investigations in future cross-language geminate studies.

It is obvious now that future research should investigate whether the KLM (+quantity) speakers can derive benefits from combining their prior L1 consonant length experience with explicit instruction in Japanese, yielding implications for both theoretical frameworks and language pedagogy. Additionally, as there is a substantial population of learners of the Japanese language in Malaysia, it might be insightful from the pedagogical perspective to recruit such learners from other Malay backgrounds and investigate potential advantages of Japanese language instruction across various learning contexts.

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APPENDIX

Mean correct length discrimination (%) of individual speakers in the three groups of participants

KDM	Mean (%)	KLM	Mean (%)	NJ	Mean (%)
KDM1	51	KLM1	78	NJ1	98
KDM2	70	KLM2	70	NJ2	98
KDM3	83	KLM3	85	NJ3	100
KDM4	88	KLM4	97	NJ4	96
KDM5	56	KLM5	89	NJ5	99
KDM6	62	KLM6	80	NJ6	99
KDM7	98	KLM7	89	NJ7	98
KDM8	93	KLM8	92	NJ8	100
KDM9	89	KLM9	65	NJ9	100
KDM10	99	KLM10	94	NJ10	100
KDM11	95	KLM11	86		
KDM12	97	KLM12	85		

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