



City University of Hong Kong

Department of Linguistics and Translation

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*Merger of the syllable-initial [n-] and [l-] in Hong
Kong Cantonese*

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Abstract

This study is a phonetic investigation of the merger of the syllable-initial [n-] and [l-] in Hong Kong Cantonese (HKC). It examines both the production and perceptual abilities of HKC speakers in the distinction between [n-] and [l-]. Ten native Cantonese-speaking university students in Hong Kong, 5 male and 5 female, produced a set of test words and sentences with the syllable-initial [n-] and [l-] for acoustic analysis and took part in a listening test to identify [n-] and [l-]. The results show that the merger of the initial [n-] and [l-] in HKC has not yet completed. In production, the initial [n-] is more often mispronounced as [l-] than the initial [l-] mispronounced as [n-]. In perception, the initial [n-] and [l-] are in general distinguishable, while confusion between [n-] and [l-] is occasionally observed. The performance of the HKC speakers is poorer in production than in perception, suggesting that mispronunciation of [n-] and [l-] may be a trigger for the merger of [n-] and [l-] in HKC and the speakers' production and perception abilities are not necessarily parallel in the distinction of the speech sounds. The findings of this study contribute to a fuller understanding of the roles of production and perception and their interrelationship in the merger of [n-] and [l-] in HKC.

Keywords: Cantonese, merger, syllable-initial [n-] and [l-], acoustic analysis, perceptual identification

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Section 1. Introduction

There have been a number of phonological variations observed in the speech of Hong Kong Cantonese (HKC) speakers. A typical case is the merger of the syllable-initial [n-] and [l-]. This section provides the background information on the variations in [n-] and [l-] in HKC. A brief introduction of the consonant inventory of HKC is given first, followed by the literature review of previous studies of the merger of the initial [n-] and [l-] in HKC.

1.1. Consonant system of HKC

According to Zee (1999), there are 19 consonants in HKC. As shown in Table 1, the consonants include eight plosives [p, p^h, t, t^h, k, k^h, k^w, k^{wh}], two affricates [ts, ts^h], three nasals [m, n, ŋ], three fricatives [f, s, h], two approximants [j, w] and one lateral approximant [l]. All these 19 consonants can occur in the syllable-initial or word-initial position, while only the three unaspirated plosives [p, t, k] and the three nasals [m, n, ŋ] can occur in the syllable-final or word-final position. Since Cantonese is a monosyllabic language, no consonant can occur in the word-medial position.

	Bilabial	Labio-dental	Dental	Alveolar	Post-alveolar	Palatal	Velar	Labial-velar	Glottal
Plosive	p p ^h		t t ^h				k k ^h	k ^w k ^{wh}	
Affricate			ts ts ^h						
Nasal	m		n				ŋ		
Fricative		f		s					h
Approximant						j		w	
Lateral Approximant			l						

Table 1. Consonant inventory of HKC (*from Zee, 1999*).

The syllable-initial [n-] and [l-] are two phonemes in HKC, as there are minimal pairs with the contrast only in [n-] and [l-], e.g., [nam²¹] 男 ‘male’ and [lam²¹] 藍 ‘blue’; [nei²³] 你 ‘you’ and [lei²³] 李 ‘Lee (a surname)’; [nou²²] 怒 ‘angry’ and [lou²²] 露 ‘to show’; [nap²] 納 ‘to accept’ and [lap²] 立 ‘to erect’. The minimal pairs with the initial [n-] and [l-] are usually associated with the tones [21, 23, 22, 2] which are traditionally in the ‘yang’ tonal category produced in a low tonal register. Table 2 gives the pitch values for the nine tones in HKC according to Zee (1999). Also presented in the table are the names of the tonal category and the division of the nine Cantonese tones in the high and low tonal registers according to the traditional tonal categorization.

	Ping (Level)	Shang (Rising)	Qu (Departing)	Ru (Entering)	
Yin (Upper) register	55	25	33	5	3
Yang (Lower) register	21	23	22	2	

Table 2. Pitch values for the nine HKC tones (Zee, 1999) in the traditional tonal categorization.

1.2. Literature review

The merger of the initial [n-] and [l-] in HKC was firstly reported in Wong (1941), where the initial [n-] is frequently pronounced as [l-], e.g., the word [nei²³] 你 ‘you’ is pronounced as [lei²³]. Likewise, Chao (1947) has asserted that Cantonese speakers have no initial [n-] and all the words beginning with [n-] are pronounced as [l-]. In the following decades, the change of [n-] to [l-] in HKC is a hot topic investigated in a number of Cantonese linguistics studies (e.g. Yeung 1980; Bauer and Benedict 1997; Zee 1999; Pan 2008, etc.).

Yeung (1980) is a sociolinguistic study of the phonetic variation and phonological change of the consonants in HKC. Table 3 presents the nine cases of mergers of the HKC consonants reported in Yeung's study. One of the nine cases is the merger of the initial [n-] and [l-]. According to the author, it is commonly for HKC speakers to pronounce [n-] as [l-], as a result the words beginning with [n-], such as [nam²¹] 男 'male' and [nan²¹] 難 'difficult', are pronounced as the same of those beginning with [l-], i.e., [lam²¹] 藍 'blue' and [lan²¹] 蘭 'orchid' (Yeung, 1980).

Syllable-initial consonant	Syllable-final consonant	Syllabic consonant
1. [n-] → [l-]	5. [-ŋ] → [-n]	9. [ŋ] → [m]
2. [ŋ-] → Ø-	6. [-n] → [-ŋ]	
3. Ø- → [ŋ-]	7. [-k] → [-t]	
4. [k ^w ɔ-] → [kɔ-]	8. [-t] → [-k]	

Table 3. Nine cases of mergers of the consonants in HKC reported in Yeung (1980).

Bauer and Benedict (1997) in their book *Modern Cantonese Phonology* also notes that in the speech of the majority of HKC speakers the initial [n-] in the words is often substituted by the initial [l-]. The merger of the initial [n-] and [l-] in HKC is also reported in two more recent studies, Zhang (2007) and Pan (2008). According to all these studies, it seems that HKC speakers have a difficulty in pronouncing the initial [n-], and it is predicted that the merger of [n-] and [l-] would come to completion, leading to the loss of the initial [n-] in HKC.

1.3. Purpose of present study

While the merger of the initial [n-] and [l-] in HKC has been a hot topic under investigation, all the investigations in previous studies are marginalized in the field of sociolinguistics, focusing on the social factors, such as speakers' age, social class and gender, involved in the sound change. For instance, Yeung (1980) compares the merger of the initial [n-] and [l-] in the speech of HKC speakers in different age groups and finds that younger speakers tended to pronounce [n-] as [l-] more often than older speakers. Similar findings are also reported in Bauer and Benedict (1997). In all these studies, there is no examination of the phonetic environment in which the merger of [n-] and [l-] happens, such as in which type of words, preceding which type of vowels and associated with which type of tone, and in which particular position of the words that the initial [n-] tends to be replaced by the initial [l-]. Thus, a phonetic study of the merger of [n-] and [l-] in HKC is called for.

Furthermore, all the previous studies only investigate the production of the initial [n-] and [l-] by HKC speakers. No perceptual data on HKC speakers' ability of the identification of the initial [n-] and [l-] are available. It follows that the relationship between production and perception in the merger of [n-] and [l-] in HKC has not yet been examined.

Also, it has been observed that the merger of [n-] and [l-] in HKC is bidirectional, where not only is [n-] pronounced as [l-] as reported in the previous studies (e.g., Wong 1941; Chao 1947; Bauer and Benedict 1997; Zhang 2007), the change also happens in reverse to pronounce [l-] as [n-].

The present study is therefore a phonetic investigation of the production and perception of the syllable-initial [n-] and [l-] in HKC. It examines the production of [n-] and [l-] in different

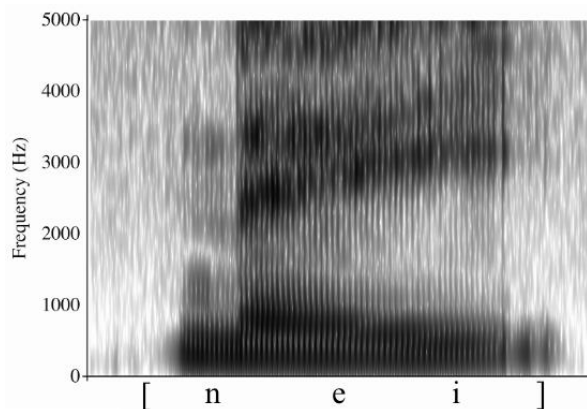
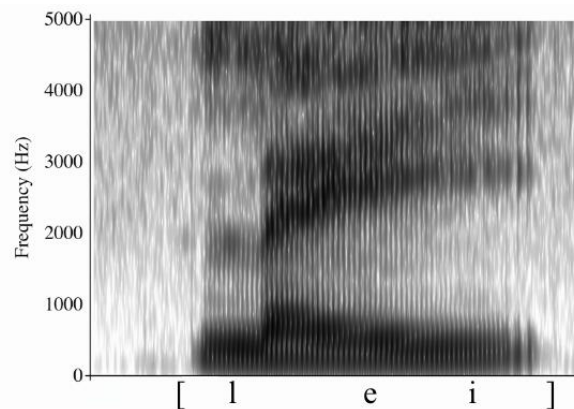
types of utterances, including monosyllabic words, bisyllabic compounds, and sentences, to determine the bidirectional change from [n-] to [l-] as well as from [l-] to [n-]. The production data are also compared with the perceptual data to evaluate the production and perceptual ability of the distinction of [n-] and [l-] in HKC speakers. The results obtained in the present study are used to discuss the issue whether the merger of [n-] and [l-] in HKC has now attained a final stage.

Section 2. Method

Two experiments, a production test and a perception test, were carried out in this study. The two tests were designed for exploring the patterns of the variations in the syllable-initial [n-] and [l-] in HKC and hence determining (i) whether the merger of the syllable-initial [n-] and [l-] in HKC as reported in a number of previous production studies (e.g., Chao 1947; Hashimoto 1972, 1989; Bauer and Benedict 1997; Bourgerie 1990) has reached the completion stage and (ii) whether the merger of [n-] and [l-] is also true in perception.

2.1. Pronunciation evaluation

In this study, the merger of the syllable-initial [n-] and [l-] in HKC is evaluated by calculating the percentage of mispronunciation of [n-] as [l-] and also [l-] as [n-] with reference to the standard pronunciation of Cantonese. The judgement of the pronunciation of the subjects is made by performing acoustic analysis of the utterances from the subjects. Figure 1 and Figure 2 show the spectrograms of the minimal pair of [nei²³] 你 ‘you’ and [lei²³] 李 ‘Lee (a surname)’ provided by the Praat program (Boersma and Weenink, 2016). The audio signals are obtained from an online electronic dictionary of spoken Cantonese (*A Chinese Talking Syllabary of the Cantonese Dialect*) published by the Chinese University of Hong Kong. As shown on the spectrograms, the acoustic energy is low for the initial [n-] and [l-] as compared the following diphthong [ei] in the words. As for the difference between [n-] and [l-], the formants occur in the low-frequency region for the nasal [n-] (Figure 1), whereas the approximant [l-] has both high-frequency and low-frequency formants (Figure 2). This observation conforms to what Ladefoged (2003: 145) said ‘*laterals differ from nasals in that their formants more readily show distinctions among them*’.

Figure 1. Spectrogram of [nei²³] 你.Figure 2. Spectrogram of [lei²³] 李.

2.2. Test materials

The test materials used in this study were Cantonese monosyllabic words with the contrast in the syllable-initial [n-] and [l-]. The test words were selected with the reference to the pronunciation of the words described in Wong (1941)'s Cantonese syllabary. In the selection, the following types of words in Cantonese were excluded.

- (i) polyphonic words,
- (ii) slang words,
- (iii) uncommon or unfamiliar words, and
- (iv) words that cannot form minimal pairs with the contrast in the initial [n-] and [l-].

In all, 20 minimal pairs of the monosyllabic words with the syllable-initial [n-] and [l-] in Cantonese were chosen as listed in Table 4.

Syllable-initial [n-]		Syllable-initial [l-]	
Test Words	Meaning	Test Words	Meaning
[nam ²¹] 男	male	[lam ²¹] 藍	blue
[nam ²³] 脯	belly	[lam ²³] 覽	to view
[nan ²¹] 難	difficult	[lan ²¹] 蘭	orchid
[nap ²] 納	to accept	[lap ²] 立	to erect
[nei ²¹] 泥	mud	[lei ²¹] 黎	a surname
[nei ²¹] 尼	nun	[lei ²¹] 離	to leave
[nei ²³] 你	you	[lei ²³] 李	a surname
[nei ²²] 膩	greasy	[lei ²²] 利	benefit
[nim ²²] 念	thought	[lim ²²] 臉	face
[nin ²¹] 年	year	[lin ²¹] 憐	poor
[niŋ ²¹] 寧	peaceful	[liŋ ²¹] 靈	spirit
[nik ⁵] 溺	to drown	[lik ⁵] 霹	thunderbolt
[nou ²¹] 奴	slave	[lou ²¹] 爐	stove
[nou ²³] 腦	brain	[lou ²³] 老	aged
[nou ²²] 怒	angry	[lou ²²] 露	to show
[noŋ ²¹] 囊	anything shaped like a bag	[loŋ ²¹] 狼	wolf
[ney ²³] 女	female	[ley ²³] 侶	couple
[noeŋ ²¹] 娘	the addressing form of mother in ancient China	[loeŋ ²¹] 糧	grain
[noŋ ²¹] 農	farming	[loŋ ²¹] 龍	dragon
[nyn ²²] 嫩	tender	[lyn ²²] 亂	chaos

Table 4. 20 minimal pairs of Cantonese monosyllabic words with the contrast in the syllable-initial [n-] and [l-] used for investigation.

2.3. Participants

Ten undergraduate students in Hong Kong, 5 male and 5 female, were recruited to take part in the production and perception experiment of the present study. The subjects were chosen after confirmation of their educational level and language experience, and they were willing participants. All of them were native speakers of Cantonese in their early twenties and had no history of speech and hearing problems. And, they were non-linguistics students without prior phonetic knowledge of the Cantonese sound system. Labels, M1 to M5 and F1 to F5, were used to name the subjects in the study.

2.4. Production test

The subjects pronounced the selected 40 Cantonese monosyllabic words with the initial [n-] and [l-] as presented in Table 4 (target words, henceforth) in three sessions for the production experiment. The target words were uttered individually as a single word in Session 1, as the second component word in bisyllabic compound words in Session 2, and as a component word in sentences in Session 3 (*See Appendix A*). For Session 1 or Session 2, there were 70 monosyllabic or bisyllabic words randomized on two lists. On each list, some dummy words that have no initial [n-] and [l-] were also included to avoid the subjects' awareness of the difference in the initial [n-] and [l-] in the target syllables. For Session 3, twelve sentences formed with some of the target words were randomized on two lists. In each sentence, the target word occurred in the sentence-medial position and preceded by another word without a final nasal consonant.

Each subject was asked to do individual audio recordings of the three sessions at a time with a five-minute break after each session. The recordings took place in the acoustic sound-proof booth in the Phonetics Lab of the Department of Linguistics and Translation at the City

University of Hong Kong. The speech data from the subjects were collected by means of a high quality digital recorder, and saved in WAV form. During the recordings, the test materials were presented to the subjects in written form of Chinese characters on the computer screen. They were instructed to read out the test words and sentences aloud at a normal rate of speech with three repetitions. A total of 3600 test tokens (40 target syllables x 3 repetitions x 3 sessions x 10 speakers) were recorded for subsequent acoustical analysis.

Using the PRAAT program (Boersma and Weenink, 2016), spectrograms of the target words were obtained for determining whether the initial [n-] and [l-] in the target words were correctly pronounced. All the target words were also perceptually judged by three linguistics undergraduate students, who have the knowledge of Cantonese phonetics and experience in phonetic transcription. Based on the analyzed data, the percentages of mispronunciation of the syllable-initial [n-] and [l-] in the target words for each of the subjects were calculated. Also, statistical analysis was performed on the results of mispronunciation for the subjects.

2.5. Perception test

The subjects took part in a perception test on another day after the completion of the production experiment. In the test, the subjects were asked to identify the 40 target words collected from the natural speech of a female native Cantonese speaker who had the knowledge of Cantonese phonetics and phonology. The pronunciation of the target words from the female speaker was first verified by the perceptual judgement of the investigator of this project, and it was doubly confirmed by checking the formant patterns of the target words on the spectrograms using PRAAT (Boersma and Weenink, 2016). The 40 target words from the female speaker were divided into 20 minimal pairs regarding the initial [n-] and [l-] in the target words. Each one of the two target words in the 20 minimal pairs was randomized in

five blocks, making up a total of 10 blocks (2 target words x 5 blocks) containing 200 stimuli (20 target words per block x 10 blocks) for a perceptual identification test (*See Appendix B*).

The subjects did the perception test individually in a quiet room. The ten blocks of stimuli were placed in random order on a playlist, with a one-minute pause after each block. All the stimuli were played once on a notebook computer through the headphones at a comfortable sound level to the subjects. The subjects were asked to identify the stimuli as one of the two target words in a minimal pair. It was a forced-choice task, where the subjects must select one of the two target words presented in Chinese characters on the answer sheet after hearing each one of the stimuli.

The obtained responses to the stimuli from the subjects were then counted for the percentages of misidentification of the initial [n-] and [l-]. Statistical analysis was further performed on the results of misidentification for the subjects.

Section 3. Results

In the production and perception experiment, both mispronunciation and misidentification of the syllable-initial [n-] as [l-] and also [l-] as [n-] are observed for the HKC speakers. In the following sections, the results of mispronunciation and misidentification of [n-] and [l-] in each case are presented.

3.1. Production results

3.1.1. Mispronunciation of [n-] as [l-]

Table 5 presents the percentages of mispronunciation of the syllable-initial [n-] as [l-] ([n-] → [l-], henceforth) in the 20 target words produced as a single monosyllabic word in Session 1, as the second component word of the bisyllabic compound words in Session 2, and as one of the medial component words of the sentences in Session 3 by the ten HKC speakers in the study. For each session, the percentages of mispronunciation or error rates of [n-] → [l-] in the 20 target words are presented in a decreasing order.

As shown in Table 5, the syllable-initial [n-] in the 20 target words produced in any session is frequently mispronounced as [l-] by the HKC speakers, with a high overall error rate around 70% for [n-] → [l-] in each of the three sessions. This indicates that the change from [n-] to [l-] is common in the speech of the HKC speakers. Comparatively, the overall error rate of [n-] → [l-] is slightly lower in Session 1 (66.7%), followed by Session 2 (72.3%) and Session 3 (78%) in an increasing order. The difference in the overall error rate of [n-] → [l-] among the three sessions is significant ($p=0.025$) based on the result of ANOVA analysis. The results of t-tests also reveal that the difference in the overall error rate of [n-] → [l-] is significant between Session 1 and Session 2 ($p=0.000048$) as well as between Session 2 and

Session 3 ($p=0.000063$), and particularly true for the difference between Session 1 and Session 3 ($p=0.000000086$). The data indicate that the mispronunciation of [n-] as [l-] is more frequent in a long utterance, like a sentence which is closer to continuous speech, than in a short utterance, such as a monosyllabic word, for which careful pronunciation is easily made.

Session 1		Session 2		Session 3		All three sessions	
Test words	Error rate	Test words	Error rate	Test words	Error rate	Test words	Error rate
[nœŋ ²¹] 娘	100%	[nœŋ ²¹] 娘	100%	[nœŋ ²¹] 娘	100%	[nœŋ ²¹] 娘	100%
[nɔŋ ²¹] 囊	90.0%	[nɔŋ ²¹] 囊	93.3%	[nɔŋ ²¹] 囊	93.3%	[nɔŋ ²¹] 囊	92.2%
[nou ²¹] 奴	80.0%	[nam ²³] 腩	83.3%	[niŋ ²¹] 寧	90.0%	[niŋ ²¹] 寧	83.3%
[niŋ ²¹] 寧	76.7%	[nei ²¹] 泥	83.3%	[nam ²³] 腩	86.7%	[nou ²¹] 奴	82.2%
[nei ²] 泥	73.3%	[niŋ ²¹] 寧	83.3%	[nei ²²] 膩	86.7%	[nam ²³] 腩	81.1%
[nam ²³] 腩	70.0%	[nou ²¹] 奴	83.3%	[nei ²¹] 泥	83.3%	[nei ²¹] 泥	80.0%
[nøy ²³] 女	70.0%	[nou ²²] 怒	80.0%	[nou ²¹] 奴	83.3%	[nou ²²] 怒	77.8%
[nou ²²] 怒	70.0%	[nøy ²³] 女	76.7%	[nou ²²] 怒	83.3%	[nøy ²³] 女	76.7%
[nik ⁵] 溺	70.0%	[nei ²¹] 尼	73.3%	[nøy ²³] 女	83.3%	[nei ²²] 膩	74.4%
[noŋ ²¹] 農	66.7%	[nap ²] 納	70.0%	[nyn ²²] 嫩	83.3%	[nyn ²²] 嫩	73.3%
[nei ²¹] 尼	66.7%	[nei ²²] 膩	70.0%	[nei ²¹] 尼	80.0%	[nei ²¹] 尼	72.2%
[nei ²²] 膩	66.7%	[nyn ²²] 嫩	70.0%	[noŋ ²¹] 農	80.0%	[noŋ ²¹] 農	71.1%
[nyn ²²] 嫩	63.3%	[nik ⁵] 溺	66.7%	[nik ⁵] 溺	73.3%	[nik ⁵] 溺	70.0%
[nou ²³] 腦	60.0%	[noŋ ²¹] 農	66.7%	[nam ²¹] 男	70.0%	[nap ²] 納	65.6%
[nap ²] 納	56.7%	[nam ²¹] 男	63.3%	[nap ²] 納	70.0%	[nou ²³] 腦	64.4%
[nei ²³] 你	53.3%	[nou ²³] 腦	63.3%	[nou ²³] 腦	70.0%	[nam ²¹] 男	61.1%
[nam ²¹] 男	50.0%	[nan ²¹] 難	56.7%	[nan ²¹] 難	66.7%	[nan ²¹] 難	57.8%
[nan ²¹] 難	50.0%	[nei ²³] 你	56.7%	[nim ²²] 念	63.3%	[nim ²²] 念	56.7%
[nim ²²] 念	50.0%	[nim ²²] 念	56.7%	[nei ²³] 你	56.7%	[nei ²³] 你	55.6%
[nin ²¹] 年	50.0%	[nin ²¹] 年	50.0%	[nin ²¹] 年	56.7%	[nin ²¹] 年	52.2%
Overall error rate	66.7%	Overall error rate	72.3%	Overall error rate	78.0%	Overall error rate	72.3%

Table 5. Percentages of mispronunciation of [n-] as [l-] in 20 target words produced in three sessions of the production test for ten HKC speakers.

Considering the 20 target words with the initial [n-] produced in each of the three sessions, the error rate of [n-] → [l-] for each word is at least 50%, which indicates that the pronunciation of [n-] as [l-] is not made by chance. There is a target word [nœŋ²¹] 娘 with the error rate of [n-] → [l-] at 100% in the three sessions for all the HKC speakers, which indicates that the syllable-initial [n-] of [nœŋ²¹] 娘 has changed to [l-]. There are some other target words, such as [nœŋ²¹] 囊, [nou²¹] 奴, [niŋ²¹] 寧, [nei²] 泥, [nam²³] 膈, [nœy²³] 女, and [nou²²] 怒, with a high error rate of 70% or above for [n-] → [l-] in each of the three sessions. Based on these words, no phonetic condition with respect to the sounds following [n-] is observed for explaining the change from [n-] to [l-], which indicates that the change is unpredictable and up to the speakers. There are also a few target words, in which the initial [n-] is correctly pronounced by some speakers. For instance, the words [niŋ²¹] 寧 and [nim²²] 念 are consistently produced with an initial [n-] in all the tokens from a female speaker, F2 and F3 respectively, in each of the three sessions. Also, in both Session 2 and Session 3, there are three target words [nan²¹] 難, [nei²³] 你, and [nin²¹] 年, in which the initial [n-] is pronounced correctly in all the tokens by one or more speakers. Thus, while the pronunciation of [n-] as [l-] is frequent in the speech of the HKC speakers, the initial [n-] is still retained in some words for some speakers.

Table 6 presents the error rates of [n-] → [l-] in the three sessions of the production experiment for each of the ten HKC speakers, five male (M1 to M5) and five female (F1 to F5). As shown in the table, for each speaker, the error rate of [n-] → [l-] in any session is over 50%, and the error rate is higher in Session 2 and Session 3 than in Session 1. Among the ten speakers, M4 and F1 mispronounce [n-] as [l-] much more frequent than the other

speakers. This is particularly in Session 2 and Session 3, where M4 and F1 have the error rate of 100% for [n-] → [l-], which indicates the disappearance of [n-] in their speech.

Speakers		Session 1		Session 2		Session 3		All three sessions	
		Error rate		Error rate		Error rate		Error rate	
Male	M1	70.0%	71%	75.0%	76.7%	81.7%	81.7%	75.6%	76.4%
	M2	71.7%		73.3%		80.0%		75.0%	
	M3	63.3%		66.7%		75.0%		68.3%	
	M4	86.7%		100%		100%		95.6%	
	M5	63.3%		68.3%		71.1%		67.8%	
Female	F1	83.3%	62.3%	100%	68.0%	100%	74.3%	94.4%	68.2%
	F2	56.7%		58.3%		65.0%		60.0%	
	F3	56.7%		58.3%		65.0%		60.0%	
	F4	58.3%		63.3%		68.3%		63.3%	
	F5	56.7%		60.0%		73.3%		63.3%	

Table 6. Percentages of mispronunciation of [n-] as [l-] in three sessions of the production test for each one of the ten HKC speakers, five male (M1 to M5) and five female (F1 to F5).

A comparison of the production data between the two genders shows that the error rate of [n-] → [l-] in each of the three sessions is slightly higher for the male speakers (71% in Session 1, 76.7% in Session 2, and 81.7% in Session 3) than the female speakers (62.3% in Session 1, 68% in Session 2, and 74.3% in Session 3). The observed gender difference is supported by the results of the t-test analysis that the difference in the error rate of [n-] → [l-] between the male and female speakers is highly significant ($p=0.0000022$).

3.1.2. Mispronunciation of [l-] as [n-]

In Table 7, the percentages of mispronunciation or error rates of the syllable-initial [l-] as [n-] ([l-] → [n-], henceforth) in 20 target words produced in the three sessions by the ten HKC speakers are presented in a decreasing order.

Session 1		Session 2		Session 3		All three sessions	
Test words	Error rate	Test words	Error rate	Test words	Error rate	Test words	Error rate
[lim ²²] 臉	80.0%	[lim ²²] 臉	40.0%	[lim ²²] 臉	30.0%	[lim ²²] 臉	50.0%
[lam ²¹] 藍	13.3%	[lam ²¹] 藍	3.3%	[lam ²¹] 藍	2.2%	[lam ²¹] 藍	7.8%
[lan ²¹] 蘭	10.0%	[lam ²³] 覽	3.3%	[lap ²] 立	2.2%	[lap ²] 立	5.6%
[lei ²³] 李	10.0%	[lap ²] 立	3.3%	[ley ²³] 侶	2.2%	[lei ²³] 李	4.4%
[lap ²] 立	6.7%	[lœŋ ²¹] 糧	3.3%	[lei ²³] 李	3.3%	[lan ²¹] 蘭	3.3%
[liŋ ²¹] 靈	6.7%	[lan ²¹] 蘭	0%	[lou ²³] 老	3.3%	[liŋ ²¹] 靈	2.2%
[lei ²¹] 黎	3.3%	[lei ²¹] 黎	0%	[lam ²³] 覽	0%	[lou ²³] 老	2.2%
[lin ²¹] 憐	3.3%	[lei ²¹] 離	0%	[lan ²¹] 蘭	0%	[ley ²³] 侶	2.2%
[lou ²³] 老	3.3%	[lei ²³] 李	0%	[lei ²¹] 黎	0%	[lam ²³] 覽	1.1%
[lyn ²²] 亂	3.3%	[lei ²²] 利	0%	[lei ²¹] 離	0%	[lei ²¹] 黎	1.1%
[lam ²³] 覽	0%	[lin ²¹] 憐	0%	[lei ²²] 利	0%	[lin ²¹] 憐	1.1%
[lei ²¹] 離	0%	[liŋ ²¹] 靈	0%	[lin ²¹] 憐	0%	[lœŋ ²¹] 糧	1.1%
[lei ²²] 利	0%	[lik ⁵] 歷	0%	[liŋ ²¹] 靈	0%	[lyn ²²] 亂	1.1%
[lik ⁵] 歷	0%	[lou ²¹] 爐	0%	[lik ⁵] 歷	0%	[lei ²¹] 離	0%
[lou ²¹] 爐	0%	[lou ²³] 老	0%	[lou ²¹] 爐	0%	[lei ²²] 利	0%
[lou ²²] 露	0%	[lou ²²] 露	0%	[lou ²²] 露	0%	[lik ⁵] 歷	0%
[loŋ ²¹] 狼	0%	[loŋ ²¹] 狼	0%	[loŋ ²¹] 狼	0%	[lou ²¹] 爐	0%
[ley ²³] 侶	0%	[ley ²³] 侶	0%	[lœŋ ²¹] 糧	0%	[lou ²²] 露	0%
[lœŋ ²¹] 糧	0%	[loŋ ²¹] 龍	0%	[loŋ ²¹] 龍	0%	[loŋ ²¹] 狼	0%
[loŋ ²¹] 龍	0%	[lyn ²²] 亂	0%	[lyn ²²] 亂	0%	[loŋ ²¹] 龍	0%
Overall error rate	7.0%	Overall error rate	4.0%	Overall error rate	4.3%	Overall error rate	4.2%

Table 7. Percentages of mispronunciation of [l-] as [n-] in 20 target words produced in three sessions of the production test for ten HKC speakers.

The data presented in Table 7 show that the mispronunciation of the initial [l-] as [n-] is not frequent for the HKC speakers, as the error rate of [l-] → [n-] is low, with the overall rate below 10% in each of the three sessions. The overall error rate of [l-] → [n-] is slightly higher in Session 1 (7%) than in Session 2 (4%) and Session 3 (4.3%). However, the result of the ANOVA analysis shows no significant difference ($p=0.44$) in the overall error rate of [l-] → [n-] among the three sessions. The results of t-tests also reveal no significant difference in the overall error rate of [l-] → [n-] between Session 1 and Session 2 ($p=0.051$), between Session 2 and Session 3 ($p=0.83$), and between Session 1 and Session 3 ($p=0.12$). The data suggest that the mispronunciation of the initial [l-] as [n-] is regardless of the utterances as the monosyllabic words (Session 1), bisyllabic words (Session 2), or sentences (Session 3).

For the 20 target words with the initial [l-] produced in each of the three sessions by the HKC speakers, the error rate of [l-] → [n-] is noticeably large for a single word [lim²²] 臉, with 80% in Session 1, 40% in Session 2, and 30% in Session 3. The data seem to indicate that the initial consonant in the word [lim²²] 臉 is [n-] instead of [l-] in the recognition of the speakers, so that the initial of this word is pronounced as [l-] with the rate of 20% in Session 1 and with the higher rates of 60% in Session 2 and 70% in Session 3, following the mispronunciation pattern for [n-] → [l-] in the three sessions as presented earlier in Section 3.1.1. Excluding the word [lim²²] 臉, just three target words, [lam²¹] 藍, [lan²¹] 蘭 and [lei²³] 李 are mispronounced with an initial [n-] at the rate of 10% or above. For these three words, the mispronunciation of [l-] → [n-] is only in one or two tokens from some speakers. There are also other target words, in which the initial [l-] is mispronounced as [n-] by some particular speakers. For instance, the mispronunciation of [l-] → [n-] in the words [lam²¹] 藍 and [lap²] 立 is mainly observed in the test tokens from F4 and M3, respectively. In general, the initial [l-] in the majority of the target words is correctly pronounced, with the error rate

of 0% in at least one session, usually Session 2 or Session 3, and there are seven target words including [lei²¹] 離, [lei²²] 利, [lik⁵] 歷, [lou²¹] 爐, [lou²²] 露, [lon²¹] 狼 and [lon²¹] 龍, in which the initial [l-] is correctly pronounced in all the three sessions. The data indicate that the mispronunciation of [l-] as [n-] is uncommon in HKC. Furthermore, there is no observable pattern for [l-] → [n-] with respect to the sounds following [l-] in the target words.

For determining the between-speaker variation, Table 8 presents the error rates of [l-] → [n-] in the target words produced in the three sessions for each of the ten speakers, M1 to M5 and F1 to F5. As shown in the table, for each speaker, the error rate of [l-] → [n-] is low, which is not more than 10% in Session 1 and not more than 5% in Session 2 and Session 3. There are two speakers, M4 and F1, who pronounce the initial [l-] correctly in all tokens, with the error rate of 0%, in Session 2 and Session 3. As presented in the previous section, M4 and F1 are the two speakers who have the error rate of 100% for [n-] → [l-] in Session 2 and Session 3. Thus, it may be considered that the merger of the initial [n-] and [l-] is nearly completed in their speech. As for the other speakers, they also tend to correctly produce [l-] more often in Session 2 and Session 3 than in Session 1. The data on the mispronunciation of [l-] → [n-] correspond to the data on the mispronunciation of [n-] → [l-] presented in the previous section that the initial [n-] is frequently pronounced in the shorter utterances, like monosyllabic words (Session 1), and mainly [l-] is pronounced in the longer utterances, including bisyllabic words (Session 2) and sentences (Session 3), for the HKC speakers.

To compare the data on the mispronunciation of [l-] as [n-] between the two genders, the error rate of [l-] → [n-] is slightly higher for the male speakers than the female speakers. While the difference in the overall error rate of [l-] → [n-] for all the three sessions between the male (4.6%) and female (3.8%) speakers is significant ($p=0.013$), the gender difference in

the error rate of [l-] → [n-] in each individual session is not significant. Also, no general pattern of the differences in the mispronunciation of the initial [n-] and [l-] in HKC is observed between the two genders.

Speakers		Session 1		Session 2		Session 3		All three sessions	
		Error rate		Error rate		Error rate		Error rate	
Male	M1	5.0%	7.7%	3.3%	3.0%	3.3%	3.0%	3.9%	4.6%
	M2	6.7%		3.3%		3.3%		4.4%	
	M3	8.3%		3.3%		3.3%		5.0%	
	M4	8.3%		0%		0%		2.8%	
	M5	10.0%		5.00%		5.0%		6.7%	
Female	F1	5.0%	6.3%	0%	2.3%	0%	2.7%	1.7%	3.8%
	F2	10.0%		1.7%		3.3%		5.0%	
	F3	5.0%		5.0%		5.0%		5.0%	
	F4	6.7%		3.3%		1.7%		3.9%	
	F5	5.0%		1.7%		3.3%		3.3%	

Table 8. Percentages of mispronunciation of [l-] as [n-] in three sessions of the production test for each one of the ten HKC speakers, five male (M1 to M5) and five female (F1 to F5).

3.2. Perception results

The perceptual data on the misidentification of the initial [n-] and [l-] for the HKC speakers are presented in Table 9. Those on the left in the table are the error rates of [n-] identified as [l-] in 20 target words. The error rates of [l-] identified as [n-] in other 20 target words are presented on the right in the table. For the two types of misidentification cases, the error rates of the 20 target words are ranked in a decreasing order.

Test words	Error rate of [n-] → [l-]	Test words	Error rate of [l-] → [n-]
[nœŋ ²¹] 娘	50.0%	[lim ²²] 臉	44.0%
[nan ²¹] 難	46.0%	[lei ²¹] 離	40.0%
[nim ²²] 念	44.0%	[lan ²¹] 蘭	38.0%
[noŋ ²¹] 農	42.0%	[lœŋ ²¹] 糧	36.0%
[nei ²¹] 尼	40.0%	[loŋ ²¹] 龍	34.0%
[nam ²³] 脯	38.0%	[lin ²¹] 憐	30.0%
[nei ²³] 你	36.0%	[lei ²²] 利	28.0%
[nyn ²²] 嫩	34.0%	[lou ²¹] 爐	26.0%
[nap ²] 納	32.0%	[lam ²³] 覽	26.0%
[nik ⁵] 溺	32.0%	[lei ²¹] 黎	24.0%
[nam ²¹] 男	30.0%	[lei ²³] 李	22.0%
[nei ²²] 膩	28.0%	[lap ²] 立	22.0%
[nin ²¹] 年	26.0%	[loŋ ²¹] 狼	20.0%
[nou ²³] 腦	24.0%	[lam ²¹] 藍	20.0%
[noy ²³] 女	22.0%	[lnŋ ²¹] 靈	18.0%
[nou ²²] 怒	20.0%	[lou ²³] 老	16.0%
[noŋ ²¹] 囊	20.0%	[ley ²³] 侶	16.0%
[nei ²¹] 泥	18.0%	[lyn ²²] 亂	14.0%
[nou ²¹] 奴	14.0%	[lou ²²] 露	12.0%
[niŋ ²¹] 寧	10.0%	[lik ⁵] 麤	10.0%
Overall error rate	30.3%	Overall error rate	24.8%

Table 9. Percentages of misidentification of [n-] as [l-] (on the left) and [l-] as [n-] (on the right) in two sets of target words for ten HKC speakers.

As presented in Table 9, the error rate of the initial [n-] identified as [l-] is ranging from 10% to 50%. Similar error rate ranging from 10% to 44% is obtained for the misidentification of the initial [l-] as [n-]. For each of the target words, the error rate is not more than 50%, and the overall error rate averaging across 20 target words is only 30.3% for [n-] identified as [l-] and 24.8% for [l-] identified as [n-]. The data suggest that the HKC speakers are in general able to identify distinctly the initial [n-] and [l-].

For both the misidentification cases of [n-] → [l-] and [l-] → [n-], there is a large variation in the error rate across the 20 target words, and the variation in the error rate has no observable pattern with respect to the phonetic structure of the target words. However, it is found that the initial [n-] and [l-] have a higher error rate in five minimal pairs of target words (34-50%), including [nœŋ²¹] 娘 and [lœŋ²¹] 糧, [nan²¹] 難 and [lan²¹] 蘭, [nim²²] 念 and [lim²²] 臉, [noŋ²¹] 農 and [loŋ²¹] 龍, and [nei²¹] 尼 and [lei²¹] 離, than in the other words (10-38%). Thus, the data indicate that the confusion between [n-] and [l-] is more likely to happen in certain words, particularly those associated with a low tone and/or having a nasal ending.

Speakers		Error rate of [n-] → [l-]		Error rate of [l-] → [n-]	
Male	M1	20.0%	16.9%	16.5%	13.8%
	M2	17.0%		13.5%	
	M3	18.0%		13.5%	
	M4	14.5%		12.5%	
	M5	15.0%		13.0%	
Female	F1	16.0%	13.4%	11.5%	11.0%
	F2	14.5%		12.5%	
	F3	12.5%		10.5%	
	F4	13.5%		10.5%	
	F5	10.5%		10.0%	

Table 10. Percentages of misidentification of [n-] as [l-] (on the left) and [l-] as [n-] (on the right) for each one of the ten HKC speakers, five male (M1 to M5) and five female (F1 to F5).

Considering the between-speaker variation, Table 10 presents the error rates of [n-] identified as [l-] (on the left) and [l-] identified as [n-] (on the right) for the ten speakers, M1 to M5 and

F1 to F5. As shown in the table, the error rates of the ten speakers are similar, ranging from 10.5% to 20% for the misidentification of [n-] as [l-] and from 10% to 16.5% for the misidentification of [l-] as [n-]. Comparing between the two genders, the error rate of [n-] identified as [l-] for all the five male speakers (16.9%) is slightly higher than that for the five female speakers (13.4%), and the gender difference in the error rate is statistically significant ($p=0.00022$) based on the result of t-test analysis. A slightly higher error rate of [l-] identified as [n-] for the five male speakers (13.8%) than the five female speakers (11%) is also observed, and the t-test analysis reveals a significant difference ($p=0.0012$) in the error rate between the two genders.

3.3. Comparison of the production and perception results

The production and perception results obtained in this study are compared for determining the difference in the ability of HKC speakers to pronounce and identify distinctly the initial [n-] and [l-] and also the relationship between production and perception in the merger of the syllable-initial [n-] and [l-] in HKC. Table 11 presents the error rates, including the percentages of mispronunciation and misidentification of [n-] as [l-] in 20 target words, for the ten HKC speakers in this study. In the table, the 20 target words are ranked in a decreasing order according to the error rate of [n-] → [l-] in the production experiment. As can be seen, for any target words, the error rate of [n-] → [l-] is noticeably higher in production, ranging from 52% to 100%, than in perception, ranging from 10% to 50%. The difference in the overall error rate of [n-] → [l-] between production (72.3%) and perception (30.3%) is highly significant ($p=0.0000000036$) based on the result of t-test analysis.

Test words	Error rate of [n-] → [l-]	
	Production	Perception
[nœŋ ²¹] 娘	100.0%	50.0%
[nœŋ ²¹] 囊	92.0%	20.0%
[niŋ ²¹] 寧	83.0%	10.0%
[nou ²¹] 奴	82.0%	14.0%
[nam ²³] 脯	80.0%	38.0%
[nei ²¹] 泥	80.0%	18.0%
[nou ²²] 怒	78.0%	20.0%
[nœy ²³] 女	77.0%	22.0%
[nei ²²] 膩	74.0%	28.0%
[nyn ²²] 嫩	73.0%	34.0%
[nei ²¹] 尼	72.0%	40.0%
[nœŋ ²¹] 農	71.0%	42.0%
[nik ⁵] 溺	70.0%	32.0%
[nap ²] 納	66.0%	32.0%
[nou ²³] 腦	64.0%	24.0%
[nam ²¹] 男	61.0%	30.0%
[nan ²¹] 難	58.0%	46.0%
[nim ²²] 念	57.0%	44.0%
[nei ²³] 你	56.0%	36.0%
[nin ²¹] 年	52.0%	26.0%
Overall error rate	72.3%	30.3%

Table 11. Percentages of mispronunciation and misidentification of [n-] as [l-] for ten HKC speakers.

Comparing the performance in the production and perception of the initial [n-] for each of the ten speakers, the data presented in Table 12 reveal that the error rate of [n-] → [l-] is much higher in production (60% or above) than in perception (20% or below). The data indicate that while the HKC speakers have a difficulty in pronouncing [n-], they are still able to distinguish [n-] from [l-] in perception. Comparing between the two genders, the error rates

of [n-] → [l-] in production and perception both are slightly higher for the male speakers (76.4% and 16.9%) than the female speakers (68.2% and 13.4%). The data suggest that the male speakers have slightly greater difficulty in distinguishing [n-] from [l-].

Speakers		Error rate of [n-] → [l-]			
		Production		Perception	
Male	M1	75.6%	76.4%	20.0%	16.9%
	M2	75.0%		17.0%	
	M3	68.3%		18.0%	
	M4	95.6%		14.5%	
	M5	67.8%		15.0%	
Female	F1	94.4%	68.2%	16.0%	13.4%
	F2	60.0%		14.5%	
	F3	60.0%		12.5%	
	F4	63.3%		13.5%	
	F5	63.3%		10.5%	

Table 12. Percentages of mispronunciation and misidentification of [n-] as [l-] for each one of the ten HKC speakers, five male (M1 to M5) and five female (F1 to F5).

Comparison of the error rates of [l-] → [n-] between production and perception is also made. Table 13 presents the percentages of mispronunciation and misidentification of [l-] as [n-] in 20 target words for the ten HKC speakers. In the table, the 20 target words are ranked in a decreasing order according to the error rate in the production experiment. As can be seen, except for the word [lim²²] 臉, the error rates of [l-] → [n-] in all the other target words are below 10% in production and noticeably increased to 10-40% in perception. The overall error rates of [l-] → [n-] are 4.12% in production and 24.8% in perception, where the difference between production and perception is highly significant ($p=0.000000083$) proved by

performing t-test analysis. The data suggest while the HKC speakers basically have no difficulty in pronouncing [l-], they have some confusion between [l-] and [n-] in perception.

Test words	Error rate	
	Production	Perception
[lim ²²] 臉	50.0%	44.0%
[lam ²¹] 藍	7.78%	20.0%
[lap ²] 立	5.56%	22.0%
[lei ²³] 李	4.44%	22.0%
[lan ²¹] 蘭	3.33%	38.0%
[liŋ ²¹] 靈	2.22%	18.0%
[lou ²³] 老	2.22%	16.0%
[ləy ²³] 侶	2.22%	16.0%
[lam ²³] 覽	1.11%	26.0%
[lɛi ²¹] 黎	1.11%	24.0%
[lin ²¹] 憐	1.11%	30.0%
[lœŋ ²¹] 糧	1.11%	36.0%
[lyn ²²] 亂	1.11%	14.0%
[lei ²¹] 離	0%	40.0%
[lei ²²] 利	0%	28.0%
[lik ⁵] 歷	0%	10.0%
[lou ²¹] 爐	0%	26.0%
[lou ²²] 露	0%	12.0%
[loŋ ²¹] 狼	0%	20.0%
[luŋ ²¹] 龍	0%	34.0%
Overall error rate	4.12%	24.8%

Table 13. Percentages of mispronunciation and misidentification of [l-] as [n-] for ten HKC speakers.

Comparing the performance in the production and perception of the initial [l-] for each of the ten speakers, the data presented in Table 14 show that the difference in the error rate of [l-] → [n-] between production (1.7-6.7%) and perception (10-16.5%) is not large, though the

performance of each speaker is slightly poorer in perception than in production. The data indicate that the speakers in general have no problem in distinguishing [l-] from [n-]. As for the performance in the production and perception of [l-] between the two genders, the difference is not pronounced. The overall error rates of [l-] → [n-] in production and perception are just slightly higher for the male speakers (4.56% and 13.8%) than the female speakers (3.78% and 11%)

Speakers		Error rate of [n-] → [l-]			
		Production		Perception	
Male	M1	3.9%	4.6%	16.5%	13.8%
	M2	4.4%		13.5%	
	M3	5.0%		13.5%	
	M4	2.8%		12.5%	
	M5	6.7%		13.0%	
Female	F1	1.7%	3.8%	11.5%	11.0%
	F2	5.0%		12.5%	
	F3	5.0%		10.5%	
	F4	3.9%		10.5%	
	F5	3.3%		10.0%	

Table 14. Percentages of mispronunciation and misidentification of [l-] as [n-] for each one of the ten HKC speakers, five male (M1 to M5) and five female (F1 to F5).

Section 4. Discussion

The data obtained in this study show that the merger of the syllable-initial [n-] and [l-] in HKC appears not only in production but also in perception. In production, the HKC speakers have difficulty mainly in pronouncing [n-]. They often mispronounce [n-] as [l-], which is more apparent in certain words and especially in long utterances, such as bisyllabic compound words and sentences, for which careful pronunciation is assumed not easily to be made. The mispronunciation of [l-] as [n-] is also observed, though it only happens in few words. The data demonstrate the neutralization of the initial [n-] and [l-] in HKC. Since both [n-] and [l-] are still found in speech, the merger of [n-] and [l-] in HKC has not yet in completion.

In perception, confusion between the initial [n-] and [l-] is also observed for the HKC speakers. Not only is [n-] misidentified as [l-], [l-] is also misidentified as [n-], and the error rates of both cases are similar. The perceptual data again demonstrate the incompleteness of the merger of the syllable-initial [n-] and [l-] in HKC. The confusion between [n-] and [l-] is more likely to happen in some minimal pairs of words which are associated with a low tone and having a nasal ending. Thus, pitch and nasality may be considered as two acoustic features attributed to the distinction between [n-] and [l-] in perception. Since the overall error rates of the identification of [n-] and [l-] are around 30%, the data suggest that the HKC speakers still have the ability to distinguish between [n-] and [l-] in perception, though their ability to pronounce [n-] distinct from [l-] is reduced. It follows that speakers' ability of production and perception is not necessarily correlated with each other in the distinction of the different sounds in language.

Regarding the between-speaker performance in production and perception of the initial [n-] and [l-] in HKC, no substantial differences are observed, though two speakers, M4 and F1, are more often to mispronounce [n-] as [l-]. The patterns of the production and perception of the initial [n-] and [l-] between the two genders are also similar, while the performance of the male speakers is slightly poorer than that of the female speakers. In general, the syllable-initial [n-] and [l-] in HKC have become non-distinctive in the speech of the younger generation, both male and female, while they are still distinguishable in perception.

Section 5. Conclusion

This study is believed to be the first phonetic investigation of the merger of the syllable-initial [n-] and [l-] in HKC in both the production and perception aspects, based on the first-hand data collected from young adult speakers, male and female. Experimental data on the mispronunciation and misidentification of the initial [n-] and [l-] from ten speakers have been presented. The findings reveal that the merger is bidirectional. In production, the merger is mainly due to the mispronunciation of [n-] as [l-], but occasional mispronunciation of [l-] as [n-] is also found. Confusion between [n-] and [l-] in perception is also observed, which is resulted from misidentifying the two initials as one another. Mispronunciation is more likely to be a trigger for the merger, as the HKC speakers' difficulty is primarily in the pronunciation of [n-]. It follows that the speakers' performance in production and perception may not be necessarily parallel in the distinction of speech sounds. In general, both the production and perception data show that phonetically HKC still has the syllable-initial [n-] and [l-], but phonologically the two initials have become non-distinctive. It follows that the merger of the syllable-initial [n-] and [l-] in HKC has not yet reached the final stage.

Last but not least, due to the time limitation for this 3-month project, only ten HKC speakers participated in the research. This study is exploratory in nature, and more samples from a larger group of speakers should be analyzed in future investigations. Also, similar to Cantonese, the variation between the syllable-initial [n-] and [l-] is also observed in other Chinese dialects, e.g., the merger of the initial [n-] and [l-] in Sichuan dialect as reported in Zhang (2007). Thus, for possible future studies in this area, the Cantonese data can be compared with those from other Chinese dialects for a fuller understanding of the general development and merger of the syllable initial [n-] and [l-] in Chinese.

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Appendix

Appendix A¹: Word lists for the audio recordings in three sessions of the production experiment

Session 1: monosyllabic words

Word list 1

1. 驕	2. 臍	3. 西	4. 亂	5. 水
6. 覽	7. 滑	8. 麗	9. 背	10. 腦
11. 利	12. 葉	13. 婆	14. 離	15. 立
16. 福	17. 蘭	18. 憐	19. 急	20. 老
21. 膩	22. 拆	23. 寧	24. 爐	25. 置
26. 臉	27. 你	28. 畢	29. 囊	30. 黎
31. 位	32. 念	33. 界	34. 靈	35. 日

Word list 2

36. 黑	37. 欲	38. 溺	39. 怒	40. 校
41. 納	42. 侶	43. 台	44. 尼	45. 娘
46. 適	47. 年	48. 男	49. 豆	50. 龍
51. 女	52. 搖	53. 狼	54. 彩	55. 快
56. 奴	57. 李	58. 愛	59. 糧	60. 難
61. 學	62. 泥	63. 農	64. 久	65. 國
66. 藍	67. 失	68. 嫩	69. 露	70. 口

¹ The target words with the initial [n-] and [l-] are in blue and bold type.

Session 2: bisyllabic compound

Word list 1

1. 驕傲	2. 胡亂	3. 西瓜	4. 膠囊	5. 水果
6. 遊覽	7. 滑雪	8. 九龍	9. 背包	10. 刁難
11. 月老	12. 茶葉	13. 位置	14. 污泥	15. 米糲
16. 急救	17. 蘇寧	18. 愛侶	19. 福音	20. 笑臉
21. 菜農	22. 拆除	23. 肥膩	24. 色狼	25. 畢業
26. 寶藍	27. 收納	28. 界刀	29. 幼嫩	30. 撇離
31. 位置	32. 爹娘	33. 欲求	34. 孤立	35. 校友

Word list 2

36. 台北	37. 日出	38. 激怒	39. 波蘭	40. 豆腐
41. 魚露	42. 牛腩	43. 彩色	44. 悉尼	45. 火爐
46. 搖頭	47. 巴黎	48. 霹靂	49. 學會	50. 貓奴
51. 桃李	52. 失敗	53. 迷你	54. 快速	55. 國家
56. 吉利	57. 大腦	58. 口碑	59. 懷念	60. 可憐
61. 黑白	62. 海女	63. 幽靈	64. 適合	65. 婆媳
66. 拯溺	67. 愛惜	68. 少男	69. 雞年	70. 久違

Session 3: sentences

Word list 1

1. 每 年 的中秋晚會，都會有舞 龍 舞獅的表演和一大群少 男 少 女 唱歌熱舞。
2. 遇到好像小 寧 這種喜 怒 無常的人時，還是 離 開遠一點比較好。
3. 這位 李 教授雖然已 老 眼昏花，但自幼博 覽 群書，頭 腦 聰明，一定可以解答 你 的問題。
4. 每次演唱會， 黎 明都金句百出，表 露 出一副智者的樣子。
5. 今天早上本來 藍 天白雲，但突然晴天霹 靂 下了一場暴雨，打 亂 了我們行山的計劃。
6. 在古時，這條村的人會將爹 娘 死後的屍骨安葬在同一 靈 墓中，讓他們有愛 侶 相伴。

Word list 2

7. 這位 尼 姑不眠不食地 念 經誦佛， 難 怪她瘦得可 憐 ，而且 臉 色很差。
8. 父母太過 溺 愛孩子，會影響他們的個人成長和獨 立 發展。
9. 他 利 用職務之便中飽私 囊 ，更試圖藏污 納 垢，與賊匪 狼 狽為奸。
10. 他的廚藝已達到 爐 火純青的地步，煮的燒雞又 嫩 又滑，牛 腩 亦肥而不 膩 ，值得一試。
11. 青協 農 場使用有機 泥 土，所種植的 蘭 花又大又香。
12. 在這條貧窮的村莊，不少家庭將兒子賣作 奴 隸來換取金錢和 糧 食。

Appendix B²: Answer sheets for the identification test of the stimuli in ten blocks in the perception experiment

Block 1

1. 你 李	_____	6. 娘 糧	_____	11. 蘭 難	_____	16. 藍 男	_____
2. 囊 狼	_____	7. 寧 靈	_____	12. 膩 利	_____	17. 納 立	_____
3. 奴 爐	_____	8. 尼 離	_____	13. 灑 溺	_____	18. 覽 腩	_____
4. 嫩 亂	_____	9. 女 侶	_____	14. 農 龍	_____	19. 腦 老	_____
5. 年 憐	_____	10. 念 臉	_____	15. 露 怒	_____	20. 黎 泥	_____

Block 2

1. 寧 靈	_____	6. 尼 離	_____	11. 男 藍	_____	16. 露 怒	_____
2. 念 臉	_____	7. 娘 糧	_____	12. 納 立	_____	17. 溺 灑	_____
3. 囊 狼	_____	8. 奴 爐	_____	13. 龍 農	_____	18. 覽 腩	_____
4. 你 李	_____	9. 女 侶	_____	14. 腦 老	_____	19. 難 蘭	_____
5. 年 憐	_____	10. 嫩 亂	_____	15. 黎 泥	_____	20. 利 膩	_____

² In each block, the word pairs have the contrast in the syllable-initial [n-] and [l-].

Block 3

1. 尼 離	_____	6. 黎 泥	_____	11. 寧 靈	_____	16. 露 怒	_____
2. 娘 糧	_____	7. 老 腦	_____	12. 嫩 亂	_____	17. 溺 麤	_____
3. 念 臉	_____	8. 覽 腩	_____	13. 年 憐	_____	18. 農 龍	_____
4. 囊 狼	_____	9. 立 納	_____	14. 你 李	_____	19. 難 蘭	_____
5. 奴 爐	_____	10. 藍 男	_____	15. 女 侶	_____	20. 利 膩	_____

Block 4

1. 麤 溺	_____	6. 娘 糧	_____	11. 蘭 難	_____	16. 藍 男	_____
2. 囊 狼	_____	7. 寧 靈	_____	12. 膩 利	_____	17. 念 臉	_____
3. 奴 爐	_____	8. 尼 離	_____	13. 你 李	_____	18. 覽 腩	_____
4. 嫩 亂	_____	9. 女 侶	_____	14. 農 龍	_____	19. 腦 老	_____
5. 年 憐	_____	10. 納 立	_____	15. 露 怒	_____	20. 黎 泥	_____

Block 5

1. 嫩 亂	_____	_____	6. 寧 靈	_____	_____	11. 藍 男	_____	_____	16. 蘭 難	_____	_____
2. 老 腦	_____	_____	7. 念 臉	_____	_____	12. 納 立	_____	_____	17. 膩 利	_____	_____
3. 囊 狼	_____	_____	8. 年 憐	_____	_____	13. 覽 脯	_____	_____	18. 靨 溺	_____	_____
4. 農 龍	_____	_____	9. 奴 爐	_____	_____	14. 你 李	_____	_____	19. 女 侶	_____	_____
5. 娘 糧	_____	_____	10. 尼 離	_____	_____	15. 黎 泥	_____	_____	20. 怒 露	_____	_____

Block 6

1. 男 藍	_____	_____	6. 露 怒	_____	_____	11. 寧 靈	_____	_____	16. 尼 離	_____	_____
2. 納 立	_____	_____	7. 溺 靨	_____	_____	12. 念 臉	_____	_____	17. 娘 糧	_____	_____
3. 龍 農	_____	_____	8. 覽 脯	_____	_____	13. 囊 狼	_____	_____	18. 奴 爐	_____	_____
4. 腦 老	_____	_____	9. 難 蘭	_____	_____	14. 你 李	_____	_____	19. 女 侶	_____	_____
5. 黎 泥	_____	_____	10. 利 膩	_____	_____	15. 年 憐	_____	_____	20. 嫩 亂	_____	_____

Block 7

1. 離 尼	_____	6. 黎 泥	_____	11. 藍 男	_____	16. 女 侶	_____
2. 娘 糧	_____	7. 老 腦	_____	12. 嫩 亂	_____	17. 溺 露	_____
3. 念 臉	_____	8. 覽 脯	_____	13. 年 憐	_____	18. 農 龍	_____
4. 囊 狼	_____	9. 納 立	_____	14. 你 李	_____	19. 難 蘭	_____
5. 奴 爐	_____	10. 靈 寧	_____	15. 露 怒	_____	20. 利 膩	_____

Block 8

1. 嫩 亂	_____	6. 寧 靈	_____	11. 藍 男	_____	16. 蘭 難	_____
2. 李 你	_____	7. 念 臉	_____	12. 納 立	_____	17. 膩 利	_____
3. 囊 狼	_____	8. 憐 年	_____	13. 覽 脯	_____	18. 露 溺	_____
4. 老 腦	_____	9. 奴 爐	_____	14. 女 侶	_____	19. 龍 農	_____
5. 娘 糧	_____	10. 尼 離	_____	15. 黎 泥	_____	20. 怒 露	_____

Block 9

1. 娘 糧	_____	6. 龍 農	_____	11. 女 侶	_____	16. 露 怒	_____
2. 念 臉	_____	7. 腦 老	_____	12. 納 立	_____	17. 溺 麗	_____
3. 囊 狼	_____	8. 奴 爐	_____	13. 尼 離	_____	18. 嫩 亂	_____
4. 你 李	_____	9. 男 藍	_____	14. 寧 靈	_____	19. 難 蘭	_____
5. 年 憐	_____	10. 覽 膺	_____	15. 黎 泥	_____	20. 利 膩	_____

Block 10

1. 尼 離	_____	6. 你 李	_____	11. 寧 靈	_____	16. 露 怒	_____
2. 娘 糧	_____	7. 老 腦	_____	12. 尼 離	_____	17. 黎 泥	_____
3. 嫩 亂	_____	8. 覽 膺	_____	13. 年 憐	_____	18. 利 膩	_____
4. 囊 狼	_____	9. 溺 麗	_____	14. 念 臉	_____	19. 難 蘭	_____
5. 奴 爐	_____	10. 藍 男	_____	15. 女 侶	_____	20. 立 納	_____