

A phonological analysis of the onset velar nasal merger in Hong Kong Cantonese

Suet-Ying Lam*

Abstract. This paper provides a phonological analysis of the onset /ŋ/ ↔ /∅/ merger in Hong Kong Cantonese (HKC). What is particularly challenging for a formal analysis here is that the insertion and deletion of [ŋ] can occur in the same environment, since a sound normally does not allow two contrasting operations in the same environment (McCarthy 2003). The current study employs an analysis using a probabilistic constraint-based grammar (Goldwater et al. 2003), by proposing that [ŋ] is a placeless consonant at the onset position. Thus, [ŋ] is inserted placelessly and gets its place from the following vowel. Insertion of other sounds can thus be excluded by penalizing place insertion.

Keywords. phonology; MaxEnt; Cantonese; merger; nasal

1. Introduction. The current paper aims to provide a phonological analysis to an ongoing sound change, i.e., the onset /ŋ/ ↔ /∅/ merger in Hong Kong Cantonese (henceforth Cantonese). While the term ‘merger’ usually refers to the contrast reduction between two sounds which form a minimal pair (Dresher 2009), [ŋ] and an empty onset are in complementary distribution in a corpus of standard Cantonese (Wong 1941). Nevertheless, the present paper uses ‘merger’ to refer to the loss of contrast between the two allophones following the sociolinguistic and phonetic studies on this topic (e.g., Cheng et al. 2022; To et al. 2015; Zee 1999).

Example (1) illustrates the insertion and deletion of [ŋ] at the onset position. The vowel-initial words appeared in the past with mid to high tones, i.e., T1, T2 and T3, while ŋ-initial words appeared with low to mid tones, i.e., T4, T5, T6 (Wong 1941). Yet, the complementary distribution has been disappearing in modern Cantonese. As illustrated in (1), for historically ŋ-initial words, both ŋ-initial or ŋ-deleted form are possible. Same for historically ∅-initial words, both vowel-initial and ŋ-inserted forms are acceptable.

- (1) a. Insertion of [ŋ] to ∅-initial words
- | Historical sound | Possible outputs | Gloss |
|------------------|------------------|-------|
| /oi1/ | [oi1]; [ŋoi1] | sad |
| /ai2/ | [ai2]; [ŋai2] | short |
| /ap3/ | [ap3]; [ŋap3] | duck |
- b. Deletion of [ŋ] from ŋ-initial words
- | Historical sound | Possible outputs | Gloss |
|------------------|------------------|-------|
| /ŋa4/ | [ŋa4]; [a4] | teeth |
| /ŋan5/ | [ŋan5]; [an5] | eye |
| /ŋaŋ6/ | [ŋaŋ6]; [aŋ6] | hard |

The challenge for a formal analysis here is the insertion and deletion of [ŋ] can occur at the same environment, since a sound normally does not allow two contrasting operations in the same environment (McCarthy 2003). The current study provides an analysis using Maximum Entropy (MaxEnt) Grammar (Goldwater et al. 2003), by proposing that [ŋ] is a placeless consonant at

* I sincerely thank Michael Becker and Gaja Jarosz for their valuable and constructive feedback on this work.
Author: Suet-Ying Lam, University of Massachusetts Amherst (suetyinglam@umass.edu)

the onset position, extending from the previous arguments that [ŋ] is placeless at coda position (e.g., Trigo 1988). Thus, [ŋ] is inserted placelessly and get its place from the following vowel. Insertion of other sounds can thus be excluded by penalizing place insertion.

Yet, one might consider the possibility of an alternative analysis that Cantonese speakers just have different underlying forms for the same word due to lexical diffusion, in which case a sound change may be ‘phonetically abrupt’ but ‘lexically gradual’, i.e., the change from sound X to sound Y in language Z is a discrete, perceptible phonological shift that in the beginning of the change affects only a few words which show variation between sounds X and Y (Wong 1969). As a result, sound change spreads faster to these words than others, for some speakers than others. In this case, the insertion of [ŋ] for historically vowel-initial words can just be the adoption of the new ŋ-initial underlying form, and no actual insertion is involved. Given that the /ŋ/ ↔ /∅/ merger is an ongoing sound change, it is possible that only part of the Cantonese speakers adopt the new ŋ-initial underlying form, and thus both outputs are possible when we observe a group of speakers. However, there is no known way to test the underlying representation of words in a morphologically-poor language. I leave this hypothesis to future research.

The paper is structured as below: Section 2 provides brief background information on relevant aspects of Cantonese phonology, including syllable structure, and the distribution of nasals and vowels. Section 3 introduces my proposal for a placeless [ŋ] onset in Cantonese, and presents evidence for it. In section 4, I present the analysis and show how MaxEnt Grammar can successfully model the distribution. Section 5 briefly discusses the account and conclude the paper.

2. Cantonese phonology.

2.1. SYLLABLE STRUCTURE. Cantonese only allows single onset and single coda, and both of them can be optional. Some examples are in (2).

(2) Syllable structures in Cantonese

V	oi3	‘love’
CV	ni1	‘this’
VC	ɐp˥6	‘duck’
CVC	sɐm1	‘heart’

2.2. NASAL CONSONANTS AND VOWELS. The distribution of onset and coda consonants is asymmetric in Cantonese. While 19 consonants are possible in the onset positions, only nasals and unreleased /p/ /t/ /k/ are allowed in the coda positions.

Three nasals are allowed in Cantonese: the bilabial nasal /m/, the alveolar nasal /n/, as well as the velar nasal /ŋ/. All three nasals can occur at onset and coda positions. In addition, /m/ and /ŋ/ can stand alone to be a syllabic nucleus. Yet, the three nasals differ in their possible combinations with vowels. There are eight vowels in Cantonese:

(3) Vowels in Cantonese (adapted from Matthews & Yip (2013))

	Front		Central	Back
	Spread	Round		
High	/i/	/y/		/u/
Mid	/e/	/ø/		/o/
Low			/ɐ/	/a/

Not every vowel can be combined with nasals. Examining the corpus reveals that front round vowels never appear with nasal onsets, except for /nyn5/ ‘warm’. In addition, velar nasals cannot be the onset of any front vowels, except for /ɲik3/, which is a very formal and infrequent word with an equivalent meaning of ‘bite’. Whereas /n/ or /m/ can be combined with front unround vowels as the onset, only /ɲ/ can be followed by the three non-high central or back vowels.

Crucially, the avoidance of front vowels is only limited to nasals, as a front vowel nucleus is possible for an onset with non-nasal velar sounds such as /k/ and /k^h/, such as /kim3/ ‘sword’ and /k^him4/ ‘clamp’.

3. Proposal: [ɲ] as a placeless onset in Cantonese. As mentioned in section 2.2, /ɲ/ can only be followed by non-high central and back vowels in Cantonese. In contrast, all other velar consonants (/k/ and /k^h/) and nasal consonants (/m/ and /n/), in which a deletion of onset is not allowed, can be followed by a front vowel nucleus. This distribution suggests a possibility for [ɲ] to be a co-articulated nasal feature. It has been argued that low back vowels tend to be somewhat nasal (Ohala et al. 1975; Whalen & Beddor 1989; Henderson 1984), because if the articulation of low vowels already lowered the velum, it only needs a relatively small change to reach a full nasalization.

The current proposal is an extension for a long-existing argument of [ɲ] as a placeless nasal in the coda position, which has been used to explain the cross-linguistic reduction of a vowel + nasal sequence to a nasalized vowel (or nasal absorption) early in Trigo (1988). By considering the creation of a nasal glide (or nasal debuccalization, the process of removing the place node of a segment, McCarthy 1988) involved in nasal absorption, she argued that nasal absorption should be formulated as the reduction of a vowel + a placeless nasal coda, which exists cross-linguistically. This proposal is also acoustically supported: Ohala et al. (1975) suggested that velar nasals are acoustically more similar to nasalized vowels than are bilabial or alveolar nasals, as they have no oral antiformants. In line with this claim, experimental studies found that nasalized vowels are both acoustically and visually more similar to velar nasals than alveolar and bilabial nasals (Johnson et al. 2007). In light of these arguments, I argue it is possible for [ɲ] to be a placeless onset in Cantonese from three pieces of evidence: (1) the occurrences of the placeless consonant [ʔ] at the same environment; (2) the flexibility of the realization of the onset [ɲ] in HKC; and (3) the correlation between typology and the distribution of nasals that undergo debuccalization.

First, earlier phonological work suggests that some speakers prefer [ʔ] for contexts where [ɲ] is used (Yip 1996). The glottal consonant [ʔ] and [h], have long been argued to be placeless (e.g., Steriade 1986), given the inherent lack of place specification in laryngeals. The possible replacement of a placeless consonant for [ɲ] suggests the placeless nature of the nasal onset.

Second, the realization of the nasal onset was argued to be flexible. For example, in a phonetic account, Yip (1996) argued that the nasality is just a by-product of the phonologically non-nasal realization of onsetless syllables with a back vowel as nucleus. Assuming that the phonetic realization of phonological outputs is flexible within the range of feature specifications listed in (4), [ɲ] is just a different realization of onsets from underlyingly onsetless syllables.

(4) Language Specific Phonetic Implementation of Onsets from Yip (1996):

- a. Onsets require a degree of closure equal to or greater than that of a glide
- b. Feature specifications cannot be altered; otherwise, targets may be achieved in various

ways, within their windows

As the articulation of a back vowel like /a/ requires the tongue to stay non-high and back, closure can be achieved by further backing, to give a uvular fricative transcribed as [ɣ] (e.g., Mandarin: Chao 1965), or by lowering the velum to reach the tongue, leading to a uvular nasal that is usually transcribed as the velar nasal [ŋ]. Furthermore, according to Cheung 1986:198, some Cantonese speakers may use a pharyngeal [ʕ] instead of [ŋ] to realize this onset, lending support to the phonological identity of these two onsets in Cantonese. Taken together, the above evidence suggests that the place of the nasal onset in Cantonese could remain unspecified and realized flexibly when followed by the back vowel.

Lastly, the dispreference of nasals in HKC seems to align with the cross-linguistic difficulty of nasal debuccalization, as argued in Trigo (1988). By reviewing data of nasal absorption in Japanese, Chicaksaw and Chinese dialects, she presented a correspondence between the hierarchy of nasal debuccalization and the hierarchy of nasal absorption (Trigo 1988:23), as shown in (5):

- (5) a. [n] [ŋ] debuccalize more promptly than [m]; they also undergo “absorption” more promptly than [m].
- b. [ŋ] debuccalizes more promptly than [n]; It also undergoes “absorption” more promptly than [n].

The susceptibility to nasal absorption and debuccalization implies that the nasal absorption of [ŋ] is due to its cross-linguistic placelessness at the coda position. In Cantonese, the ease of debuccalization also aligns with the ease of having nasal-related variations, regardless of its position in the syllable: While [ŋ] is dispreferred in onset and syllabic positions (also in coda positions, i.e., [ŋ] → [n], despite not discussed in this paper, see Cheng et al. (2022); To et al. (2015)), and [n] is dispreferred in the onset position, [m] is never dispreferred. While this paper does not aim to account for the distribution of the variations in HKC, this correlation is in line with the account that [ŋ] is a placeless onset here.

4. Analysis. Given my proposal of treating [ŋ] as a placeless consonant, I first present the violation profiles of the variations presented in (1) using the constraint set presented below. I further simulated the account using MaxEnt Grammar based on the experimental data from Cheng et al. (2022).

Here I use *NASAL to penalize [ŋ] instead of a specific *ŋ constraint, because there are also other nasal-related mergers in Cantonese. For example, the onset /n/ is in free variation with /l/ (Bauer 1983). Thus, words like [nei2] ‘you’ are often pronounced with initial /l/, indistinguishable with [lei2] ‘Li (surname)’.

At first sight, it seems that the variation between /ŋ/ and /Ø/ can be represented by a dynamic competition between *NASAL and ONSET. If the dispreference for nasal is stronger than the dispreference for the lack of onset, [ŋ] should be deleted. If the dispreference for the lack of onset is stronger, then [ŋ] should remain or be inserted.

The tableaux in (6) provides the violation profile with ŋ-initial word as the input.

- (6) a. η -deletion: $*\text{NASAL} \gg \text{ONSET}$

/ŋa/	*NASAL	ONSET
a. ŋa	* W	
☞ b. a		* L

- b. Surface faithfully: $\text{ONSET} \gg * \text{NASAL}$

/ŋa/	ONSET	*NASAL
☞ a. ŋa		* L
b. a	*! W	

However, this straightforward solution is problematic for the insertion of [ŋ], because $*\text{NASAL}$ will penalize all the nasal insertions and favour the insertion of other sounds. This suggests a need for a constraint that penalizes insertion other than [ŋ]. I suggest that a non- η insertion can be excluded by $\text{DEP}(\text{PLACE})$. Assuming that the onset [ŋ] as a nasal feature that is coarticulated with the vowel, only the insertion of [ŋ] does not affect the place of articulation of $\emptyset$ -initial words.

This is illustrated in tableaux (7).

- (7) a. η insertion: $\{\text{DEP}(\text{PLACE}), \text{ONSET}\} \gg \{*\text{NASAL}, \text{DEP}\}$

/ɔi/	DEP(PLACE)	ONSET	*NASAL	DEP
☞ a. ŋɔi			* L	* L
b. ɔi		* W		
c. kɔi	*! W			*
d. nɔi	*!		*	*

- b. Surface faithfully: $\{\text{DEP}(\text{PLACE}), *\text{NASAL}, \text{DEP}\} \gg \text{ONSET}$

/ɔi/	DEP(PLACE)	*NASAL	DEP	ONSET
a. ŋɔi		*! W	* W	
☞ b. ɔi				* L
c. kɔi	*! W		*	
d. nɔi	*!	*!	*	

4.1. SIMULATION AND RESULTS. I ran simulations using the distribution of surface forms for all words, with default settings provided by the MaxEnt Grammar Tool (Hayes et al. 2009). The historical sounds were used as the input of a word, with its η -initial and $\emptyset$ -initial variants as the candidates. The frequencies of the candidates are from an experimental study Cheng et al.(2022), as shown in Table 2. To show that the constraint set is sufficient to avoid non- η insertion, I included some losing candidates, such as non-nasal velar k-initial sound and non-velar n-initial in the simulation.

Table 1 shows the weighting of each constraint, and Table 3 shows the results of the simulation, in comparison with experiment data from Cheng et al. (2022). As MaxEnt is a batch learning algorithm that considers all words as a set of training data, it predicts a mean distribution of the surface forms across all words, instead of a by-word distribution. Results are therefore compared with the grand total percentage in Table 2, instead of by-word. As can be seen, the given constraint set successfully predicted the mean distribution of the surface form.

*Nasal	Onset	DEP	Dep(Place)
24.13	23.62	0.29	38.60

Table 1. Constraints weighting of the resulted learning simulations

Historically $\emptyset$ -initial	% of η -initial	% of $\emptyset$ -initial
aak1 (shake in ‘shake hands’)	76	24
ai2 (short in terms of height)	76	24
au2 (vomit)	71	28
oi3 (love)	68	32
Grand Total:	73	27
Historically η -initial	% of η -initial	% of $\emptyset$ -initial
η aak1 (deceive)	69	31
η ai4 (dangerous)	80	20
η au4 (cow)	84	16
η o5 (1sg)	84	16
Grand Total:	79	21

Table 2. Production data by word from Cheng et al. (2022)

Historical sound	Output	Observed %	Predicted %
η -initial	η -initial	73	73
	$\emptyset$ -initial	27	27
	k-initial	0	0
	n-initial	0	0
$\emptyset$ -initial	η -initial	79	79
	$\emptyset$ -initial	21	21
	k-initial	0	0
	n-initial	0	0
k	koi	100	100
	oi	0	0

Table 3. Predicted distribution of η -initial and vowel-initial outputs

5. Discussion and conclusion. The current paper provides a phonological analysis for the $/\eta/ \leftrightarrow / \emptyset /$ merger in Hong Kong Cantonese, which allows both deletion and insertion of $[\eta]$. Although the insertion and deletion of the same sound is challenging for a constraint-based grammar, I propose that this issue can be resolved by treating $/\eta/$ as a placeless onset in Cantonese. Simulations from MaxEnt Grammar support the validity of the account.

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