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The morphology of Cantonese "changed tone": Extensions and limitations

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Abstract: Cantonese substitutes a base tone with either a high-level or high-rising tone in certain derived environments, a kind of process morphology dubbed pinjam (變音) "changed tone". We develop a comprehensive analysis of Cantonese pinjam morphology that predicts this tonal change as the realization of a tonal affix that is shaped by both language particular patterns and universal constraints. The predictions of this core analysis are then used to explore a range of morphological and syntactic constructions that also have a *pinjam*, but have not been fully analyzed in prior research. This investigation also makes an empirical contribution by showing how the core analysis can extend naturally to many under-studied constructions, as well as documenting some of the limits of this analysis.[*]

Keywords: Chinese tone, Cantonese, tonal morphemes, process morphology, Optimality Theory

1. Introduction

Surnames in Cantonese may receive the familiar prefix, 阿 *aː-*, to mark familiarity or informality with the addressee. As shown below, these derived forms, dubbed familiar vocatives, can change the base tone, illustrating a kind of process morphology called *pinjam* (變音) "changed tone".

Table 1. Changed tone in familiar vocatives.

a. gu^{M} → aː-gu^{MH}	b. dze^{L} → aː-dze^{MH}	c. woŋ^{ML} → aː-woŋ^{MH}
阿顧'Mr. Gu'	阿謝 'Mr. Tse'	阿黃 'Mr. Wong'

Though its *raison d'être* is morphological, *pinjam* morphology is also shaped by phonology. The tonal change is determined by the first tone of the base. As sketched below, if the base tone starts with a H tonal target, the surface tone is a level H; otherwise, the base tone becomes a high-rising MH tone. We refer to this pattern as Yip's generalization, after Yip (1980).

Non-vacuous	HM → H	L, LM, M, ML → MH
Vacuous	H → H	MH → MH

Figure 1. Yip's generalization: H if base starts with H, else MH.

The idea that *pinjam* is essentially morphological, but influenced by phonology, is also due to Yip (1980). Yip proposed that the *pinjam* is a floating H suffix whose realization is governed by

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the principles of autosegmental phonology (Goldsmith 1976; Williams 1976). In some cases, surface MH arises as the simple association of the floating H to the base tone (Figure 2a). In other contexts, however, phonological constraints prevent simple docking and lead to tonal changes. Thus, the docking of H to a L base tone (as in Figure 2b) results in a LH tone that is unattested in Cantonese. As argued in Chen (2000), the change from LH to MH can be seen as a repair that preserves the structure of the tonal inventory. Likewise, linking a floating H to a base with a complex tone results in over-crowding of tones (Figure 2c), so the delinking of the medial tone can be attributed to the No Crowding constraint (Gordon 2003; Levi 2002).

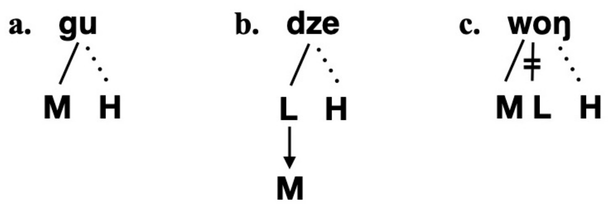

Figure 2. Autosegmental sketch of changed tone.

Cantonese *pinjam* appears to be a clear case of autosegmental morphology, with the tonal allomorphy reflecting both language particular restrictions and universal constraints on tone structure. Indeed, all contemporary approaches to Cantonese tone assume some kind of tonal morpheme like the one sketched above (Bao 1999; Chen 2000; Yip 2002). Despite this consensus, however, *pinjam* morphology has never received an analysis that captures these insights. Like Yip's (1980) initial sketch of the problem using Chao tone digits, more recent accounts only give cursory treatments, and no analysis has successfully integrated all of the data with the larger tonal system. Furthermore, Cantonese linguistics recognizes a level H *pinjam* tone that is distinct from the H ~ MH pattern illustrated above (Bauer and Benedict 1997), raising questions of how many *pinjam* there are in the grammar. As a result of these shortcomings, the import of Cantonese *pinjam* for contemporary morphology and phonology is at present uncertain.

Another problem looms large in the analysis of Cantonese *pinjam*, namely its scope in the grammar. *Pinjam* morphology is not a simple pattern of process morphology in a small handful of contexts. Rather, it is a word-formation device that is attested in a wide range of word structures and morpho-syntactic environments (Bauer and Benedict 1997; Whitaker 1955-56; Yue-Hashimoto 1972). Thus, *pinjam* morphology is used to produce new stems from simple roots, several types of compounds, kinship terms, reduplicative verbs and adjectives, and even loanwords. In addition, some researchers have argued the same mechanism underlying *pinjam* morphology is at work in a phrasal pattern of syllable contraction (Bai 1989; Bao 1999; Yu 2007, cf. Chen 2000) . The pervasiveness of *pinjam* again raises the issue of whether Yip's generalization holds true in all of these contexts, and if a tonal morpheme analysis is even possible in them.

We address these concerns by giving a comprehensive analysis of *pinjam* morphology in Optimality Theory (McCarthy and Prince 1995; Prince and Smolensky 1993/2004). In particular, we use recent constraint-based approaches to autosegmental morphology (Akinlabi 1996; Kurisu 2001; McPherson 2017; van Oostendorp 2005; Wolf 2005) to implement the analysis and integrate it with the phonology of Cantonese tone (sections 2 to 3). The analysis makes crucial use of the notion of recoverability of autosegmental morphology (Trommer and Zimmermann 2014; van Oostendorp 2005), which enables the larger analysis to realize the insight that the *pinjam* is a tonal morpheme shaped by both language particular patterns and universal constraints on tone structure. In section 4, our analysis also makes an empirical contribution to the description of changed tone by extending the account of well-known cases to the many unexplored empirical domains discussed above. We argue further that the analysis of *pinjam* as a word-formation device is at work at the phrasal level, extending the core analysis to a synchronic pattern of syllable contraction that patterns similarly to word-level *pinjam* (as shown in section 5). To give comparison analysis, we also contrast our analysis in section 6 with the most complete generative analysis of *pinjam* to date, the derivational analysis of Bao (1999). We close in section 7 with some concluding remarks and problems for future research.

2. Cantonese tone

Pinjam morphology works on all Cantonese tones, and it is shaped by restrictions on the tonal inventory. Below we give a description and analysis of this inventory in order to set up the analysis of *pinjam* morphology that follows.

2.1 Description

Cantonese tones can be cross-classified by the existence of a contour, the contour pattern, the syllable the tone is realized on (i.e., CV(N) vs. CVq), and register (high vs. low). These distinctions result in the nine tone categories given in Table 2 from traditional Chinese dialectology, which are transcribed using the Chao notation system that characterizes pitch shapes with transitions on a numerical scale (Chao 1930). The so-called checked tones [5q 3q 2q] are "allotones" shorter in duration than the corresponding non-checked tones, and are limited to syllables ending in an unreleased stop (CVq), namely, /p t k/. In addition, CVq syllables do not allow contour tones, except in contexts derived by a MH *pinjam*. CV(N) syllables, which include open syllables and syllables closed by nasals, allow all the contour tones and longer level tones. The behavior of high-level [55] and high-falling [53] tones varies by speaker: they are contrastive for some speakers (e.g., common in Guangzhou dialects), in free variation in others (as in some older Hong Kong speakers), and neutralized to [55] in still other speakers (Bauer and Benedict 1997). Though the neutralization pattern is more common, we retain the distinction between [55] and [53] because it is necessary to a general analysis of *pinjam* morphology.

Table 2. Tone categories.

	Level		Contour	
	CV(N)	CVq	rising	falling
high (*yin*)	33	5q 3q	35	53 ~ 55
low (*yang*)	22	2q	23	21

Generative accounts of Cantonese tone merge the checked level tones with their corresponding longer tones, and account for the shorter duration of the checked tones as a consequence of the shorter duration of checked syllables (see, e.g., Yue-Hashimoto (1972: 92)). The tonal inventory therefore has six or seven tones, depending on the existence of the high-falling tone. In terms of the features used to distinguish these categories, there are five distinct featural systems for Cantonese tone (Bao 1999; Barrie 2007; Chen 2000; Lee 2012; Yue-Hashimoto 1972), and unfortunately no clear consensus as to which is correct for *pinjam* tone or the larger system. The systems of tonal features in Lee (2012) and Bao (1999) are not well-suited for this problem (see sections 3 and 6), and Yue-Hashimoto's (1972) is not consistent with many assumptions in contemporary phonology. For concreteness, therefore, we adopt the system of privative tone used in Chen (2000) because it supports a rather transparent analysis of tonal morphology, and, as shown by Chen, it generalizes to African tone and other Chinese languages.

In Chen's system, there are L (low), M (mid), and H (high) level tones, and contours transition from one target to another, as shown in Table 3 with the corresponding Chao notation in superscript. Speakers with a contrast between [55] and [53] thus have both H and HM tones. An important gap is that no contour transitions from a L to H tone, or from H to L.

Table 3. Tonal inventory from Chen (2000: 33).

	level	rising	falling
high (*yin*)	M(q)$^{3(3)}$	MH^{35}	HM~H(q)$^{53\sim5(5)}$
low (*yang*)	L(q)$^{2(2)}$	LM^{23}	ML^{21}

Phonetic analysis of the high-rising tone [35] shows that the tonal onset is comparable to the low register tones, suggesting [25] in Chao notation (Bauer and Benedict 1997; Mok and Wong 2010). This pitch shape is consistent with Chen's MH contour, because the low-falling contour ML has the same first tone, but the phonetic implementation of these tones may have to distinguish M tone targets in the onsets of level versus contour tones. This phonetic analysis is a necessary consequence of using the same tonal targets for level and contour tones. However, this additional phonetic analysis does not distinguish Chen's system from others, as tone needs to be interpreted phonetically in all other systems.

2.2 Analysis

We begin the analysis by building a linguistic system with mappings from all possible one- and two-tone inputs. Simple H, M, and L tones are preserved faithfully, as are licit contours, that is, MH, ML, LM, and in some dialects HM. However, double identical tones and illicit contours HL and LH are, by hypothesis, reduced to the first tone of a sequence (e.g., /HL/ → [H]), to be consistent with this pattern of tonal resolution in *pinjam* morphology (see section 3). To summarize, 12 possible inputs (three simple + nine combinations of simple tones) are mapped to six or seven tones, depending on the dialectal feature of retaining the marked HM.

Our analysis of this system draws on standard correspondence-theoretic notions of faithfulness (McCarthy and Prince 1995) applied to tone (Gussenhoven 2000; Yip 2002; Zimmermann 2016; Zoll 2003). In particular, faithfulness to Chen's privative tone targets is formalized with Max and Dep-style faithfulness constraints for tone, as well as IdentTone. As for markedness, the Cantonese system requires two universal constraints, OCPTone and NoCrowding (Goldsmith 1976; Gordon 2003; Leben 1973; Levi 2002), and two specific constraints against unattested contours. The constraint MaxToneDistance≤1 (or MTD≤1 for short) accounts for the fact that the distance between the tone targets of contours never exceeds 1 on a tonal scale H>M>L (Chen 2000). Thus, a low-falling tone ML is admitted, but a fall from H to L is not allowed because it has a distance of two steps on the tonal scale. Finally, we propose *HM as the ban on the high-failing contour. *HM is justified as the conjunction of two independently motivated tonal markedness constraints, *H and *Falling (Chen 2000), and is motivated empirically by the loss of HM in most dialects and its neutralization in sandhi contexts in conservative dialects (Yip 2002).

Table 4. Faithfulness and markedness constraints for tone.

MaxTone: an input tone has an output correspondent.

DepTone: an output tone has an input correspondent.

IdentTone: corresponding tones match.

OCPTone: two identical adjacent tones are prohibited.

NoCrowding: syllables can be associated with no more than two tones.

MaxToneDistance(MTD)≤1: on the tone scale H>M>L, the distance between tones in a contour is equal to or less than one (i.e., *HL, *LH).

*HM: HM tone contours are prohibited.

The constraints above were ranked to capture the mappings of the linguistic system (as shown in Table 5), and this ranking was verified computationally with OTWorkPlace (Prince et al. 2013). Our computational tests used all of the possible inputs and outputs sketched in the linguistic system above (the OTWorkPlace files available from the first author's website fully demonstrate these results and those described below).

Table 5. Core ranking for tonal inventory.

Stratum 1	Stratum 2
*HM, OCP, MTD≤1, DepTone, IdentTone	MaxTone

The crucial ranking relationship in this system is the domination of MaxTone by the three markedness constraints shown below, which retains licit contours (Table 6a) and reduces illicit ones to simple tones (Table 6b-d).

Table 6. Illustration of contour reduction.

Input	Output	*HM	OCP	MTD≤1	DepTone	MaxTone
a. /LM/	→ LM					
	L					*!
b. /HM/	→ H					*
	HM	*!				
c. /LL/	LL		*!			
	→ L					*
d. /LH/	LH			*!		
	→ L					*

3. A constraint-based analysis of Yip's generalization

We illustrate the core analysis of *pinjam* by applying it to the facts of familiar vocatives. Surnames and kinship terms in Cantonese may take the prefixes *a:33-* 阿 and *lou23-* 老 'old' to produce a familiar form of address. These forms convey a sense of familiarity and intimacy, and in the case of *lou23-*, a form of respect for an older addressee. The use of these prefixes correlates systematically with the tonal changes described by Yip's generalization (Figure 1) (Bauer and Benedict 1997; Yip 1980; Yue-Hashimoto 1972). Thus, a non-high tone in the base receives a MH* *pinjam* (Table 7a), a HM tone (for speakers that have this tone) receives a H* *pinjam* (Table 7b), and *pinjam* morphology is vacuous with MH and H base tones (Table 7c). In these illustrations, and others below, a *pinjam* tone are distinguished from other tones with "*". Certain suffixes expressing terms of address can also combine with a *pinjam*, with the same meaning and tone patterns (Table 7e). Importantly, prefixes are optional in disyllabic surnames (Table 7d), showing that the *pinjam* is not dependent on an affix.

Table 7. Pinjam morphology in familiar vocatives.

a. MH^{35*} *pinjam*

$L^{2} \rightarrow MH^{35*}$	/a:33-dze22/ → a:33**dze35***	阿謝 'Mr. Tse'
	/a:33-jip22/ → a:33**jip35***	阿葉 'Mr. Yip'
$LM^{23} \rightarrow MH^{35*}$	/a:33-ŋ23/ → a:33**ŋ35***	阿伍 'Mr. Ng'
	/lou23-lei23/ → lou23**lei35***	老李 'Old (revered) Li'
$M^{3} \rightarrow MH^{35*}$	/a:33-gu33*/ → a:33**gu35***	阿顧 'Mr. Gu'
	/lou23-got33/ → lou23**got35***	老葛 'Old Got'
$ML^{21} \rightarrow MH^{35*}$	/a:33-woŋ21/ → a:33**woŋ35***	阿黃 'Mr. Wong'
	/lou23-tsan21/ → lou23**tsan35***	老陳 'Old Chan'

b. H^{55*} *pinjam*

$HM^{53} \rightarrow H^{5*}$	/a:33-foŋ53/ → a:33**foŋ55***	阿方 'Mr. Fong'
	/lou23-dzy53/ → lou23**dzy55***	老朱 'Old Chu'

c. Vacuous *pinjam*

$MH^{35} \rightarrow MH^{35*}$	/a:33-duŋ35/ → a:33duŋ35*	阿董 'Mr. Tung'
$H^{5} \rightarrow H^{5*}$	/a:33-buk55/ → a:33buk55*	阿卜 'Mr. Buk'

d. Disyllabic surnames

a:33au55**jœŋ35*** ~ au55**jœŋ35***, cf. au55jœŋ21 歐陽 'Mr. Au-yeung'

a:33si55**tou35*** ~ si55**tou35***, cf. si55tou21 司徒 'Mr. Szeto'

e. Terms of address suffixes

woŋ35*sou35, cf. woŋ21 黃嫂 'Mrs. Wong'

lau35*suk55, cf. lau21 劉叔 'Uncle Lau'

The fact that *pinjam* morphology may appear on its own in disyllabic surnames, and with a range of different suffixes and prefixes, indicates that the familiar vocatives above have complex morphology: an affix and the changed tone suffix (Yip 1980). An alternative that analyzes these constructions with a set of circumfixes, as in *a:*+BASE+<H>, is therefore untenable because it requires a circumfix analysis for over six morphemes, and an independent *pinjam* suffix is still required for disyllabic surnames and a host of other constructions reviewed in section 4.

The input-output mappings sketched below illustrate the attested changes to tone. Three generalizations are of interest. First, the H tone of the suffix is always realized as the final tone at the surface: H or MH. Second, there is a general preference for retaining the first tone of the base, as illustrated by ML+H → MH. Third, the tonal changes respect the tonal inventory, and so when docking the suffixal H produces an unattested contour, as in LH, a tonal change is needed.

Table 8. Sketch of autosegmental actions resulting in tonal changes.

	Simple docking	Tone deletion	Tone change
Input	M <H> gu	ML <H> woŋ	L <H> dze
Output	MH gu	MH woŋ	MH dze

One might question the necessity of the /L + H/ → MH mapping, given that the pitch profiles of MH seem to have f0 onsets that compare with both LM and ML tones (see section 2.1). In other words, perhaps /L+H/ simply maps to LH, and this output produces a pitch profile of [25] that is similar to at least some low register tones, obviating the need for a change of L to M. This is a significant departure from past analyses which posit just two allomorphs H ~ MH. In Chen's (2000) account, for example, tone change derives from the fact that there is a three-way contrast in level tones, and so mapping them to either H ~ MH requires a tone change. The motivation given by Chen is that retaining LH in derived words violates structure preservation (Kiparsky 1985), because the larger inventory does not have contours that cross register from low to high.

These assumptions are questioned in Lee (2012), however, who develops a system of tonal features for Cantonese closer to the phonetic analysis. The innovation in Lee's system is to assign the standard stock of tonal features, [upper] and [raised], to both the onset and offset of a contour. This system has the advantage of giving more phonetic precision, including the analysis of MH as [25]. However, it leads to a significant problem in the treatment of tonal similarity effects in Cantonese. A recent study of speech errors in Cantonese has shown that tone slips are more common when two tones are phonologically similar (Alderete et al. 2019). For example, the most common type of slip by far involves a substitution of the L^{22} and M^{33} tones, the smallest possible change in tone. It turns out that these two tones are in fact the most dissimilar in Lee's system because they differ in all four tone features (i.e., [upper] and [raised] for both the onset and offset). This result is completely contrary to the similarity effect. Thus, while Lee's system allows for more phonetic precision, it is not viable in terms of its psychological reality. This conclusion supports the traditional analysis that assumes tone change.

Returning now to the core analysis, the generalizations from Table 8 require two new constraints. To account for the first generalization, we draw on a long line of research in Optimality Theory developed to account for tonal morphology (Akinlabi 1996; Cahill 2000; Kurisu 2001; McPherson 2017; van Oostendorp 2005; Wolf 2005). In particular, we adopt the constraint RealizeMorpheme from van Oostendorp (2005) to motivate the realization of the floating H tone. Because the *pinjam* is a single H tone, this constraint is violated if this H is not realized in the output. The second generalization is an anchoring effect (McCarthy and Prince 1995): AnchorToneLeft has the effect of favoring retention of the first tone of the base.

Table 9. Morpho-phonological constraints for pinjam morphology.

RealizeMorpheme: For every morpheme in the input, some phonological element should be present in the output.

AnchorToneLeft: The leftmost tone of a base has an output correspondent.

By adopting RealizeMorpheme, we follow accounts of autosegmental morphology that focus on morphemes rather than floating features (Wolf 2005). However, Wolf's MaxFlt constraint is a suitable alternative to RealizeMorpheme in our analysis if tonal features are adopted.

We created a linguistic system that combines the phonology of the tonal inventory with the morpho-phonology of *pinjam*. In particular, the 12 mappings from section 2.2 were combined with all logically possible mappings for derived familiar vocatives. The latter were generated by attaching a floating H tone to all possible bases (seven in total). The resulting constraint system, shown in Table 10, preserves much of the structure of basic tonal system, but builds in new strata in order to rank IdentTone, OCP, and AnchorToneLeft relative to each other.

Table 10. Revised ranking for familiar vocatives and tonal inventory.

Stratum 1	Stratum 2	Stratum 3	Stratum 4	Stratum 5
*HM, MTD≤1, DepTone RealMorph, NoCrowding	AnchorL	IdentTone	OCP	MaxTone

The following OT tableaux flesh out the role of these constraints and show how it accounts for Yip's generalization. Starting out with Table 11, the faithful mapping in Table 11a illustrates simple docking: accommodation of the floating H tone violates no constraints because the base tone is a simple M. Attaching a floating H to a MH base tone, however, requires deletion to satisfy NoCrowding (Table 11b). Thus, the second base tone (H_1) is omitted because deleting the suffix tone violates RealizeMorpheme, and retaining just the last two H tones, and omitting the initial M, violates AnchorLeft and the OCP. This case also reveals the role of grammar in eliminating homophonous candidates: MH_1 and MH_2, and effectively MH_1H_2 as well, have the same pitch shape, but the grammar selects MH_2 because it realizes the suffix tone (see van Oostendorp (2005) for a similar account of homophonous candidates in morphological tone). Other mappings not shown here, including from inputs with base ML, H, and HM, illustrate the same role for these constraints.[1]

Table 11. Tone docking and deletion with M and MH base tones.

Input		Output	RealMorph	NoCrowd	AnchorL	OCP	Max
a. /M + H/	→	MH					
		M	*!				*
		H			*!		*
b. /MH_1+H_2/		MH_1H_2		*!		*	
		MH_1	*!				*
	→	MH_2					*
		H_1H_2			*!	*	*

Base tones with an initial L present a problem for docking, as well as reveal a subtle role for RealizeMorpheme (as shown in Table 12). The retention of both the L and H in both mappings produces a contour that is not allowed in Cantonese and is specifically ruled out by high-ranking MTD≤1. Ranking this constraint, together with RealizeMorpheme and

[1] As shown in the linked OTWP files, an interesting outcome of this analysis is that /HH/ inputs in underived words surface as H as a result of the OCP, but /H+H*/ inputs surface as HH and therefore violate the OCP. While it is possible that derived HH differs from underived H phonetically, as found in MH* *pinjams* (Yu 2007), since phonetic analysis is lacking, we assume that the surface HH is redundant and has the same pitch peak as underived H.

NoCrowding, above IdentTone produces the shift from faithful LH to MH in Table 12a, because changing L to H produces an OCP violation. The same ranking yields a change of the first tone and deletion of the medial tone in Table 12b.

Table 12. Effect of inventory with L and LM base tones.

Input		Output	RMorph	NoCrd	MTD≤1	AnchL	Ident	OCP	Max
a. L_1+H_2		L_1H_2			*!				
		L_1	*!						*
		H_2				*!			*
	→	M_1H_2					*		
**recoverability*		L_1M_2	*!				*		
		H_1H_2					*	*!	
b. $L_1M_2+H_3$		$L_1M_2H_3$		*!					
		L_1M_2	*!						*
**recoverability*		L_1M_3	*!				*		*
		L_1H_3			*!				*
	→	M_1H_3					*		*
		M_2H_3				*!			*
		H_1H_3					*	*!	*

These mappings reveal a subtle and important assumption about RealizeMorpheme violations. In both mappings above, there is a losing LM candidate that retains the initial L tone of the base and changes the suffix H tone to M (these candidates are labelled "**recoverability*" on the left). The reason the winning MH candidate is chosen must be that the loser LM violates something else besides IdentTone (which is ranked too low to rule out tonal change). We assume, as shown above, that this constraint is RealizeMorpheme. In particular, we follow recent approaches to process morphology that the realization of autosegmental morphemes, like tonal morphemes, must be recoverable from the output (Trommer and Zimmermann 2014; van Oostendorp 2005). The key difference between retaining and changing the base tone (<u>M</u>H) and retaining and changing the suffix tone (L<u>M</u>) is that the *pinjam* is a single H tone, and so changing it or deleting it altogether entails that the tonal morpheme is not recoverable.[2] Failing to realize the base tone does not violate RealizeMorpheme because the base stem is recoverable from its segmental melody. We opt for the RealizeMorpheme approach to this problem because we feel that the notion of recoverability has a range of advantages, both empirical and theoretical (McPherson 2017; van Oostendorp 2006; Zimmermann 2016), that set it apart from the alternative accounts of this problem.[3]

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[2] By recoverable, we employ the strictly formal sense of this term developed by van Oostendorp and colleagues whereby the lexical and surface forms are identical, and not psycholinguistic senses that investigate constraints on native speakers' ability to recover lexical representations from non-identical surface forms (e.g., Farris-Trimble & Tessier 2019).

[3] There are a range of alternatives to this analysis of the losers that are non-recoverable. For example, MH could be favored over LM with markedness to contour tones in low registers, as in Chen's (2000) account of tone sandhi in Wu Chinese dialects. Another alternative is to decompose the floating H tone into the component features [+upper, +raised] commonly used for Chinese tone (Yip 2002), and substitute RealizeMorpheme with MaxFloat of Wolf

The above analysis achieves our primary goal of accounting for Yip's generalization with an internally consistent analysis of tonal morphology in Cantonese. We have constructed such an analysis by building a grammar entirely from independently motivated constraints. Our constraints on faithfulness to underlying tone are required in any system of tonal contrast. Likewise, we employ constraints on the docking and anchoring of tone that enjoy cross-linguistic appeal, and a constraint against maximal transitions in pitch that is clearly motivated by the inventory of Cantonese. Finally, we propose that the realization of the tonal morpheme is governed by RealizeMorpheme, a constraint-based approach to docking featural and tonal morphemes that again has a strong appeal in contemporary morphology (McPherson 2017; van Oostendorp 2005). By integrating constraints on the realization of the floating H tone with other constraints in the phonology of Cantonese tone, we have shown explicitly how these constraints shape the allomorphy of Cantonese *pinjam*. The next two sections explore the extent to which this analysis can be applied to new constructions with different morphological requirements and input tones, as well as some of the limits of this analysis.

4. *Pinjam* as a word-formation device

We have illustrated the core analysis with familiar vocatives because it exhibits a consistent set of alternations that has been addressed in most prior work. However, *pinjam* is a pervasive word-formation device in Cantonese that is found in a range of different contexts. This raises the question of whether the tonal suffix analysis sketched above can be extended to these new environments.

The focus of our investigation is on the two surface *pinjam* MH* [35] and H* [55] because they are the focus of all prior analyses of the tonal morphology. Traditional accounts also recognize a ML [21] *pinjam*, as illustrated in reduplicative kinship terms like *mui21mui35* 妹妹 "little sister". This putative *pinjam* is rather rare, and past generative accounts do not treat the allomorphy of MH* ~ H* in the same analysis as the ML *pinjam* because the latter is not systematic and has a very limited distribution. These facts point to a construction-specific account, as in Yu (2009), that is separate from our investigation.

4.1 Derived stems

Pinjam morphology may be applied to simple roots to derive morphologically related stems (Bauer & Benedict 1997: 190 ff; Yue-Hashimoto 1972). Derivation with a *pinjam* may produce deverbal nouns, stems with a more semantically narrow meaning than their base, and free stems from bound morphemes, as illustrated in Table 13 below.

(2005). This morphological approach privileges realization of this featural complex, and LM with low register [-upper] fails to realize the [+upper] of the suffix. While both of these accounts are viable alternatives to the RealizeMorpheme account, we see no evidence from Cantonese that distinguishes them, and so we follow the recent trends favoring the recoverability account.

Table 13. Stems derived with a pinjam.

a. Deverbal nouns	*Related root*
/boŋ22/ → boŋ35* 磅 'a scale'	boŋ22磅 'to weigh'
/paːu21/ → paːu35* 刨 'a plane'	paːu21刨 'to plane'
/daːi33/ → daːi35* 帶 'belt, ribbon'	daːi33帶 'to take, guide, lead'
/deŋ53/ → deŋ55* 釘 'a nail'	deŋ53釘 'to nail' (Guangzhou speakers)
b. Semantic narrowing	
/nœi23/ → nœi35* 女 'daughter'	nœi23女 'female'
/wai22/ → wai35* 位 'seat, space'	wai22位 'place'
c. Free stems from bound	
/-mui22/ → mui35* 妹 'younger sister'	mui22-fu55妹夫 'younger sister's husband'

Bauer and Benedict (1997) compare these stem formations to stress-shifting noun-verb pairs in English, emphasizing the process-based nature of the morphology. To test the viability of this pattern and the predictions of our analysis, we investigated 130 derived stems from lexical resources (Huang 1970; Yue-Hashimoto 1972) with a step sample examining every other item. A majority of derived stems (roughly 74%) are built from independent words. Of these, the input and output stems always have the same spelling, a consistent part of speech, and a transparent semantic relationship. The second author also assessed her own intuitions about the morphological relationship between words using the "comes from" test (Derwing 1976), and found a straightforward derivational relationship in all cases. Thus, the evidence clearly indicates that *pinjam* is a viable morphological process requiring analysis.

It seems reasonably clear that these derivations can arise from a tonal morpheme. In particular, the suffixation of a floating H tone to a bare root will produce the same alternations we observed in surnames in the vocative constructions (section 3), because the inputs are identical. However, with the exception of some of the kinship terms like *mui35** 妹 'younger sister', the meanings introduced by this *pinjam* are not always the same as the vocative *pinjam* (i.e. familiarity, intimacy, and diminution). The tonal morpheme analysis therefore requires additional tonal suffixes with new meanings, the most important of which seems to be a noun-forming suffix. However, we do not believe that expanding the set of tonal morphemes poses a general problem to the analysis. A more important question is whether our analysis of Yip's generalization holds up in terms of the specific mappings from base tones to MH* and H*. In our list of 130 derived stems, Yip's generalization correctly predicts all stems with a MH* *pinjam* because their bases do not have an initial H. However, five exceptions were found in stems with an H*, shown below, because they have MH or ML bases and should therefore map to MH*.

Table 14. Stems with H* pinjam that should have MH*.

biu55 錶 'watch', cf. biu35
lo55 籮 'bamboo basket', cf. lo21 'a bamboo basket of (classifier)'
maːu55 貓 'cat', cf. maːu21
man55 蚊 'dollar', cf. man21
man55 蚊 'mosquito', cf. man21

In sum, the majority of derived stems are predicted by Yip's generalization and our analysis of this generalization, but there is a well-defined set of exceptions with a H* *pinjam*.

4.2 Compounds

Compounds are another major morphological structure exhibiting *pinjam* morphology. Compounding is an important word formation device in general in Cantonese, and they often exhibit a *pinjam* on the final syllable. Since Whitaker (1955-56), many have grouped the compounds and derived stems with a *pinjam* by noun category, because of the assumption that *pinjam* is more frequent in these specific categories. The range of these categories is vast,[4] and one may wonder if there are any semantic fields in the Cantonese lexicon untouched by *pinjam* morphology. Our focus, however, is if this morphology requires revision of the tonal morpheme analysis. For this reason, we have organized the data in Table 15 not by noun category, but by compound type, which is more directly relevant to the analysis. This organization includes Verb + Object phrases (given in Table 15d), which pattern like compounds but are more systematic.

Table 15. Compounds and phrases with a pinjam.

a. Noun-Noun	/tsœŋ55mun21/ → tsœŋ55mun35* 窗門 'window'
	/ŋa:n23geŋ33/ → ŋa:n23geŋ35* 眼鏡 'eyeglasses'
	/kau21pa:k33/ → kau21pa:k35* 球拍 'racket'
b. Adjective-Noun	/ma:ŋ21tsœŋ21/ → ma:ŋ21tsœŋ35* 盲腸 'appendix'
	/wa:i22da:n22/ → wa:i22da:n35* 壞蛋 'bad man'
	/jyn23toŋ21/ → jyn23toŋ35* 軟糖 'toffee'
c. Possessor Noun	/ji21dzœŋ22/ → ji21dzœŋ35* 姨丈 'mother's sister's husband'
(non-reduplicated kinship)	/syn55nœi23/ → syn55nœi35* 孫女 'granddaughter'
	/gu55dzœŋ22/ → gu55dzœŋ35* 姑丈 'father's sister's husband'
d. Verb Object Phrase	/pa:i21dœi22/ → pa:i21dœi35* 排隊 'to queue up, stand in line'
	/da:35pa:i21/ → da:35pa:i35* 打牌 'to play cards, majong'
	/lok22lau21/ → lok22lau35* 落樓 'to go downstairs'

In terms of the viability of *pinjam* in compounds, the process itself is robust, but somewhat less productive and transparent than what we have seen in derived stems. While *pinjam* may be more frequent in the semantic classes identified above, we have only found 548 cases out of approximately 5,817 compounds (roughly 9.42%) in our lexical resources (Huang 1970; Yue-Hashimoto 1972). So, perhaps one in 10 compounds has a *pinjam*. This lack of productivity also correlates with clear semantic drift and a lack of salience to the canonical meanings of *pinjam* in many cases. On the other hand, its appearance in kinship terms, body parts, and occupation names shows the connection to these senses. In sum, while *pinjam* morphology is clearly less productive and less transparent in compounds, it is still a viable morphological process that requires analysis.

As for the implications for analysis, compounds present the same problems observed above with derived stems. Thus, compounds introduce additional meanings, which in turn require additional suffixes, including grammatical ones like abstract nouns. Compounds also

[4] Bauer and Benedict (1997), for example, group words with *pinjam* into the following classes: names of animals, plants, fruit, vegetables, occupation names, body parts, a variety of inanimate objects, kinship terms, building types, modes of transportation, prepared foods, games, apparel, abstract nouns, precious metals, and diseases.

demonstrate problems for Yip's generalization, because many have an H* *pinjam* where an MH* is predicted (i.e., in base tones beginning with either M or L). In our list of 548 compounds with a *pinjam*, 58 of them (10.58%) have H* on a syllable with a source tone that is not H or HM, as illustrated below. These exceptions are skewed towards base tones ML and LM, which is true of *pinjam* generally, but there is a non-negligible number of exceptions in all tone classes.

Table 16. Compounds with H that should have MH*.*

N (%)	Base tone	
28 (48.28)	ML	hat55ji55* 乞兒 'beggar' ŋau21laːn55* 牛欄 'cow pen' baːk33je55*-guŋ55 百爺公 'old man'
15 (25.86)	LM	sau55mei55* 收尾 'afterward, later on' si55naːi55* 師奶 'married women who typically stay at home' gam55maːn55*-hak55 今晚黑 'tonight'
5 (8.62)	L	maːŋ21mui55* 盲妹 'blind girl'
4 (6.90)	M	tsœt55soŋ55* 出喪 'funeral procession'
6 (10.34)	MH	ji22gaː55dze55* 二家姐 'second oldest sister'

Another empirical issue concerns the position of the *pinjam*. It appears on the final syllable as a rule on Verb + Object compounds and the majority of other compounds (71%), so these cases pose no problem. However, there are cases with a non-final *pinjam*, like *gam55maːn55*hak55* 'tonight', that require our attention because they are not straightforwardly the realization of a suffix tone. There are only four cases with a *pinjam* on the initial syllable, as in *man55*dzœŋ33* 蚊帳 'mosquito net', but it turns out that all of these also have a *pinjam* as independent stems (see Table 14), so we can safely assume they receive the *pinjam* at an earlier level of analysis. Of the remaining 13 cases with a medial *pinjam*, in all but two compounds, the *pinjam* occurs on the final syllable of an internal compound, as illustrated by *[baːk33je55*]-guŋ55* 百爺公 'old man', which can be treated with a *pinjam* suffixed to the internal compound. The remaining two cases can be treated with a suffix to the first member of the compound, as has been proposed for affixation of [voice] in Japanese compounds (Mester and Itô 1989). It seems therefore that the position of the *pinjam* can be straightforwardly accounted for with suffixation, though the exceptions with H* require additional analysis.

4.3 Reduplicative constructions

Pinjam morphology is also used in a variety of constructions in combination with reduplication (Bai 1989; Bauer and Benedict 1997; Matthews and Yip 2011). Kinship terms are often reduplicated roots, and the second member tends to have a changed tone, as do non-reduplicated compound-like kinship terms (Table 17). Reduplicated kinship terms can also have ML tone on the initial syllable (see above discussion of the putative [21] *pinjam*), but this is not a rule and only replaces lexical tone in certain restricted contexts. Reduplication with a *pinjam* also produces two characteristic meanings in stative verbs: intensification 'very X' with an initial *pinjam*, and 'rather X' with a *pinjam* on the second syllable and a final *dei*35 哋. Similar results are found with adjectives following the AA*B template.

Table 17. Pinjam morphology with reduplicated structures.

a. Kinship terms	Pattern
po21po35* 婆婆 ‘grandmother (maternal)’	AA*
dze21dze55* 姐姐 ‘older sister (childish)’	AA*
b. Stative verbs, intensification	
daːi35*daːi22大大 ‘very big’	A*A
huŋ21huŋ35* dei35 紅紅哋 ‘rather red’	AA* dei35
c. Adjectives	
kam21-kam35*tseŋ55擒擒青 ‘in a mad rush’	AA*B
lap22-lap35*lyn22立立亂 ‘messy, disorganized’	AA*B

These constructions are more systematic, and so pattern like familiar vocatives in terms of the observed changed tones. The kinship terms seem amenable to an analysis using the same *pinjam* as that employed in vocatives, expressing familiarity and appearing on the final syllable. The intensive meanings in verbs and adjectives, however, require an additional morpheme to express the meaning of intensity. Statives with *dei35* and AA*B reduplicative structures likewise place the *pinjam* on the final syllable, but A*A stative verbs require a suffix to the first stem, similar to the affix used in a couple compounds and many patterns of process morphology (section 4.2). In sum, the reduplicative constructions can be accounted for under the basic floating H tone suffix analysis with some motivated extensions.

4.4 Loans

A *pinjam* often shows up on the final syllable of a loan, or transliterations that resemble the adaptions of loans. For example, names of foreign cities and countries based on their transliteration have a strong tendency to have the MH* *pinjam* on the final syllable, as illustrated in Table 18. English names adapted into Cantonese also have a final *pinjam*, as do other loans (Silverman 1992).

Table 18. Loans with pinjam on final syllable.

a. Transliterated foreign cities
bo55si22dœn35* 波士頓 ‘Boston’, cf. marked variant bo55si22dœn22
wan55go55waː35* 溫哥華 ‘Vancouver’, cf. variant wan55go55waː21
b. English names
/fæni/ → fen55ni35* ‘Fanny’
/nɛli/ → ne55li35* ‘Nellie’
c. Loans from English
/tʃiz/ → dzi55si35* ‘cheese’
/ordər/ → o55daː35* ‘order’

The morphology of these formations seems straightforward: like other *pinjam* inserted for emphasis, familiarity, and intimacy, loans as a class have a final MH*, perhaps resulting from a semantic feature associated with foreign words. The position and neutralization patterns of this class are parallel to those of familiar vocatives and compounds and therefore do not require new analytical assumptions.

4.5 Analysis of the exceptions

The investigation thus far has shown that Yip's generalization accounts for the majority of the data—approximately 92% of words in this section with a *pinjam* can be predicted with the mappings in Figure 1 and the constraint system from section 3. A complete analysis requires some new meanings for the *pinjam* to account for constructions like intensives, and also analysis of the position of the suffix in a handful of cases with a non-final *pinjam*. As explained above, however, these extensions seem rather straightforward, and they do not seem to require any major modifications.

On the other hand, we have identified a sizable class of exceptions to Yip's generalization with a high-level H* *pinjam*. It is at this point that we should emphasize that *pinjam* morphology is not traditionally described as a pattern of allomorphy, as embodied by Yip's generalization, in which the two surface *pinjam* are in complementary distribution and replace different base tones. Rather, they have been described as independent morpho-phonological devices (Bauer and Benedict 1997; Zong 1964), and the H* *pinjam* is typically described as having the potential to replace any lexical tone. While Yip's approach has a strong appeal in the canonical cases like familiar vocatives and reduplicative constructions, where the allomorphy is systematic, it is actually inconsistent with this traditional view in other contexts.

What is the evidence that H* and MH* are at least in part independent word formation devices? We have already seen a number of cases in derived stems and compounds in which a base tone beginning with either M or L maps to a H* (sections 4.1 and 4.2). If there was a distinct *pinjam* that maps all base tones to H*, we can account for these apparent exceptions by appealing to this subsystem. In addition, prior research has tried to distinguish different meanings for the two *pinjam* (Kam 1977; Whitaker 1955-56; Zong 1964), even identifying minimal pair-like constructions that establish this contrast. Bauer and Benedict (1997: 186 ff.) review constructions demonstrating these contrasts, including noun compounds, adverbs, and stative verbs. For example, in the noun phrase *jat55-go33-jan21* 一個人 'one person', one can use the H* *pinjam* on the final syllable, as in *jat55-go33-jan55** to emphasize that only one person and no more is involved. By contrast, the MH* *pinjam* can be used on the same syllable, *go35-go33-jan35** 嗰個人 'that *guy* (contempt)', to refer to the person in an unfriendly way. Some of these contrasts are subtle, and the second author does not recognize all of them as grammatical. However, the larger collection of evidence supports the long-held claim that there exists a H* *pinjam* that is not a simple allomorph of MH*.

It is technically possible to describe the exceptions with re-structuring of tone in lexical representations. After all, some of the less regular constructions (i.e., compounds) seem to have semantic drift that is consistent with a new base tone. However, such an analysis would require diachronic motivation for the observed tone changes producing H* rather than MH*, and there does not seem to be any historical process, sporadic or otherwise, that can account for the surface H tones (Chen 2000). Furthermore, the re-structuring approach does not account for the meanings that prior research has uncovered for the distinct *pinjam*, nor does it account for the patterned nature of the exceptions: the only exceptions to Yip's generalization are H* that replace the base tones M, L, ML, and LM. Instead, it seems clear that we require a grammatical account of the examples.

The constraint set given in section 3 is insufficient to the task because no ranking of the constraints can produce the desired mapping from all base tones to H*. This is because the mapping of base tones M and L to H* is harmonically bound by the mapping of these tones to MH*, which preserves both the base and the suffix tone. From the spectrum of possibilities, we propose that there exists an "all tones go to H*" subsystem in which a general constraint against contours, *Contour (Yip 2002), is added to the first stratum (see Table 19). This constraint forces a competition between retaining the base or the affix tone. As shown in Table 20, RealizeMorpheme favors the retention of the suffix tone because the stem's exponence can be realized by the segments associated with it. This construction-specific mapping can be implemented either with candidate-specific constraints (Pater 2007) or co-phonologies in which constructions have distinct subsystems and can therefore re-rank constraints like *Contour as shown below (Inkelas 2014).

Table 19. Substratum for universal mapping to H.*

Stratum 1	Stratum 2	Stratum 3	Stratum 4	Stratum 5
*HM, MTD≤1, DepTone RealMorph, NoCrowding $*Contour_X$	AnchorL	IdentTone	OCP	MaxTone

Table 20. Illustrating universal mapping to H.*

Input		Output	$*Contour_X$	RMorph	NoCrowd	AnchorL	Max
a. $/M + H_X/$		MH	*!				
		M		*!			*
	→	H				*!	*
b. $/ML+H_X/$		MLH	*!		*!		
		MH	*!				*
		M		*!			*
	→	H				*!	*

There exist alternatives that can achieve the same result, for example, by appealing to distinct markedness effects associated with specific tones and tone register. However, the above ranking achieves exactly the desired results with a subsystem that has a transparent relationship with the core analysis of Yip's generalization. Further, it makes use of the constraint, *Contour, which has both language-particular and universal support (Chen 2000; Yip 2002). The important point is that our grammar includes a subsystem that formalizes the mapping of all tones to H*.[5]

5. ***Pinjam*** at the phrasal level

The analysis of *pinjam* morphology has focused on word formation. However, the same alternations and the same basic mechanism of tonal stability are observed in a pattern of syllable contraction in which a function word deletes and its tone migrates to the stem before it. The formal parallels between word-level *pinjam* and syllable contraction have been taken as evidence that the two phenomena have the same underlying analysis (Bai 1989; Bao 1999; Yu 2007). On the other hand, Chen (2000: 38) recommends against unifying the two analyses, arguing instead that syllable contraction is best analyzed as a case of tone sandhi. We weigh in on this debate in this section, showing that the basic constraint system that produces a *pinjam* at the word level can produce the same results in phrases.

[5] There exists another intriguing alternative that does not require a new constraint ranking, but instead posits a H+*base*+H circumfix analysis of the H* *pinjam*. We have tested this analysis, and compared it to the history of *en-* and *-en* in English, which also combines suffixation and prefixation, and found that this circumfix analysis also produces the universal H* mapping.

5.1 Reviewing the facts

A number of function words in Cantonese may elide in fast speech and cause a changed tone in the content word preceding it. Table 21 illustrates this phenomenon with functional morphemes that bear both a level H tone and a high raising MH tone (all examples are from Bai (1989: 114 ff.)). In terms of which tones are affected, there is broad agreement that content morphemes with M, L, LM, and ML receive the *pinjam* MH, but those with H and MH are not changed (Bai 1989; Bauer and Benedict 1997; Yue-Hashimoto 1972). In other words, the replacement of tone in content words is identical to that found at the word level. The behavior of the marginal HM tone is less clear, with some researchers documenting HM → H* (Cheung 2007), just like word-level *pinjam*, and others saying that it is unaffected (Bai 1989). Because of this uncertainty and the marginal status of HM in general, we focus our analysis on a tone system that lacks this tone. However, our analysis below can be easily adapted to both patterns of behavior.[6]

Table 21. Phrasal changed tone.

a. Changed tone in Verb *jat*55 Noun frame
俾 我 望 一 眼 啦 'Let me have a look.' give me look one eye SFP bei35 ŋo23 **moŋ22 jat55** ŋa:n23 la:55 ↓ … **moŋ35 Ø** ŋa:n23 …
b. Changed tone in Verb *dzo*35 frame
佢 贏咗 一 大 筆 'He won a big sum of money.' he win-PFV one big sum kœi23 **jeŋ21dzo35** jat55 da:i22 bat55 ↓ … **jeŋ35 Ø …**
c. Changed tone in Verb *hai*35 frame
啲 飯 留 喺 鑊 度 等 你 返 嚟 食 'The rice has been left in the pot for you to eat when you come back.' CL rice leave at wok-there wait you come-back eat di55 fa:n22 **lau21 hai35** wok22dou22, daŋ35 lei23 fa:n55lei21 sik22 ↓ … **lau35 Ø …**

An important point is that only MH and H toned syllables, when elided on a function word, produce a *pinjam* on the preceding syllable (Bai 1989). For example, a host of additional aspectual markers can occupy the slot filled by *dzo35* in the example above, for example, *gwo33* 過 'experiential', *jyn21* 完 'completion', *ha:23* 下 'delimitative', and *dzy22* 住 'continuous' (Matthews and Yip 2011), and none of these can be elided and produce a *pinjam*.

[6] Accounts of the contraction of some function words are sometimes said to produce a lengthening of the preceding syllable, as, for example, stated by Yue-Hashimoto (1972: 186) for the perfective morpheme *dzo35*. We have attempted to elicit these generalizations with five native speakers, and have not found the patterns predicted by this or other accounts. Since this pattern is not addressed in any other generative accounts, we do not address it here.

The parallels between word-level *pinjam* and syllable contraction are strong. The same tones that receive a changed tone at the word level are also affected at the phrasal level (including in some accounts of HM). Likewise, those that are vacuous in word formation with a *pinjam* (H and MH) are also vacuous in phrases. More importantly perhaps, these two phenomena involve the same autosegmental phonology: a floating tone is docked to a preceding syllable and subject to the constraints of the ambient phonology. Indeed, syllable contraction is a synchronic reduction pattern that embodies what most phonologists believe to be the historical source of word-level *pinjam*, namely the retention of the tone of a following morpheme that is lost over time (Bauer and Benedict 1997; Yu 2007). It seems clear, therefore, that the null hypothesis is that the same autosegmental mechanisms at work at the word level can in principle form the basis of a phrasal *pinjam*, and that is the assumption that drives our analysis below.

5.2 Analysis of stability of H tone

Our analysis employs the same basic constraints from above, including RealizeMorpheme, which formalizes the functional pressure to retain the tone of the elided morpheme. As far as why the function word elides, we have little to say other than it appears to be part of a general pattern in which function words are the targets of reduction and contraction processes in prosodically weak positions (Selkirk 1995). The contexts for elision support this view. The items deleted are always functional items, and the tone of the elided morpheme reliably shifts to the syllable before it, which is always a content morpheme. Thus, the verbal particles *dzo*35, *hai*35, *dou*35, and *dak*55 always form a constituent with a preceding verb, and the article *jat*55 forms a constituent with a preceding verb and a following noun in [Verb *jat*55 Noun] constructions. In the [*jat*55 Noun (*jat*55) Noun] construction, it is likewise surrounded by content morphemes. It is unclear to us at this time the specific mechanism for deleting the function word. Since this is not our primary focus, we simply posit a constraint, FuncReduce, that encapsulates this imperative to delete a function word in fast speech. We further assume that this constraint only has force with these specific functional items, either through markedness constraints that are indexed to specific morphemes (Pater 2007), or construction-specific phonology in which the constructions containing these morphemes may have distinct rankings (Inkelas 2014). This assumption effectively limits the tones that produce a *pinjam* to MH and H tones, as desired. It produces this restriction by stipulation, as in all prior analyses (see section 6), but it may have a functional solution, which we explore in section 7.

The system of tonal stability in function words can be accounted for by inserting FuncReduce at the top of our hierarchy developed above, as shown below.

Table 22. Ranking for phrasal tone change with a [55] function word.

Stratum 1	Stratum 2	Stratum 3	Stratum 4	Stratum 5
*HM, MTD≤1, DepTone RealizeMorph, NoCrowding **FuncReduce**	AnchorL	IdentTone	OCP	MaxTone

Table 23 shows how this ranking accounts for a phrasal *pinjam* when a function word with a level H tone is elided. Importantly, the same constraints that are operative in shaping morpho-lexical *pinjam* are also at work here: NoCrowding prohibits a syllable with more than two tones, MTD≤1 avoids the dreaded LH or HL contours, and RealizeMorpheme prevents complete omission of the function word.

Table 23. Tonal stability in function words.

Input		Output	FuncReduce	NoCrowding	RealMorph	MTD≤ 1	Ident	OCP
a. /verb^{LM} func^{H}/		verb^{LM} func^{H}	*!					
		verb^{LM} Ø			*!			
		verb^{LMH} Ø		*!				
		verb^{LH} Ø				*!		
	→	verb^{MH}					*	

5.3 Analysis of stability of MH tone

Some of the functional items that produce a changed tone have a MH tone rather than the H tone assumed in the canonical analysis of *pinjam*. This fact raises the question of how the same patterns of changed tones can arise from a different input tone. Below we sketch how this is possible in the tonal morpheme analysis.

The correct pattern of tonal stability with a MH function word can be achieved with a minor update of the above ranking, as shown in Table 24. In particular, we employ an additional anchoring constraint, AnchorRight, which requires the rightmost tone in the input to have an output correspondent. Intuitively, this constraint assigns a faithfulness privileged to the final element of the tone of the function word, which is revealed by this data because the function word has a contour. The new ranking below also works with floating H tones (see sections 3 and 5.2) because the floating H is retained and also final. Thus, the new ranking below is simply a revision of the larger ranking for *pinjam* morphology, and not a modification for a restricted subset of the data that requires constraint-reranking.

Table 24. Ranking for phrasal tone change with a [35] function word.

Stratum 1	Stratum 2	Stratum 3	Stratum 4	Stratum 5
*HM, MTD≤1, DepTone RealizeMorph, NoCrowding FuncReduce, **AnchorR**	AnchorL	IdentTone	OCP	MaxTone

As shown in Table 25, the same complementarity is observed in input tones: when the verb contains a tone that begins with H, it is mapped to HH (Table 25b), but other tones, like L, are mapped to MH (Table 25a). The role of AnchorRight is revealed in the mapping /verb^{L} func^{MH}/ → verb^{LM}, where failure to retain the last tone of the contour rules out this candidate.

Table 25. Tonal stability in function words with [35].

Input		Output	FuncReduce	NoCrowding	RealMorph	MTD≤ 1	AnchorRight	Ident	OCP
a. /verb^{L} func^{MH}/		verb^{L} func^{MH}	*!						
		verb^{L} Ø			*!		*		
		verb^{LMH} Ø		*!					
		verb^{LH} Ø				*!			
		verb^{LM} Ø					*!		
	→	verb^{MH} Ø						*	
b. /verb^{H} func^{MH}/		verb^{H} func^{MH}	*!						
		verb^{H} Ø			*!				
		verb^{HMH} Ø		*!					
		verb^{MH} Ø						*!	
	→	verb^{HH} Ø							*

In general, it appears that the changed tone system retains the final tone of the grammatical morpheme, be it a floating H or MH, and the initial tone of the first morpheme (though it may change to avoid illegal tones). Anchoring constraints accomplish this by assigning special faithfulness properties to these edge tones.

This result with function words containing MH dovetails with the historical evidence for the emergence of *pinjam*. There is general consensus that at least some *pinjam* are the historical tones of elided morphemes. For example, Bauer and Benedict (1997) use comparative evidence to plot out a possible history of how present-day MH* could have arisen from the erosion of a diminutive suffix *–ŋin* in the Yue dialect of Bobai, a morpheme that also has a rising tone. Other proposed historical sources include additional forms with the high-rising tone (e.g., *dzi35* 'son') as well as cases with a high-level tone (e.g., *ji55* 'child', an older variant form of present-day *ji21*) (Cheng 1973; Wong 1982). In other words, the posited sources for word-level *pinjam* are the same as those we observed synchronically in the elided function words in syllable contraction. AnchorRight provides the formal mechanism for unifying the behavior of MH and H floating tones by requiring the final tone to be realized. This accounts for both the fact that function words bearing both of these tones produce the same pattern of changed tone at the phrasal level, and also the fact that these are the two tones conjectured to give rise to the same patterns at the word level. In sum, by extending the word-level analysis to the phrasal level, we have provided a formal analysis of the emergence of *pinjam* in words.

6. An alternative: Bao (1999)

Prior generative works have given structure to the analysis of *pinjam*, as in Chen's (2000) sketch of the necessary autosegmental assumptions and Yip's (1980) organization of the data using Chao tone digits. However, Bao's (1999) account, building on earlier ideas in Bao (1990), is the only account to date that proposes explicit tonal representations for inputs and outputs and gives a complete account of the processes producing *pinjam* in surface forms. Like Yip (1980), Bao posits a floating H tone suffix, and the analysis is couching in a larger argument for autosegmental morphology and phonology. On this count, we are in complete agreement.

However, the explicit assumptions made in Bao's analysis of the input representations and its associated tonal rules are starkly different from that proposed here, and underscore the role of independent evidence used in our OT account.

Like many contemporary approaches to tone in Chinese languages (Zhang 2010), Bao (1999) separates tone register and contour, specifically employing the Register and Contour nodes from Bao (1990). Thus, a MH tone has high register with an [l h] contour, written H(l h) below (note that the H register tone here is not to be confused with an H tonal target; see Wee (2019)). Departing from most accounts (Bauer and Benedict 1997; Yip 1980; Yu 2007; Yue-Hashimoto 1972), however, Bao assumes that the basic tonal inventory is simpler than prior accounts in that there is no underlying high-level tone (H). Instead, the H tone in a CVq syllable is an allotone of the high-rising MH tone, and the H tone in CVN is an allotone of the high-falling tone HM, which entails that the system has this tone underlyingly. The rationale behind positing H and MH as allotones is that it simplifies the analysis of *pinjam*, but as we shall see, this assumption requires a host of mechanisms that are only required for *pinjam*, and so they are suspect. Concretely, the surface forms of H, including the level high *pinjam*, are generated with the rules shown below, following Bao's numbering.

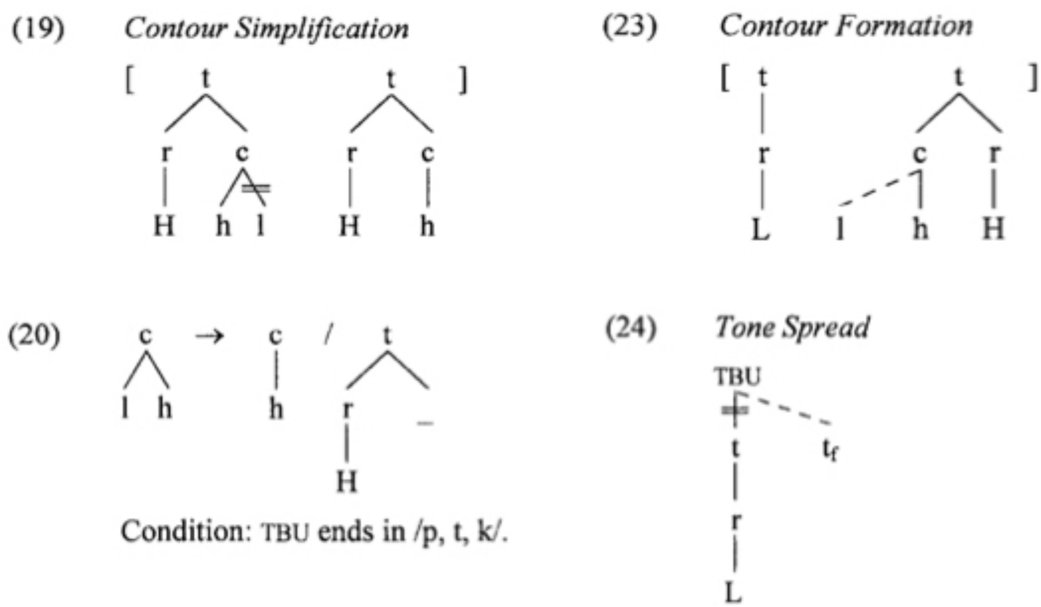

Figure 3. Bao's (1999) rule system for changed tone.

Starting first with surface level H tones, these come about from two different inputs and two different tonal reduction rules. An H tone in a checked syllable is underlyingly an MH, or H(l h), and is reduced to H with Rule (20) (see Table 26a). Other H tones in non-checked syllables are assumed to be variants of HM, and so they are H(h l) underlyingly and must be reduced by an (unacknowledged) rule that reduces it to H(h) as well, as shown in Table 26b. The reason the reduction process (20) is a phonological process and not, for example, a redundancy rule, is that it feeds Contour Simplification, a general rule of tone sandhi which neutralizes HM/H contrasts before another H tone (as in Table 26c).

Bao's analysis of *pinjam* stems from two separate derivations for H* and MH*. The floating tone suffix is underlyingly H(h), so it must be transformed by Contour Formation to a high raising H(l h) before Tone Spread supplants the base tone by spreading this new contour (Table 26d). The high-level tone, on the other hand, simply triggers tone sandhi on a base high falling tone H(h l), as shown in Table 26e. The high-level tone does not replace any other base tones because Tone Spread (see above) stipulates that the floater only spreads before a low register tone. Bao's (1999) analysis also extends to syllable contraction (p. 134-136). The same basic mechanisms, the spreading of MH* before a low register tone and tone sandhi before H, are employed in phrases where an elided function word produces floating tones.

Table 26. Derivations from Bao (1999).

	a. 5 in CVq	b. 55 in CVN	c. Tone Sandhi	d. Pinjam 1	e. Pinjam 2
Examples	wat5 'twisted'	wan55 'warm'	/gei53duk5/ gei55duk5 'Christ'	/jy21/ jy35* 'fish'	/san53/ san55* 'new'
Input	H(l h)	H(h l)	H(h l) H(l h)	L(h l) <H(h)>	H(h l) <H(h)>
20 Reduction*	H(h)	---	H(h l) H(h)	---	---
19 C. Simplification	---	---	H(h) H(h)	---	H(h) <H(h)>
23 C. Formation*	---	---	---	L(h l) <H(l h)>	---
24 Spreading	---	---	---	H(l h)	---
Other reduction*	---	H(h)	---	---	---
Output	H(h)	H(h)	H(h) H(h)	H(l h)	H(h) <H(h)>
Surface tone	wat5	wan55	gei55duk5	jy35*	san55*

Bao motivates the assumption that surface MH and H in CVq tones are the same tone underlyingly, that is the high-rising tone H(l h), because they pattern together: both of these tones are unaffected by *pinjam* and they are the two tones that, when occurring on elided function words, produce a phrasal *pinjam*. However, it is not clear that this assumption produces any gains in the analysis of *pinjam*. The reason MH and H patterns are unaffected by *pinjam* is because they are high register, and Tone Spread only applies to low register tones, as stipulated by Rule (24). A contrast between MH and H in the input would also be unaffected by Tone Spread. Likewise, the fact that both MH and H in function words lead to a *pinjam* in syllable contraction does not require the homology between MH and H. The analysis does not predict that only these tones produce a *pinjam* (Tone Spread does not target any special tone), and so it is not clear how merging MH/H would assist in this endeavor.

More concerning, however, is that the unification of MH and H leads to significant complication in the analysis. In particular, it means that a lexical MH must be reduced to H by Rule (20) to predict the correct surface tone, and MH must also be reduced to H with Rule (20) in order to trigger Contour Simplification (19) for tone sandhi. The homology in reverse, linking the H tonal morpheme to MH, also means that the analysis needs a special rule, Contour Formation (23), to produce the desired MH* allomorph of the *pinjam*. The three rules marked with a "*" in Table 26 are only needed to undo the consequences of the unification of MH and H, and so they are really only needed in the analysis to account for *pinjam*. In sum, the core of the analysis that maps MH to H and H to MH does not have any independent support.

The analysis developed in sections 3 to 5, by contrast, does not build an analysis around special *pinjam* phonology. Rather, the intricate facts of *pinjam* are explained by a set of mechanisms that enjoy independent motivation. Thus, tonal contrasts are simply posited underlyingly and preserved with faithfulness constraints. The allomorphy of MH* and H* *pinjam* derives not from two separate rule systems, but from the basic assumption that output forms are subject to general constraints on docking, anchoring, and realization of the underlying H tone. Limits on the size of the contour fall out because of the general ban in the language against contours greater than two tones (NoCrowding). Further, the avoidance of LH from a base L + H suffix follows from the ban against LH tones (*MTD>1) in the language as a whole. The MH* allomorph therefore does not need to be constructed with a special rule like Contour Formation because its shape is predicted from the optimal realization of the tonal morpheme and low register base tones. The problems presented by Chinese languages are sometimes argued to show the limits of constraint-based solutions (Zhang 2010), and indeed require mechanistic accounts in some contexts. However, the two analyses presented above for Cantonese *pinjam* suggest the opposite is true. By embedding the imperative to realize the tonal morpheme, RealizeMorpheme, in the larger phonology of Cantonese tone, we have shown that such mechanistic accounts are really unnecessary.

7. Conclusion

This article proposes an explicit analysis of the process morphology of *pinjam* in Cantonese, effectively implementing the insights of Yip (1980) and Chen (2000) in a constraint-based model. Our analysis builds on the core idea of tonal morphology, namely that an affix can be composed of just a tonal melody, and that constraints in the larger grammar are responsible for predicting exactly how the tonal morpheme is realized. By giving a formally explicit analysis, we are able to examine its predictions for precisely how input tones are mapped onto distinct surface tones, how it applies to other word structures that have been understudied in the past, and how it applies at the phrasal level. On the balance, we feel that this implementation has been successful in that it accounts for both cases of *pinjam* morphology and syllable contraction in phrases, and also unifies the analysis of the two by showing how the latter could have given rise to *pinjam* as a word-formation device. This analysis has also been successful in identifying counter-examples to Yip's original analysis, and a straightforward extension of the core analysis was shown to account for these exceptions.

It is important to emphasize the explanatory nature of the proposed analysis, and how it predicts rather intricate facts from very general principles. The key assumption is that affixes can be composed of just tones, an insight that has been explored in dozens of languages and many other kinds of non-tonal feature structure (Akinlabi 1996; Ettlinger 2004; Kurisu 2001; McPherson 2017). The precise ways in which the H tone affix is realized are predicted by the larger constraint system. In particular, it employs a standard stock of faithfulness constraints for tone, well-motivated markedness constraints on surface tone structure (i.e., OCP, NoCrowding, and *Contour), a constraint used widely for process morphology (RealizeMorpheme), and two other constraints, namely *HM and MTD≤1, that have direct support in the tonal inventory of Cantonese. Thus, while the facts are intricate and multi-layered, the underlying analysis is simple: the realization of the H affix is constrained by the larger grammar of tone.

While we have tried to leave no stone unturned, a few problems remain to be taken up in future research. Our focus has been on establishing an analysis of *pinjam* morphology that implements Yip's generalization in all its contexts. In this analysis, a tonal morpheme categorically supplants a base tone, ignoring the fact that the realization of *pinjam* is variable, exhibiting both lexical variation and speaker variation (Bauer and Benedict 1997; Yue-Hashimoto 1972). Now that an internally consistent analysis exists, it can be formalized in related constraint-based frameworks, such as Stochastic OT (Boersma and Hayes 2001), Harmonic Grammar (Coetzee and Pater 2011), and Maximum Entropy Grammar (Hayes and Wilson 2008), that have the power to predict variable patterns. In these frameworks, the impact of conditioning factors on *pinjam* can be varied through the treatment of constraints responsible for them, like the impact of *Contour in predicting across-the-board mapping to H* as opposed to MH*/H*, as discussed in section 4.5. Indeed, mechanisms exist in some of these frameworks to predict patterns from non-linguistic factors like speaker style (Shaw and Kawahara 2018), which are clearly relevant to *pinjam* morphology (Yue-Hashimoto 1972). Lexical variation can also be investigated with standard ranking algorithms (Coetzee 2009), or by generating a probability distribution for a range of surface variants, as done in Ito (2014). A great deal of empirical work is needed to understand the factors impacting *pinjam*, as there is no systematic analysis of this variation in any particular domain. However, when these factors are well-understood, the constraint-based system proposed here can be extended in a variety of ways to investigate variation.

Another problem that we believe can be fruitfully investigated in future research is the fact that only MH and H tones, when occurring on elided function words, produce a *pinjam*. Our analysis has shown how it is possible that both tones can produce the pattern of allomorphy observed in *pinjam*. However, like prior research, it stipulates that only these tones produce this surface pattern. We wonder, however, if this is a condition that requires explicit grammatical control, or if it could not instead be given a functional account. In particular, most of the meanings associated with *pinjam*, that is, familiarity, intimacy, contempt, and diminution, have an expressive quality to them that suggests an iconic function of *pinjam*. Indeed, some tonal changes have been associated with sound symbolic and onomatopoeic words, as in /gœt22gœt22seŋ55/ → *gœt21gœt35*seŋ55* 噱噱聲 'snoring sound' (Matthews and Yip 2011). Furthermore, the historical origins of *pinjam* rely on morphemes that are frequently associated with magnitude sound symbolism, including the Mandarin diminutive morphemes, *dzi35* 'son' and *ji55* 'child' (Bauer and Benedict 1997). As is well known, magnitude sound system is frequently coded by high pitched sound structure (Nichols 1971; Ohala 1994). The fact that *pinjam* is generally coded by the high-register tones H and MH, the only two high pitch tones in regular use (given the marked status of HM), could therefore be simply due to the fact that these tones make the best use of the link between high frequency sound structure and the sound symbolic meanings invoked in *pinjam* environments. Surely, more abstract meanings will need to be included, like the grammatical meanings discussed in section 4, but these too can follow known trajectories of semantic extension (Regier 1988). Thus, while there is still some work to establish the iconic nature of *pinjam*, we find the parallels above to be tantalizing, and that they indeed constitute the null hypothesis for understanding the limits on the tonal sources of *pinjam*.

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[要旨]

広東語の「變音」をめぐる形態要因と構造分析：その領域拡大と限界点について

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広東語には、語がもともと持ついくつかの音調のタイプが、ある種の派生環境において高音調 HH または上昇調 MH に中和されるという現象がある。これは形態要因による過程であり、「變音」(changed tone) と呼ばれる。この論文では「變音」をめぐる形態現象について包括的な分析を展開し、この音調変化の現象が個別言語的な要因と普遍的な音韻制約のもとで「音調接辞の付加」により実現されることを示す。特に、この基本的な分析が「變音」を持つ形態統語上の構文（しかも先行研究での分析では十分な説明が与えられていなかったもの）にも広範に当てはまることを立証する。さらには、この基本的分析が未開拓の様々な構文に対してどの領域まで拡大でき、どの領域に限界点があるのかを調査することにより、この研究が理論的分析だけでなく経験的検証にも資するものであることを示す。