The Role of the Glottal Stop in Diminutives:
An OT Perspective[*]

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In this article, we first sort out the glottal stop patterns in the YBTH diminutives, namely, middle-GSI, final-GSI, and no-GSI (GSI = glottal stop insertion). After further analysis, those varieties in appearance come out essentially with different rankings of the same set of phonological constraints. In the middle-GSI type of dialects, the related phonological constraints work in the ranking order of MAX-IO, ANCHOR-BD(L/R), SON-SEQ, MAX-BD, LINEARITY-BD >> IDENTITY-BD[F], CONTIGUITY-BD, DEP-BD, while in the final-GSI dialects, the order is MAX-IO, ANCHOR-BD(L), CONTIGUITY-BD, SON-SEQ, MAX-BD, IDENTITY-BD[F], LINEARITY-BD >> ANCHOR-BD(R), DEP-BD. The no-GSI type of dialects are unique in that the order of the constraint is ANCHOR-BD(L/R), CONTIGUITY-BD, SON-SEQ, MAX-BD, DEP-BD, IDENTITY-BD[F], LINEARITY-BD >> MAX-IO, which places the MAX-IO in the lowest ranking. It is obvious that MAX-IO, as a constraint of the Faithfulness family, plays a central role for the presence or absence of the glottal stop. When MAX-IO is ranked high, the glottal stop shows up. When it is low, there is no glottal stop.

Key words: glottal stop, diminutive, Yuebei Tuhua, optimality theory, output-to-output correspondence (OOC)

1. Introduction

This article is an investigation into the role of the glottal stop in the development and formation of diminutives in Chinese dialects in general, and in *Yuebei Tuhua* (hereafter, YBTH) in particular. The essential goal is to capture the glottal stop patterns exhibited in the twelve YBTH varieties from the optimality theory (henceforth, OT) perspective. It is expected that the findings of this study will shed some light on the interaction between diachronic and synchronic studies on Chinese linguistics.

Yuebei, literally the northern part of Guangdong, is surrounded by different Chinese dialects: Hakka, Yue, Xiang, etc. (Zhuang 2004). As a result, YBTH is kind of *Creole*

resulting from a mixture of those dialects.[1] More specifically, YBTH shares linguistic characteristics of: Hakka (Li 2000, Lin et al. 1995, Sagart 2001); Yue (Lin et al. 1995); Gan (Zhuang 1999); Southwest Mandarin (Zhuang 2004); and Xiangnan Tuhua and Guibei Pinghua (Wang 2001, Zhan et al. 2003).

Chinese diminutives have long been an intriguing topic in the literature.[2] However, as pointed out in Tsao (2004), most of the literature is concerned with dialectal characteristics or with descriptive data collection. Little, if any, attention has been focused on the patterns of historical development, let alone the attempt to account for the basic motivation behind the different types of diminutive formation. For this reason, we are going to explore the role of the glottal stop in the development of diminutives on the basis of YBTH data.

Diminutives in YBTH are shaped in terms of tone and/or rime changes of the base (i.e. a word). It is a quite general tendency for the development of diminutives by dint of rime change with the insertion of a glottal stop /ʔ/ into syllable-medial or -final position, making a single syllable sound like two or creating a new syllable ending with a glottal stop. In addition, a new tone results from the diminutives, called diminutive tone (hereafter, DT). There are basically two types of DT formation: *convergence* and *splitting*, the former giving rise to one single tone, the latter two.[3]

There are twelve varieties of YBTH under discussion, namely, Shangyao (上窑), Zhoutian (周田), Baisha (白沙), Lishi (犁市), Lashi (臘石), Meicun (梅村), Guitou (桂頭), Shitang (石塘), Beixiang (北鄉), Changlai (長來), Changjiang (長江) and Wujing (烏逕). As shown in (1), these dialects can be classified into three types in terms of the glottal stop, each of which can be further divided into *convergence* or *splitting* by tonal pattern.

Concerning (1), further comments are called for, however. To begin with, diminutives can be identified by either a tone or a glottal stop. Most dialects get a glottal stop in the middle- or final-GSI, together with a tonal change. In dialects such as Changlai,

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[1] This claim is based on our two fieldwork trips. In the literature, however, YBTH has been a cover term.

[2] The diminutives in Chinese dialects have been surveyed in a great body of literature, including Chen (1997), Deng (2004), Ding (2002), Hu (1994), Huang (1993), Jiang (1999), Li (1978), Lian (2000), Xu (2002), and Zhao (2002), among others.

[3] Convergence is termed *hebianshi* (合變式) and splitting, *fenbianshi* (分變式) in Cao (2001). In *convergence*, all syllables, regardless of citation tones, bear the same DT (e.g. [55] in Tangxi (湯溪) and [ʔ45] in Lishui (麗水)). In *splitting*, syllables of different citation tones have different DTs. However, citation tones and DTs may not be in a one-to-one correspondence. Several citation tones with similar characteristics may have the same DT. Different dialects have their own criteria to select appropriate DTs. For example, in Qingtian (青田), [ʔ55] is used for Level tones, whereas [ʔ224] for non-Level tones.

Changjiang, and Wujing, there is no glottal stop insertion, but there is a tone shift. Next, all dialects in the final-GSI group belong to the *convergence* type. In other words, they have only one DT, leaving the *splitting* slot in (1) empty. Third, there are only two types of DTs in the *splitting* dialects: one is upper-register and the other lower-register. As is often the case with tone and onset, register distinctions are subject to the [±voice] values of obstruents in Middle Chinese. However, limited space precludes us from detailed discussion of the interaction between GSI and DT.[4] Therefore, the present focus is on the GSI in the YBTH diminutives.

(1)		Diminutive Tone (DT)				
		Convergence (One DT)		Splitting (Two DTs)		
Glottal Stop Insertion (GSI)	Middle-GSI	Shangyao	→ MʔH	Baisha	→	MʔH / LʔM
		Zhoutian	→ LʔM	Lishi	→	MʔH / LʔM
				Lashi	→	MʔH / LʔM
	Final-GSI	Meicun	→ MLʔ			
		Guitou	→ MLʔ			
		Shitang	→ MLʔ			
		Beixiang	→ MLʔ			
	No-GSI	Changlai	→ HL	Wujing	→	ML / HM
		Changjiang	→ H↗			

The rest of this article is organized as follows. Section 2 is a review of the formation of the YBTH diminutives and their historical evolvement. Section 3 introduces the theoretical architecture of optimality theory (OT) and output-to-output correspondence (OOC). The optimality-theoretical analyses of glottal stop insertion (GSI) in YBTH diminutives are presented in §4. Section 5 consists of concluding remarks.

2. The formation of the YBTH diminutives

This section will explore the formation of the YBTH diminutives. Glottal stop insertion (GSI) is treated as an important indicator for diminutives. The data here are based on Zhuang (2004) and on our two fieldwork trips.

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[4] This fascinating topic will be taken up in a separate paper.

2.1 Middle glottal stop insertion

Middle-GSI, in itself, means that there is a glottal stop inserted into the base, and hence breaks the single syllable into two. Middle-GSI behaves differently towards different syllable types. For C(G)V: or C(G)V$_i$V$_j$ type, middle-GSI leads to the following diminutives: C(G)VʔV or C(G)V$_i$ʔV$_j$.[5] However, in the type of CVG and CVN base, middle-GSI gives rise to the diminutives CVʔG̩ and CVʔN̩. These can be shown in (2). The citation tones of the base are skipped here, for they are not so relevant to the selection of the different DTs.

(2) Diminutives created by middle-GSI

| Locations / Gloss		Convergence		Splitting		
		Shangyao	**Zhoutian**	**Baisha**	**Lishi**	**Lashi**
'cover'	Base	kuy	kɔe	kʉ:	kwo:	kuy
	Dim.	ku^{M}ʔy^H	kɔ^{L}ʔe^M	kʉ^{L}ʔʉ^M	kwo^{L}ʔo^M	ku^{L}ʔy^M
'spring'	Base	tsʰon	tʃʰun	tsʰun	tsʰɐn	tsʰwɔn
	Dim.	tsʰo^{M}ʔn̩^{H}	tʃu^{L}ʔn̩^{M}	tsʰu^{L}ʔn̩^{M}	tsʰe^{L}ʔn̩^{M}	tsʰwɔ^{L}ʔn̩^{M}
'goose'	Base	ŋᵍɔw	ŋɔ:	ŋɔ:	gow	gɔw
	Dim.	ŋᵍɔ^{M}ʔw̩^{H}	ŋɔ^{L}ʔɔ^M	ŋɔ^{M}ʔɔ^H	go^{M}ʔw̩^{H}	gɔ^{M}ʔw̩^{H}
'money'	Base	tsʰen	tsʰyɛn	tsʰye:	tsʰey	tsʰen
	Dim	tsʰe^{M}ʔn̩^{H}	tsʰyɛ^{L}ʔn̩^{M}	tsʰye^{M}ʔe^H	tsʰe^{M}ʔy^H	tsʰe^{M}ʔn̩^{H}

Investigation of (2) brings us to the following findings. First, two DTs (LM and MH) are accompanied with middle-GSI. Dialects may choose either LM, or MH or both as their DTs. Second, we assume that the postvocalic G or N is parsed to the nucleus of the new syllable. As a consequence, C(G)VG and C(G)VN has phonologically become C(G)VʔG̩ and C(G)VʔN̩, respectively. Otherwise, the inserted glottal stop will find no skeletal slot in the Chinese canonical template CGVE.[6] Third, compared with the tone

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[5] As pointed out in Chung (1989), there is only one canonical template for a Chinese syllable: CGVE, where C=consonants, G=glides, V=nucleus vowels, and E=ending (which might be glides or consonants).

[6] In the literature, a Chinese syllable is assumed to have two tonemes, say, HL or LH for instance. However, in diminutive syllables like C(G)VʔG or C(G)VʔN, whether there is only a single syllable or two is still controversial. One thing that is clear so far is that the tone for such syllables is longer, which is the basis on which it is claimed to have two syllables. Such long syllables other than diminutives are also found in Southern Min (Chung 1996), Huangyan (Chao 1934), Mandarin Chinese (Cheng 1973). In those syllables, it is noticed that there is a glottal stop between the nucleus vowel and the coda.

before the glottal stop, the tone following it is always higher, as witnessed in (3).

(3)   Three diminutive words in Baisha
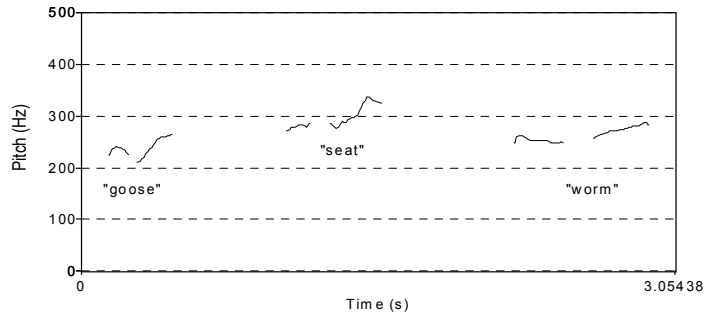
From acoustic and perceptual perspectives, there are obvious discontinuous parts of the pitch contours in the spectrogram in (3). It is decoded that the glottal stop appearing in the discontinuous parts results in the gap for vocal fold vibrations. The discontinuous parts, due to the pressing of vocal folds, produce a sudden stop in speech perception as well.

From an articulatory point of view, the glottal stop is produced with complete closure of the vocal folds so that it will be followed by an increasing frequency of vibration.[7] Consequently, the post-glottal vowel in VʔV comes up naturally with a higher tone (i.e. fundamental frequency or pitch).[8] This observation is also empirically supported in Hirata (1983) and Chen (1992).

Hirata notices that tone changes in diminutives are closely related to the glottal stop or glottalization. He observes that the most commonly utilized tonal shapes in diminutives are high-rising or high-level, and the glottal stop and glottalization are tied to the tonal changes. Chen (1992) further proposes that the developmental process might be traced back in the following stages: glottal stop → glottal stop and high tone → high tone.

The middle-GSI in diminutives is not uncommon in Chinese dialects. For example, dialects spoken in Ningpo (Chen 1992), Lichuan (Yan 1989), Hangzhou (Xu 2002) are all reported to have the same characteristics.

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[7] For more detailed discussion of the phonetics and phonology of glottal consonants, see Pennington (2005) and Zhu (2006).

[8] For the correlation of pitch and sub-glottal pressure, see Pickett (1999:78-85).

2.2 Final glottal stop insertion

Now we turn to the glottal stop added to the end of a syllable (henceforth, final-GSI). Syllable structures, such as C(G)VV, C(G)VG and C(G)VN, show up as C(G)VVʔ, C(G)VGʔ and C(G)VNʔ, as shown in (4). Note that all the final-GSI diminutives occur in the *convergence* type.

(4)   Diminutives created by final-GSI

Locations / Gloss		Convergence				Splitting
		Meicun	**Shitian**	**Guitou**	**Beixiang**	None
'cover'	Base	kwɤ	kwa	kvu	kwɛ	
	Dim.	kwɤʔ^{ML}	kwaʔ^{ML}	kvuʔ^{ML}	kwɛʔ^{ML}	No dialects with final-GSI are of the *splitting* type.
'spring'	Base	tsʰaŋ	tsʰwɛŋ	tsʰaŋ	tʃʰaŋ	
	Dim.	tsʰaŋʔ^{ML}	tsʰwɛŋʔ^{ML}	tsʰaŋʔ^{ML}	tʃʰaŋʔ^{ML}	
'goose'	Base	gɔw	ŋoː	gɔw	ŋɜw	
	Dim.	gɔwʔ^{ML}	ŋoːʔ^{ML}	gɔwʔ^{ML}	ŋɜwʔ^{ML}	
'money'	Base	tsʰɛŋ	tsʰiŋ	tsʰɛn	tʃʰi	
	Dim.	tsʰɛŋʔ^{ML}	tsʰiŋʔ^{ML}	tsʰɛnʔ^{ML}	tʃʰiʔ^{ML}	

Note that all dialects in (4) display the same diminutive tone, ML, a falling low-register tone. The across-the-board presence of a low-register falling DT is attributed to the effect of the syllable-final glottal stop, which is produced with tight-closure vocal folds. Different from middle-GSI, no more sounds immediately follow the glottal stop in the final-GSI pattern. Accordingly, once the vocal folds are tightly held, vibration decreases and then stops completely, which naturally leads to a falling tone.

For the inserted glottal stop in the canonical template, two possibilities emerge. First of all, we assume that it occupies the coda position, together with the preceding nasal consonant in the forms of consonant clusters. The other is that the inserted glottal stop functions simply as a phonological feature, very much like the glottal stop as the feature of an entering tone in Southern Min (Li 1986, Chung 1996). In either case, no problem would be raised theoretically.

Furthermore, the diminutives identified by final-GSI and tonal changes are abundant in the literature, such as Wenzhou (溫州), Lishui (麗水), Yongjia (永嘉), Wuyi (武義), Ningpo (寧波), Qingtian (青田), Nanxiong (南雄) and Shaoguan (韶關) (Cao 2001, Egerod 1983, Pan 1988, Zhengzhang 1980, 1981).

2.3 No glottal stop insertion

The last type in the YBTH diminutives is no-GSI. As implied in the term, no glottal stop is inserted into the base. The formation of diminutives is exclusively achieved via DT, as illustrated by the data in (5).

(5)   Diminutives created by no-GSI

a.

Gloss	'bucket'		'orange'		'grandma'		'mother'	
Locations	Base	Dim.	Base	Dim.	Base	Dim.	Base	Dim.
Wujing	ku	ku^{ML}	kã	kã^{ML}	pʰo	pʰo^{HM}	ŋyõ	ŋyõ^{HM}

b.

Gloss	'filter'		'head'		'grid'		'mode'	
Locations	Base	Dim.	Base	Dim.	Base	Dim.	Base	Dim.
Changjiang	sɛ	sɛ$^{H↗}$	tʰɛw	tʰɛw$^{H↗}$	kɛ	kɛ$^{H↗}$	tsʰɔŋ	tsʰɔŋ$^{H↗}$
Changlai	ʃi	ʃi^{HL}	ti	ti^{HL}		ka^{HL}	tsʰaŋ	tsʰaŋ^{HL}

As displayed in (5a), Wujing has two DTs, a low-register ML and a high-register HM, both being falling in contour. In Changjiang and Changlai, however, the DTs are unique in that the Changlai DT is HL, which falls quickly from H to L, while in Changjiang, DT is a super-high tone (H↗). To put it more clearly, let us compare the phonetic pitches reflected in citation tones and DTs in (6) and (7).

(6)   Five citation tones in Changjiang
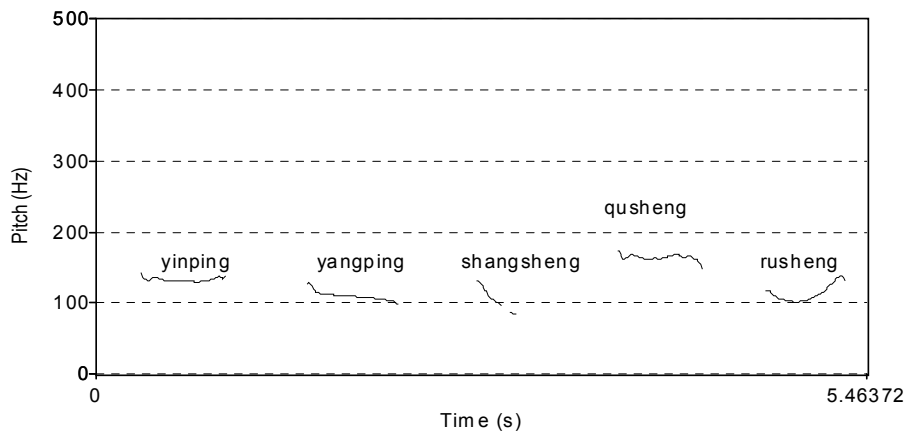
(7) Four diminutive words in Changjiang
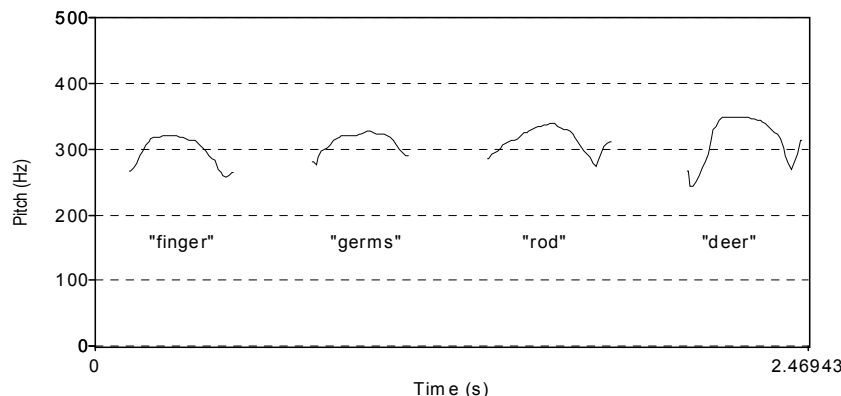
As shown in (6), the pitch values of the five citation tones in Changjiang are lower than 200 Hz. Nonetheless, in (7) the pitch values for four diminutive words are all higher than 300 Hz. Furthermore, the diminutives based on super-high tones can also be found in other Chinese dialects (Li 1996, Li & Chang 1992). To illustrate, some examples of Xinyi are given in (8) (Ye & Tang 1982:48).

(8)

hɔ^{11} → hɔ ↗	'small river'	ap^{33} → am ↗	'little duck'
lu^{22} → lu ↗	'small road'	kɛk^{33} → kɛŋ ↗	'small foot'
kɔŋ^{53} → kɔŋ ↗	'small tub'	tip^{22} → tim ↗	'small dish'

2.4 From middle-GSI to no-GSI: a historical perspective

The diminutives with DTs are pretty common in southeastern Chinese dialects, and are widely described in the literature. However, it has remained unclear as to what the source of the tone changes for diminutives is.

Hirata (1983) has observed that tone changes occurring in the diminutives are closely correlated with the glottal stop or glottalization. He further points out that the most commonly utilized tonal shapes are high-rising or high-level and that the glottal stop (or glottalization) is usually tied to tonal changes. It is not difficult to account for rising tonal shapes due to the closure of the vocal folds when producing the glottal stop. Following the closure naturally comes a high frequency in F_0, which turns out to be a high tone in essence. To put it another way, in the process of diminutive formation, the segmental feature (i.e. glottal stop) will affect the suprasegmental feature (i.e. high tone). This is also confirmed by Chen's study (1992), which claims that the glottal stop (or

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glottalization) is one of the important characteristics of diminutives in southern Chinese dialects.[9] It further suggests that the glottal stop /ʔ/ is the early form of tonal changes in the process of diminutive formation.[10] Such a claim is based on the data of Ningpo (寧波) and many other southern Chinese dialects (e.g. Qingtian 青田, Wenzhou 溫州, Huangyan 黃岩, YBTH), in which a glottal stop always occurs with the diminutives. The co-occurrence of the glottal and tonal change can be seen in (9).

(9)
Base	Dim.	Gloss	
hei^{21}	heiʔ^2	'monkey'	
mɯɯŋ^{21}	mɯɯŋʔ^2	'mosquito'	(Egerod 1983)
lue^{213}	lueʔ$^{\underline{355}}$	'donkey'	
ŋe^{213}	ŋeʔ$^{\underline{355}}$	'fish'	
ji^{213}	jiʔ$^{\underline{355}}$	'lamb'	
ja^{22}	jaʔ$^{\underline{224}}$	'swallow'	
bĩa^{22}	bĩaʔ$^{\underline{224}}$	'a braid or pigtail'	(Pan 1988)

If the glottal stop is taken to be the early form of the diminutives, then, it follows naturally that the diminutives in YBTH with middle- and final-GSI must have been present before those with no-GSI. Now consider the following data (based on Zhuang 2004:255).

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9 Chen (1992) investigates two types of diminutives. In addition to the syllable-final glottal stop /-ʔ/ or glottalization, another type of diminutive has a syllable-final nasal /-n/, as indicated in Qian (1991), Huang (1993), Zhou (1987), et al. Moreover, these two types of diminutive are not mutually exclusive, both of them appearing in many dialects, like Ningpo (寧波).

10 From the glottal stop to high DTs, Chen (1992) proposes a serial derivation process: /-ʔ/ → glottalization and high tone → high tone. Close observation of the process reveals that the glottal stop is weakened at the 2nd stage, and disappears at the last stage. Namely, /-ʔ/ at the 1st stage is a primary segmental feature. At the 2nd stage, /-ʔ/ is weakened, which has an impact on tone. It is this change that enables Hirata (1983) and Chen (1992) to hypothesize that the glottal stop is greatly relevant to high DTs. At the 3rd stage, the glottal stop disappears, and high tones are thus generated (Dell 1977, Matisoff 1970), becoming the primary distinctive feature for diminutives. In YBTH, for dialects with a final glottal stop, the DT is not a high tone, but a falling ML tone. If Chen's theory is correct, the YBTH diminutives with final-GSI are still at the first stage, and hence no tone changes occur.

(10)　　　Informant A　　　　Informant B　　　　　　　　　　Gloss

a.　geyʔ^M　tya^{M}ʔa^H　　geyʔ^M　tya^{M}ʔa^H　　　　　　'sun'

b.　pay^{ML}　sye^{M}ʔe^H　　pay^{ML}　sye^{M}ʔe^H　　　　　'tomb'

c.　key^{ML}　kɛ^{L}ʔŋ^M　　key^{ML}　kɛ^{L}ʔŋ^M　　　　　'a cock'

d.　vowʔ^M　kwo^{L}ʔo^M　　vowʔ^M　kwo^{L}ʔo^M　　　　'a pan cover'

e.　tsʰaw^{MH}　pye^{M}ʔe^H　　tsʰaw^{MH} **pye^{M}ʔe^H** / tsʰaw^{MH} **pyeʔ^H**　'a lawn'

f.　sɪ^{HM}　hya^{M}ʔa^H　　sɪ^{HM} **hya^{M}ʔa^H** / sɪ^{HM} **hyaʔ^H**　　'when'

g.　tʰu^{HH}　tsʰa^{M}ʔɣ^H　　tʰu^{HH} **tsʰa^{M}ʔɣ^H** / tʰu^{HH} **tsʰayʔ^H**　'belly button'

h.　geyʔ^M　ta^{L}ʔŋ^M　　geyʔ^M **ta^{L}ʔŋ^M** / geyʔ^M **taŋʔ^M**　　'daytime'

In (10), there are eight speech samples by two informants at Lishi. In (10a-d), both informants use middle-GSI for the diminutives. However, differences come into light in other data. The first informant still keeps using middle-GSI diminutives in (10e-f), while the second informant takes advantage of either middle-GSI or final-GSI diminutives. Compared with the second informant, the first informant is older, less educated, and hence is supposed to have a better command of his dialect. Therefore the different diminutives in (10e-f) imply that middle-GSI diminutives should be diachronically prior to final-GSI ones, for the use of diminutives is shifted from middle-GSI to either middle or final-GSI. The same linguistic behavior is also explored in Zhao (2002). Accordingly, the YBTH diminutives begin with middle-GSI, then followed by the stage of final-GSI, and finally come to the form of no-GSI.[11] Moreover, as indicated in Hirata (1983), loss of the final glottal stop leads to high tones: high-rising (H ↗) or high-falling (HL).

3. Theoretical framework

3.1 Optimality theory and output-to-output correspondence

OT is a framework in which *input*, *Gen*(*erator*), *Eval*(*uator*) and *optimal output* are essential parts (Kager 1999, McCarthy 2004). For a given input, *Gen*, an output-producing

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[11] In addition to the diachronic order for GSI, the historical development for the DTs can also be recognized in terms of *splitting* and *convergence*. In YBTH, the criterion for the DT *splitting* depends on the voiced/voiceless contrast at the onsets in Middle Chinese: a voiced onset gets a lower register, while a voiceless onset, higher register. Nonetheless, in the DT pattern of *convergence*, the diminutives pick up a fixed upper- or lower-register, without regard to voicing. For this reason, *splitting* must be diachronically prior to *convergence*, for the former can be traced at least back to the time before voiced obstruents became devoiced. This can account for the relationship between *splitting* and *convergence* in middle-GSI diminutives in YBTH. However, it fails to explain the diachronic order of *splitting* and *convergence* in no-GSI diminutives. It seems that *convergence* in no-GSI diminutives appears before *splitting* because of the high DTs resulting from the loss of the final glottal stop.

device, representing human beings' language device, generates an infinite number of logically possible output candidates. The set of output candidates are then evaluated for optimality (i.e. harmony) by *Eval*, comprising a set of violable but hierarchically ranked constraints on a language-specific basis. The candidate that incurs the least violations of constraints is assumed to be the optimal form.

Behind the OT framework, there are two major conflicting forces: *Faithfulness*[12] and *Markedness*,[13] both of which are intrinsically conflicting, in the sense that the satisfaction of one implies the violation of the other. Constraints reveal not only language-universal properties, but also language-specific structural requirements. In a nutshell, each language has its own ranking for these constraints. Different constraint ranking leads to different patterns among languages or dialects.

At the heart of OT lies the force of faithfulness and identity that competes against the force of markedness and requests morphologically related forms to be identical or similar. What is implied behind the input-output faithfulness and the base-reduplicant identity is a general concept of generalized correspondence (Prince & Smolensky 1993). Correspondence and correspondents are defined below (after McCarthy & Prince 1999):

(11) **Correspondence**
Given two strings S_1 and S_2 (input and output, base and reduplicant, etc.), *correspondence* is a relation $\mathcal{R}$ from the elements of S_1 to those of S_2.

Correspondents
Elements $\alpha \in S_1$ and $\beta \in S_2$ are referred to as *correspondents* of one another when $\alpha \mathcal{R} \beta$

Not merely established in the input-output faithfulness and the base-reduplicant identity, correspondence can also be extended to hold between different, but morphologically related output forms, named output-to-output correspondence (henceforth,

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[12] Faithfulness functions as a protector for lexical properties, "making it possible for languages to have sets of formally distinct lexical items to express different meanings (Kager 1999:10)." Another function of Faithfulness is to restrict the shape between input and output (called *shape invariability*), requesting the outputs not to be different from their input forms.

[13] Markedness is a structural well-formedness requirement for output that helps unmarked structures to be presented. For instance, "sonorants must be voiced (*Sonorant [-vd])" and "syllables must not have codas (No-Coda)." However, the pressure toward the unmarked structures is counterbalanced by Faithfulness, which enforces the output to preserve the properties of the input. Different from Markedness that does not take input forms into account, Faithfulness involves both input and output in the meantime, such as MAX-IO (no deletion) and DEP-IO (no insertion). In OT, constraints that are exclusively involved in input are impossible (i.e. Richness of the Base: No constraints hold at the level of underlying forms).

OOC).[14] Given this background, OOC aims to maximize the phonological identity between morphologically related output forms. With the advent of OT, a large body of research (Benua 1995, Kenstowicz 1994, McCarthy & Prince 1995, Steriade 1996, among others) has brought OOC into focus.

3.2 OT in historical linguistics

Within the framework of Generative Phonology, the key motivation of historical sound change is attributed to the change of phonological rules (King 1969, Kiparsky 1971, Hock 1986). This view is adapted and modified into the OT framework by claiming that it is not rule change but the change of phonological constraints ranking (McMahon 2000) that accounts for sound change in history. As a matter of fact, one of the advantages of OT is that the difference in constraint ranking provides strong arguments for the birth of different dialects (for more discussion, see McCarthy 2004). Based on the previous background, we shall argue in the following section that the historical developments of the YBTH diminutives naturally come to light in lieu of the different ranking of the same constraints.

4. OT analyses and glottal stop insertion in the YBTH diminutives

This section is devoted to the discussion on OT analyses of GSI in the YBTH diminutives. GSI plays a key role in the formation of the YBTH diminutives and causes the base rimes to be changed. We shall show that all the developments of the YBTH diminutives fall quite naturally into the prediction of OT. With a common set of constraints of syllable structure and output-to-output correspondence (OOC), the three patterns of GSI become transparent owing to the different rankings.

4.1 Middle-GSI

As shown in (2), Middle-GSI refers to syllable types in which the glottal stop occurs between bases. Such a derivation is entirely born out with OOC. The constraints in the OOC family are composed of the following constraints.

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[14] OOC is different from the input-output faithfulness, since the former deals with two separate output forms without reference to the input while the latter refers to both the input and the output. Unlike the base-reduplicant identity in which two representations are co-existent in a single output form, OOC copes with two output forms that are not co-presented simultaneously.

(12)   MAX(IMALITY)-BD :   Every element of *Base* has a correspondent in
                                    Diminutive. ('No deletion of segments from *Base*')
            DEP(ENDENCE)-BD :   Every element of *Diminutive* has a correspondent in
                                    Base. ('No epenthesis of segments in *Diminutive*')
            IDENT(ITY)-BD[F] :   Correspondent segments have identical values for
                                    feature [F], where [F] stands for any features. ('No
                                    feature changes between *Base* and *Diminutive*')
            LIN(EARITY)-BD :   *Base* is consistent with the precedence structure of
                                    Diminutive, and vice versa. ('No metathesis between
                                    Base and *Diminutive*')

Further investigation of the data in (2) implies that MAX-BD is respected while DEP-BD gets violated. To be precise, all segments in the base have correspondents in the diminutives, but not vice versa. The inserted glottal stop in the diminutives cannot trace its correspondent back to the base. The corresponding relationships of both constraints are schematically illustrated in (13), with the base *kuy* 'cover' in Shangyao as an expository instance. It is clear that the glottal stop cannot find its correspondent in the base (as indicated by ※).

(13) a. MAX-BD 'no deletion'   b. DEP-BD 'no epenthesis'
      Base: k   u   y   Base: k   u   ※   y
              ↓   ↓   ↓   ↑   ↑   ↑   ↑
      Dim.:   k   u   ʔ   y̩   Dim.:   k   u   ʔ   y̩

The middle-GSI diminutives are formed by the epenthesis of a glottal stop, which means that middle-GSI diminutives will, no doubt, violate DEP-BD in (13b). However, such a violation is tolerable. On the contrary, violation of MAX-BD must be completely avoided. All the middle-GSI diminutives must match MAX-BD, because no segments in the base can be truncated in the diminutives, as in (13a). It follows that MAX-BD outranks DEP-BD:

(14)   MAX-BD >> DEP-BD

Next, consider LIN-BD and IDENT-BD[F]. LINEARITY-BD is perfectly matched in the middle-GSI diminutives. This is because the linear order of segments in the base remains the same in the diminutives, without regard to the inserted glottal stop. Unlike LIN-BD, glides or nasals are changed to be [+syllabic] and are placed in the nucleus position, giving rise to a violation of IDENT-BD[F]. Accordingly, IDENT-BD[F] should be low-ranked so that the optimal outputs CVʔG̩ and CVʔN̩ can emerge. As for the constraint ranking,

LIN-BD and MAX-BD should be ranked as undominated, for none of them can be violated. The constraints are therefore ranked as follows:

(15) Constraint ranking for YBTH middle-GSI diminutives
     MAX-BD, LIN-BD >> IDENT-BD[F], DEP-BD

The constraints so far are not yet adequate, as illustrated by *tsʰon* 'spring' in Shangyao:

(16) Input: /tsʰon+ʔ/[15] Base: [tsʰon]	MAX-BD	LIN-BD	IDENT-BD[F]	DEP-BD
☞ a. tsʰon				
b. onʔ	*!			*
c. tsʰoʔ	*!			*
d. tsʰotʔ			*!	*
e. tsʰnoʔ		*		*
? f. ʔtsʰon				*
? g. tsʰʔon				*
? h. tsʰoʔn				*
? i. tsʰoʔn̩			*!	*
? j. tsʰonʔ				*

The constraints in (15) can now accurately evaluate the candidates (16b-e). There are two problems, however. First, candidate (16a) is wrongly selected as the optimal output (as marked by ☞). To solve this problem, we need an input-output faithfulness constraint: MAX(IMALITY)-IO in (17).

(17) MAX-IO[16]: Input segments must have output correspondents.
               ('No deletion')

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[15] In this article, GSI is represented as "+ ʔ" in the input. As mentioned previously, the earliest form of the diminutives should be a glottal stop. Hence, /ʔ/ must be present in the input in all kinds of GSI.

[16] This constraint ensures all segments in the input appear in the output. In fact, MAX-BD can cover most functions of MAX-IO; however, as shown in (16), MAX-BD only compares the base with its diminutive form, without referring to the input. This is why (16a) is taken to be the optimal output. Moreover, according to OT, input-output faithfulness is made up of several constraints, such as DEP-IO, IDENTITY-IO, and LINEARITY-IO. In this article, except for MAX-IO, the functions of other input-output faithfulness constraints are replaced by its corresponding OOC.

The second problem is that the candidates (16f-j) incur one violation of DEP-BD and, thus, all of them take a chance to be the optimal output. For this reason, there must exist other constraints that can rule in (16i, h, j), which are the two OOC constraints, ANCHORING-BD and CONTIGUITY-BD,[17] and SON-SEQ, as defined in (18).

(18)   ANCHOR(ITY)-BD : Any element at the Left or Right edge of *Base* has a
                         correspondent at the Left or Right edge of *Diminutive*.
                         ('No epenthesis or deletion at Left or Right edge of
                         Diminutive')

    CONT(IGUITY)-BD : The portion of *Diminutive* standing in correspondence
                      forms a contiguous string, as does the correspondent
                      portion in *Base*. ('No **medial** epenthesis or deletion of
                      segments in *Diminutive*')

    SON-SEQ :   Complex onsets rise in sonority, and complex codas fall
                      in sonority.

ANCHOR-BD (comprising ANCHOR-BD(L) and ANCHOR-BD(R)) requires that the leftmost and rightmost segments in the base should occur on the left and right edges in the diminutives. Consequently, ANCHOR-BD rules out (16f) and (16j). Given that ANCHOR-BD is inviolable, it is CONTIGUITY-BD that protects the contiguous integrity of the base in diminutives.

Now let us consider (16g-i). Note that all the three candidates violate CONTIGUITY-BD, incurring one violation mark equally. Further investigation indicates the necessity of Sonorant Sequence Principle (SSP), which requires that, within a syllable, onsets to rise in sonority toward nucleus and codas to fall in sonority from the nucleus. The sonority hierarchy here follows the version of Kiparsky (1982): vowels (5) > Glides (4) > Liquids (3) > Nasals (2) > Obstruents (1). The constraint based on SSP is SON-SEQ, which was

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[17] An alternative to deal with this phenomenon is alignment constraints (ACs), instead of ANCHORING-BD and CONTIGUITY-BD. Constituent edges have always occupied a significant status in linguistic analyses, and alignment, as a corollary, plays a significant part.

However, ACs are not adopted here. First, the emphases of ALIGNMENT and OOC are different. The former concentrates on the constituent edges, while the latter, the identity between the base and its morphologically related words. Second, alignment and OOC belong to two different frames in OT. Under the economic principle, one single frame (i.e. OOC) simplifies the grammar. Third, if we use alignment constraints, the number of constraints is not as economical as that of OOC. At least, three alignment constraints, listed below, are called for.
ALIGN-L   : The left edge of the base coincides with the left edge of a prosodic word.
ALIGN-R   : The right edge of the base coincides with the right edge of a prosodic word.
ALIGN-ʔ-R : The right edge of /ʔ/ coincides with the right edge of a prosodic word.

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given in (18). The interaction among the three constraints in (18) is:

(19) Constraint ranking for YBTH middle-GSI diminutives
      MAX-IO, ANCHOR-BD(L/R), SON-SEQ, MAX-BD, LINEARITY-BD >>
      IDENTITY-BD[F], CONTIGUITY-BD, DEP-BD

The success of the related constraints for the diminutives of middle-GSI is illustrated below, taking *tsʰye* 'money' in Lishi and *tsʰen* 'money' for instance:

(20) Input: /tsʰyee+ʔ/ Base: [tsʰyee]	MAX-IO	ANCHOR-BD(L/R)	SON-SEQ	MAX-BD	LIN-BD	IDENT-BD[F]	CONTIG-BD	DEP-BD
a. tsʰyee	*!							
b. tsʰeeʔ	*!	*		*				*
c. tsʰeyeʔ		*!				*		*
d. ʔtsʰyee		*!	*					*
e. tsʰʔyee			*!				*	*
f. tsʰyʔee			*!				*	*
g. tsʰyʔee						*!	*	*
☞ h. tsʰyeʔe							*	*
i. tsʰyeeʔ		*!						*

(21) Input: /tsʰen+ʔ/ Base: [tsʰen]	MAX-IO	ANCHOR-BD(L/R)	SON-SEQ	MAX-BD	LIN-BD	IDENT-BD[F]	CONTIG-BD	DEP-BD
a. tsʰen	*!							
b. tsʰeʔ	*!	*		*				*
c. tsʰnʔe			*!		*		*	*
d. tsʰetʔ		*!	*			*		*
e. ʔtsʰen		*!	*					*
f. tsʰʔen			*!				*	*
g. tsʰeʔn			*!				*	*
☞ h. tsʰeʔn̩							*	*
i. tsʰenʔ		*!						*

As pointed out, such constraints as MAX-IO, ANCHOR-BD(L/R), SON-seq, MAX-BD, IDENT-BD[F], LIN-BD are undominated. As a result, candidates violating other constraints would be counted as: the less violation, the better. Accordingly, candidate (20g), even though violating CONT-BD and DEP-BD, satisfies all high-ranked constraints and turns

out to be the optimal output. A similar case occurs in (21). Candidate (21h), without any violation of the high-ranked constraints, is picked out as the optimal output. As a result, the constraints and the ranking in (19) can well account for the middle-GSI in the YBTH diminutives.

4.2 Final-GSI

As a matter of fact, there are many similarities between cases of middle- and final-GSI. For this reason, the four OOC constraints (i.e. MAX-BD, IDENT-BD[F], LIN-BD, DEP-BD) still remain in effect. However, there are also some differences. First of all, unlike middle-GSI, the alignment of the glottal stop with the right edge of the diminutive in final-GSI is indispensable. This is essentially a cross-linguistic tendency that epenthesis applies between morphemes, but not within morphemes. Consequently, the constraint CONT-BD should be ranked higher than ANCH-BD(R):

(22) Constraint ranking for YBTH final-GSI diminutives
MAX-IO, ANCHOR-BD(L), CONTIGUITY-BD, SON-SEQ, MAX-BD,
IDENTITY-BD[F], LINEARITY-BD >> ANCHOR-BD(R), DEP-BD

The constraint ranking order discussed thus far works well, as illustrated below with *kwa* 'cover' and *tsʰwɛŋ* 'spring' from Shitang.

(23) Input: /kwa+ʔ/ Base: [kwa]	MAX -IO	ANCH -BD(L)	CONTIG -BD	SON -SEQ	MAX -BD	IDENT -BD[F]	LINEAR -BD	ANCH -BD(R)	DEP -BD
a. kwa	*!								
b. kaʔ	*!				*			*	*
c. kawʔ							*!	*	*
d. gwaʔ						*!		*	*
e. ʔkwa		*!		*					*
f. kʔwa			*!	*					*
g. kwʔa			*!	*					*
☞ h. kwaʔ								*	*

In (23), the number of violation marks of the high-ranked constraints is crucial in picking out the optimal output. No violation of any high-ranked constraints leads the candidate (23h) to the optimal form, even if it violates the two low-ranked constraints, ANCHOR-BD(R) and DEP-BD. The same is also true in (24), where the violation of the low-ranked constraints (24i) becomes optimal since it violates no high-ranked constraints.

(24) Input: /tsʰwɛŋ+ʔ/ Base: [tsʰwɛŋ]	MAX -IO	ANCH -L	CONTIG -BD	SON -SEQ	MAX -BD	IDENT -BD[F]	LINEAR -BD	ANCH -R	DEP -BD
a. tsʰwɛŋ	*!								
b. tsʰwɛʔ	*!				*			*	*
c. tsʰwŋɛʔ							*!	*	*
d. tsʰwɛgʔ				*!		*		*	*
e. ʔtsʰwɛŋ		*!		*					*
f. tsʰʔwɛŋ			*!	*					*
g. tsʰwʔɛŋ			*!	*					*
h. tsʰwɛʔŋ			*!	*					*
☞ i. tsʰwɛŋʔ								*	*

4.3 No-GSI

The last type is the case of no-GSI diminutives: no glottal stop is added. The diminutives are carried out exclusively by DTs.

From the segmental viewpoint, the diminutives of no-GSI are entirely the same as the base. However, after careful investigation of southern Chinese dialects, Chen (1992) claimed that the earliest form of the diminutives is no more than a glottal stop. Based on this claim, we assume that there is a glottal stop present in the input, and that some constraints prevent the glottal stop from appearing in the output.

Three comments are called for, however. To begin with, bases are significant, since the diminutives have the same shape in appearance. It follows that the four high-ranked OOC constraints (i.e. MAX-BD, IDENT-BD[F], LINEARITY-BD, DEP-BD) activate obviously without segment deletion, feature change, metathesis, and segment insertion in the no-GSI diminutives. Next, all the bases (as well as diminutives) abide by SSP, which, undoubtedly, entails the high-ranked status of SON-SEQ. Third, given that it is impossible for the glottal stop to occur at leftmost or rightmost edges in no-GSI diminutives, both edges of diminutives and bases must be identical. To achieve this goal, ANCHORI-BD(L/R) and CONT-BD are ranked high:

(25) Tentative constraint ranking for YBTH no-GSI diminutives
ANCHOR-BD(L/R), CONTIGUITY-BD, SON-SEQ, MAX-BD, DEP-BD,
IDENTITY-BD[F], LINEARITY-BD >> ϕ
(ϕ stands for any constraints not mentioned temporarily)

What is missing in (25) is the constraint, MAX-IO. The function of MAX-IO is to ensure that every segment in the input must be present in the output (i.e. no deletion).

Note that MAX-IO is obligatory for the presence of the glottal stop. Now, the glottal stop in no-GSI diminutives is by no means present, which means that violation of MAX-IO is inevitable. However, such violation is tolerable since MAX-IO is ranked comparatively low:

(26) Constraint ranking for YBTH no-GSI diminutives
ANCHOR-BD(L/R), CONTIGUITY-BD, SON-SEQ, MAX-BD, DEP-BD,
IDENTITY-BD[F], LINEARITY-BD >> MAX-IO

The success of the previous constraints to account for the no-GSI case is illustrated below (*ŋyõ* 'mother'):

(27) Input: /ŋyo+ʔ/ Base: [ŋyo]	ANCH -BD	CONTIG -BD	SON -SEQ	MAX -BD	DEP -BD	IDENT -BD[F]	LINEAR -BD	MAX -IO
☞ a. ŋyo								*
b. ŋoʔ	*!			*	*			
c. ŋoʔy		*!			*		*	
d. nyoʔ	*!				*	*		
e. ʔŋyo	*!				*			
f. ŋʔyo		*!	*		*			
g. ŋyʔo		*!	*		*			
h. ŋyoʔ	*!				*			

In (27), the optimal output (27a) does not incur any violation mark on the high-ranked constraints, in spite of its violation of MAX-IO. The rest candidates are ruled out because of incurring two or three marks on the high-ranked.

So far, the same set of constraints is able to account for the different types of GSI. To have a clearer scenario, we summarize the constraints together their ranking order in (28).

(28) YBTH middle-GSI diminutives
MAX-IO, ANCHOR-BD(L/R), SON-SEQ, MAX-BD, LINEARITY-BD >>
IDENTITY-BD[F], **CONTIGUITY-BD**, **DEP-BD**
YBTH final-GSI diminutives
MAX-IO, ANCHOR-BD(L), **CONTIGUITY-BD**, SON-SEQ, MAX-BD,
IDENTITY-BD[F], LINEARITY-BD >> ANCHOR-BD(R), **DEP-BD**
YBTH no-GSI diminutives
ANCHOR-BD(L/R), **CONTIGUITY-BD**, SON-SEQ, MAX-BD, **DEP-BD**,
IDENTITY-BD[F], LINEARITY-BD >> MAX-IO

There is a diachronic order of historical evolvement for the three types of GSI. In the next section, we are going to explore these constraints from a historical perspective.
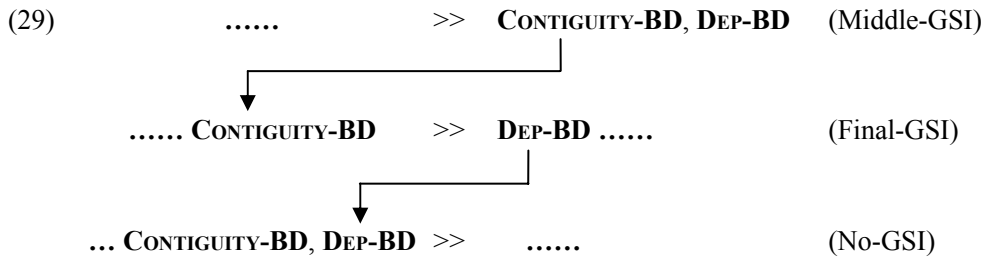
4.4 GSI: a historical perspective

An essential contribution of OT is its capability to characterize various sound changes. Here we would like to approach the developments of the YBTH diminutives in the light of OT. We are going to start with the competition between cases of middle-GSI and final-GSI. According to the constraint rankings in (28), CONTI-BD and DEP-BD are low-ranked in middle-GSI; whereas CONT-BD is ranked high for final-GSI. The contrast reveals that the contiguous integrity of the base is maximally respected in the evolvement from middle-GSI to final-GSI.

In the case of the YBTH diminutives, middle-GSI shows a marked pattern of epenthesis, for middle-GSI unexceptionally breaks the integrity of the base. In contrast to the high-ranked CONT-BD in final-GSI, the contiguity of the base is preserved. As a result, the evolvement from middle-GSI to final-GSI, diminutives can be interpreted as a development from a marked to an unmarked pattern of epenthesis. On the other hand, it is necessary to lower the rank of ANCHOR-BD(L/R). If the contiguous integrity of the base is maintained, the glottal stop can only be inserted on the left- or right-edge of the base. However, for YBTH final-GSI diminutives, the high-ranked ANCHOR-BD(L) prevents the glottal stop from occurring at the leftmost edge. Such a prohibition follows the cross-linguistic tendency that the left edge of a word is respected in sound change (Kager 1999). Hence, the glottal stop can occur on the right edge of the base, which makes ANCHOR-BD(R) low in the ranking.

With respect to the competition between final-GSI and no-GSI, the low-ranked DEP-BD in final-GSI is ranked high in no-GSI. Note that MAX-BD and DEP-BD pursue the identity between the base and its morphologically related optimal output, and maximizes the phonological identity between them. The central idea of OOC is directly reflected in the no-GSI diminutives in YBTH for the base.

Finally, it is the rank of MAX-IO. Like ANCHOR-BD(R), the lowering of MAX-IO is quite obvious since both MAX-BD and DEP-BD require no segments to be deleted or inserted in the diminutives. This means that the occurrence of the glottal stop in diminutives is avoided.

In brief, the historical evolvement from middle-GSI to no-GSI results from the different rankings of CONTIGUITY-BD and DEP-BD, as shown in (29) schematically.

(29)   ……   >>   **CONTIGUITY-BD**, **DEP-BD**   (Middle-GSI)

           …… CONTIGUITY-BD   >>   **DEP-BD ……**   (Final-GSI)

       … CONTIGUITY-BD, **DEP-BD** >>   ……   (No-GSI)

5. Concluding remarks

In this article, we first characterized the glottal stop patterns in the YBTH diminutives, namely, middle-GSI, final-GSI, and no-GSI (GSI = glottal stop insertion.) After further analysis, those varieties in appearance come out essentially with different rankings of the same set of phonological constraints. In the middle-GSI type of dialects, the related phonological constraints work in the ranking order of MAX-IO, ANCHOR-BD(L/R), SON-SEQ, MAX-BD, LINEARITY-BD >> IDENTITY-BD[F], CONTIGUITY-BD, DEP-BD, while in the final-GSI dialects, the ranking order is MAX-IO, ANCHOR-BD(L), CONTIGUITY-BD, SON-SEQ, MAX-BD, IDENTITY-BD[F], LINEARITY-BD >> ANCHOR-BD(R), DEP-BD. The no-GSI type of dialects are unique in that the order of the constraint is ANCHOR-BD(L/R), CONTIGUITY-BD, SON-SEQ, MAX-BD, DEP-BD, IDENTITY-BD[F], LINEARITY-BD >> MAX-IO, which places the MAX-IO in the lowest ranking. It is obvious that MAX-IO, as a constraint of the Faithfulness family, plays a central role for the presence or absence of the glottal stop. When MAX-IO is ranked high, the glottal stop shows up. When it is low, there is no glottal stop.

Our analysis here is twofold. One implication is that the interaction between morphological and phonological components is entirely subject to the output-to-output correspondence (OOC). The various morphological types in phonetics are attributed to different rankings, but not to different constraints. All the constraints are basically identical, although they may be labeled with different terms or names in the literature. If this is the case, OT provides a better mechanism toward the ideal of Universal Grammar.

The other implication is that morphological or phonological changes in history are due to a change in the rankings of constraints; the constraint in itself does not change greatly. For instance, in the case of the YBTH diminutives, the historical development from middle-GSI to no-GSI is observed from the gradual raise of CONTIGUITY-BD and DEP-BD in the constraint rankings. In prior literature, diminutives appearing in different dialects have intrigued a great number of researchers. Their documents clearly indicate where the difference lies, but what motivates the difference is merely discussed sparsely.

Our attempt here in this article has, at least, bridged the gap between descriptive data collection and theoretical analyses.

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喉塞音在粵北土話小稱詞演變中的角色

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　　本文以優選理論來探討喉塞音在粵北土話小稱詞演變中的角色。首先，我們將粵北土話中的喉塞音類型做歸類整理，將之分為中塞、後塞，及無塞等三種。然後，基於優選理論「各種喉塞音的類型都是由於同一組制約的不同層次排列」之假設，我們認為中塞型方言的制約排列為 MAX-IO, ANCHOR-BD(L/R), SON-SEQ, MAX-BD, LINEARITY-BD >> IDENTITY-BD[F], CONTIGUITY-BD, DEP-BD，而後塞型的排列為 MAX-IO, ANCHOR-BD(L), CONTIGUITY-BD, SON-SEQ, MAX-BD, IDENTITY-BD[F], LINEARITY-BD >> ANCHOR-BD(R), DEP-BD。至於無塞音型的方言，則由於 ANCHOR-BD(L/R), CONTIGUITY-BD, SON-SEQ, MAX-BD, DEP-BD, IDENTITY-BD[F], LINEARITY-BD >> MAX-IO 之排列。因此，粵北方言中各種喉塞音的類型，最主要的是 MAX-IO（輸入及輸出必須相同），如果這個制約排在高層次，我們有了喉塞音；如果排在低層次，則沒有喉塞音。

關鍵詞：喉塞音，小稱詞，粵北土話，優選理論，輸出到輸出制約