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Unexpected Morphophonological Outputs*

Yen-Hwei Lin
Michigan State University

This paper examines unexpected morphophonological outputs under diminutive rime change in Huojia, Jiyuan and Hongan, and explores a systemic contrast-based approach to show how preservation of phonological/phonetic contrasts serves to preserve morphophonological contrasts within the root-diminutive paradigm. The proposed anlaysis (i) shows that contrast-based constraints can provide a unified account of certain types of unexpected but systematic linguistic forms, (ii) adds to the growing body of research supporting a systemic approach to contrast preservation in phonology and morphology, and (iii) demonstrates that the notion of *systemic contrast preservation* can account for otherwise unexplained morphophonolgoical outputs and why contrast-based constraints should be extended to morphophonology and morphological paradigms.

1. Introduction

In this paper, I discuss the issue of analyzing unexpected outputs in Chinese affixal phonology by examining three cases of unexpected morphophonological outputs under diminutive rime change and exploring a systemic contrast-based approach to show how preservation of phonological/phonetic contrasts serves to preserve morphophonological contrasts within the root-diminutive paradigm.

A well-known example of unexpected outputs comes from Beijing Mandarin -*er* suffixation, in which the syllable coda of the root is replaced by the suffix. If the coda is a velar nasal, the replacement also leads to nasalization of the nuclear vowel, as the example in (1a) shows, which seems to indicate a general process of vowel nasalization when a nasal coda is lost to the suffix, as in (1b). However, contrary to the expectation of a generalized rule, when the coda of the root is an alveolar nasal, no vowel nasalization applies, as illustrated by (1c). There have been many different analyses in the literature, e.g. Cheng 1973, Lin 1989, 2005bc, 2007a, Duanmu 2000/2007, Wang 1993, Wu 1994, Li 1999, Zhang 2000, to name just a few.

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(1) An example of unexpected outputs under Beijing -*er* suffixation

a. Nasal deletion and vowel nasalization:
p^{h}aŋ + ɹ → p^{h}ãɹ 'side'

b. Expected general rule:
VN + ɹ → [V, +nasal]ɹ

c. Nasal deletion but no vowel nasalization:
p^{h}an + ɹ → p^{h}aɹ 'plate'

For example, Zhang (2000) offers a phonetically-based account, in which the asymmetry in (1a) and (1c) is explained by phonetic differences in the degree of nasal flow: vowel nasalization induced by /ŋ/ is stronger than that induced by /n/, hence the lack of nasalization resulting from the loss of /n/. In a contrast-based account (Lin 2005bc), the choice for an oral versus a nasal vowel (instead of two oral or two nasal vowels) in the *er*-suffixed forms has the advantage of preserving the morphological contrast: the *er*-suffixed forms (p^{h}ãɹ vs. p^{h}aɹ) of the two distinct roots (p^{h}aŋ vs. p^{h}an) remain distinct. Other less-studied cases, especially those under the rime change process, are more difficult to account for, and I will examine three cases from Huojia, Jiyuan and Hongan and offer potential analyses.

When unexpected or seemingly exceptional morphophonological outputs occur, there can be three approaches. The first is the do-nothing approach, in which the aberrant data are exceptions that are arbitrary (probably due to diachronic changes) and memorized by the speakers/learners, so no analysis is necessary. The second is the diachronic/socio-dialectal approach, in which the problematic data are explained by tracing sequences of diachronic changes, sociolinguistic variation and/or language contact. In the third synchronic theoretical approach, specific rules and/or constraints are proposed to derive the unexpected outputs. These approaches are not necessarily mutually exclusive since one set of data may be better explained by one approach than another or by some combinations of more than one approach. My discussion will focus on the third approach.

Diminutive rime change (*bianyun* 变韵) is a process that alters the root rime with featural or prosodic changes to produce various diminutive and/or hypocoristic forms, as the examples in (2) from Huojia illustrate.

(2) *zi* and D rime change in Huojia (Henan Province) (He 1981, 1989)

root	*zi*-word		root	D-word	
fa	fɔ	‘raft’	li	liə → liɛ	‘Li’
p^{h}an	p^{h}ã	‘plate’	mau	mɔ	‘Mao’

Earlier analyses (Lin 1989, 1993) posit subsegmental affixes such as featural or prosodic affixes (e.g. [+back, +round] or a mora/default vowel) and templatic output restrictions (e.g. an open syllable). In some cases of rime change, however, there are puzzling unexpected alternations that are difficult to explain and analyze.

In this paper, the rime change cases I examine are those in which unexpected morphophonological outputs cannot be attributed to lexical idiosyncrasies. My attempt to account for these seeming exceptions is based on the notion of *contrast*, similar to those proposals for phonology in Flemming (2004) and Lubowicz's (2003), and for morphophonology and morphological paradigms in Itô & Mester (2004) and Kenstowicz (2005). In what follows, I introduce relevant contrast-based constraints in Optimality Theory (OT) in §2 before discussing the unexpected outputs under Huojia D rime change (§3), Huojia and Jiyuan zi rime change (§4), and Hongan diminutive rime change (§5). The final section (§6) summarizes the proposal and offers concluding remarks.

2. Contrast Preservation

The notion of *contrast* has been formalized in recent studies to account for phonological, morphophonological and morphological alternations, and there is a growing body of research supporting a systemic approach to contrast preservation in OT, e.g. Flemming 2002, 2004, Padgett 1997, 2003, Sanders 2002, Itô and Mester 2004, 2007, Kenstowicz 2005, to name just a few. Examples of systemic contrast-based constraints include those in (3).

(3) Systemic contrast-based constraints
  a. MINDIST constraints (Flemming 2002, 2004) and SPACE constraints (Padgett 2003) maximize/preserve the distinctiveness of contrasts.
  b. Minimize articulatory efforts and maximize the number of contrasts (Flemming 2002, 2004).
  c. NOMERGE penalizes neutralization of contrasts (Padgett 2003).
  d. CONTRAST>i/e (Itô and Mester 2007) or μ-CONTRAST (Itô and Mester 2004) declares the contrast between two mora-sized items as insufficient if they are identical at their left edges and contrast only in their vowel quality [i] vs. [e].
  e. PRESERVECONTRAST constraints require that each pair of inputs that are distinct in some property P need to remain distinct in the outputs or avoid output ambiguity in P property (Lubowicz 2003, Tessier 2004).

In addition to phonological contrasts in sound inventories and phonological input-output mappings for pairs or sets of words, contrast-based constraints are also applicable to morphological paradigms, examples of which are given in (4). Whereas *paradigm uniformity* requires members or related words within a morphological paradigm to be phonologically/phonetically uniform in their shared base/stem (e.g. Kenstwoicz 1996, 2005, Benua 1997, Steriade 2000, McCarthy 2005, Trón and Rebrus 2005), *paradigm contrast* demands paradigm members to be phonologically/phonetically distinct.

(4) Paradigmatic/morphological contrast preservation

a. PARADIGMCONTRAST (PARCONTRAST) (Itô and Mester 2004; cf. Kenstowicz 2005): The cells of a paradigm are pair-wise phonologically distinct. Assign one mark for each pair of paradigm members that are not phonologically distinct.

b. DISTINCTSTEM: The unaffixed stem must be distinct from the affixed stem; i.e., zero affixation is prohibited (Rose 1997, Urbanczyk 1998).

c. Transderivational anti-faithfulness constraints (Alderete 1999, 2001, cf. Hayes 1999).

d. CON(D): A form realizing some value of a morphosyntactic dimension D of paradigm x must be phonetically distinct from forms realizing other values of D (Rebrus & Törkenczy 2005) or PRINCIPLE OF CONTRAST (Trón & Rebrus 2005).

Under such a contrast-based analysis, the output candidates consist of sets of forms, such as a sound inventory (Flemming 2002, 2004), an idealized set of words (Padgett 2003, Lubowicz 2003), or a morphological paradigm (Itô & Mester 2004; cf. McCarthy 2005, Kentowicz 2005, Rebrus & Törkenczy 2005). In my analysis, I adopt constraints similar to those in (3) and (4) with some modifications.

3. Huojia D rime change

Under Huojia D rime change for adjectives and familiar local names (He 1989), the affix is either /ə/ (Lin 2001) or an empty mora (Lin 1993), as the examples in (5a) show, and due to an output templatic constraint that bans complex rimes for D words, coalescence applies to a complex rime (Lin 1993), examples of which are given in (5b).

(5) Huojia D rime change for adjectives and local names (He 1989)

a.	root rime	D changed rime	root rime	D changed rime
	u	wə → wɤ	i	jə → jɛ
b.	root rime	D changed rime	root rime	D changed rime
	ai	ɛ	au	ɔ

The examples in (6) show that vowel-nasal root rimes become nasal vowels through coalescence under D rime change, but the resulting nasal vowels are not always as expected based on faithful parsing of the features of the root segments. A nasal schwa is not a licit D changed rime for (6bd), and if [n] contributes to the fronting for [ən] (→ [ɛ̃]) in (6b), the same fronting effect does not apply to [an] (→ [ã] but not *[ɛ̃]) in (6a). The low vowel in (6c) does not remain a low vowel in the changed rime, and for root rimes ending in a velar nasal (6cd), a rounding feature is mysteriously added in the changed rimes to yield [ɔ̃].

(6) Nasal vowels created by coalescence under Huojia D rime change

	root rime	D changed rime			root rime	D changed rime	
a.	an	ã	*ɛ̃	c.	aŋ	ɔ̃	*ɑ̃ *ã
b.	ən	ɛ̃	*ə̃	d.	əŋ	ɔ̃	*ə̃ *ɤ̃

Note that the resulting three nasal vowels are maximally dispersed within the non-high vowel perceptual space (given that the root rimes all have non-high vowels), as illustrated in (7). I propose that contrast maximization (Flemming 2002, Sanders 2002, Padgett 2003, Itô & Mester 2004, 2007), together with rounding enhancement for back vowels (Stevens et al. 1986), motivates the selection of these three nasal vowels.

(7) Vowel dispersion for perceptual distinctiveness within the non-high vowel space

ɛ̃ ɔ̃

ã

The contrasts in the three pairs of rimes in (8) and (9) are maximized in the front-back and/or mid-low dimensions, and hence the resulting nasal vowels are maximally dispersed within the non-high perceptual space. With rounding enhancement for back nasal vowels, the perceptual contrasts in the two pairs in (8) are maximized. Through fronting a central vowel, the perceptual contrast in the pair in (9) is also maximized. However, contrast neutralization of [ə̃]-[ã] → [ɔ̃]-[ɔ̃] in (10) then becomes inevitable since there is no way to maximize contrasts for all four pairs of rimes to have maximally dispersed nasal vowels.

(8) Maximize the front-back contrast with rounding enhancement.

a.	an	←→	aŋ	contrast in root rimes
	ã		ã	no contrast in changed rimes
	ã		ɑ̃	better contrast in changed rimes
	ã		ɔ̃	best contrast in changed rimes
b.	ən	←→	əŋ	contrast in root rimes
	ə̃		ə̃	no contrast in changed rimes
	ɛ̃		ɤ̃	better contrast in changed rimes
	ɛ̃		ɔ̃	best contrast in changed rimes

(9) Maximize the mid-low contrast for the [ən] - [an] pair.

ən	←→	an	contrast in root rimes
ɛ̃		ɛ̃	no contrast in changed rimes
ə̃		ã	better contrast in changed rimes
ɛ̃		ã	best contrast in changed rimes

(10) The mid-low contrast for the [əŋ] - [aŋ] pair is neutralized.

əŋ	←→	aŋ	contrast in root rimes
ɔ̃		ɔ̃	no contrast in changed rimes

Assuming that the various nasal vowels have roughly the perceptual distance as shown in (11), where the numbers indicate the hypothesized spacing/distance, I present in (12) and (13) an analysis making use of Flemming's (2002, 2004) contrast maximization constraints and output-output correspondence (Benua 1997) between the root rimes and the D changed rimes.

(11) Perceptual space for nasal vowels (cf. Flemming 2002, 2004, Padgett 1997, Sanders 2002, Wright 1986)

	ĩ			ũ	1
	ɛ̃	ə̃	ɤ̃	ɔ̃	2
		ã	ɑ̃		3
	1	2	2.5	3	

(12) Contrast-based analysis: constraints (cf. Lin 2005abc, Lin 2008b)

a. Contrast maximization constraints (Flemming 2002, 2004)
MAXIMIZE CONTRASTS: Maximize the number of contrasts.
MINDIST: Maximize the perceptual distinctiveness of contrasts.

b. Output-output correspondence (Benua 1997)
IDENT OO-HI: The base/root vowels and the vowels in the derived words have the same height specification.

The candidate set (13a) is best in maximizing perceptual contrasts but it is not faithful to the root rimes in vowel height. The other candidate sets in (13c-f) fail to maintain minimal perceptual contrasts, so (13b) emerges as the optimal set of changed rimes with nasal vowels.

(13) Contrast-based analysis: tableau

bases:	ən əŋ an aŋ	IDENT OO-HI	MINDIST ≥ 2	MAXIMIZE CONTRASTS
a.	ĩ ũ ã	*!*		✓✓✓
→ b.	ɛ̃ ɔ̃ ã			✓✓✓
c.	ɛ̃ ɔ̃ ã ɑ̃		*!*	✓✓✓✓
d.	ə̃ ɤ̃ ã ɑ̃		*!***	✓✓✓✓
e.	ɛ̃ ɤ̃ ã		*!*	✓✓✓
f.	ə̃ ã		*!	✓✓

In sum, The unexpected nasal vowels derived by Huojia D rime change can be accounted for in terms of maximization of perceptual distinctiveness of the nasal vowels within the limit of an output-output (root-D words) correspondence requirement. The data from Huojia D rime change then illustrate how contrast maximization simultaneously enhances contrast preservation and produces contrast neutralization in a morphological context, and how phonetic/perceptual factors influence morphophonological alternations.

4. Huojia and Jiyuan *zi* rime change

Under Huojia and Jiyuan *zi* rime change, the *zi* changed rimes are derived by associating the featural affix [+back, +round] to the root and by segmental merger of some vowel-nasal rimes (Lin 1989, 1993). The evidence for the [+back, +round] featural affix comes from examples like (14a-d): High front vowels in (14ab) are suffixed with a back rounded glide and the non-high vowels in (14cd) are both backed and rounded in the changed rimes.[1] However, in (14e-h), where the alveolar nasal coda is changed to a back velar nasal in (14ef) and the nasal coda is merged with the preceding non-high vowel in (14gh)[2], the [+round] part of the affix is not always manifested, as shown in (14e) and (14g).

[1] For a complete set of data, see He (1981, 1989), and for the details of data interpretation and analysis, see Lin (1993, 2001).

[2] Lin (1993) attributes the vowel lengthening in (14ef) to a requirement of transition from a front vowel to a back nasal (cf. schwa insertion between a high front vowel and a velar nasal in Standard Mandarin in Lin (2007a:177)). It is also stipulated that only low vowels undergo segmental merger to become nasalized vowels, as in (14gh).

(14) Huojia and Jiyuan *zi* rime change (data from He 1981,1989)

	root rime	*zi* changed rime	
a.	i	iu	
b.	y	yu	
c.	a	ɔ	
d.	ə	o	
e.	in	i:ŋ	*y:ŋ *i:ŋ^{w}
f.	yn	y:ŋ	
g.	an	ã	*ɔ̃
h.	aŋ	ɔ̃	

Given that a labialized nasal such as [ŋ^{w}] (derived from [n] + [+back, +round]) is illicit in modern Chinese in general (Lin 1993:664), if the affix is faithfully and fully parsed, we expect both [in] and [yn] in (14ef) to become [y:ŋ] and both [an] and [aŋ] in (14gh) to become [ɔ̃], i.e. with both [+round] and [+back] features in the changed rimes. Although the unexpected outcomes could technically be analyzed as in Lin (1993) with specific rule orderings and feature configuration/cooccurrence constraints, the real explanation remains illusive.

One interesting observation to make, however, is that when the rounding feature of the affix fails to be manifested in the changed rimes in (14e) and (14g), the contrast between each pair of root rimes (i.e. the (14ef) pair and the (14gh) pair) is preserved in the changed rimes. As illustrated in (15a), if the [+round] feature of the affix were faithfully parsed, the changed rimes for both [in] and [yn] root rimes would be identical; on the other hand, the defective parsing of the affix, as in (15b), preserves the morphophonological contrast within the root-diminutive paradigm.

(15) a. When [+round] of the *zi* affix is manifested:

root rime	*zi* affix	→	*zi* changed rime
in	[+back, +round]	→	y:ŋ
yn	[+back, +round]	→	y:ŋ
in ←→ yn			y:ŋ ←→ y:ŋ
contrast			no contrast

b. When [+round] of the *zi* affix is not manifested in the changed rime for [in]:

root rime	*zi* affix	→	*zi* changed rime
in	[+back, +round]	→	i:ŋ *y:ŋ
yn	[+back, +round]	→	y:ŋ
in ←→ yn			i:ŋ ←→ y:ŋ
contrast			contrast

The same observation also applies to the (14gh) pair, as illustrated in (16ab). The intuition then is that the conflicting demands between faithful parsing of the root/affix and phonological contrast preservation between pairs of root rimes and their corresponding changed rimes are resolved at the expense of faithful parsing when necessary.

(16) a. When [+round] of the *zi* affix is manifested:

root rime	*zi* affix	→	*zi* changed rime
an	[+back, +round]	→	ɔ̃
aŋ	[+back, +round]	→	ɔ̃
an ←→ aŋ			ɔ̃ ←→ ɔ̃
contrast			no contrast

b. When [+round] of the *zi* affix is not manifested in the changed rime for [an]:

root rime	*zi* affix	→	*zi* changed rime
an	[+back, +round]	→	ã *ɔ̃
aŋ	[+back, +round]	→	ɔ̃
an ←→ aŋ			ã ←→ ɔ̃
contrast			contrast

The usual paradigmatic contrast preservation constraints, such as those given in (4) above, evaluate members of a morphological paradigm sharing the same base/stem, but here we are evaluating how contrastive root rimes remain contrastive in their corresponding changed rimes. This mode of evaluation bears resemblance to Lubowicz's (2003) contrast preservation theory for phonological input-output mappings (cf. (3e)), but what we have here is morphophonological in nature and thus requires output-output mappings in which a distinctive pair of root forms need to remain distinct in the affixed forms. Such a contrast preservation constraint is formulated in (17a). Together with the faithfulness constraint in (17b), the two exceptional cases in Huojia and Jiyuan *zi* rime change, where [+round] of the affix is not parsed, are analyzed as in (17cd). The winning candidates are those that satisfy the contrast preservation constraint but violate faithful parsing of the affix.

(17) Contrast-based analysis (cf. Lin 2008b)

a. PRESERVECONTRASTROOT-DERIVED (PC(R-D)): Each pair of root forms X and Y that are distinct must remain distinct in their corresponding derived forms.

b. MAX: no deletion of input elements.

c.

	root *zi* in in + [+bk, +rnd] yn yn + [+bk, +rnd]	PC(R-D)	MAX
→	in iːŋ yn yːŋ		*+rnd
	in yːŋ yn yːŋ	*!	

d.

	root *zi* an an + [+bk, +rnd] aŋ aŋ + [+bk, +rnd]	PC(R-D)	MAX
→	an ã aŋ ɔ̃		*+rnd
	an ɔ̃ aŋ ɔ̃	*!	

To summarize, I have suggested that the seemingly mysterious non-parsing of the [+round] feature of the *zi* affix in Huojia and Jiyuan can be explained if we take into account pair-wise contrasts between roots and their derived forms.

5. Hongan diminutive rime change

The general patterns of Hongan diminutive rime change are shown in (18). In general, there is a back and front contrast between the root rime and the changed rime, with the exception of (18ag) where the changed rimes do not have a front feature. In addition, many root rimes do not have corresponding changed rimes, as given in (19).[3]

There are three major problems that challenge a unified analysis of Hongan rime change. The first concerns the issue of allomorph selection. There appear to be two allomorphs for the diminutive affix, [əɹ] (18ag) and a featural affix [-back] (18b-f). Allomorph selection is based on the phonological make-ups of the roots, so an adequate explanation is needed regarding how and why an allomorph is selected over the other for a particular root type. The second issue involves exceptions/unexpected outputs. A high

[3] Surveys of Chinese dialects do not always make clear how to form a diminutive form for a root rime lacking a corresponding changed rime. Normally the diminutive form of such a root rime may employ alternative morphological processes such as reduplication or affixation of a morpheme meaning “small”. This is what I assume here for Hongan (cf. Huojia analyzed by Lin (2007b)). However, in some dialects, a root rime that does not undergo rime change may have identical base and derived forms, e.g. perfective rime change in Junxian Mandarin analyzed by Jiang (2008).

front nasal vowel [ĩ] in (18e) is supposedly derived from the combination of the [an] or [ən] root rime and the [-back] affix; however, this result is unexpected because the root vowel is non-high and the derived nasal vowel is also expected to be non-high (e.g. like those in (18fg)). The third is the issue of paradigm gaps: there are many gaps in the root-diminutive paradigm since quite a few root rimes, as listed in (19), do not have any changed rime counterparts.

(18) Diminutive rime change in Hongan (Hubei Province)
(data from Chen & Li 1996: 1728-1748)

	root rime	changed rime		root rime	changed rime
a.	o, au	əɹ	e.	an, ən	ĩ
b.	a	æ	f.	aŋ	æ̃
c.	ai	e	g.	oŋ	ə̃ɹ
d.	əu	əɥ			

(19) Root rimes without corresponding changed rimes
a. i, y, æ, ɥæ, e, ie, ɥe, ei, uei, ɥei
b. u, əɹ

The general ideas for the proposal are that (i) the allomorph [-back] is the default form of the affix (cf. the analysis of Jiyuan in Lin (1989, 1993)), (ii) the notion of systemic contrast preservation for output-output mappings accounts for cases where the affixal [-back] fails to be manifested and where unexpected outputs occur, and (iii) the paradigm gaps are attributed to paradigm contrast preservation.

Consider first the allomorph selection issue: why is that some root rimes undergo [–back] affixation but some do not? The examples in (20) are those that undergo [–back] affixation, and those in (21) are root rimes that take the alternative allomorph.

(20) Rimes affixed with [-back] for (18bcdf)

a.	a	+	[-back] →	æ
b.	ai	+	[-back] →	e
c.	əu	+	[-back] →	əɥ
d.	aŋ	+	[-back] →	æ̃

(21) Rimes with [o]/[au] in (18ag)

a.	o/au	+	[-back]	→	*e
b.	oŋ	+	[-back]	→	*ẽ
c.	o/au	+	əɹ	→	əɹ
d.	oŋ	+	əɹ	→	ə̃ɹ

Note that the potential changed rimes derived by [-back] affixation for [o]/[au], as in (21ab), are either identical or very similar to the changed rime for [ai] in (20b). When the alternative allomorph is chosen as in (21cd), the changed rimes for [o]/[au] become more distinct from the changed rime for [ai]. The contrast-based explanation is schematized in (22). Since the root rimes [ai] versus [o]/[au] and [ai] versus [oŋ] are distinct from one another or in contrast, sufficient distinctiveness of contrasts is also maintained for their corresponding changed rimes.[4] Under this view, the alternative allomorph is selected for the purpose of contrast preservation in the root-diminutive paradigm (cf. Löfstedt 2008).

(22) Contrast preservation

a. Avoid identical changed rimes for different root rimes.

root rimes	changed rimes
ai ←→ o/au	e ←→ əɹ
contrast	contrast
ai ←→ o/au	e ←→ e
contrast	no contrast

b. Maintain sufficient distinctiveness of contrasts in the changed rimes for different root rimes.

root rimes	changed rimes
ai ←→ oŋ	e ←→ ə̃ɹ
contrast	contrast
ai ←→ oŋ	e ←→ ẽ
contrast	insufficient contrast

Similar contrast-based explanation can also account for the second issue under Hongan rime change, i.e. the exceptions/unexpected outputs. Consider the two rimes in (23). Although default [-back] affixation applies, the changed rimes unexpectedly fail to maintain the [-high] property of the root vowels. In comparison, the vowels of other changed rimes all maintain the same height of the root vowels.

(23) Rimes with [an]/[ən] in (18e)

a.	an	+	[-back]	→	*æ̃
b.	ən	+	[-back]	→	*ẽ
c.	an	+	[-back]	→	ĩ
d.	ən	+	[-back]	→	ĩ

[4] See Flemming (2002, 2004) and Padgett (2003) on how sufficient perceptual contrasts are determined phonetically and phonologically and how languages may differ in the degree of sufficient perceptual distance for contrastive purposes. Specifically how Hongan determines sufficient distinctiveness of contrasts awaits detailed phonetic and phonological studies.

If the vowels of these two changed rimes remain [-high], as in (24ab), they would be either identical to the changed rime of [aŋ] (20d) or similar to the changed rime of [ai] (20b).[5] The contrast-based analysis is schematized in (24). Since the root rimes [an] and [aŋ] are in contrast, the corresponding changed rimes maintain a contrast, as shown in (24a). Similarly, since the root rimes [ai] and [ən] are in contrast, the corresponding changed rimes maintain sufficient distinctiveness of contrasts, as shown in (24b). Therefore, vowel raising in these two changed rimes serves the purpose of contrast preservation.

(24) Contrast preservation

a. Avoid identical changed rimes for different root rimes.

root rimes	changed rimes
aŋ ←→ an	æ̃ ←→ ĩ
contrast	contrast
aŋ ←→ an	æ̃ ←→ æ̃
contrast	no contrast

b. Maintain sufficient distinctiveness of contrasts in the changed rimes for different root rimes.

root rimes	changed rimes
ai ←→ ən	e ←→ ĩ
contrast	contrast
ai ←→ ən	e ←→ ẽ
contrast	insufficient contrast

To capture the explanation formally, two contrast-based constraints are given in (25ab). The first performs pair-wise evaluations of root forms and corresponding affixed forms, which requires evaluations of output-output mappings, as we have seen earlier in (17a). The second constraint is modeled after a constraint proposed by Itô and Mester (2004, 2007), given in (3d) earlier, and requires the contrast for two rimes to be sufficient. Specifically, (25b) declares that the contrast between [e] and [ẽ] is not sufficient.

(25) Contrast-based analysis (cf. Lin 2009)

a. PRESERVECONTRASTROOT-DERIVED (PC(R-D)): Each pair of root forms X and Y that are distinct must remain distinct in their corresponding derived forms.

[5] Selecting the alternative allomorph would not help either: the changed rime for [an]/[ən] would then be [ə̃ɹ], which is identical to the changed rime for [oŋ] (21d).

b. CONTRAST>e/ẽ: The contrast of two rimes differing only in [e] versus [ẽ] is insufficient.

c. Analysis of allomorph selection

	root *dimimutive* ai ai + [-bk]/əɹ o o + [-bk]/əɹ	CONTRAST >e/ẽ	PC(R-D)
→	ai e o əɹ		
	ai e o e		*!

d. Analysis of exceptions/unexpected outputs

	root *diminutive* ai ai + [-bk]/əɹ ən ən + [-bk]/əɹ	CONTRAST >e/ẽ	PC(R-D)
→	ai e ən ĩ		
	ai e ən ẽ	*!	

The two tableaux in (25cd) show how the two constraints select the correct candidate sets to resolve the issues of allomorph selection and exceptions/unexpected outputs. In (25c), the alternative allomorph is selected for the changed rime for the [o] root rime because the second candidate set contains identical changed rimes for two distinct root rimes, violating the constraint PRESERVECONTRASTROOT-DERIVED in (25a). In (25d), the oral and nasal mid front vowels in the changed rimes of the second candidate set are not sufficiently contrastive, and hence vowel raising applies.

There are a couple of potential problems with this analysis. First, the root rimes [a] and [aŋ] have the changed rimes [æ] and [æ̃] respectively (18bf). The question then is this: if the contrast between the oral and nasal vowels [e] and [ẽ] is insufficient, why is the contrast between the oral [æ] and the nasal [æ̃] considered sufficient and tolerated? For the analysis to work, a constraint like CONTRAST>æ/æ̃ must be lower ranked, indicating that for purposes of contrast maintenance, the perceptual distance between [æ] and [æ̃] is more adequate than that between [e] and [ẽ]. Since a high or low vowel as opposed to a mid vowel is peripheral, the oral-nasal contrast is likely to be maintained better (Jie Zhang, personal communication). In addition, since a nasal low vowel is perceived higher than its oral counterpart (Beddor 1993; cf. Wright 1986, Padgett 1997, Sanders 2002), the contrast between [æ] and [æ̃] could be considered more adequate and sufficient.

The second problem is that the existence of other pairs of identical and similar changed rimes seems to constitute counterexamples to the main idea of the proposed analysis. For example, the root rimes [o] and [au] have the same changed rime [əɹ] (18a), and [an] and [ən] have the same changed rime [ĩ] (18e), violating PRESERVECONTRASTROOT-DERIVED. In addition, [o]/[au] and [oŋ] have changed rimes [əɹ] and [ə̃ɹ] respectively, whose degree of contrast does not seem to be sufficient. What is important to point out is that it is often impossible to contrast all pairs in the changed rimes or in a derived paradigm, so some neutralization is inevitable (see, for example, contrast preservation and neutralization of nasal vowels under Huojia D rime change in §3). It seems that when a pair of root rimes are more similar, contrast neutralization in the changed rimes is more likely to occur. A more comprehensive study examining how contrast preservation and contrast neutralization interact in a principled way is left for future research (cf. Lin 2005abc, Lin 2008ab).

Consider now the last issue on the paradigm gaps. I suggest that the presence of these gaps can be attributed to the requirement of contrast or distinctiveness between the root rimes and their potential changed rimes. Those root rimes without corresponding changed rimes listed in (19a) already contain a front vowel, and the fronting process of rime change would have failed to distinguish the root rimes from their potential changed rime counterparts, as the examples in (26a) demonstrate. Choosing the alternative allomorph, on the other hand, would create massive violations of PRESERVECONTRASTROOT-DERIVED with many identical changed rimes, as the examples in (26b) show.

(26)	a.	e	+ [-back]	→	*e
		i	+ [-back]	→	*i
	b.	e	+ əɹ	→	*əɹ
		i	+ əɹ	→	*əɹ
		o	+ əɹ	→	*əɹ

The constraint that avoids identity or similarity between a base/stem and its derived form is given in (27a), which follows the formulation in Itô and Mester (2004) but is similar in nature to constraints proposed in other studies (e.g. Kentowicz 2005, Rebrus & Törkenczy 2005, Lin 2008ab). As shown in (27b), the first candidate set violates PARADIGMCONTRAST twice since two root rimes are identical with their derived changed rimes, and the second candidate set violates PRESERVECONTRASTROOT-DERIVED since the changed rimes of three distinctive root rimes are identical. Therefore, PARADIGMCONTRAST, together with PRESERVECONTRASTROOT-DERIVED, helps select the third candidate set in which [i] and [e] have no corresponding changed rimes.[6]

[6] For various approaches to analyzing paradigm gaps or absolute ungrammaticality in OT, see Prince and Smolensky (1993, 2004), Orgun & Sprouse (1999), Klein (2005), Rice (2007, 2009), Lin (2007b).

(27) Contrast-based analysis (cf. Lin 2009)

a. PARADIGMCONTRAST (PARCONTRAST): The members of a morphological paradigm sharing the same base/root are pair-wise phonologically distinct.

b. Analysis of paradigm gaps

	root	*dimimutive*	PARADIGM CONTRAST	PC(R-D)
	i e o	i + [-bk]/əɹ e + [-bk]/əɹ o + [-bk]/əɹ		
	i e o	i e əɹ	*!*	
	i e o	əɹ əɹ əɹ		*!**
→	i e o	 əɹ		

Consider now the lack of changed rimes for the two root rimes with central/back vowels, i.e. [u] and [əɹ] in (19b). The potential changed rimes for [u] and [əɹ] with default fronting could be [y] and [e]/[əɥ] respectively. However, the potential changed rimes [e] and [əɥ] for [əɹ] are identical to the changed rimes for root rimes [ai] and [əu] respectively (18cd) and would violate PRESERVECONTRASTROOT-DERIVED. Selecting the alternative allomorph would make the root rime and the changed rime identical, violating PARADIGMCONTRAST. Therefore, the root rime [əɹ] lacks a changed rime counterpart. A changed rime like [y] for [u] should be fine with PRESERVECONTRASTROOT-DERIVED and [y] is a possible vowel in Hongan, so it is unclear why there is no changed rime for [u]. A proper analysis of this example is left for future research.

To summarize, the puzzling and unexpected outputs under Hongan diminutive rime change can be accounted for by systemic contrast preservation within the root-diminutive paradigm.

6. Concluding remarks

I have examined specific cases in which unexpected outputs and/or unfaithful parsing of some root/affix features occur under Huojia, Jiyuan and Hongan diminutive rime change processes, and suggested that these seemingly exceptional cases can be explained by contrast preservation within the root-diminutive morphological paradigm. A new constraint that assesses output-output mappings in which a distinctive pair of root forms must remain distinct in the affixed/derived forms, i.e. PRESERVECONTRASTROOT-

DERIVED, is thus proposed to be added to the list of systemic contrast-based constraints (cf. (3-4)). Under Huojia D rime change, the unexpected nasal vowels can be accounted for in terms of maximization of perceptual distinctiveness. Under Huojia and Jiyuan *zi* rime change, the unexpected non-parsing of the [+round] feature is attributed to maintaining pair-wise output-output contrasts. In Hongan, the alternative allomorph [əɹ] is selected so as to maintain sufficient contrasts in the changed rimes for different root rimes, and the feature [-high] is replaced with [+high] in the changed rimes for [an]/[ən] so as to maintain sufficient contrasts in the changed rimes for different root rimes. The PARADIGMCONTRAST constraint, together with PRESERVECONTRASTROOT-DERIVED, is proposed to account for the paradigm gaps in Hongan. This study (i) suggests that contrast-based constraints can provide a unified account of certain types of unexpected but systematic linguistic forms, and (ii) adds to the growing body of research supporting a systemic approach to contrast preservation in phonology and morphology.

If this approach is on the right track, there are a couple of theoretical implications. First, The "do-nothing approach" may not be the best approach to unexpected but systematic morphophonological alternations that have remained unexplained or unanalyzed, especially when the data cannot be attributed to lexical idiosyncrasies. Second, the data and the analysis illustrate how the notion of *contrast* plays a crucial role in morphophonological alternations, suggesting that at least some unexpected and otherwise unexplained morphophonological outputs may be accounted for by appeal to phonetic/phonological and morphological contrast preservation.

Some of the questions for future research include: (i) How many and what types of morphophonological unexpected outputs can be explained by contrast preservation? (ii) Other than idiosyncratic lexical markings, paradigm uniformity and paradigm contrast, and now output-output contrast preservation, what additional formal devices are needed to account for unexpected outputs in morphophonological alternations? (iii) How should we deal with unexpected outputs or exceptions in general in phonological and morphophonological analysis? (iv) What phonetic and psycholinguistic experiments can be conducted to verify proposed formal analyses and to help understand how unexpected outputs are processed? It is hoped that this study can lead to more research on why unexpected outputs occur, how they are processed, and how linguistic theory can approach this difficult issue.

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