Vowel emphatic reduplication in Jeju Korean[*]

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Kang, Seokhan, and Rhee, Seok-Chae. 2009. Vowel emphatic reduplication in Jeju Korean. *Studies in Phonetics, Phonology and Morphology* 15.3. 423-439. It is argued that the emphatic reduplication of Jeju Korean is a case of cooperation of universal grammar of perception and localized grammar of production. While the general shape of emphatic forms is made through maximizing the perceptual distance such as Maximize Distance of Formants, the specific arrangement of the perceptual principles is applied by phonotactic grammars which are realized as raising and fronting in vowels. This process of negotiation between two grammars is a motivation of the emphatic reduplication. **(Seoul National University and Yonsei University)**

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I. Introduction

This paper claims that emphatic reduplication of Jeju Korean is driven by the negotiation between universal contrast of perception and localized grammar of production. It is argued that non-morphological motivation inherited in both perception and production is crucial in forming the vowel emphatic reduplication. That is, emphatic reduplication in Jeju Korean is controlled by perceptual principle – maximizing the contrast, but the specific grammar of production is formalized by localized phonotactic rules, in which production grammar realizes its goals through fronting and raising in vowels.

A key idea is that localized rules of production are strongly rooted in perceptual enhancement, in which the principles require unique grammar of production in Jeju Korean. Until now, the study of Jeju Korean emphatic reduplication tends to describe its phenomena on 'sound feeling' embedded in the words. Some researchers (e.g., Lee, 1982; Kang, 1986) classified the vowel emphatic forms of repeated adverbs into 40 classes of contrast pairs such as /ʌ/:/i/, /ʌ/:/e/, /o/:/i/, etc, claiming that vowel contrast could be explained as the conception of 'sound feeling'.

Generally the study of Jeju Korean emphatic reduplication was reported to have been closely related with onomatopoeia represented in Standard Korean. The studies (e.g., Martin, 1962; Cha, 1987, 2003; Park, 1993) of onomatopoeia which present the similar process to the emphatic forms as Jeju Korean have described the emphatic function as 'sound feeling'. Their suggestion is that positive vowels composed of non-high vowels of /a/, /o/ described as /ㅏ/, /ㅗ/, refer to the 'feeling of small things', while the negative vowels of high-vowels of /ɨ/, /u/, /i/ represented as /ㅡ/, /ㅜ/, /ㅣ/, refer to the 'feeling of large things.' (e.g., *tal.lang* vs. *təl.ləng*). This semantic explanation through the contrast of high vowels and non-high vowels, frequent in Korean or Japanese, missed the phonetics/perceptual principles even though the sound feeling takes place clearly from sound contrast resided in the phonemes.

The idea that the conception of 'sound feeling' should consider both speaker's production and listener's perception keeps pace closely with the current stream of the phonology. Some research in phonology (e.g., Jun, 1995; Steriade, 1995, 1997; Flemming, 1996, 2005; Rhee, 1999; Write, 2001) suggest that phonological grammar could be decided by perceptual principles. In this respect, it is true that emphatic formation is related with perceptual contrast (e.g., Wedel, 2000; Urbanczyk, 2005; Kang, 2008), but the phonological realization is different depending on the specific languages. Urbanczyk (2005) suggests that Turkish emphatic reduplication should be explained in the relationship between phonology and perception, in which perceptual contrast triggers phonological emphatic forms.

By following the principles of the functional phonology, this paper claims that emphatic reduplication in Jeju Korean should consider the interface between production and perception, in which the perceptual distance such as Maximize Difference of Formants causes particular phonotactic grammars such as raising and fronting in vowels.

Jeju Korean, a member of the Korean language family, has 14 consonants and 7 vowels, in which sound change occurs rapidly; Seoul Korean had 8 vowels in 1960s and 7 vowels in 1990s, while Jeju Korean had 9 vowels in 1960s and 7 vowels (or 8 vowels for rural speakers) (Cho, Jun, Jung, & Ladeforged, 2000). Figure (1) is the vowel inventory in Jeju Korean.

(1) Vowel inventory of Jeju Korean

	Front	Back
High	i	ɨ, u
Mid	e	ə, ʌ, o
Low	æ	a

Recently, /æ/ merges into /e/ along with /ʌ/ into /o/. On the contrary, consonantal change hardly occurs. Some researchers (e.g., Cheong, 1996;

Cho, Jun, & Ladeforged, 2002) reported that the consonantal difference of the acoustical features between Jeju and Seoul is not different significantly.

This study focuses on emphatic total reduplications used in Jeju Korean (e.g., *tong.ol.tong.ol.* → *tong.kol.tong.kol.* → *tong.k^{h}ol.tong.k^{h}ol.* → *tong.k^{h}ol.lak.tong.k^{h}ol.lak.*). Generally Jeju Korean has two types of reduplication – partial (e.g., *pə.t^{h}ɨk.* → *pə.t^{h}ɨ.tɨk.*), and total reduplication (e.g.,*cul.lak.* → *cul.lak.cul.lak.*) -, the emphatic total reduplications with four syllables become our object of the study. It is not unreasonable to choose the total reduplication with four-syllabic template (2 syllables of base plus 2 syllables of reduplicant) because most of the reduplications consist of 4-syllables, though some compose other structure with 2 or 6 syllables (e.g., *c'ɔk.c'ɔk.,* or *keng.kɨl.lang.keng.kɨl.lang.*).

Jeju Korean has various alternations such as vowel change (e.g., *pa.kak.pa.kak.* → *po.kak.po.kak.),* consonantal change (*pu.sa.pu.sak.* → *p^{h}u.sak.p^{h}u.sak.),* or co-change of vowel and consonants (*pang.us.pang.us.* → *pang.kus.pang.kus.).* Most variations occur in the vowels (51%) rather than in consonants (32%) or co-change in both vowels and consonants (32%). This study focuses on the vowel alternative reduplication which occupies the majority of the emphatic forms.

Vowel emphatic reduplication in Jeju Korean enforces the semantic meaning through various changed forms. For example, the 1st emphatic reduplication of '*p^{h}o.kɨn.p^{h}o.kɨn.*' derived from the base of '*p^{h}o.kɨn.*' with the meaning of 'warm' develops to the 2nd emphatic form of '*p^{h}u.kɨn.p^{h}u.kɨn.*' with the meaning of 'very warm' which has more strengthened semantic meaning.

Like the standard Korean, this kind of semantic strengthening also occurs in changing the base form, in which consonant or vowel alternation in the base form could create adverb-like verbs differently. For example, the basic form of '*p^{h}o.kɨn.*' with the meaning of 'warm' could be strengthened to '*p^{h}u.kɨn.*' so that each adverb can make different words attaching verb-suffix of '*ha.ta.*' like '*p^{h}o.kɨn.ha.ta.*' (it is warm) or '*p^{h}u.kɨn. ha.ta.*' (it is very warm).

Interestingly, these two emphatic forms derived from the same base develop to the emphatic forms differently: the original base of '*p^{h}o.kɨn.*' has the emphatic reduplication of '*p^{h}o.kɨn.p^{h}o.kɨn.*', while the emphatic base of '*p^{h}u.kɨn.*' has the emphatic reduplication of '*p^{h}u.kɨn.p^{h}u.kɨn.*'. So the meaning hierarchy could be done as follows: '*p^{h}o.kɨn. >> p^{h}u.kɨn.*, or *p^{h}o.kɨn.p^{h}o.kɨn. >> p^{h}u.kɨn.p^{h}u.kɨn.*'

This study will be carried out around phonological changes of the reduplications because our concern lies on the sound variation, comparing various emphatic reduplications. The organization of this paper is as follows: in the next section, the formation of emphatic reduplication is presented, in which general characteristics are mentioned. Section 3 presents the data of vowel variations: fronting and raising. Section 4 discusses process and direction which occupies the emphatic reduplication

realized in vowel variation. In section 5, we argue that the emphatic reduplication is the process of negotiation between the universal grammar of perception and the localized grammar of production.

2. The formation of emphatic reduplication

Alternative reduplication to which the non-morphological paradigm is applied implies the asymmetrical phoneme coordination between original and changed sounds through input and output, or output and output. Depending on the relationship between input and output, or output and output, we can classify reduplication into 3 kinds universally: the groups of same I(nput)-B(ase) and different B(ase)-R(eduplicant), of different I-B and same B-R, and of different I-B, different I-R, and same B-R as seen in (2).

(2) The models of alternative reduplication

a. B   ≠   R   b. B   =   R   c. B   =   R
  ‖   ⊬   ⊬   ⊬
  I   I   I

*I: input.   B: base.   R: reduplicant.

By following this model, (a) represents a typical partial reduplication and (b) is a total reduplication controlled by phonological rules, while (c) represents emphatic reduplication. Following examples represent the cases of (a) and (b) models.

(3) Data of (a) and (b) models

    a. Seoul Korean (Jun and Lee, 2006)
    siŋsuŋ   siŋsuŋ-sɛŋsuŋ
    holkis   holkis-halkis
    mulk'ɨrəm   mulk'ɨrəm-malk'ɨrəm
    allok   allok-tallok
    əlluk   əlluk-təlluk
    omok   omok-comok

    b. Javanese (Inkelas, 2008)
    donga   dongɔ-dongɔ
    abur   abʊr-abʊr
    tules   tulis-tulis-an
    tutop   tutup-tutup-an

The cases of (a) express the asymmetry relationship between base and reduplicant (Output-Output dissimilation), violating the O-O Identity. The alternative reduplication implies OCP effect in output-output relationship. Jun and Lee (2006) reported that Korean partial reduplication is occurred by high ranked OCP and some PHON constraints along with morphological constraint of CONTIG. On the contrary, the cases of (b) refer to the sound asymmetry between I-B and B-R reduplication. The violation of I-B faithfulness arises from the requirement of production grammar. In the case of Javanese, the phonological grammar of vowel rounding, laxing, lowering, and h-deletion in final position prohibits the symmetrical input occurrence.

Unlike the formation of (a) and (b), the emphatic form of (c) model shows the different sound coordination between first and second output, along with the symmetrical coordination between base and reduplicant in each output level. Even though they have same morphological copy between input and reduplicant, their outputs are different depending on each emphatic level. Jeju Korean reduplication tends to follow the cases of different I-B, different I-R, and same O2-O2 which could be found similar data in Seoul Korean. In spite of the similar process, the emphatic reduplication in Jeju Korean is a much richer phenomenon than in Seoul Korean. The data on normal and emphatic reduplications of two dialects of the Korean language are presented as follows:

(4) Emphatic reduplication data

a. Seoul Korean

pal.khak.	pal.khak.pal.khak.	pəl.khək.pəl.khək.
k'am.pak.	k'am.pak.k'am.pak.	k'am.p'ak.k'am.p'ak.
	k'im.p'ək.k'im.p'ək.	
tal.s'ak.	tal.s'ak.tal.s'ak.	tɨl.s'ək.tɨl.s'ək.
chal.sak.	chal.sak.chal.sak.	chəl.s'ək.chəl.s'ək.

b. Jeju Korean

kong.kɨl.	kong.kɨl. kong.kɨl.	
	kong.kɨl.lak.kong.kɨl.lak.	
	kung.kɨl.kung.kɨl.	
	kung.kɨl.lak.kung.kɨl.lak.	
	kung.kɨl.lang.kung.kɨl.lang.	
kɔm.cak.	kɔm.cak.kɔm.cak.	kɔm.c'ak.kɔm.c'ak.
cuŋ.kɨs.	cuŋ.kɨs.cuŋ.kɨs.	cuŋ.k'ɨs.cuŋ.k'ɨs.
ku.tɨl.	ku.tɨl.ku.tɨl.	k'u.tɨl.k'u.tɨl.
co.kɨl.	co.kɨl.co.kɨl.	c'o.kɨl.c'o.kɨl.
pɔl.chak.	pɔl.chak.pɔl.chak.	pal.chak.pal.chak.

     pəl.chak.pəl.chak.   pul.chak.pul.chak.
     pul.chik.lak.pul.chik.lak.

* source: Jeju Korean - Cecumal Kɨn Sacen. (Song, S-J. 2007)
    Seoul Korean – Yonsei Hankuker Sacen (Yonsei Univ., 2006)

In this study, 2251 reduplications in both Koreans are checked. 74 % of 1741 reduplications in Jeju Korean have emphatic forms, while only 43% of 532 reduplications in Seoul Korean have its emphatic forms. They have different numbers in emphatic forms. In Jeju Korean, the reduplication with one-time emphatic forms occupies 71% along with 17% of two-time emphatic form, 6% of three-time form, and 3 % over four-time form, while Seoul Korean has 80% of one-time form and 18% of two-time form. It is safe to say that emphatic forms are a much richer in Jeju Korean than in Seoul Korean.

While Seoul Korean achieves its emphatic form through changing the vowels regardless of the syllable placement on whether it is penult or ultima, Jeju Korean follows some specific rules on vowel heightening or fronting, and syllable placement. Even though Jeju Korean has the various alternations such as vowel change (51%), consonantal change (17%), or co-change of vowel and consonant (32%), the study focuses only on vowel variations.

In the case of vowel variation, the structure of the pre-changed stem favors the mid-vowel in the penult (62%) and non-mid vowel in the ultima (90%) (e.g., *tʌŋ.kɨl.tʌŋ.kɨl.*). Especially /æ/, /ə/ may not occur in the ultimas, while /ʌ/, /o/, or /a/ favors the occurrence in the penults.

Vowel variation has the favor of change in penult rather than in ultima. The search for 395 emphatic forms reveals that the penult is easily changed as 67% (e.g., *sɨ.lɨk.sɨ.lɨk.* → *si.lɨk.si.lɨk.*) rather than 17% of ultima (e.g., *i.sɨl.i.sɨl.* → *i.sil.i.sil.*). The other 16% of the variations include the syllable insertion, or onset/coda-alternation without changing vowels or consonants themselves (e.g., *kən.tɨs. kən.tɨs.* → *kən.tɨl. kən.tɨl.*).

3. Vowel variation

The emphatic form through vowel change has two patterns; fronting and raising, in which over 70% of the vowel change prefers its raising rather than the fronting. Also the change favors in penults rather than in ultimas. Along with the vowel height and front, the syllable placement of the variation (penult or ultima) is very critical because its placement takes part in deciding the variation frequency.

One-way ANOVA conducted for each task shows that the variation is greatly related with the height and front of the pre-changed vowels in penults, $F(2,393)=17.8$, $p<.01$, and in ultimas, $F(2,393)=4.2$, $p<.05$, the changed vowels in penults, $F(2,393)=33.7$, $p<.01$, and ultimas,

F(2,393)=17.8, p<.05. It means that the syllable placement (penult or ultima) in the structures of base or reduplicant has an influence on the variation forms with height and front.

3.1. Raising

(5) a → o   pʰak.sak.pʰak.sak. → pʰok.sak.pʰok.sak.
             pa.kak.pa.kak. → po.kak.po.kak.

(6) o → u   pʰo.kɨn.pʰo.kɨn. → pʰu.kɨn.pʰu.kɨn.
             pol.t'ak.pol.t'ak. → pul.t'ak.pul.t'ak.
             ko.sil.lak.ko.sil.lak. → ku.sil.lak.ku.sil.lak.
             ko.bos.ko.bos. → ko.bus.ko.bus.
             po.kak.po.kak. → pu.kak.pu.kak.

(7) a → i   pʰa.ci.cik.pʰa.ci.cik. → pʰi.ci.cik.pʰi.ci.cik.
             pi.cal.pi.cal. → pi.cil.pi.cil.
             can.tɨk.can.tɨk. → cin.tɨk.cin.tɨk.

(8) a → ə   k'ul.k'ak.k'ul.k'ak. → k'ul.k'ək.k'ul.k'ək.
             tu.sang.tu.sang. → tu.səng.tu.səng.
             tɨm.sang.tɨm.sang. → tɨm.səng.tɨm.səng.
             kan.tɨl.kan.tɨl. → kən.tɨl.kən.tɨl.

(9) a → u   pal.tʰang.pal.tʰang. → pul.tʰang.pul.tʰang.
             ke.cak.ke.sak. → ke.cuk.ke.cuk.

(10) æ → i   pæ.tɨl.lang.pæ.tɨl.lang.→ pi.tɨl.lang.pi.tɨl.lang.
             pæ.s'ɨk. pæ.s'ɨk. → pi.s'ɨk.pi.s'ɨk.

(11) ə → i   tə.k'in. tə.k'in. → ti.k'in. ti.k'in.
             təl.kang.təl.kang. → til.kang.til.kang.

(12) ʌ → i   tʌl.s'ak.tʌl.s'ak. → til.s'ak.til.s'ak.
             tʌn.cik.tʌn.cik. → tin.cik tin.cik.
             cʌl.kang.cʌl.kang. → cil.kang.cil.kang.

(13) ʌ → u   pʌl.k'in.pʌl.k'in. → pul.k'in.pul.k'in.
             kʌm.c'ak.kʌm.c'ak. → kum.c'ak.kum.c'ak.

The vowel raising, mainly /o/ → /u/, /a/ → /ə/, occurs in penult (the first syllable of the base) with some exceptions shown in (8), under condition that /a/, /ɨ/, and /o/ remain unchanged in ultima (the second syllable). It means that non-high back vowels tend to rise to the place of the non-low vowels.

Height in Jeju Korean vowels is partially predictable. In the stem of the reduplication, it is common form composed of non-high vowel in penult and non-low vowel in ultima. However, this default formation has the emphatic counterpart with high vowels in both penult and ultima as seen in the Table 1.

Table 1. The raising movement of the vowels between original and changed reduplication

	Pre-changed		After-changed	
	Penult	Ultima	Penult	Ultima
High	60	**196**	**208**	**231**
Mid	**235**	35	93	25
Low	86	158	84	133

This table shows that mid-vowels tend to rise to high vowels, while low-vowels tend to keep their articulatory place. In the original reduplications, the forms of mid-vowels in penult and high-vowels in ultima are quite common such as *'ko.tɨl.ko.tɨl → ku.tɨl.ku.tɨl.'* The majority of stems with mid-vowel in penults (almost 61%) rise as seen in (14. a), but 39% fail to rise, while the low-vowels in penults refuse to rise to the non-low vowels as seen in (14. b).

(14)   a. tʌl.s'ak.tʌl.s'ak.   →   tɨl.s'ak.tɨl.s'ak.
           cʌl.kɨs. cʌl.kɨs.   →   cil.kɨs. cil.kɨs.
           hək.sak.hək.sak.   →   hɨk.sak.hɨk.sak.

       b. paŋ.sak.paŋ.sak.   →   pɛŋ.sak. pɛŋ.sak.
           pan.tɨl.pan.tɨl.   →   pan. tɨk.pan.tɨk.
           tal.kaŋ.tal.kaŋ.   →   tal.kɨ.laŋ.tal. kɨ.kaŋ.

In the data of (b) which refuse to rise, strategy to choose the variation includes fronting, onset/coda change, or syllable addition.

3.2. Fronting

The vowels of normal reduplication achieve its goal to move the vowel feature in penults forward to the front placement of the vowel inventory.

(15) ɨ → i   sɨl.kɨs.sɨl.kɨs. → sil.kɨs.sil.kɨs.
               sɨl.c'ak.sɨl.c'ak. → sil.c'ak.sil.c'ak.
               sɨl.kang.sɨl.kang. → sil.kang.sil.kang.

(16) ʌ → a   tʰʌl.kɨ.lak.tʰʌl.kɨ.lak.→tʰal.kɨ.lak.tʰal.kɨ.lak.
               pʌ.tɨk.pʌ.tɨk. → pa.tɨk.pa.tɨk.

(17) a → e   pa.kɨl.lak.pa.kɨl.lak. → pe.kɨl.lak.pe.kɨl.lak.
pang.sak.pang.sak. → peng.sak.peng.sak.
ca.kɨl.ca.kɨl. → ce.kɨl.ce.kɨl.
hang.kɨl.lang.hang.kɨl.lang.→
heng.kɨl.lang.heng.kɨl.lang.

(18) ə → e   pən.ti.ling.pən.ti.ling.→ pen.ti.ling. pen.ti.ling.
pəl.luk.pəl.luk. → pel.lik. pel.lik.
təp.pak.təp.pak. → tep.pak.tep.pak.

(19) u → i   puk.cak.puk.cak. → pik.cak.pik.cak.
pul.lak.pul.lak.   → pil.lak.pil.lak.
cu.cʰum.cu.cʰum. → cu.cʰim.cu.cʰim.

The vowel fronting, mainly in the change form of /ɨ/ → /i/, or /a/ or /ə/ → /e/, occurs in penults of the base, under condition that /a/ and /ɨ/ leave unchanged in ultimas.

Fronting in Jeju Korean vowels is partially predictable. In the stem of the reduplication, it is common forms composed of back-vowels in both penults and ultimas. The formation changes into back-vowels in penults and non-back vowels in ultimas as seen in Table 2.

Table 2. The fronting movement of the vowels between original and changed reduplication

	Pre-changed		After-changed	
	Penult	Ultima	Penult	Ultima
Front	48	27	75	46
Mid	101	130	127	**272**
Back	**226**	**157**	**174**	70

This table shows that back-vowels tend to move forward to non-back place (mid or front place) in both penults and ultimas. The small percentage of stems with back-vowels in penults as only 23% is fronting, in which the high back vowel of 'u' tends to refuse to be fronting as seen in (20.a). On the contrary, the majority of back vowels in ultima (almost 55%) is fronting as seen in (20.b), in which back-vowels in ultimas are easily frontized rather than those in penults. It means that the vowel front as well as vowel height is critical to trigger the variation.

(20) (a) tum.sim.tum.sin.   → tum.sil.tum.sil.
su.kun.su.kun.   → su.kun.tak.su.kun.tak.
ku.pak.ku.pak.   → k'u.pak.k'u.pak.

(b) pʌ.tak.pʌk.   → pə.tak.pə.tak.
     cʌŋ.kɨs.cʌŋ.kɨs.   → ciŋ.kɨs.ciŋ.kɨs.
     puk.cak.puk.cak.   → pik.cak.pik.cak.
     mun.cal.mun.cal.   → min.cal.min.cal.

4. The emphatic process

4.1. Morphological motivation

The emphatic process has two kinds of motivations: morphological and non-morphological motivations. Morphological motivation is applied, repeating its morphological base. The examples are pairs of bases and reduplicants as follows:

(21) Morphological reduplication in Jeju Korean

     kʌm.cak.   kʌm.cak.kʌm.cak.
     to.kin.   to.kin.to.kin.
     tiŋg.kis.   tiŋg.kis.tiŋg.kis.
     cəl.tuk.   cəl.tuk.cəl.tuk.
     pɔl.cʰak.   pɔl.cʰak.pɔl.cʰak.
     te.kak.   te.kak.te.kak.

The base repeat gives rise to morphological enhancement. Pure reduplication follows the constraint of IDENT [IR] – [F] which requires the same features between input and reduplicant, just repeating the base. This occurs only within the morphological boundary. The critical point in the case of emphatic reduplication, however, is that emphatic forms require phonological motivation rather than morphological structure.

4.2. Phonological motivation

4.2.1. Principles for vowel change

Phonological motivation of perception and production leads the emphatic forms through vowel change such as fronting and heightening after morphological repeat. The phonotactic constraints of perceptual OCP(Obligatory Contour Principle) are deeply involved in creating emphatic forms.

Generally OCP means that output must not contain two identical elements (Leben, 1973; Goldsmith, 1976; MaCarthy, 1986, 1995). This formulation is dependent on tier segregation. Suzuki (1998) reformulates the OCP to avoid the tier-dependence and suggests GOCP (generalized obligatory contour principle) which prohibits occurrence of X. Yip (1998) adopts the feature in the conception of OCP. Her assumption is that the

scope of OCP is expanded from ruling out identical root nodes to ruling out identical features.

Boersma (2000) criticizes production-oriented OCP in that he provides the grammar with faithfulness-like constraints that favor the presence of specific acoustic cues in the output. By following his assumption, OCP is suggested as the interaction between acoustic cues and perceptual features. In this respect, the constraint of OCP $\Delta(\alpha_1, \alpha_2)$ suggests that the maximal acoustic difference of cue1 and cue2 leads the perceptual features in its output, in which these features form the specific production grammar. The difference of some main cues triggers the phonological contrast in the partial reduplication.

Vowel variation in Jeju Korean occurs between the input and the output, keeping the OCP between penults and ultimas. The vowel raising, mainly derived from the change form of /o/ → /u/, or /a/ → /ə/, occurs in penults of the base, under condition that /a/, /i/, and /o/ remain unchanged in ultimas of the base.

The sound variation occurred in vowels of either penults or ultimas leads to the perceptual contrast between two syllables within a base. The contrast model of vowel change is given in (22).

(22) Contrast model of vowel change

back/low vowel   front/high vowel

                        contrast

Minimize △[F2-F1] ⟷   Maximize △[F2-F1]
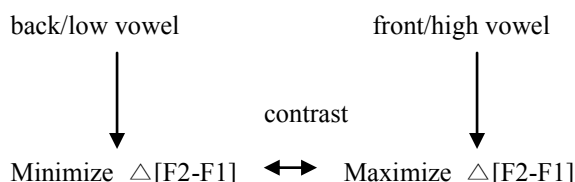
It seems that raising and fronting are the different phenomena, but the apparently different production merges into unique perceptual goal: maximizing the difference of F1 and F2 which prefers the front/high vowels. It is well known that F1 varies mostly with tongue height, while F2 varies mostly with tongue advancement. Figure 1 shows stylized formant patterns that illustrate this acoustic-articulatory relation. In general, low and back vowels have a small F2-F1 difference, whereas high and front vowels have a large F2-F1 difference.
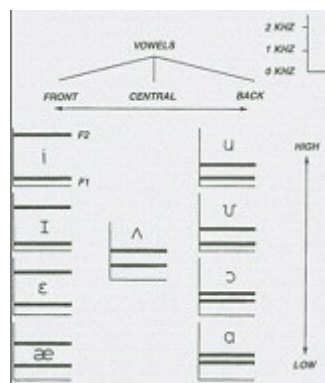
Figure 1. Stylized spectrograms showing the relationship between F1 and F2 (Kang, 2007).

We can find similar patterns in Jeju Korean vowels. Utsugi and Fukumori (1999) reported the formant frequency of 7 Jeju Korean vowels for women like follows:

Table 3. Formant frequency of F1 and F2 for Jeju Korean women.

	F1	F2
i	356	2789
ε	680	2427
a	1135	1587
ɔ	722	1186
o	515	890
u	416	992
ɨ	429	1157

By following this report, the direction of fronting and raising pursues the maximum difference between F1 and F2. We can set up the constraint of Maximum $\triangle$(F2-F1) which requires the fronting and raising of vowels.

4.2.2. The direction of the process

The direction of the vowel variation keeps the rule of perceptual distance of formants so that the asymmetry between the input and the output causes the maximum contrast of F1 and F2 between penults and ultimas. The reason why the emphatic forms of Jeju Korean follow the non-low front vowels is to meet the perceptual distance between penults and ultimas. We can summarize the direction of the vowel variation.

First, they have the specific rules in variations: triggers should be mid-back vowels in both penults and ultimas such as /ʌ/, or /o/, while high-back vowel of /u/ triggers the change only in ultimas. It means that syllable placement as well as articulatory place of vowels (height or front) is critical in the variation. The search for 395 emphatic forms reveals that the exposure to change takes place mainly in penult as 67% rather than in ultimas as 17%. The other 16% of the variations include the syllable insertion, or onset/coda-alternation.

Second, the frequency of heightening in low vowels is comparatively rare, while back vowels show the large amounts of movement to the place of non-back vowels. In the search, low-vowels in both penults (84/86) and ultimas (133/158) hard to be raised to the non-low vowels, while back-vowels in both penults (174/226) and ultimas (70/157) move forward comparatively easily. The difference could be related with the perceptual contrast of formants. The low vowels already have comparatively large distance of formants, while the back vowels show a small difference of F1 and F2.

Third point is that only 25% (57 out of 226 words) in penults moves forward to the non-back place, while comparatively large amount of 57% (87 out of 157 words) in ultimas causes the movement. The result shows that sound variation triggered by perceptual difference considers the articulatory sides.

Finally, the maxima forms which reach the high and front place such as [i] choose other strategies if they want to enforce the semantic feeling more. The rules of coda addition, syllable addition, onset-alternation in consonants, or tensification or aspiration as feature alternation substitute the effect of vowel alternation. All of the rules embedded in vowels, consonants, and features pursue the OCP between two syllables.

5. Conclusion

The emphatic reduplication form of Jeju Korean pursues the functional goal of non-morphological negotiation between localized grammar of production and universal contrast of perception. Morphological function has the limitation only in making pure reduplication with the base repeating twice. Beyond the first morphological reduplication, perceptual OCP strongly applied under the condition that penults and ultimas must have perceptual asymmetry in formants in the case of vowel alternation.

This asymmetry principle of perception produces the localized grammar of production existed in Jeju Korean: raising and fronting in vowels. The OCP, representing global constraint of perception, shapes the macro-structure of the emphatic form, while the asymmetrical feature arrangement to meet OCP causes language-specific grammar of raising and fronting in one syllable, leaving unchanged in other syllables.

In the emphatic process, the preference to feature change exists, in which heightening in vowel change is a much favor rather than fronting in vowels. It seems that acoustical perception on F1 contrast is bigger than on F2 contrast in its degree. That is, the change in F1 has the greater perceptual influence than in F2. The perceptual effect leads the sound change in the emphatic reduplication.

Along with the perceptual difference, we should consider easy production, in which the syllable placement in base or reduplicant takes part in deciding the direction of emphatic variations. The priority puts heavily on penult rather than on ultima. It seems that the change in the first syllable is easy for Jeju Koreans. The principles of perception and production lead the sound change in emphatic reduplication.

Appendix A. Vowels of Jeju Korean

[i]	ㅣ
[u]	ㅜ
[ɨ]	―
[e]	ㅔ
[o]	ㅗ
[æ]	ㅐ
[ə]	ㅓ
[ʌ]	·
[a]	ㅏ

Appendix B. Glossary

	Represented data	Meaning
(5)	pʰak.sak.pʰak.sak.	crisp
	pa.kak.pa.kak.	scrape
(6)	pʰo.kin.pʰo.kin.	warm
	pol.t'ak.pol.t'ak.	hopping
	ko.sil.lak.ko.sil.lak.	crooked
	ko.bos.ko.bos.	tamely
	po.kak.po.kak.	bubble
(7)	pʰa.ci.cik.pʰa.ci.cik.	flashing
	pi.cal.pi.cal.	stagger
(8)	k'ul.k'ak.k'ul.k'ak.	gulping
	tu.sang.tu.sang.	buzz
	tim.sang.tim.sang.	sparsely
	kan.til.kan.til.	wobble

(9) pal.thang.pal.thang.   burst
     ke.cak.ke.sak.   forcibly

(10) pæ.tⁱl.lang.pæ.tⁱl.lang.   abruptly
     pæ.s'ⁱk. pæ.s'ⁱk.   sloping

(11) tə.k'ⁱn. tə.k'ⁱn.   fully
     təl.kang.təl.kang.   clattering

(12) tʌl.s'ak.tʌl.s'ak.   boisterous
     tʌn.cik.tʌn.cik.   robustly
     cʌl.kang.cʌl.kang.   sticky

(13) pʌl.k'ⁱn.pʌl.k'ⁱn.   all of a sudden
     kʌm.c'ak.kʌm.c'ak.   budging

(15) sⁱl.kⁱs.sⁱl.kⁱs.   furtively
     sⁱl.c'ak.sⁱl.c'ak.   skillfully
     sⁱl.kang.sⁱl.kang.   nimbly

(16) thʌl.kⁱ.lak.thʌl.kⁱ.lak.   rattling
     pʌ.tⁱk.pʌ.tⁱk.   abruptly

(17) pa.kⁱl.lak.pa.kⁱl.lak.   all of sudden
     pang.sak.pang.sak.   smile
     ca.kⁱl.ca.kⁱl.   sizzling
     hang.kⁱl.lang.hang.kⁱl.lang.   swaying

(18) pən.tⁱ.lⁱng.pən.tⁱ.lⁱng.   impudent
     pəl.luk.pəl.luk.   unexpectedly
     təp.pak.təp.pak.   strutting

(19) puk.cak.puk.cak.   bustling
     pul.lak.pul.lak.   rash
     cu.chum.cu.chum.   hesitantly

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