On Constraint Combinations*

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Lee, Yongsung. (2013). On Constraint Combinations. *The Linguistic Association of Korea Journal, 21*(3), 151-172. This paper introduces three types of constraint combinations applicable in Optimality theoretic analyses: conjunctive combinations (CAP-junctions), disjunctive combinations (CUP-junctions) and implicational combinations (IF-junctions). Each of these combinations is discussed with illustrations from the phonological data previously introduced in different theoretical frameworks. It shows that combined constraints have a vital role to play in Optimality theoretic analyses of various phonological and morphological phenomena. It also presents the reanalysis of coda consonant voicing assimilation to show that we can dispense with markedness-faithfulness combination. It supports the idea that only the constraints from the same constraint family can be combined.

Key Words: Optimality theory, constraint combination, conjunction, disjunction, implication, coda conditions, onset conditions, Diyari stress, Dyirbal ergative allomorphs, Western Aranda stress, voicing assimilation.

1. Introduction

Since its introduction in Green (1993) & Smolensky (1993), the constraint conjunction has been repeatedly employed to build up complex constraints from primitive ones. These complex constraints have played dynamic roles in explaining apparently difficult issues in Optimality theory (=OT). For example, Moreton and Smolensky (2002) successfully employed the constraint conjunction

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in their explanation of chain shifts, part of the so-called underapplication opacity. Itô & Mester (1998) expand the application of constraint conjunction to other types of underapplication opacities. Crowhurst (2011) surveys different types of constraint conjunctions based on the formal logic of Boolean operations.

This paper is partially based on Crowhurst & Hewitt's (1997) and Crowhurst's (2011) proposal on constraint conjunctions. But it goes further to show that they can be applied to the actual data and that we need more refined conditions on possible constraint combinations. To that end, this paper introduces three different types of constraint combinations and how they deal with some recalcitrant problems in phonological research. To be more specific, this paper proposes disjunctive combination (CUP-junction), conjunctive combination (CAP-junction) and implicational combination (IF-junction) and illustrates how these combinations are used in selecting optimal forms.

Further, this paper discusses conditions on possible constraint combinations. It supports the restriction on combinability proposed by Itô & Mester (1998) that only the constraints of the same family can be combined, i.e. we argue against the combination of a markedness constraint with a faithfulness constraint. The focus is given to the reanalysis of Dutch-style consonant cluster voice assimilation given in Crowhurst (2011) based on Lombardi (1999) and Bakovič (2000). It shows that markedness-faithfulness combination (=MF combination) can be dispensed with and it supports the claim that a faithfulness constraint and a markedness constraint cannot be conjoined.

Accordingly, we will discuss the three different constraint combinations in Section 2. Section 3 will argue against the combination of constraints from different constraint family and Section 4 wraps up the discussion and concludes this paper.

2. Three Constraint Combinations

Crowhurst & Hewitt (1997) introduce three types of connectives to form complex propositions from simple ones. In formal logic, these connectives, or operators, are used in judging the truth value of the combined propositions. These Boolean operators are given in (1):

(1) Boolean operations

a. Conjunction:	$X \cap Y$	X and Y
b. Disjunction:	$X \cup Y$	X or Y
c. Implication:	$X \rightarrow Y$	if X then Y

The truth value interpretation of these complex propositions goes as follows. The conjunctive combination of propositions in (1a), $X \cap Y$, is true if and only if both X and Y are true. The disjunctively conjoined proposition in (1b) is false if and only if both X and Y are false. Finally the implicational conjunction in (1c) is false if and only if X is true but Y is false. These truth value judgments in formal logic can also be interpreted to mean satisfaction or violation of the combined constraints. In the following subsections, we will see how these logical combinations work in conjoined constraints.

2.1 CUP-junction

We will first talk about (1b) as it is the most common type of constraint combination, also known as local constraint conjunction.[1] When two constraints X and Y are disjunctively combined, the complex constraint is violated if and only if both X and Y are violated. We may see it in the following table.

(2) Disjunctive combination (CUP-junction)

	[X∪Y]	X	Y
a.	✓	✓	✓
b.	✓	*	✓
c.	✓	✓	*
d.	*!	*	*

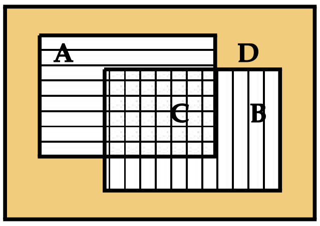
The logical disjunction, [X∪Y], is informally read "X-CUP-Y," hence the term CUP-junction, which is used to mean the disjunctive combination in this paper. (2) shows that the CUP-joined constraint, [X∪Y], is violated when both X and Y

1) The term “conjunction” is confusing as it may mean the disjunction in (1b) and at the same time, it may also mean the “conjunction” given in (1a). We stay away from this ambiguous term, “conjunction” and use “combination” instead.

are violated as in (2d). This is the way to filter out the worst form of violation and Crowhurst (2011. p. 1462) described it as rejecting the "worst of the worst."

We also see its effect in the set theory. Suppose that D is the universal set, the set that includes all the elements[2] and that there are two sets in D such that set X has subsets of A and C, and that Y has the subsets of C and B. We can represent the distribution of the sets X and Y in D as in (3):

(3) Representation of violation in set theory model for [X∪Y]



X = A + C
Y = C + B

In (3), the grey area represents the violation or falsehood of the combined constraint, [X∪Y]. When a structure is the member of A, B, or C, the structure passes the evaluation. But if a structure does not belong to any of the set A, B or C, it is marked as violation of the combined constraint, [X∪Y].

The typical example of CUP-joined constraints is coda condition. The coda condition is shown in various languages. For example, English does not allow /h/ in coda. In Korean [-continuant] and/or [+spread glottis] is banned in coda. In Japanese, obstruents are forbidden in coda. Again, German codas do not have voiced obstruents. As a matter of fact, it is generally accepted that there is an asymmetry in the distribution of consonants in that onsets have more segments or features than codas. Such coda conditions can be represented as CUP-junction of markedness constraints.

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2) It should be made clear at this point that Set D encompasses all the sets including A, B and C in (3). To be more specific, the scope of Set D is to be defined for each CUP-joined constraint. Local constraint conjunction proposals (Smolensky, 1993, Prince & Smolensky, 1993) come with a certain domain where the conjoined constraints work. The domain here is viewed as a device to restrict Set D.

(4) Schematic representation of CodaCond

CodaCond = [NoCoda ∪ Segmental/Featural Markedness]$_{SEG}$

In this case, having either a coda or a marked segment/feature is not critical in the given language, but the violation of both of these markedness constraints results in the violation of the CUP-joined constraint in evaluation.

The local self-conjunction is another case of CUP-junction. Itô & Mester (1998) show that the OCP effect can be best explained by employing self-conjunction.[3] They observe the well-formedness condition of Japanese mono-morphemic words and confirm the Lyman's law that a morpheme cannot have two voiced obstruents. Consider the following examples.

(5) Lyman's Law in Japanese morphemes (Itô & Mester, 1998, p. 2)

a. futa (lid)
b. fuda (sign)
c. buta (pig)
d. *buda

There is no word like (5d) in Japanese. The Lyman's Law says that the words in (5a), (5b) and (5c) have at most one voiced obstruent. Now, when there are two or more voiced obstruents as in (5d), it leads to the violation of the self-conjoined constraint *VoiObs^2. This can be viewed as a special case of constraint conjunction, which can be represented by [$X_i \cup X_j$]. This constraint may allow the presence of a voiced obstruent in a morpheme. But if there are two or more voiced obstruents in a candidate, it is filtered out by the self-conjoined constraint.

Another use of CUP-junction is in explaining counterfeeding or underapplication opacity. The typical example of counterfeeding opacity is found in Bedouin Arabic (cf. McCarthy, 2007). In this language, the vowel

3) The OCP or the Obligatory Contour Principle is the term first introduced in Goldsmith (1976). McCarthy (1986, p. 208) gives the following formal definition of OCP:

The Obligatory Contour Principle (=OCP)

At the melodic level, adjacent identical elements are prohibited.

The OCP blocks the presence of multiple number of the identical constraint.

raising and epenthesis interact in an interesting way to produce opacity. Consider the brief description of Bedouin Arabic phonology:

(6) Bedouin Arabic vowel raising and epenthesis (McCarthy, 2007)
a. Raising of /a/ in an open syllable. (*aCV ≫ ID(low))
/katab/ → ki.tab 'he wrote'
b. Epenthesis (NoComplex ≫ Dep-V)
/himl/ → hi.mil 'load'
c. Interaction: raising → Epenthesis
/gabr/ → ga.bur (*gi.bur) 'a grave'
d. Wrong evaluation

gabr	NoComplex	*aCV	Dep-V	ID(low)
? actual ga.bur		*!	*	
✓chosen gi.bur			*	*

The constraints given in (6) are from McCarthy (2007). The undesirable result shown in (6d) represents the problem in opacity. As shown in (6a) *aCV should be higher than Ident(low). But as long as we keep the ranking, ⟦*aCV ≫ ID(low)⟧, there is no plausible way to explain the opaque interaction in Bedouin Arabic. However, if we set up a combined constraint, $[\text{ID(low)} \cup \text{Dep-V}]_{\text{ADJ-}\sigma}$, and put it anywhere above *aCV, we can get the correct result as shown in (7):

(7) Correct evaluation of Bedouin Arabic opacity

gabr	[ID(low) ∪ Dep-V][4]	No Complex	*aCV	Dep-V	ID (low)
✓a. ga.bur			*	*	
b. gi.bur	*!			*	*

(7) tells us that the problem with [gibur] is that there are violations of two faithfulness constraints in a given domain, the adjacent syllables. This is a very

4) The domain of the combined constraint is not represented except in the formal definition for the sake of descriptive simplicity.

straightforward way to capture the deviant behavior of counterfeeding opacity in Bedouin Arabic as well as in many other languages.5)

2.2 CAP-junction

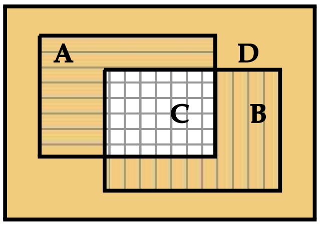
Though constraint conjunction in OT usually means the CUP-junction introduced in 2.1, there are other cases of constraint combinations. In this subsection, we turn to Boolean conjunction in (1a). Crowhurst (2011) observes that the Boolean conjunction can be employed in constraint combination to select the "best of the best." Here the combined constraint, [X∩Y] (X-CAP-Y), is satisfied if and only if both X and Y are satisfied. In this paper, the combination X∩Y is called CAP-junction. Consider the violation table and the distribution of violation given in (8):

(8) CAP-junction

a. violation table

	[X∩Y]	X	Y
i.	✓	✓	✓
ii.	*	*	✓
iii.	*	✓	*
iv.	*	*	*

b. Representing violation distribution



(Grey area represents violation.)

As shown in (8), the CAP-joined constraint, $[X \cap Y]_D$, is satisfied only when

5) It should be pointed out that McCarthy (2007, p. 35) takes issues with the domain of the conjoined constraint $[ID(low) \cup Dep\text{-}V]_{ADJ\text{-}\sigma}$, citing the problem it may have in explaining the violation of the combined faithfulness constraint in heteromorphemic adjacent syllables. This potential problem, however, does not concern us in this paper as it needs further research.

both X and Y are satisfied in a given domain. In (8b), we see that only those elements in Set C, representing the satisfaction of X and Y at the same time, can pass the evaluation.

Crowhurst (2011) shows a convincing example of using CAP-junction to explain the distribution of stress in the Diyari language. Diyari has a syllable trochee stress system. Consider the Diyari foot structures:

(9) Diyari footing (data rearranged from Crowhurst, 2011, p. 1478)

a. Monomorphemic words

ˈkaɲa	(ˈkaɲa)	"man"
ˈpinadu	(ˈpina)du	"old man"
ˈŋandaˌwalka	(ˈŋan.da)(ˌwal.ka)	"to close"
ˈwintaraˌnaya	(ˈwinta)ra(ˌnaya)	"how long"

b. Polymorphemic words

ˈmaɖa-ɭa-ɲi	(ˈmaɖa)-ɭa-ɲi	"hill-char-loc"
ˈpinadu-ˌwaɽa	(ˈpina)du-(ˌwaɽa)	"old man-pl"
ˈɲanda-na-ˌmaʈa	(ˈɲanda)-na-(ˌmaʈa)	"hit-past-ident"

Diyari words have primary stresses in the initial syllables, but the distribution of the secondary stress needs some refinement. The final example in (9a) shows that feet are aligned to the left and the right edge of a word, and the three-syllable example, ˈpinadu, shows that feet must be bisyllabic. Crowhurst (2011) suggests the following constraints:

(10) Diyari constraints (cf. Crowhurst, 2011, p. 1478)[6)]

a. MorphemeFt-Left (MFL)
The left edge of a morpheme must be aligned with the left edge of a foot.

b. MorphemeFt-Right (MFR)
The right edge of a morpheme must be aligned with the right edge of a foot.

6) The description of the constraint and the representation of the CAP-joined constraints are slightly modified for the ease of exposition.

c. [MFL∩MFR]$_{MORPH}$
A morpheme must observe both MFL and MFR.
d. FtMin
Feet are bisyllabic.

Here the ranking, ⟦FtMin ≫ [MFL∩MFR]$_{MORPH}$ ≫ NoStruc(Ft) ≫ MFL ≫ MFR⟧, is crucial in explaining the stress distribution. It allows morpheme internal unparsed syllables and at the same time it blocks the parsing of a monosyllabic morpheme even if it may result in two adjacent unparsed syllables as in the first example (9b). Consider the following evaluation tableaux:

(11) Evaluation tableaux
a. wintaranaya

wintaranaya	FtMin	[MFL∩MFR]	NoStruc	MFL	MFR
✓i. ('winta)ra(ˌnaya)			**		
ii. ('winta)(ˌrana)ya		*!	**		*
iii. win(tara)(ˌnaya)		*!	**	*	
iv. wintaranaya		*!		*	*

b. maɖa-ɭa-ɲi

maɖa-ɭa-ɲi	FtMin	[MFL∩MFR]	NoStruc	MFL	MFR
✓i. ('maɖa)-ɭa-ɲi		*	*	*ɭa *ɲi	*ɭa *ɲi
ii. ('maɖa)-(ˌɭa-ɲi)		*	**!	*ɲi	*ɭa
iii. ('maɖa)-(ˌɭa)-(ˌɲi)	*!*		***		

(11ai) is the only optimal form as the other candidates crucially violate the CAP-joined constraint, [MFL∩MFR]. But as shown in (11b), the monosyllabic morphemes are left unparsed, as their parsing would result in the violation of the CAP-joined constraint or FtMin.

One interesting observation to make in (11b) is that NoStruc should dominate both MFL and MFR and at the same time it should be dominated by the CAP-joined constraint, [MFL∩MFR]. The crucial ranking, ⟦[MFL∩MFR] ≫ NoStruc ≫ MFL ≫ MFR⟧, explains that even when both MFL and MFR are dominated by NoStruc, the CAP-joined constraint still dominates NoStruc.

Without the CAP-joined constraint, the Diyari stress pattern is simply left unexplained.

Another application of CAP-junction can be found in bijective constraint found in allomorph selection in Dyirbal ergatives. Consider the distribution of ergative allomorphs, /-ŋgu/ and /-gu/:

(12) Dyirbal ergative allomorphy (McCarthy & Prince 1993a, p.117)

a. /-ŋgu/ after (and only after) disyllabic V-final nouns

yaɽa-ŋgu "man"

b. /-gu/ after longer V-final nouns

yamani-gu "rainbow"

balagara-gu "they"

One possible approach may be to set up an alignment constraint for /-ŋgu/ such as Align-{ŋgu}-to-Ft so that it can only be attached to disyllabic words as discussed and rejected in Paster (2006). This approach, however, fails to deal with the allomorph selection. Though it may block /-ŋgu/ from being attached to three or more syllabled words, it cannot block the attachment of /-gu/ to disyllabic base as discussed in Wolf & McCarthy (2005), Paster (2006), Bye (2007) and others. The problem is shown in (13):

(13) Unfortunate result in evaluation

yaɽa-{gu_1, $ŋgu_2$}	Faith	Align-{ŋgu}-to-Ft	NoCoda
✓ a. (yaɽa)-gu_1			
? b. (yaɽa-ŋ)gu_2			*!
c. (yaɽa)-gu_2	*!		*
d. (yaɽa-ŋ)gu_1	*!		*

The actual output form is (13b), but as long as there is (13a), the perfect one, (13b) cannot be optimal. The problem here is that (13a) takes /gu/ instead of /-ŋgu/ to stay away from NoCoda violation and there is no constraint that penalizes /gu_1/-affixation to disyllabic words. Given this observation, we may posit the following allomorph distribution constraint as in Lee (2010):

(14) Ergative allomorph distribution (=AlloDist) (Lee, 2010, p. 484)
[Align-{ŋgu}-to-Ft∩Align-Ft-to-{ŋgu}]WORD
Assign an asterisk if {ŋgu} is not preceded by a foot, or if a foot is not followed by {ŋgu}.

(14) presents a bijective constraint, which requires alignments to each other, which can effectively eliminate (13a) with the ranking, ⟦Faith, AlloDist ≫ NoCoda⟧.

(15) Correct evaluation

yaɽa-{gu_1, $ŋgu_2$}	Faith	AlloDist	NoCoda
a. (yaɽa)-gu_1		*!	
✓ b. (yaɽa-ŋ)gu_2			*
c. (yaɽa)-gu_2	*!		*
d. (yaɽa-ŋ)gu_1	*!		

As shown in (15), AlloDist, the CAP-joined constraint, [Align-{ŋgu}-to-Ft∩Align-Ft-to-{ŋgu}]WORD penalizes (15a). In (15a), the foot (yaɽa) is not followed by {$ŋgu_2$}. So it is a violation of Align-Ft-to-{ŋgu}. It also means that it violates the CAP-joined constraint AlloDist, as it passes only the best of the best. On the other hand, (15b) satisfies both Align-{ŋgu}-to-Ft and Align-Ft-to-{ŋgu}. Therefore it also satisfies AlloDist. So far, we have seen that CAP-junction has a definite role to play in explaining phonological and morphological changes. Now we turn to the third type of constraint combination.

2.3 IF-junction

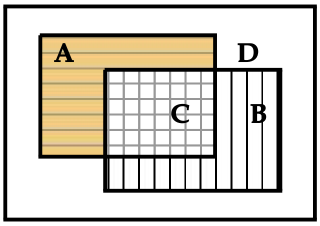
The third type is implicational combination as shown in (1c). [X→Y] combination, called IF-junction in this paper, means if X then Y. This constraint ensures that if X is satisfied, then Y should also be satisfied. Consider the violation table and distribution of violation of the IF-joined constraint given in (16):

(16) IF-junction

a. violation table

	[X→Y]	X	Y
i	✓	✓	✓
ii	✓	*	✓
iii	*	✓	*
iv	✓	*	*

b. representing violation distribution



(Grey area represents violation.)

As shown in (16), the IF-joined constraint, [X→Y], is violated if and only if X is satisfied and Y is not.[7] Though this type of constraint combination is not studied in depth, we can easily see its application. Researchers of Korean phonology are quite familiar with the onset condition in Korean that /ŋ/ is not allowed in the onset. (see Chung, 2001, Lee, 2008, Ahn, 2009 and others for more recent references.)

(17) Korean onset condition (cf. Chung, 2001, p. 182)

a. prose description

The velar nasal /ŋ/ is not allowed as an onset element in Korean.

b. formal representation

$[\text{Onset}\rightarrow{}^*\text{ŋ}]_{\text{SEG}}$

(17) penalizes a candidate that has /ŋ/ in the onset. If the candidate does not have an onset, (17) is vacuously satisfied. However, the presence of /ŋ/ in non-onset position does not constitute a violation. (17) is violated if and only if

7) Logically speaking, the IF-joined constraint, [X→Y], can be rewritten using CAP-junction or CUP-junction. In set theory, X→Y is equivalent to ~X∪Y or ~(X∩~Y).

there is an onset segment and it violates *ŋ. This is the typical case of IF-joined constraint evaluation. Therefore, we see that (17a) can be rewritten using an IF-junction connective as in (17b). The IF-joined constraint (17b) is not violated by any non-onset segment or by any /ŋ/ in the coda.

Another possible application of IF-conjunction is in dealing with the stress patter in Western Aranda. Though it is generally agreed that the Western Aranda word has syllable-trochee system with primary stress in the initial syllable, there are some deviations from this pattern as shown in (18):

(18) Western Aranda stress (data from Davis, 1988, p. 1)
a. Consonant-initial words of three or more syllables
túkura 'ulcer'
kútungùla 'ceremonial assistant'
wóratàra (place name)
b. Vowel initial words of three or more syllables
ergúma 'to seize'
artjánama 'to run'
utnádwàra (place name)
c. Bisyllabic words
ílba 'ear'
káma 'to cut'
wúma 'to hear'

The Western Aranda language has primary stress in the first syllable in trisyllabic or longer words as in (18a), but if the first syllable does not have an onset, as illustrated by the data in (18b), the primary stress appears in the second syllable. In bisyllabic words, however, the primary stress falls on the initial syllable even if it is onsetless as shown in (18c). Descriptively, we can see that the head syllable must have an onset, and if the initial syllable of a word is onsetless, it cannot be the head foot in trisyllabic or longer word. But the requirement of onset for the head syllable is dominated by the constraint that requires a prosodic word to have a stress. The straightforward way of capturing this generalization is to posit the following constraints and ranking.

(19) Constraints and ranking for Western Aranda stress.

a. Constraints

i) Foot Binarity (=FtBin) (Prince & Smolensky, 1993, p. 47)
Feet are binary on the syllabic level.

ii) Align-Pwd (McCarthy & Prince, 1993b, p. 80)
Align the left edge of a Prosodic word with the left edge of a foot.

iii) Parse-σ (McCarthy & Prince, 1993b, p. 91)
All syllables must be parsed by feet.

iv) $[\text{FtHead} \rightarrow \text{Onset}]_{\text{SYLL}}$
A head syllable must have an onset

b. Constraint ranking

FtBin ≫ [FtHead→Onset] ≫ Align-Pwd, Parse-σ

The IF-conjoined constraint, [FtHead→Onset], penalizes the foot head that does not have an onset. This leads to the violation of Align-Pwd and/or Parse-σ. Consider the following evaluation tableaux, illustrated with the first words in (18a), (18b), and (18c):

(20) Evaluation tableaux of Western Aranda Stress

a. tukura → (túku)ra

tukura	FtBin	[FtHead →Onset]	Align-Pwd	Parse-σ
✓ i. (túku)ra				*
ii. tu(kúra)			*!	*
iii. (tú)(kùra)	*!			

b. erguma → er(gúma)

erguma	FtBin	[FtHead →Onset]	Align-Pwd	Parse-σ
i. (érgu)ma		*!		*
✓ ii. er(gúma)			*	*
iii. (ér)(gùma)	*!	*		

c. ilba → (ílba)

ilba	FtBin	[FtHead →Onset]	Align-Pwd	Parse-σ
✓ i. (ílba)		*		
ii. il(bá)	*!		*	*

The evaluation tableaux are self-explanatory. The interesting cases are (20b) and (20c). In (20b), the stress on the initial onsetless syllable, (20bi), is filtered out by the IF-joined constraint. But the same constraint, being dominated by FtBin, does not hinder the choice of the optimal form in the bisyllabic word as shown in (20c). As such, the proposal of IF-joined constraint, [FtHead→Onset], can plainly capture the interesting aspect of Western Aranda stress patterns.[8)]

3. Restraining Constraint Combinations

As shown in Section 2, we see that not only CUP-joined constraints but also CAP-joined and IF-joined constraints take active parts in explaining constraint interaction. Interestingly however, all the constraint combinations introduced so far are either the combination of markedness constraints or the combination of faithfulness constraints. One readily emerging research question is whether we should have a constraint conjunction of a markedness constraint and a faithfulness constraint.

Itô & Mester (1998) explicitly argue against MF-combination. Fuzakawa and Miglio (1998) propose that only the constraints of the same family can be conjoined. This proposal also argues against MF-combination. Bakovič (2000), on the other hand, argues for the necessity of MF-combined constraints, based on the discussion in Lombardi (1999). We summarize the findings and MF-combination analysis of Bakovič (2000) and propose an alternative to show that his analysis fails to support MF-combination.

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8) It should be noted that there are other analyses for Western Aranda stress such as Davis' (1985) moraic onset analysis, Goedemans' (1994) proposal of Align (Foot Left, Onset Left), and Downing's (1998) proposal of CAP-joined constraint, [Onset∩Align-σ]. The detailed comparison of these analyses is needed to see which is the best way to explain the apparent extrametrical nature of the initial onsetless syllable in three or more syllabled words. We leave this open to further research. Another area of application of the if-junction is to deal with overapplication opacity. If-junction can be used to break off the shackle of harmonic bounding and thus open a door for explaining overapplication opacity without resorting to surgical operation of the OT theory itself. This is also open to future research.

(21) Coda consonant cluster assimilation

a. /pd/# → [pt]#
b. /bt/# → [pt]#
c. /zgt/# → [skt]#
d. /skd/# → [skt]#

Bakovič (2000) considers the coda voicing assimilation of Dutch and shows that (21c) may present problems in the conventional OT analysis. Consider the following evaluation tableaux:

(22) Evaluation tableaux for coda consonant cluster
(adapted from Crowhurst, 2011, p. 1473)

a. /pd/# → [pt]#

/pd/	Agree (voice)	Ident (voice)	*VoiObst
i. pd	*!		*
ii. bd		*	*!*
✓iii. pt		*	

b. /bt/# → [pt]#

/bt/	Agree (voice)	Ident (voice)	*VoiObst
i. bt	*!		*
ii. bd		*	*!*
✓iii. pt		*	

c. /zgt/# → [skt]#

/zgt/	Agree (voice)	Ident (voice)	*VoiObst
i. zgt	*!		**
✓ ii. zgd		*	***
? iii. skt		**!	

d. /skd/# → [skt]#

/skd/	Agree (voice)	Ident (voice)	*VoiObst
i. skd	*!		*
ii. zgd		**!	***
✓iii. skt		*	

The evaluation works well except for (22c), where a non-surface form [zgd] is chosen as optimal. The problem with the /zgt/→[skt] mapping lies in the two violations of Ident(voice). Bakovič (2000) observes this phenomenon and calls it "majority rule" effect. In the sequence of [αF][αF][-αF], the assimilation to [αF] has just one violation of Ident(αF), but the assimilation to [-αF] results in two violations of Ident(-αF). Given this situation, we see that the normal evaluation always favors the least number of Ident(f) in assimilation.

Bakovič argues that the "majority rule" problem can be resolved by positing the locally conjoined constraint, $[\text{Ident(voice)} \cup \text{*VoiObst}]_{SEG}$, and put it between Agree(voice) and Ident(voice).[9] Now consider the revised evaluation of (22c):

(23) Revised evaluation of (22c)

/zgt/	Agree (voice)	[Ident(voice)∪ *VoiObst]	Ident (voice)	*VoiObst
i. zgt	*!			**
ii. zgd		*!	*	***
✓iii. skt			**	

With the introduction of the combined constraint, [Ident(voice)∪*VoiObst], the evaluation correctly picks [skt] as optimal. But it is made possible only with the MF-combined constraint, as Ident(voice) is a faithfulness constraint and *VoiObst is a markedness constraint. If we take (23) as the legitimate evaluation, we have to accept the possibility of MF-combination contrary to the claim made in Itô & Mester (1998) and in Fuzakawa & Miglio (1998).

This paper, however, shows that there is an alternative explanation without resorting to MF-combination. The point of departure from (22) is the introduction of Max/Dep(feature) that replaces Ident(voice) in line with Lombardi (1998).[10] The idea is that devoicing is the violation of Max(voice) while voicing assimilation violates Dep(voice). In Ident(voice) approach, both the voicing and the devoicing assimilation violates the same Ident(voice) constraint.

9) The actual local constraint conjunction proposal made by Bakovič (2000) is $*[\alpha F]\&_{l}$ID-IO[F]. This constraint penalizes the combined violation of *[αF] and ID-IO[F] in a given domain. It is, therefore, a notational equivalent of the constraint, $[\text{Ident(voice)} \cup \text{*VoiObst}]_{SEG}$, proposed here.

10) Note that in Lombardi's proposal, the features are not attributes or properties of a segment. Rather it is viewed as the autosegment (1998, p.6) represented as a privative or monovalent feature. Therefore, in this approach, there is no [-voice] or [-nasal] feature at all.

What the data in (21) show is that Dep(voice) is higher than Max(voice). With the ranking, ⟦Agree(voice), Dep(voice), *VoiObst ≫ Max(voice)⟧, we obtain the same results as shown in (24):

(24) Revised evaluation with Dep(voice) and Max(voice)

a. /pd/# → [pt]#

/pd/	Agree (voice)	Dep (voice)	*VoiObst	Max (voice)
i. pd	*!		*	
ii. bd		*!	**	
✓iii. pt				*

b. /bt/# → [pt]#

/bt/	Agree (voice)	Dep (voice)	*VoiObst	Max (voice)
i. bt	*!		*	
ii. bd		*!	**	
✓iii. pt				*

c. /zgt/# → [skt]#

/zgt/	Agree (voice)	Dep (voice)	*VoiObst	Max (voice)
i. zgt	*!		**	
ii. zgd		*!	***	
✓iii. skt				**

d. /skd/# → [skt]#

/skd/	Agree (voice)	Dep (voice)	*VoiObst	Max (voice)
i. skd	*!		*	
ii. zgd		*!*	***	
✓iii. skt				*

Examining (24c), we see that we can explain the optimal nature of /zgt/# → [skt]# with Max/Dep(feature) without invoking MF combination. (24a), (24b) and (24d) simply shows that the Max/Dep(feature) analysis does not cause problems in these cases as well. The analysis given here clearly demonstrates that the schematic data in (21) cannot be used to support the MF-combination. It, therefore, indirectly supports the proposal against MF-combination by Itô & Mester (1998) and Fuzakawa & Miglio (1998). In the absence of any other convincing analyses that support MF-combination, this paper claims that the only possible combinations of constraints are markedness-markedness combinations or faithfulness-faithfulness combinations, ruling out markedness-faithfulness combinations.

4. Conclusion

In this paper, we have observed three different types of constraint combinations. Though the local constraint conjunction is well-known and frequently employed in the phonological analysis, we see that there are two more constraint combinations. Local constraint conjunctions or self-conjunctions are the example of CUP-junction shown in this paper. Beside CUP-junction, we find two other types of combination: CAP-junction and IF-junction. In evaluation, $[X \cup Y]_D$ penalizes the candidate which shows violations of both X and Y in a given domain, so as to filter out the worst candidate. $[X \cap Y]_D$, on the other hand, penalizes any candidate that violates X or Y (or both) to allow the "best of the best" form to pass. The third type, IF-junction represented as $[X \rightarrow Y]_D$, penalizes only those candidates that satisfy X but violate Y.

This paper shows the application of these combined constraints in explaining coda conditions, Lyman's law in Japanese, Bedouin Arabic opacity, Korean onset condition, Diyari stress pattern, Dyirbal ergative allomorphy and Western Aranda stress. The analyses shown in this paper implies that there are many other applications of the combined constraint in explaining phonological and morphological changes, thus opening a door for further research related to the legitimacy of the combined constraints, to the application of combined constraints, to opacity studies and to conditions on conjoined constraints.

The hypothesis that markedness and faithfulness constraints are combined together is reviewed in this paper. Presenting an alternative explanation without resorting to markedness-faithfulness combination, this paper argues against it. It is granted that we need further research on positional faithfulness to positively support the idea that only intra-family combinations such as markedness-markedness combinations or faithfulness-faithfulness combinations should be allowed.

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