First consonant deletion in constraint-based approaches*

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Kim, Gyung-Ran. 2011. First consonant deletion in constraint-based approaches. *Studies in Phonetics, Phonology and Morphology* 17.3, 365-383**.** This paper gives an analysis of the phenomenon of first consonant deletion in several versions of Optimality Theory, comparing their strong and weak points. Generally, C_1 instead of C_2 gets deleted in a VC_1C_2V sequence fed by syncope from VC_1VC_2V. A traditional parallel version of Optimality Theory (P-OT) fails to describe the phenomenon properly, even when equipped with a positional faithfulness constraint MAX(STRONG). Based on perceptional strength, MAX (STRONG) guarantees the survival of segments in a context of strong perception, that is, in prevocalic position. No allowance of intermediate derivational steps in P-OT makes MAX(STRONG) overexert its influence, failing to select a correct output. Another analysis in P-OT, Wilson (2001), is reviewed, describing the phenomenon with the help of a targeted constraint and cumulative harmonic ordering. These two additional devices are employed to compare the relationships among candidates as well as between input and output as a way out of the problem facing P-OT. On the other hand, Harmonic Serialism, a serial version of OT equipped with gradualness and harmonic improvement, provides input in each step of derivation and has no difficulty presenting a proper analysis. Presenting a path from P-OT through a targeted-constraints theory to HS, it is confirmed again that the more tightly restricted a theory is like HS, the less powerful it is, giving a better solution to a problem. **(Yeungnam University)**

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1. Introduction

This paper shows how first consonant deletion fed by syncope has been dealt with from the standard parallel Optimality Theory (Prince and Smolensky 1993/2004) through a target-constraints theory (Wilson 2001) to Harmonic Serialism (Smolensky 1997, Prince and Smolensky 1993/2004, McCarthy 2000, 2008a, b), comparing weak and strong points of each theory. No allowance for intermediate derivational steps in the standard parallel OT (P-OT henceforth) has been acknowledged to be one of the basic properties of the theory. However, this property has become a kind of Achilles' heel when it comes to opacity. Drawing mainly on the data involving syncope, the present paper presents how intermediate forms are referred to indirectly in a target-constraints theory (Wilson 2001) or

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directly in Harmonic Serialism as OT theories have developed.

As well noted in the literature, the first consonant C_1 gets generally deleted in consonant cluster VC_1C_2V, which is generally called *first consonant deletion*. It holds true whether the cluster comes from a previous application of syncope or not. The examples in (1) show a case where syncope applies first, providing the environment for the application of first consonant deletion (Wilson 2001: 153, McCarthy 2008a: 304).[1]

(1) a. Carib

s-enaa**pɨ-s**a	→ senaa**s**a	'I eat it'
s-enee**pɨ-s**aʔ	→ senee**s**aʔ	'I bring it'
wɨ:**to-s**a	→ wɨ:**s**a	'I go'
epa:no**pɨ-k**o	→ epa:no:**k**o	'help him'
aj-uku:**tɨ-s**a-ɲ	→ ajuku:saɲ	'he knows you'

b. Tunica

ti'tih**ki-t**ʔɛ	→ ti'tih**t**ʔɛ	'a river'
ti'tih**ki p**i'rʔutakʔahča	→ ti'tih**p**i'rʔutakʔahča	'it will turn into a bayou'

A sample description of the data in a rule-based approach is given in (2).[2]

(2)

	Carib	Tunica
Input	s-enaapɨ-sa	ti'tihki-tʔɛ
syncope	s-enaap-sa	ti'tihk-tʔɛ
cluster simplification[3]	s-enaa-sa	ti'tih-tʔɛ
output	[senaasa]	[ti'tihtʔɛ]

On the other hand, the data in (3) are the case of first consonant deletion involving no prior application of syncope (Wilson 2001: 148, Sapir 1965).

(3) a. Diola-Fogny

le**t-k**u-dʒaw	le**k**udʒaw	'they won't go'
kutɛ**b s**inaŋas	kutɛ**s**inaŋas	'they carried the food'
ɛkɛ**t b**o	ɛkɛ**b**o	'death there'
udʒu**k-dʒ**a	udʒu**dʒ**a	'if you see'
ko**b-k**ob-en	ko**k**oben	'yearn for'

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[1] Glottals /h/ and /ʔ/ in Tunica may not be regarded as normal consonants. Otherwise, the resulting sequences -htʔ- in [ti'tihtʔɛ] 'a river' would be illegitimate. The treatment of these glottals is discussed in Section 2.

[2] Since the environment of vowel deletion is not our concern, its proper description is omitted here.

[3] Although a rule-based analysis can describe first consonant deletion with a rule like C → ø / C, it cannot explain why it is the first consonant that is generally deleted.

b. West Greenlandic

qani**k-l**erpoq	qani**l**erpoq	'begins to approach'
ukiju**q-t**uqaq	ukiju**t**uqaq	'old year'
angu**ti-k**ulak	angu**k**ulak	'he goat'

A question arises as to why it is generally the first consonant that gets deleted ($VC_1C_2V \rightarrow VC_2V$), not the other way around ($^*VC_1C_2V \rightarrow VC_1V$). Some previous works have tried to answer to this question with positional faithfulness constraints (Itô and Mester 1993, Beckman 1998, Lombardi 1999) and licensing-by-cue constraints (Jun 1995, Steriade 1999a, b, 2000), to name a few.

The present paper is going to compare an analysis of first consonant deletion based on faithfulness constraints for consonants in a strong position with that based on markedness constraints for consonants in a weak position in three frameworks of OT theories. The organization of the paper is as follows. Section 2 gives an analysis of the data in P-OP by employing a contextual faithfulness constraint MAX(STRONG). This constraint guarantees the preservation of a consonant in a strong context, which is C_2 in prevocalic position. However, it will be shown that P-OT cannot analyze the data properly, especially when consonant cluster is fed by syncope. Section 3 reviews another analysis in the P-OT framework, Wilson (2001), which relies on a targeted constraint NOWEAKCONS and order-based optimization of a constraint hierarchy. The use of targeted constraints and cumulative harmonic ordering of candidates is shown to make the analysis more complex. Section 4 shows that Harmonic Serialism (HS henceforth), a serial version of OT, has no difficulty presenting a proper analysis of C_1 deletion fed by syncope. It is because the mechanism of HS such as gradualness and harmonic improvement provides input in each step of derivation, allowing for one change only from input to output. However, it is necessary for consonant deletion to take two steps, one for making coda Placeless via CODACOND and the other for deleting the segment itself against MAX[PLACE] and MAX. Section 5 discusses what is presented here and concludes the paper, showing that any theory cannot get along with an analysis of C_1 deletion without referring to intermediate steps one way or the other.

2. Analysis in P-OT

To see how P-OT deals with deletion of C_1 in cluster, let us take a look at Diola-Fogny (3a) again. The situation of [lekudʒaw] from /let-ku-dʒaw/ 'they won't go' is shown in tableau (5) and the relevant constraints are listed in (4).

(4) NOCONSONANTCLUSTER(*CC): assign a violation mark to consonant cluster.
MAX: assign a violation mark to an input segment which has no

correspondent in the output.
NOLABIAL/DORSAL(*PL(LAB/DOR)): assign a violation mark to a labial or dorsal consonant.
NOCORONAL(*PL(COR)): assign a violation mark to a coronal consonant.

Since coronals are less marked than labials or dorsals, the ranking between the two place-markedness constraints is fixed as *PL(LAB/DOR) » *PL (COR). The symbol ← indicates the attested form, while the symbol → points the optimal output form in the following tableaux.

(5) Diola-Fogny: /let-ku-dʒaw/ → [lekudʒaw] 'they won't go'

let-ku-dʒaw	*CC	MAX	*PL(LAB/DOR)	*PL(COR)
a. letkudʒaw	*!		*	*
← b. lekudʒaw		*	*!	
→ c. letudʒaw		*		*

According to the constraint ranking, candidate (5c) is the optimal form. However, the attested and correct form is candidate (5b) [lekudʒaw]. Placing MAX below *PL(COR) in the rank would not change the situation at all due to the ranking *PL(LAB/DOR) » *PL(COR).

In order to save C_2, which is a prevocalic consonant, a positional faithfulness constraint MAX(STRONG) may be suggested. It is well observed that consonants are strong in contexts where strong perceptual cues are present and that prevocalic position provides such contexts. On the other hand, consonants are weak in contexts where strong perceptual cues are not present. For example, consonants in front of another consonant are perceptually weak. The stronger their perceptual cues are, the more likely consonants are to survive. In short, compared with C_2 in a VC_1C_2V sequence, C_1 is perceptually weak and thus more likely to get deleted. A contextual faithfulness constraint MAX(STRONG) takes care of the survival of C_2.

(6) MAX(STRONG): assign a violation mark to every prevocalic consonant in the input which does not have an output correspondent.

MAX(STRONG) is more specific than MAX, the former ranking higher than the latter: MAX(STRONG) » MAX. The addition of MAX(STRONG) changes the situation from tableau (5) to tableau (7).

(7) /let-ku-dʒaw/ → [lekudʒaw] 'they won't go'

let-ku-dʒaw	*CC	MAX(S)	MAX	*PL(L/D)	*PL(C)
a. letkudʒaw	*!			*	*
→ b. lekudʒaw			*	*	
c. letudʒaw		*!	*		*

Candidate (7b), where C_2 from a strong context of prevocalic position survives, fares better than candidate (7c), where C_1 survives from a weak context of preconsonantal position and violates MAX(STRONG).

Now let us move on to the case where syncope and first consonant deletion interact. Tableau (8) for Carib (1a) shows what the situation is like. Constraint SYN is responsible for the deletion of high vowel /ɨ /.

(8) Carib: /s-enaapɨ-sa/ → [senaasa] 'I eat it'

~ apɨ-sa	SYN	*CC	MAX(S)	MAX	*PL(L/D)	*PL(C)
a. apɨsa	*!				*	*
b. apsa		*!		*	*	*
c. apa			*	**	*!	
→ d. asa			*	**		*

The higher constraints SYN and *CC rule out (8a) and (8b), respectively. According to constraint MAX(STRONG) in (6), /p/ and /s/ in the input should have their output correspondents.[4] However, /s/ has no correspondent in (8c) and the same holds to /p/ in (8d). Thus both (8c) and (8d) equally violate MAX(STRONG) and MAX, but *P(L/D) rules out (8c), selecting (8d) as optimal.

How would the Tunica data do? As briefly mentioned in footnote 1, glottals /ʔ/ and /h/ in Tunica should be regarded as consonants with no Oral Place node. The data below are repeated from (1b).

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[4] Considering more data related with assimilation in Carib, constraint *CC should be revised. Coda nasals assimilate in Place to a following stop. However, they debuccalise to [ʔ] before another nasal because the language has no geminates (McCarthy 2008a: 288).

a. Coda assimilation in Carib

eka:numɨ-potɨ	→ eka:nu**m**botɨ	'to turn repeatedly'
kɨn-eka:num-ta	→ kɨne:ka:nu**n**da	'he will run'
aj-eka:numɨ-ko	→ aje:ka:nu**ŋ**go	'run!'

b. Coda debuccalisation in Carib

eka:numɨ-no	→ eka:nu**ʔ**no	'running'

(9) Tunica

/ti'tih**ki** + **t**ʔɛ/	→ ti'tih**t**ʔɛ	'a river'
/ti'tih**ki** **p**i'rʔutakʔahča/	→ ti'tih**p**i'rʔutakʔahča	'it will turn into a bayou'

After /i/ is deleted by syncope, the intermediate consonant clusters [hktʔ] and [hkp] become [htʔ] and [hp] respectively in [ti'tihtʔɛ] and [ti'tihpi'rʔutakʔahča]. Since the Tunica data are not sufficient enough, it is rather difficult to make any definite conclusion about syllable structure. However, it seems reasonable to assume that Tunica does not allow for consonant cluster with Oral Place features. Since glottals /h/ and /ʔ/ have no Oral Place features at all (Sagey 1986, Halle 1992, 1995),[5] it is possible for sequences like [htʔ] and [hp] to appear in the output.

Constraint NoConsonantCluster (4) is revised into (10).

(10) NoConsonantCluster(*CC): assign a violation mark to consonant cluster with separate Oral Place nodes.

With this constraint on hand, the situation of [ti'tih**p**i'rʔutakʔahča] from /ti'tih**ki** **p**i'rʔutakʔahča/ can be shown in tableau (11).

(11) Tunica: /ti'tih**ki** **p**i'rʔutakʔahča/ → ti'tih**p**i'rʔutakʔahča

~ hki_1 pi_2 ~	Syn	*CC	Max(s)	Max	*Pl(L/D)
a. hki_1pi_2	*!				**
b. $hkpi_2$		*!		*	**
⇄ c. hpi_2			*	**	*
→ d. hki_2			*	**	*

Candidates (11c) and (11d) fare equally in terms of violations in Max(strong), Max, and *Pl(L/D). There is no way to get an attested optimal output (11c), marked by ← and winning over (11d). This is mainly because P-OT's input to output mappings conflates the effects of many processes such as syncope and first consonant deletion.

It will be seen in section 4 that the problem lies not only in the constraints or their ranking but also in the way of interpretation of 'the input.'

[5] Place node in Sagey (1986) or Oral Place node in Halle (1992), for example, consists of Labial, Coronal and Dorsal nodes. There are no features for glottals under Place or Oral Place node. Syllable division involving glottal in Tunica is discussed again in footnote 9.

3. Review of Wilson (2001)

This section reviews how C_1 deletion is treated in Wilson (2001). Even though the concept of 'derivation' is excluded totally, it is noted in Wilson (2001) that any P-OT analysis based solely on input and output property cannot give a satisfactory account of C_1 deletion. So he asserts that the relationships among relevant candidate outputs be examined to account for the data. That is, in addition to the input and output comparison, it needs to consider similarity among candidates.

Drawing on the evidence from the licensing-by-cue framework (Steriade 1999a, b, 2000)[6] and experimental work on perceptual cues (Ohala 1990, Kingston 1990, 1994) that consonants released into a sonorant or a vowel are the strongest ones, Wilson proposes *weak element principle* (Wilson 2001: 159).

(12) Weak element principle
A representation *x* that contains a poorly cued (or 'weak') element *α* is marked relative to the representation *y* that is identical to *x* except that *α* has been removed.

This principle leads to NOWEAKCONS in (13), which plays a pivotal role in explanation of C_1 deletion (Wilson 2001: 160).

(13) NOWEAKCONS
Let *x* be any candidate and *α* be any consonant in *x* that is not released by a vowel. If candidate *y* is exactly like *x* except that *α* has been removed, then *y* is more harmonic than *x* (i.e. $y > x$).

This constraint is a key to choosing VC_2V as a harmonic output, ruling out VC_1C_2V. Since C_1 is defined as a weak element in (12), VC_1C_2V is less harmonic than VC_2V, that is, $VC_2V > VC_1C_2V$. If MAX dominates NOWEAKCONS, the harmonic ordering between VC_1C_2V and VC_2V is set as $VC_1C_2V > VC_2V$. However, when NOWEAKCONS dominates MAX, VC_2V is more harmonic than VC_1C_2V.

What about another possible candidate VC_1V, where C_2 is deleted? Constraint NOWEAKCONS has no say about the relative harmonic relation between VC_1V and VC_1C_2V since the former is not identical to the latter with the strong consonant C_2 removed. From auditory or perceptional point of view, VC_1C_2V and VC_1V are too dissimilar to be compared by NOWEAKCONS. If the constraint is to work, C_1 should be removed instead of C_2. On the other hand, MAX prefers VC_1C_2V to VC_1V, that is, VC_1C_2V

[6] An exemplary constraint in this framework is License-Place which assigns a violation mark for every place feature that is not associated with a released consonant. The first consonant C_1 in VC_1C_2V violates the constraint.

> VC_1V.

Combining the two harmonic orderings $VC_2V > VC_1C_2V$ and $VC_1C_2V > VC_1V$ leads to $VC_2V > VC_1C_2V > VC_1V$ by transitivity. Candidate VC_2V is the only optimal candidate since it is not less harmonic than any other candidate. Even if there is another constraint which prefers VC_1V to VC_2V, it is not possible to refute the above optimality relation when the constraint in question is placed lower than NoWeakCons and Max.

Let us apply constraint NoWeakCons into the data. According to Wilson (2001: 161), the optimality relation adopted in Diola-Fogny (3a) is diagrammed as (14). In the diagram, each arrow points in a direction of increasing harmony and the number in a circle indicates the constraint's position in the rank.

(14) Optimality of first consonant deletion in Diola-Fogny

letkudʒaw
↙ ↖
① NoWeakCons ② Max
☞ lekudʒaw (③ *PL(L/D) →) letudʒaw

Candidate [lekudʒaw] fares better than [letkudʒaw] in terms of the highest constraint NoWeakCons. As a result, this leads to the harmonic ordering of [lekudʒaw] > [letkudʒaw]. Max chooses [letkudʒaw] over [letudʒaw]: [letkudʒaw] > [letudʒaw]. By transitivity, these two harmonic orderings are ordered as [lekudʒaw] > [letkudʒaw] > [letudʒaw]. Even though *PL(L/D) prefers [letudʒaw] to [lekudʒaw], this hierarchy is overridden by what the higher constraints NoWeakCons and Max have already established. Thus, *PL(L/D) is placed in the parentheses. This results in candidate [lekudʒaw] as the optimally harmonic output marked with ☞.

Wilson's tableau for the Diola-Forny data in (3a) is illustrated in (15), where a targeted constraint is indicated by ↠ . Due to the space limitation in the tableau, -*dʒaw* part is omitted in the data. The shaded boxes in the following tableaux mean that the harmonic orderings in them are not relevant in calculating cumulative ordering and thus can be ignored (Wilson 2001: 165).

(15) First consonant deletion in /let-ku-jaw/ → [lekujaw]

let-ku-dʒaw	↠ NoWCon	Max	*PL(L/D)	*PL(C)
a. letkudʒaw	leku>letku!		(letu>letku)	leku>letku
☞b. lekudʒaw		(letku>leku)	(letu>leku)	
c. letudʒaw		letku>letu!		leku>letu
cumulative ordering	*leku>letku*	*leku>letku>letu*		

The harmonic ordering asserted by the targeted constraint NoWeakCons is that [letkudʒaw] is less harmonic than [lekudʒaw]. The cumulative ordering in the lowest row specifies this as [lekudʒaw] > [letkudʒaw] under the column of NOWEAKCONS.

The next constraint MAX asserts the opposite harmonic ordering, [letkudʒaw] > [lekudʒaw]. However, MAX cannot do anything about the harmonic ordering established by the highest constraint NOWEAKCONS. Thus this harmonic ordering is in the parentheses as (letku > leku) in (15b). Instead, MAX decides the relative ordering between [letkudʒaw] and [lekudʒaw], which is [letkudʒaw] > [letudʒaw].

By transitivity, [lekudʒaw] > [letkudʒaw] and [letkudʒaw] > [letudʒaw] yield the ordering [lekudʒaw] > [letkudʒaw] > [letudʒaw], as summarized in the cumulative ordering under the column of MAX. The other harmonic orderings asserted by the lower-ranked constraints *PL(L/D) and *PL(C) are irrelevant since the higher-ranked constraints have already decided the ordering.

Compared with tableau (5), where it is impossible to get a correct attested form, tableau (15) shows how C_1 deletion in Diola-Fogny is described by employing a targeted constraint and cumulative harmonic ordering.

When it comes to the Tunica data in (1b), the targeted-constraint approach will have the following optimality diagram (16).

(16) Optimality of first consonant deletion fed by syncope in Tunica

~hktʔɛ ← ① SYN
↙ ↖ ~hkitʔɛ
② NOWEAKCONS ③ MAX
☞ ~htʔɛ (④ *PL(L/D) →) ~hkɛ

Constraint SYN is the highest in the rank and candidate [~hkitʔɛ] fares worst, which leads to the harmonic ordering [~hktʔɛ], [~htʔɛ], [~hkɛ] > [~hkitʔɛ]. Here again NOWEAKCONS is the targeted constraint and asserts that [~htʔɛ] is better than [~hktʔɛ] due to a weak consonant [k] in the latter: [~htʔɛ] > ~hktʔɛ]. The accumulation of the harmonic orderings asserted by SYN and NOWEAKCONS yields two orderings: [~htʔɛ] > [~hktʔɛ] > [~hkitʔɛ] and [~hkɛ] > [~hkitʔɛ]. The next constraint MAX refutes what the higher constraints have asserted except for [~hktʔɛ] > [~hkɛ]. This ordering is combined into the two harmonic orderings set by NOWEAKCONS, leading to [~htʔɛ] > [~hktʔɛ] > [~hkɛ] > [~hkitʔɛ]. This is the final harmonic ordering, which thus selects [~htʔɛ] as the most harmonic output form.

Tableau (17) shows how the output [ti'tih**t**ʔɛ] comes from /ti'tih**ki-t**ʔɛ/ in Tunica.

(17) first consonant deletion fed by syncope: /~ hki-tʔε/ → [~ htʔε]

~hki-tʔε	SYN	↠ NOWCON	MAX	*PL(L/D)
a. ~hkitʔε	hktʔε, htʔε, hkε>hkitʔε!			hkε>hkitʔε
b. ~hktʔε		htʔε>hktʔε!	(hkitʔε>hktʔε)	(hkε>hktʔε)
☞c. ~htʔε			(hkitʔε,hktʔε> htʔε)	(hkε>htʔε)
d. ~hkε			hktʔε>hkε! (hkitʔε>hkε)	
cumulative ordering	hktʔε, htʔε, hkε>hkitʔε	htʔε>hktʔε> hkitʔε hkε>hkitʔε	htʔε>hktʔε> hkε>hkitʔε	

So far it has been shown how a targeted-constraints theory in combination with cumulative harmonic ordering describe C_1 deletion in consonant cluster, whether the cluster is fed by syncope or not.

Wilson's analysis can be said to make a step further into considering intermediate forms in P-OT.

However, it is not clear how to select a targeted constraint among many constraints. The comparison of tableaux (15) and (17) does not explain why the highest constraint SYN, instead of NOWEAKCONS, cannot be a targeted constraint. Is it because the phenomenon of C_1 deletion is the one under consideration?[7] Even if SYN is designated as a targeted constraint in (17), there will be no problem in calculating cumulative harmonic ordering; the accumulation of harmonic orderings asserted by each constraint proceeds from the highest constraint to the next one in the ranking hierarchy. Indispensable as they may be, both targeted constraints and cumulative harmonic ordering are an additional burden to an analysis in P-OT. Optimality diagrams such as (14) and (16) are one more complex step of understanding, even though they pave the way for tableaux with targeted constraints and cumulative ordering. By the way, a special symbol (↠) for marking targeted constraints and a separate row for cumulative harmonic ordering in tableaux add to the complexity of interpreting tableaux.

4. Analysis in HS

The conundrum in the above P-OT analysis comes from the fact that P-OT allows for no intermediate derivational steps by its nature. It only compares

[7] It seems to be true, considering that Wilson(2001: 190) proposes constraint NOWEAKCONSTRAINT in treating continuant consonant deletion in conjunction with place assimilation in Nancowry.

the input and output at one swoop. Constraint MAX(STRONG) requires prevocalic consonants /k/ and /p/ in the input to have their output correspondents in tableau (11). However, this leads to a difficult situation as seen in the above.

A way out of the problem is to adopt the framework of Harmonic Serialism, where derivational steps are allowed with certain conditions attached. The main difference between HS and P-OT lies in how GEN and EVAL work, which is succinctly illustrated in (18) and (19) (Elfner 2009: 3).

(18) P-OT
Input → GEN → candidates → EVAL → Output
(unrestricted)
(19) Harmonic Serialism
Input → GEN → candidates → EVAL → Output → Convergence
↑ (restricted) ↓
← ← ← ← ← ← ←

According to what McCarthy (2008a) calls *gradualness*, GEN is allowed to make a single modification to the input and can add violations of only one basic faithfulness constraint at a time. Among such basic faithfulness violations are deletion(MAX), insertion(DEP), and changing a feature value(IDENT).[8] As a result, only a restricted number of candidates are generated in each step of derivation. After one operation of change in the input, a locally harmonic candidate is chosen as the optimal output, which in turn becomes another input in the next step of derivation. Each operation in the sequence should improve Harmony, which is dubbed *harmonic improvement*. Derivational steps are repeated until input and output become equal, which results in convergence, and derivation comes to an end. See McCarthy (2000, 2008a, b) and Elfner (2009) for more details about HS.

Before looking into the data on hand, it is necessary to see how C_1 deletion is dealt with in harmonic improvement. The main thread of argument in this section follows that of McCarthy (2008a). An important thing to notice is that unlike the way it is treated in P-OP, C_1 deletion does not occur in one change from VC_1C_2V to VC_2V. Here C_1 needs to be in coda to lose its Place on its path to deletion. For this McCarthy (2008a) employs CODACOND in his explanation of cluster simplification.

[8] In addition to structure changing operations, HS is adopted for structure building operations related with tone or stress, too. For example, it is argued in Pruitt(2010) that HS with serial foot building provides an advantage over the standard theory of stress in P-OT in accounting for natural language stress systems.

(20) CodaCond

Assign one violation mark for every token of Place that is not associated with a segment in the syllable onset.

C_1 in cluster goes through the deletion of its Place features first and then the Placeless segment itself is deleted: $VC_1.C_2V \rightarrow VH.C_2V \rightarrow V.C_2V$. Here [H] denotes a segment with no Place features.

Another constraint in need is HavePlace, which requires each segment to have Place features.

(21) HavePlace

Assign one violation mark for every segment that has no Place specification.

In order to treat consonant deletion as gradual attrition, one more constraint is needed (McCarthy 2008a: 277).

(22) Max[Place]

Let *input Place tier* = $p_1p_2p_3...p_m$ and *output Place tier* = $P_1P_2P_3...P_n$. Assign one violation mark for every p_x that has no correspondent P_y.

Accordingly, there are at least two unfaithful operations in consonant deletion, one to delete Place and the other to delete the rest of the consonant.

It can be noticed that the above three constraints and an ordinary Max constraint can replace such constraints used in a P-OP analysis as Max(strong), *CC, *Pl(Lab/Cor) and *Pl(Cor).

The harmonic improvement in $VC_1.C_2V \rightarrow VH.C_2V \rightarrow V.C_2V$ is shown in the following.

(23) harmonic improvement in $VC_1.C_2V \rightarrow VH.C_2V \rightarrow V.C_2V$

/VC_1C_2V/	CodaCond	HaveP	Max[P]	Max
a. $VC_1.C_2V$	*			
less harmonic than				
b. $VH.C_2V$		*	*	
less harmonic than				
c. $V.C_2V$				*

By the way, what would happen if C_2 is deleted in the cluster? Since [$VC_1.C_2V$] harmonically bounds [$VC_1.HV$] in any possible ranking, there is no way for [H] from the input C_2 to get deleted to become [$VC_1.V$].

(24) harmonic bounding of $VC_1.C_2V \rightarrow VC_1.HV$

$/VC_1C_2V/$	CODACON	HAVEP	MAX[P]	MAX
a. $VC_1.C_2V$	*			
more harmonic than				
b. $VC_1.HV$	*	*	*	

Now let us go back to our data. Since syncope is not involved in C_1 deletion in Diola-Fogny, it will just do when actual consonants in cluster are inserted in place of C_1 and C_2 in tableau (23). Thus let us skip the Diola-Fogny data and go straight to the Carib data.

Tableau (8) in P-OT is changed into tableaux from (25) to (28) in HS. Since only one change is possible from input to output, optimal form in step 1 is (25a) with /ɨ/ deleted via syncope.

(25) Step 1 /s-enaapɨ-sa/ → [se.naap.sa]: syncope

~ apɨ-sa	SYN	CODACOND	HAVEP	MAX[P]	MAX
→a. ~ ap.sa		*			*
b. ~ a.pɨ.sa	*!				

In the next step, coda [p] in [~ ap.sa] becomes Placeless [H] in order not to violate CODACOND.

(26) Step 2 [se.naap.sa] → [se.naaH.sa]: coda becomes Placeless

~ ap.sa	SYN	CODACOND	HAVEP	MAX[P]	MAX
→ a. ~ aH.sa			*	*	
b. ~ ap.Ha		*!	*	*	
c. ~ ap.sa		*!			

A locally optimal output in step 2 is (26a), where cluster [p.s] becomes [H.s]. Candidate (26b) shows why coda (C_1) instead of onset (C_2) in a C_1C_2 sequence should be Placeless; when onset becomes Placeless, CODACOND as well as HAVEPLACE is violated. Thus (26a) fares better than (26b).

Candidate (26a) becomes the input in step 3, where Placeless [H] gets deleted.

(27) Step 3 [se.naaH.sa] → [se.naa.sa]: deletion of Placeless [H]

~ aH.sa	SYN	CODACOND	HAVEP	MAX[P]	MAX
→ a. ~ a.sa					*
b. ~ aH.sa			*!		

Candidate (27a), which is locally optimal, becomes the input in the next step.

(28) Step 4 [se.naa.sa] → [se.naa.sa]: no change = convergence

~ a.sa	SYN	CODACOND	HAVEP	MAX[P]	MAX
→ a. ~ a.sa					
b. ~ a.Ha			*!	*	

When onset [s] becomes Placeless [H] as in (28b), both HAVEPLACE and MAX[PLACE] are violated. On the other hand, there is no change from input to output in (28a), making a case of convergence. Derivation stops here.

In passing, tableau (29) shows how harmony improves from the original input /s-enaapɨ-sa / to [se.naa.sa] 'I eat it,' where C_1 deletion is fed by syncope.

(29) harmonic improvement tableau in Carib

		SYN	CO	HP	M[P]	M
Original Input	/~ apɨ-sa/ *less harmonic than*	*				
Step 1	~ ap.sa *less harmonic than*		*			
Step 2	~ aH.sa *less harmonic than*			*	*	
Step 3	~ a.sa *equally harmonic to*					*
Step 4	~ a.sa					

Now it is time to take a look at the Tunica data. Tableau (11) in P-OT is changed into tableaux from (30) to (33). The same steps of derivation as those for the Carib data are illustrated here, too.

(30) Step 1 /ti'tihki pi'rʔutakʔahča/ → [ti'tihkpi'rʔutakʔahča]: syncope

~ hki$_1$ pi$_2$	SYN	CODACON	HAVEP	MAX[P]	MAX
→ a. ~ hk.pi$_2$		*			
b. ~hki$_1$.pi$_2$	*!				

SYN rules out candidate (30b), making (30a) a locally optimal output, which in turn becomes input in the next step. When irrelevant, SYN will be omitted in the following tableaux.[9]

[9] Right now we have no clear idea how a syllable is divided in Tunica. However, it seems that after syncope there is a syllable boundary between [k] and [p] in [~ ihk.pi ~]. At this point we can raise a question as to whether there is any difference between underlying /h/ and Placeless [H]. It is temporarily assumed here that just like Placeless [H] in coda, underlying /h/ and /ʔ/

(31) Step 2 [~ hk.pi ~] → [~ hH.pi ~]: C_1 becomes Placeless [H]

~ hk.pi ~	CODACOND	HAVEP	MAX[P]	MAX
→a. ~ hH.pi ~		*	*	
b. ~ hk.Hi ~	*!	*	*	
c. ~ hk.pi ~	*!			

Both (31b) and (31c) equally violate the highest constraint CODACOND and they are ruled out. Though HAVEPLACE and MAX(PLACE) are violated, (31a) is selected as locally optimal, becoming the input in step 3.

(32) Step 3 [~ hH.pi ~] → [~ h.pi ~]: deletion of [H] in coda

~ hH.pi ~	CODACOND	HAVEP	MAX[P]	MAX
→a. ~ h.pi ~				*
b. ~ hH.pi ~		*!		

In the last step of process, there is no change at all and derivation ends here.

(33) Step 4 [~ h.pi ~] → [~ h.pi ~]: convergence

~ h.pi ~	CODACOND	HAVEP	MAX[P]	MAX
→a. ~ h.pi ~				
b. ~ h.Hi ~		*!	*	

Like tableau (29), tableau (34) shows how harmony improves from step 1 to 4 from /ti'tihki pi'rʔutakʔahca/ to [ti'tihpi'rʔutakʔahca].

have no Place. Thus [h] and [ʔ] in the output form [ti'.tih.pi'.rʔu.ta.kʔah.ča] 'it will turn into bayou' can be in coda and onset, respectively. If /h/ and /ʔ/ have [pharyngeal] Place, it is impossible for them to be either in coda or in onset. Or we can think of syllable division like [ti'.ti.hpi'.rʔu.ta.kʔa.hča] where both [h] and [ʔ] are in onset. Even when this is the case, [h] and [ʔ] are considered Placeless. Otherwise, complex onsets such as [hpi], [rʔu], [kʔa], and [hča] should be allowed. It seems plausible to say that /h/, /ʔ/ and [H] are all Placeless regardless of how a syllable is divided in Tunica.

(34) harmonic improvement tableau in Tunica

		S	CODA	HP	M[P]	M
Original Input	/ ~ hki$_1$ pi$_2$ ~ / *less harmonic than*	*				
Step 1	~ hk.pi$_2$ ~ *less harmonic than*		*			
Step 2	~ hH.pi$_2$ ~ *less harmonic than*			*	*	
Step 3	~ h.pi ~ *equally harmonic to*					*
Step 4	~ h.pi					

It has been shown so far that HS is able to give a proper analysis of C_1 deletion fed by syncope, while P-OP is not. As for an analysis in P-OP, even the adoption of constraint MAX(STRONG) cannot improve the situation in the Tunica data. However, the mechanism of HS, which stems mainly from an allowance for derivational steps based on *gradualness* and *harmonic improvement*, is instrumental to the analysis of C_1 deletion.

5. Discussion and conclusion

This study has shown how C_1 deletion in cluster fed by syncope has been treated in three different versions of Optimality Theory such as P-OT, a targeted-constraints theory, and HS. In the meantime, two kinds of change in focus are witnessed. One kind is a change from faithfulness constraints like MAX(STRONG) and a targeted constraint NOWEAKCONS to keep C_2 in a strong position to a markedness constraint like CODACOND to delete C_1 in a weak position. The other kind is on a change from input-output forms only to intermediate forms as well.

P-OT, a standard parallel version of OT, cannot provide a satisfactory analysis to the data, since the comparison between input and output is given only once by its nature, with no consideration of intermediate derivational steps. This makes MAX(STRONG), a contextual faithfulness constraint, overexert its influence on the deletion of C_1 in a syncope-fed candidate VC_1C_2V from the original input VC_1VC_2V, failing to choose a correct output form VC_2V.

Another analysis in P-OT, Wilson (2001), is successful in describing the data even with no use of syllable structure. On the other hand, it depends heavily on the help of a targeted constraint NOWEAKCONS, and cumulative harmonic ordering as a way of comparing candidates as well as input and output. These two additional tools are indispensable to the analysis of Wilson's in order to overcome the problem met in tableau (5) in P-OT.

Wilson's targeted-constraints theory can be said to bridge the gap between P-OT with no allowance of derivation and HS with a full use of derivational steps. Though Wilson's analysis does not directly refer to intermediate steps, it implies them indirectly in the definition of NOWEAKCONS based on *weak element principle*.

However, as implied in McCarthy (2011), if a targeted-constraints theory is another theory based mainly on perception, it is a burden to the theory not to consider whether the consonant in question is released or not. This is because what matters in phonetically-based phonology is the naturalness of processes, not that of underlying to surface mappings.

In contrast, an analysis in HS does not need an additional apparatus like targeted constraints or cumulative harmonic ordering of Wilson (2001) since the theoretical framework itself allows for intermediate derivational steps. The main argument draws on the fact that deletion does not take place at one swoop due to *gradualness, harmonic improvement* and *local optimality*, which are the founding tenets of HS. Accordingly, it takes two steps for C_1 deletion in cluster. First, a coda consonant becomes Placeless [H] and then this [H] as a segment is deleted: $VC_1.C_2V \rightarrow VH.C_2V \rightarrow V.C_2V$. In so doing, it is necessary to employ markedness constraints CODACOND and HAVEPLACE on top of faithfulness constraints MAX[PLACE] and MAX. In relation to HAVEPLACE and MAX[PLACE], features should be considered entities rather than attributes in order to treat consonant deletion as gradual attrition. It is confirmed again that the more tightly restricted a theory is like HS, the less powerful it is, giving a better solution to a problem.

Even though gradualness and harmonic improvement are intrinsic to HS, harmonic improvement tableaux based on them are a burden to HS, just so are optimality diagrams to a targeted-constraints theory of Wilson. In addition, a question still remains regarding why it is Place features that get deleted, not other types of features. In the meantime, we cannot get rid of the impression that however theoretically well-established those apparatuses of HS's are, HS's intermediate derivational steps remind us of those of a rule-based analysis and that harmonic improvement tableaux reflect the order of rule application.

It can be said here that any version of OT needs to refer to intermediate forms one way or another to give a proper analysis to first consonant deletion fed by syncope. What matters is how properly.

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