# A Look at Derived Environment and Optimality Theory

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## 1. Introduction

Derived environment has been part of the theory of Lexical Phonology with special reference to cyclicity of rule application. Since then the derivational model of phonology has been seriously challenged by the parallel model of Optimality theory. In this paper, I attempt to investigate the notion of derived environment with respect to Optimality theory and account for the case which might require the serial derivation from the traditional sense of rule ordering. By adopting McCarthy's new revised version of the theory which recognizes two levels in accounting for phonological opacity, I intend to show how the serial feeding order limited to the phonologically derived forms can be accounted for by utilizing the markedness constraint. This paper is organized with preliminary review on the concept of derived environment and subsequent analysis on Finnish spirantization which exhibits both morphologically and phonologically derived environments.

## 2. Derived Environment and Phonological Rules

### 2.1. Historical Perspectives

As one characteristic of rule application, the failure of applying phonological rules has long been recognized in nonderived, monomorphemic forms. Some rules apply only to derived forms; i.e. derived via morpheme concatenation or as the result of prior rule application. In SPE, a phonological rule like trisyllabic shortening (such as [ay]~[ɩ] as in 'divine/divinity') is recognized to apply mostly in the case of derived environment. To avoid the application of the trisyllabic shortening rule in underived forms, SPE posits abstract underlying representation for the underived forms (for instance, /nixtVngæ:l/) which later undergo independently motivated neutralization rule (ix ⟶ i ⟶ ay).

On the basis of sound change Kiparsky argues against such absolute neutralization and suggests the alternation condition as in (1).

**(1) The Alternation Condition**

Obligatory neutralization rules cannot apply to all occurrences of a morpheme.

This condition makes it unplausible to assume abstract underlying representation for a morpheme as in the case of English trisyllabic shortening.

Kiparsky then shifts the focus from the neutralization rule to the inability of rules to apply in derived environment. He introduces the notion of "derived environment." Derived environment is the result of morphological concatenation or phonological processes. According to the new revised alternation condition, trisyllabic shortening fails to apply to nonderived environment.

**(2) Revised Alternation Condition**

Obligatory neutralization rules apply only in derived environment.

For instance, spirantization in Finnish applies only after the morpheme is concatenated or a phonological rule is applied.

**(3) Finnish spirantization**

| | | |
|---|---|---|
| a. | halut-a | 'want' |
| | halus-i | 'wanted' |
| b. | vete-nä | 'water' (ess.) |
| | vesi | 'water' (nom.): after raising e ⟶ i |
| c. | tila | 'place' |

Thus, the spirantization applies after the morpheme concatenation (3.a) or vowel raising (3.b) but not in underived monomorphemic form (3.c).

Mascaro (1976) then claims the rule application in derived environment as part of characteristics of cyclic rule application. Kiparsky (1982) develops this idea of cyclicity of phonological rules in his theory of Lexical Phonology. As one of the main concepts of the theory, he claims that cyclic rules exhibit the "derived-environment-only" behavior.

(4) **Strict Cycle Condition (Kiparsky, 1982:41)**

a. Cyclic rules apply only to derived representations.

b. A representation $\phi$ is *derived* w.r.t. rule R in cycle j iff $\phi$ meets the structural analysis of R by virtue of a combination of morphemes introduced in cycle j or the application of a phonological rule in cycle j.

He further extends his argument by claiming that the cyclic rules are structure-preserving while noncyclic rules can be structure-changing. And this concept becomes the central idea regarding general patterns of rule application. Thus, the lexical rules apply in structure preserving pattern. In the postlexical level, however, such restriction ceases to hold. Along with this concept about structure preservation, metrical rules such as syllabification are considered to apply even to underived environment since they are structure building rules.

On the other hand, mismatches between morphological constituent and phonological constituents have resulted in reconizing the prosodic constituents independent of morphology (Selkirk 1980, Inkelas 1989, Cohn, 1989, Nespor & Vogel 1986, etc.). Inkelas (1986) presents an analysis in which she formulates parallel prosodic constituents via mapping them with morphological concatenation in a cyclic manner. Once prosodic constituents are formulated, information on the morphological constituents are invisible after the bracket erasure. In that sense her analysis presents some problems regarding the notion of morphologically derived environment which has to recognize morphological concatenations of affixes and sometimes compounds.

Inkelas cites Myers' analysis on English trisyllabic shortening as to what would be really going on in the case of so called morphologically derived forms. Myers (1987) reanalyzes the process as closed syllable shortening which applies to the syllable which has undergone resyllabification and resulted in [CVVC] syllable which is prohibited in English. Thus, in his analysis, English shortening does not have to refer to morphological information since the environment can be viewed to be solely phonological. Inkelas thus suggests the possibility that other morphologically oriented derived environments could be reanalyzed as phonological ones.

Examining the reality of cyclic rules, Cole (1995) examines the property of strict cyclicity and argues against cyclic rules. She also claims that derived environment is independent of cyclicity unlike the claim made by Mascaro and Kiparsky. She points out that there is a discrepancy between the numbers of morphologically derived forms and phonologically derived forms. Besides the few cases of phonologically derived environments which are repeatedly cited in the literature such as Finnish, most cases are the results of morpheme concatenation. She also presents the problem in Kiparsky's cyclic analysis on Finnish. Raising feeds the rule of spirantization as in (3.b). The strict cyclicity (4) makes the spirantization rule a cyclic rule since it applies only in derived environment. However, the raising rule cannot be a cyclic rule since it applies word finally. In terms of the lexical phonology, the raising rule is a word level non-cyclic rule. The dilemma here is that the post-cyclic rule has to apply prior to the cyclic lexical rule. Cole looks at the possibility that the spirantization is not a cyclic rule. This possibility fails since the rule will then have to apply to nonderived forms. Thus, Cole claims that the concept of derived environment should not be confused with and included in the notion of the cyclicity. In fact, she argues against the reality of cyclic rules in general. Rather, she suggests that there should be a certain kind of independent constraint similar to Kiparsky's revised alternation condition which restricts the rule application only to the derived environment.

This strong suspicion against cyclicity is extended in the Optimality theory which is based on parallelism of phonological processes and effectively utilizes the concept of Alignment.[1]

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[1] In Cohn and McCarthy (1994), unusual stress pattern in the Indonesian words with suffixes is analyzed from the point of Alignment instead of cyclic application of rules.

## 2.2. Derived Environment-Revisited

A closer look at the derived environment and examples exhibit three types. First case is not exactly derived but it is rather prosodically motivated for the alternation due to the resyllabification or ambisyllabicity. Second and third cases are derived ones in a true sense: one is through the feeding relation between two phonological rules; the other is purely morphological in that the alternation exists only when other morphemes are added.

As for the first case, English closed syllable does not necessarily apply to derived environment as briefly mentioned earlier. Myers analyzes the trisyllabic shortening (in SPE term) as applying to the closed superheavy syllable after the resyllabification as in (5).

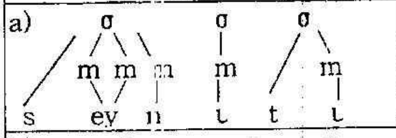
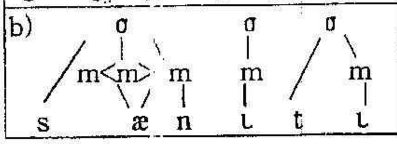
**(5) The environment for English closed syllable shortening (Myers, 1987)**

```
     x
     x
     x                 x        x
     σ                 σ        σ
   //\\                |      /   \
  C V  V C             V     C     V
  |  \/  |             |     |     |
  s  ey  n             ι     t     ι
```

Since the [CVVC] syllable is not allowed word medially in English, the superheavy syllable [seyn] has to undergo the closed syllable shortening. Thus, the shortening process is not viewed as the result of morpheme concatenation but of the prosodic constraint on syllable template. Myers lists other instances which require the resyllabification or at least ambisyllabicity such as English flapping, [h]~Ø alternation, and palatalization as supporting evidence for the resyllabification analysis.

This view is analyzed in terms of optimality theory as well. Prince & Smolensky (1993) and Sherer (1994) present the following analysis on the same phenomenon.

**(6) English Vowel Mora Underparsing**[2]

| /seɪnɪtɪ/ | $*\sigma_{mmm}$ | $Parse_m$ |
|---|---|---|
| a)  | *! | |
| b)  | | * |

Here, the first syllable is extra heavy in that it violates the constraint which prohibits three moras. Thus, (6.b) is the optimal form in terms of the constraint hierarchy given in (6).

The other two cases involve the true sense of derived environments; i.e., one is derived through the application of phonological rule(s) and the other via morpheme concatenation. Finnish presents both instances of derived environment as repeated in (7).

**(7) Finnish spirantization**

a. halut-a 'want'
   halus-i 'wanted'
b. vete-nä 'water (ess.)
   vesi 'water (nom.): after raising e ⟶ i
c. tila 'place'

When monomorphemic as in (7.c), the underlying form does not undergo the spirantization. On the other hand, suffixation provides with the environment for the spirantization as in (7.a) and vowel raising creates the environment for the process as in (7.b).

In the derivational model the spirantization in (7.b) is triggered after the raising as in (8).

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[2] Regarding Optimality theory, a discussion is given in the next section.

(8) UR: /vete/
veti : word-final raising
[vesi] : spirantization

Thus, rule ordering and strict cyclicity play roles.

In the following sections, I will attempt to analyze the process in relation to the notion of derived environment from the optimality framework.

# 3. Theoretical Background

## 3.1. Optimality Theory in General

Instead of serial derivational model taken in generative phonology, the optimality contends a theory of parallel nonderivational model. Thus, under parallelism, the serial rule ordering is replaced by hierarchical constraints. The simultaneous evaluation of constraints replaces the derivation. The motivation and effects of optimality theory are well documented in the optimality literature (McCarthy & Prince 1993, Prince & Smolensky 1993, etc.)

In the optimality theory, the grammar is composed of Gen and evaluation. The Gen creates candidates for the evaluation and the evaluation process operates by the constraints which have language particular constraint hierarchy.

(9) Gen $(in_i) \longrightarrow \{cand_1, cand_2, ....\}$
Eval $(\{cand_1, cand_2, ....\}) = out_{real}$

The candidate that best satisfies the constraint hierarchy will be chosen as the most harmonious, optimal surface output. In this model, every candidate created by the Gen is evaluated once and for all without any serial derivation.

As one of three underlying principles[3] that governs the operation of Gen,

[3] which are Freedom of Analysis, Containment, and Consistency of Exponence (McCarthy & Prince, 1993)

Consistency of Exponence constrains the composition of a morpheme to be intact. McCarthy and Prince (1993) explain that "Consistency of Exponence means that the phonological specifications of a morpheme (segments, moras, or whatever) cannot be affected by Gen. In particular, epenthetic segments posited by Gen will have no morphological affiliation, even if they are bounded by morphemes or wholly contained within a morpheme......Thus, any given morpheme's phonological exponents must be identical in underlying and surface form, unless the morpheme has no phonological specifications at all...." This principle prohibits the configuration with an epenthetic segment appearing inside the morpheme. Russel (1995) points out that it is not possible to have a morpheme whose edge undergoes featural change according to the principle. For instance, two identical feature specifications from distinct morphemes can easily undergo merging as a result of morpheme concatenation in conformity with the Obligatory Contour Principle as in (10).

**(10) Example of OCP at the edge of a morpheme**

```
x    +    x         ——→      x  +  x
|         |                   \   /
[+F]    [+F]                  [+F]
```

In fact, many cases which involve the derived environment are concerned with edge segment of morphemes, which should violate the Consistency of Exponence. Thus, the principle does not seem to shed much light on the issue in discussion.

## 3.2. Correspondence Theory of Optimality

An obstable to the parallelism assumed in the Optimality theory is the phonological opacity which has been considered to be an evidence for rule derivation. McCarthy (1994) takes up on the issue of the notion of opacity. The types of opacity discussed by Kiparsky are repeated in (11).

**(11) Opacity**

A phonological rule P of the form $A \longrightarrow B\ /\ C\_D$ is **opaque** if there are surface structures with any of the following characteristics:

a. instances of *A* in the environment *C__D*
b. instances of *B* derived by P that occur in environments other than *C__D*.
c. instances of *B* not derived by P that occur in the environment *C__D*.

A rule without these characteristics is **transparent.**
Thus, in all the cases of (11), the surface environment does not necessarily include the information which might have been there underlyingly. This fact proves that there must be serial derivation.

On the basis of their function, McCarthy divides constraints in optimality theory into two classes, *structural* constraints and *faithful* constraints. He states that "the structural constraints express, as categorical statements, such preferences as any theory of Universal Grammar must demand: syllables have onsets; vowels are not both front and rounded; metrical feet are binary; nasals agree in place of articulation with following consonants... Faithfulness constraints assert that the surface form and lexical form are identical." To keep faithfulness constraints satisfactory, the optimality theory assumes Containment in Gen under which the candidate forms include maximum information which is necessary to undergo the evaluation and eventually results in the output forms.

To capture the opacity effect, McCarthy presents a revised version of optimality. The new revised version includes the faithfulness condition which is regulated by correspondence theory between two levels.

**(12) Correspondence**
Given two strings $S_1$ and $S_2$, **correspondence** is a relation R from the elements of $S_1$ to those of $S_2$. $\alpha \in S_1$ and $\beta \in S_2$ are referred to as **correspondents** of one another when $\alpha R \beta$.

The faithfulness includes both segmental and featural informations. Some of the faithfulness constraints are formulated under corresponence theory as below.

(13) **MAX**

Every segment $S_1$ has a correspondent in $S_2$.
(I.e., there is no phonological deletion.)

(14) **DEP**

Every segment of $S_2$ has a correspondent in $S_1$.
(I.e., there is no phonological epenthesis.)

(15) **IDENT(γF)**

Let α be a segment in $S_1$ and β be a correspondent of α in $S_2$.
If α is [γF], then β is [γF].
(I.e., underlying [γF] cannot change to [-γF], assuming full specification.)

To derive the opacity effect, besides the above faithfulness conditions the new version employs some markedness constraints which specify not only the targets but also the repairs that surface in the targets. McCarthy assumes that every constraint is negative target defined over no more than two segments, α and β. The constraint contains the following information.

(16) **the canonical constraint imposed on α and β such as *{α, β}**

(i) a specification of the featural properties of α and β as individual segments.
(ii) a specification of the linear order relation between α and β (α<β, β<α, or both in the case of mirror-image rules.)
(iii) a specification of the adjacency relation between α and β (e.g., strict adjacency, vowel-to-vowel adjacency, etc.)

In this framework, the constraint must designate the level (underlying, surface, or either) at which it is effective. Correspondence theory enables the segments in question to be related at one level or the other. McCarthy (1994) presents a hypothetical Hebrew dialect in which velar spirantization is triggered by underlying [i] regardless of whether it is later deleted or not.[4] The whole constraint hierarchy

[4] Actual case with the same effect is found in Bedouin Arabic dialect with velar palatalization

includes other constraints with the hierarchy as *Complex >> No-V-STOP >> DEP >> IDENT (-cont). Among them, the markedness condition can be schematized as follows.:

(17)

| * | Condition | Level |
|---|---|---|
| α | | |
| β | | |
| Linear Order | | |
| Adjacency | | |

In default case which does not involve the opacity, the level assignment is assumed to be on surface. However, the cases with the opacity differs. As one instance, the No-V-STOP constraint with the opacity can be expanded as in (18).

**(18) No-V-STOP constraint with opacity**

| * | Condition | Level |
|---|---|---|
| α | V | underlying |
| β | [-son, -cont] | Surface |
| Linear Order | α > β | underlying |
| Adjacency | Strict. | underlying |

**(19) The Result of Constraint (18) Applied**

<table>
<tr><td></td><td>a.</td><td>b.</td><td>c.</td></tr>
<tr><td>Underlying</td><td>malakīm</td><td>mal k</td><td>malakē</td></tr>
<tr><td></td><td>| | | | | | |</td><td>| | | |</td><td>| | | | |</td></tr>
<tr><td>Faithful Candidate</td><td>məlākīm</td><td>melek</td><td>mal kē</td></tr>
<tr><td>Required Conditions for Constraint Applicability</td><td colspan="3">Conditions Observed in these Candidates S/U Pairings</td></tr>
<tr><td>α=V at U</td><td>α=V at S & U</td><td>α=V at S!</td><td>α=V at U</td></tr>
<tr><td>β=stop at S</td><td>β=stop at S & U</td><td>β=stop at S & U</td><td>β=stop at S & U</td></tr>
</table>

(McCarthy, 1994).

| | | | |
|---|---|---|---|
| $\alpha>\beta$ at U | $\alpha>\beta$ at S & U | $\alpha>\beta$ at S! | $\alpha>\beta$ at U |
| $\alpha^\frown\beta$ at U | $\alpha^\frown\beta$ at S & U | $\alpha^\frown\beta$ at S! | $\alpha^\frown\beta$ at U |
| Conclusion: | (18) is applicable (18) is | (18) is | |
| | and violated | inapplicable, | applicable |
| | | so obeyed | and violated |

The * sign in (18) means that the constraint is about prohibition and thus the configuration given in the condition column is not allowed in this language. The ! in (18) signals that there is not a match for the constraint in the specified level and thus it is not possible to evaluate whether the forms in question show correct correspondence. When the constraint is inapplicable and thus it satisfies the constraint vacuously, the faithful output which obeys the next-ranked constraint IDENT(-cont) is optimal.

Thus, by assuming additional noncanonical subpart of markedness condition, McCarthy manages to account for the opacity effect originally taken into consideration for the reality of rule ordering. The other crucial things to remember here are that the constraint is given as negative target and underlying and surface levels are posited to induce the matching (or correspondence) relation between the two levels.

## 4. Derived Environment and Correspondence theory of Optimality

As for the derived environments discussed in the earlier sections, the Finnish spirantization exhibits both environments; i.e., derived via phonological rule and morpheme concatenation. In the case of morphologically derived one, we can take Cole's suggestion on the derived environment as being a type of condition on monomorphemic form. The constraint can be stated as in (20).

**(20) *Feature-spreading in monomorphemic form**

Within a root or stem, feature spreading is not allowed.

Without considering the constraint (20), the hierarchy of constraints to result in the correct forms for /vete/ and /halut-i/ are given in (21) and (22).[5]

(21)[6]

| /vete/ | *Word-final [e] | *[-cont]-[i] sequence | IDENT(-cont) |
|---|---|---|---|
| vete | *! | | |
| veti | | *! | |
| ⟶ vesi | | | * |

(22)

| /halut-i-/ | *Word-final [e] | *[-cont]-[i] sequence | IDENT(-cont) |
|---|---|---|---|
| haluti | | *! | |
| ⟶ halusi | | | * |

The problem, however, lies in the fact that this constraint should not be problematic in the case of underived [tila] which does not undergo the spirantization.

(23)

| /tila/ | *Word-final [e] | *[-cont]-[i] sequence | IDENT(-cont) |
|---|---|---|---|
| tila | | *! | |
| ⟶ sila | | | * |

Thus, we need the constraint (20) which prohibits the [si] sequence in monomorphemic form. The constraint (20) is considered to dominate the constraint barring the [-cont]-[i] sequence for the time being.

(24)

| /tila/ | *Spreading in Monomorpheme | *[-cont]-[i] sequence |
|---|---|---|
| ⟶ tila | | * |
| sila | *! | |

5 as in Hebrew spirantization, the constraint No-[-cont]-[i] appears to lack the characterization of phonological process, in this case, the assimilation which used to be described as feature spreading in the derivational rule approach.

6 Here, ⟶ signals the optimal form.

Predictably enough, the above constraint does not work in the case of phonologically derived environment such as [vesi] from /vete/.

(25)

| /vete/ | *Word-final [e] | *Spreading in Monomorpheme | *[-cont]-[i] sequence |
|---|---|---|---|
| ⟶ veti | | | * |
| vesi | | *! | |

To avoid the spirantization in the underived form, the No-[-cont]-[i] constraint may have to be revised to No Word Final [-cont]-[i] sequence constraint. This constraint, however, does not account for the fact that the spirantization fails to apply to nonderived monomorphemic forms. In fact, the word final vowel raising feeds the spirantization in the derivational model. Although the result seems to be about transparent environment, we should be able to capture the failure of the spirantization applying to the underived form. It is not that the spirantization is limited to the word final [ti] sequence. The spirantization occurs only to that sequence word finally due to the environment for the vowel raising which feeds the process. The constraint should thus say something about the nature of special feeding relation in this case which is the result of word final vowel raising. Thus, canonical constraint is not sufficient and I assume the following constraint which describes the two segments in question, featural composition, precedence and locality relation, and additional environment necessary for the word final vowel.

(26)

| * | condition | level |
|---|---|---|
| α | [-cont] | surface |
| β | i) [i] | surface |
| | ii) Word-final | indifferent |
| Linear Order | α > β | indifferent |
| Adjacency | Strict | indifferent |

Here the condition on β contains not only the featural information but its positional relation to bigger phonological constituent like syllable, word, etc. Here, it is word final as the result of vowel raising. In other words, the vowel raising adds special phonological status, namely, word-final position, to the segment β. The constraint bars the [ti] sequence to the underived forms due to the fact that [i] in that sequence is not the result of word final vowel raising. The correspondence application of the constraint (26) is given below.

**(27) The Result of Constraint (26) applied**

| | | | |
|---|---|---|---|
| underlying | a. | b. | |
| | vete | vete | |
| | \|\|\|\| | \|\|\|\| | |
| Faithful candidate | vesi | *veti | |
| Required conditions | Conditions observed in these candidates | | |
| for constraint applicability | S/U pairings | | |
| α=[-cont] at S | α=[+cont] at S | α=[-cont] at S & U | |
| β=[i] at S | β=[i] at S | β=[i] at S | |
| β is word final | yes | yes | |
| Conclusion: | (26) is applicable and obeyed | (26) is applicable and violated | |
| underlying | c. | d. | e. |
| | tila | tila | sila |
| | \|\|\|\| | \|\|\|\| | \|\|\|\| |
| Faithful candidate | tila | *sila | sila |
| Required conditions | Conditions observed in these candidates | | |
| for constraint applicability | S/U pairings | | |
| α=[-cont] at S | α=[-cont] at S & U | α=[+cont] at S | α=[+cont] at S & U |
| β=[i] at S | β=[i] at S & U | β=[i] at S & U | β=[i] at S,U |
| β is word final | no! | no! | no! |
| Conclusion: | (20) is inapplicable, so obeyed | (20) is inapplicable, so obeyed[7] | (20) is inapplicable, so obeyed |

Going back to the constraint (20), it is necessary to point out that the constraint will prohibit the form like [vesi] since it is monomorphemic. On the other hand, the constraint given in (26) cannot produce the form like [halus-i] since it contains non-matching configuration and is thus vacuously unviolated. On the other hand, the constraint (20) has nothing to do with other constraints which should be applicable to monomorphemic forms. Thus, the constraint (20) that limits the domain of the process is mixed with other structural constraints if we follow the constraint hierarchy given in (26). The constraint (20) and No-word final [e] constraint do not show any hierarchy and should be treated independently. Along the line of this observation, I suggest a parameterization of constraint (20) which will be on or off according to the property of the alternation. Thus, the constraint will be relevant only in the case of *[ti] sequence in Finnish.

I assume two constraints (20) and (26) play roles in the optimality of the forms in question in a related way and the two constraints operate according to Elsewhere Condition (Kiparsky, 1982a). The more specific constraint (26) will be put into consideration first and otherwise the constraint (20) will be in effect. Thus, the form /vete/ will be realized as [vesi] according to the constraint (26) while underived form [tila] and morphologically derived /halut-i-/ will be under the evaluation of the constraint (20). This point is summarized in (28).

| (28) | Underlying | Surface | Regulated by | Spirantization |
|---|---|---|---|---|
| a. | /vete/ | [vesi] | constraint (26) | Yes |
| b. | /tila/ | [tila] | constraint (20) | No |
| c. | /halut-i/ | [halusi] | constraint (20) | Yes |

## 5. Conclusion

In this paper, I have reviewed the concept of derived environment in the literature and repeated the recent claim that the notion of derived environment should be separated form that of cyclicity. I examined the two distinct cases of derived

[7] This form will eventually be out by the next constraint in the hierarchy [IDENT(-cont)].

environment in terms of correspondence optimality theory. Phonologically derived forms were accounted for by utilizing negative markedness constraint which attempts to find matching correspondence between underlying and surface configurations. I claimed that we need an additional condition on the markedness constraint besides the ones presented in McCarthy (1994). On the other hand, morphologically derived forms were assumed to be the result of constraint that is somewhat similar to the classic definition of the Alternation Condition. The two constraints were regarded to operate disjunctively according to the Elsewhere Condition.

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