Chapter 4 OCP on Features, Local Conjunction, and Sympathy Theory: An Analysis of Yucatec Maya Consonant Clusters

4.1 Introduction

In Chapter 2 and 3, we have seen the basic typology of featural OCP effects. In this chapter I will examine a language which, while it fits into the typology, requires that we call on additional theoretical resources for a complete analysis. I will show that the OCP effect demonstrated by Yucatec Maya provides evidence for two recent theoretical proposals. First, the triggering constraint will be shown to be a kind of double OCP by Local Conjunction of constraints (Smolensky 1993, 1995, 1997). Second, I will show that the output of stop-initial clusters requires the use of Sympathy Theory (McCarthy 1997b, 1998).

In Yucatec Maya, when a stop is followed by a homorganic stop (or affricate), it becomes [h], and when an affricate is followed by a homorganic stop (or affricate), it spirantizes into a homorganic fricative (Straight 1976). At first glance, this looks similar to the Basque stop deletion. Lombardi (1990a, b) analyzes this Yucatec phenomenon as the result of delinking the feature [stop] from a segment due to the effects of the OCP, thus treating it the same as the Basque case which we observed in section 3.3. Does this mean that both languages belong to the same typological type? Since Basque is already confirmed as a Type 4 language, is Yucatec Maya also Type 4?

The same OCP is in effect in both Basque and Yucatec Maya, nonetheless the two languages appear to differ on the following two points: First, the OCP on [stop] effects any cluster in Basque, but only homorganic clusters in Yucatec Maya. Second, in a sequence of two stops, one of the stops deletes in Basque, while it becomes [h] in Yucatec Maya. There is no principled explanation of these two asymmetries in previous autosegmental analyses.

In this chapter, I claim that Basque and Yucatec Maya do not belong to the same type in terms of the typology of the OCP effects on features. I argue that the two languages demonstrate distinct constraint rankings. The grammar of Yucatec Maya does not exhibit a Type 4 constraint ranking. I will make it clear that it belongs to Type 3 language in which featural deletion and insertion are observed.

Furthermore, I indicate that special constraint interactions are observed in the grammar of Yucatec Maya. First, I discuss what triggers the alternation of stops or affricates. When two adjacent segments share only the same place features, the alternation is not observed. Also, when they share only the stop feature, the alternation does not take place. I therefore assert that no single OCP constraint such as OCP[Place], OCP[stop], etc. forces the alternation. I claim that it is a local conjunction, OCP[Place]&OCP[stop], that triggers the stop alternation.

Secondly, I demonstrate the constraint interaction that accounts for why the segment does not delete but is replaced by [h] in the case of stop alternation. As I mentioned in section 3.3, in a similar environment in Basque, the entire stop segment deletes due to the constraint ranking, OCP[stop], HAVEPLACE >> MAX-IO, MAX[stop]. I show that the Yucatec Mayan grammar consists of a different ranking of these constraints than Basque; therefore, segmental deletion does not take place.

Thirdly, I discuss the asymmetry between the affricate alternation and the stop alternation. While only the stop feature changes in the case of affricates, both the manner and place features change in the manner alternation. I introduce Sympathy Theory (McCarthy 1997b, 1998), and argue that the asymmetry can be explained only when the sympathetic faithfulness relations are allowed in the grammar.

4.2 Yucatec Maya Consonant Clusters

In this section, I will examine Yucatec Mayan data. The following data show phonological alternations observed in consonant clusters in the language:

(1) **Yucatec Maya** (Straight 1976):

a. taaŋ **k p**ak'ik **k k**ool	→ taaŋ **k p**ak'ik **h k**ool "we're planting our clearing."
b. tun koli**k k'**aaš	→ tun koli**h k'**aaš "he's clearing bush"
c. leʔ iŋ w o**t č**o	→ leʔ iŋ w o**h č**o "that house of mine/my house there"
d. ʔu**c t** iŋ w ič	→ ʔu**s t** iŋ w ič "I like it (lit. goodness is at my eye)."
e. ʔu k'áat u kaŋ kàa**st**eyàanoh	→ ʔu k'áat u kaŋ kàa**st**eyàanoh "He wants to learn Spanish."

Let us summarize what emerges from the above data as follows:

1) A stop becomes [h] before a homorganic stop or affricate (a–c);

2) An affricate becomes a homorganic fricative before a homorganic stop or affricate (d);

3) A stop or an affricate preserves its original form before non-homorganic stop or affricate (a);

4) A fricative preserves its original form before a homorganic stop (e).

In the above data, "homorganic" refers only to major place feature. Coronal obstruents count as homorganic regardless of their value for [anterior]. Also, it does not matter whether the consonants differ in glottalization (k or k').

It seems that the above phenomena in Yucatec are similar to the deletion and spirantization in Basque, discussed in section 3.3. In the following sections, I will review how the Yucatec Maya phenomena have been previously analyzed in autosegmental phonology, identify the points which need to be reanalyzed, and reanalyze them within the OT framework.

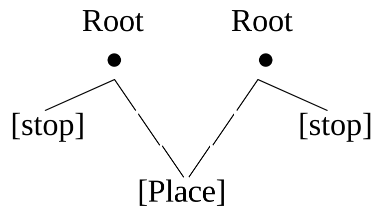
4.3 The Previous Analyses in Autosegmental Phonology: What Triggers the OCP Effects

This section will point out some aspects of the phenomena under consideration which were left unexplained in previous analyses of Yucatec Maya, and indicate how they will be accounted for within the OT framework. On the basis of the argument in this section, the Yucatec phenomena will be reanalyzed in detail in section 4.4.

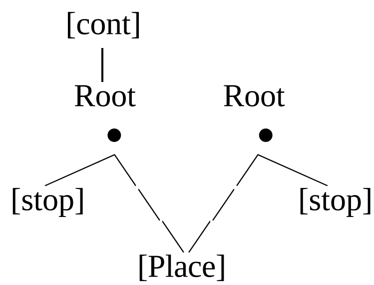
Lombardi (1990a, b) argues that a stop debuccalizes into [h], and an affricate spirantizes into a homorganic fricative in Yucatec Maya due to the same effects of the OCP on [stop] that are observed in deletion and spirantization in Basque. She claims, however, that the environments which trigger the OCP effects are different in the two languages:

OCP[stop] affects two adjacent [stop] features in Basque regardless of their place features as illustrated in section 3.3. On the other hand, in Yucatec Maya, the OCP shows an effect only when the two nodes share identical place features in addition to having two adjacent [stop] features. This is formulated in (2) and (3):

(2) a stop + a homorganic stop:



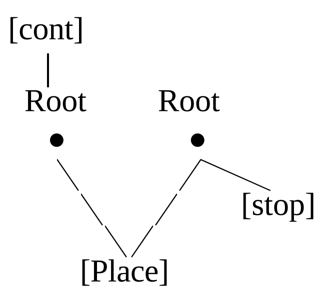
(3) an affricate + a homorganic stop:



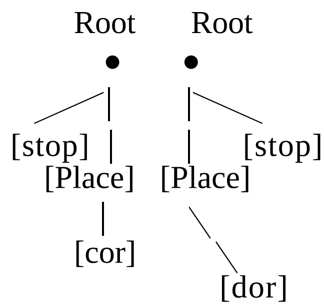
In both of the sequences in (2) and (3), one of the [stop] features deletes.

In other words, the following two environments will not trigger the OCP effects in Yucatec Maya:

(4) a fricative + a homorganic stop:



(5) a stop + a non-homorganic stop:



In (4), the two adjacent segments have different manner features even though they share the same place node. In (5), the two adjacent segments do not share the same place node even though their manner features are the same. Therefore, the OCP effects will apply neither in (4) nor in (5).

This distribution raises two questions. First, what is the causal relationship between sharing place features and the effects of the OCP on [stop]? In other words, why must the two adjacent segments have the same place features as well as the same manner feature in order to get the OCP effects on [stop]?

Secondly, if the two adjacent segments can share the same place feature by double linking, then, why can they not share the same manner feature [stop] by double linking and thus avoid OCP effects on [stop]?

To address these two questions, I will consider the following two points which will be discussed in detail in section 4.4:

Both [stop] and [Place] are clearly involved in the alternations, since only two stops that agree in Place are affected. Lombardi (1990a, b) used double linking of [Place] to formalize the involvement of [Place]. However, I claim that [Place] is not doubly linked, and that, for this reason, it gives rise to an OCP effect.

First, I propose that double linking of features to two segments is not possible in this language due to a high-ranked UNIFORMITY[F] constraint. This leads to the conclusion that (2), (3) and (4) are impossible representation in Yucatec Maya, and should be revised as follows:

(6) a stop + a homorganic stop (revised formulation of (2)):

```
        [dor]     [dor]
          |         |
     Root •    Root •
          |         |
        [stop]    [stop]
```

(7) an affricate + a homorganic stop (revised formulation of (3)):

```
        [cor]             [cor]
          |                 |
     Root • — [cont]  Root •
          |                 |
       [stop]            [stop]
```

(8) a fricative + a homorganic stop (revised formulation of (4)):

```
        [cor]     [cor]
          |         |
     Root •    Root •
          |         |
       [cont]    [stop]
```

(9) a stop + a non-homorganic stop (revised formulation of (5)):

```
        [dor]     [lab]
          |         |
     Root •    Root •
          |         |
       [stop]    [stop]
```

As (6) and (7) show, my hypothesis is thus that there are two adjacent [stop] features and two adjacent identical place features in the sequence of a stop and a homorganic stop and the sequence of an affricate and a homorganic stop. On the other hand, in the sequence of a fricative and a homorganic stop (8), the two adjacent segments have the same place features but different manner features. In the sequence of a stop and a non-homorganic stop in (9), the two segments have the same manner features but different place features.

Secondly, as a consequence of these representations, two kinds of OCP effects will simultaneously arise in Yucatec Maya: one on [stop] and one on [Place] features. I propose that two adjacent segments with the same place features and the same stop features are affected by the combination of these two OCP effects.

I claim that the constraints on [stop] and [Place] must both be violated in order to observe the relevant phonological alternations in this language. That is why the alternations are not observed in either the sequence of a stop and a non-homorganic stop or in the sequence of a fricative and a homorganic stop. In those cases, only one of the OCP constraints is violated. On the other hand, in the sequence of a stop and a homorganic stop, both the OCP on [stop] and on [Place] are violated. To account for this, I propose the conjoined constraint OCP[stop] & OCP[Place].

I will argue that the Yucatec phenomena are explained by an interaction of two separate single OCP constraints, the conjoined OCP constraint, segmental faithfulness constraints, and featural faithfulness constraints.

4.4 An Analysis within the OT Framework

4.4.1 An Analysis with Single Constraints Does Not Work

In this section, I will consider analyses that rank only single constraints, and indicate why they do not work. Next, the analysis using local conjunction will be introduced making clear why local conjunction is necessary in the analysis of the Yucatec data.

I have pointed out in section 4.3 that two kinds of OCP effects should be considered in Yucatec: One is on the [Place] feature, and the other is on the [stop] feature. I have also claimed that deletion of the [stop] feature is observed as the result of the OCP. Within the OT framework, therefore, there are at least three kinds of constraints interacting here: OCP[Place], OCP[stop] and MAX[stop].

Since we actually observe the effects of the OCP, we must assume that OCP constraints are relatively high-ranked in this language. They must be satisfied at the expense of violating some lower-ranked constraint(s). Since one of the [stop] features deletes, it is assumed that the violated lower-ranked constraint is a featural faithfulness constraint for [stop], namely, MAX[stop].

The fact that constraints make reference to [Place] as a feature requires some justification. Padgett (1995b, c) proposes "CONSTRAINT(CLASS)". This is a constraint which targets any subset of a feature class. In a constraint like "MAX[Place]", the class is ***Place***, and the constraint targets any subset of the class, such as ***Lab, Cor, Dor*** or ***Phar.*** Therefore, MAX[Place] entails MAX[lab], MAX[cor], MAX[dor] and MAX[phar]. DEP[Place] entails DEP[lab], DEP[cor], DEP[dor] and DEP[phar]. OCP[Place] entails OCP[lab], OCP[cor], OCP[dor], and OCP[phar].

As the data in (1) above shows, when a stop is followed by a homorganic stop, the first stop becomes [h]. For example, /**k** **k**ool/ becomes [**h** **k**ool] (1 a). Therefore, I assume the following ranking:

(10)

```
   OCP[Place], OCP[stop]
       ______|______
       |           |
MAX[Place]  MAX[stop]
```

Let us examine this data in the following tableau:

(11) a stop and a homorganic stop:

/ **k** **k**ool/	OCP[Place]	OCP[stop]	MAX[Place]	MAX[stop]
☞ a. **h** **k**ool			*	*
b. **k** **k**ool	*!	*!		

Candidate (b), in which no alternation is observed, violates both of the two higher-ranked constraints, namely, OCP[Place] and OCP[stop]. Since both of them are high-ranked, the violation of only one of them is enough for the candidate to lose. On the other hand, candidate (a), in which the alternation is observed, violates neither OCP[Place] nor OCP[stop]; therefore, it wins. The ranking in (10) correctly provides the optimal candidate. From tableau (11), we should conclude that at least one of the OCPs must outrank MAX[Place] and MAX[stop] to account for the correct output.

Let us now look at other data: a stop and a non-homorganic stop. In this sequence, no phonological alternation is observed. Therefore, we must assume that

OCP[stop] is lower ranked than the faithfulness constraint. However, the ranking given in tableau (11) produces the incorrect result.

*(12) a stop and a non-homorganic stop:

/ **k** **p**ak'ik/	OCP[Place]	OCP[stop]	MAX[Place]	MAX[stop]
*☞a. **h p**ak'ik			*	*
b. **k p**ak'ik		*!		

Candidate (b), in which no alternation is observed, incorrectly loses due to the fatal violation of OCP[stop], despite the fact that this is the actual output. From this tableau, we must conclude that OCP[stop] must be lower ranked than either MAX[Place] and MAX[stop].

Let us examine one more example: a fricative and a homorganic stop. In this sequence, no phonological alternation is observed either. Therefore, we must conclude that OCP[Place] does not outrank the faithfulness constraints.

*(13) a fricative and a homorganic stop:

/kàa**s** **t**eyàanoh/	OCP[Place]	OCP[stop]	MAX[Place]	MAX[stop]
*☞ a. kàa**ht**eyàanoh			*	
b. kàa**st**eyàanoh	*!			

Again, candidate (b) in which no phonological alternation is observed incorrectly loses due to the fatal violation of OCP[Place].

We have a conclusion from tableau (11) that at least one of the OCPs should outrank MAX[Place] and MAX[stop].

(14) Tableau (11) requires:

Either

(a) OCP[Place]

MAX[Place] MAX[[stop]

Or

(b) OCP[stop]

MAX[Place] MAX[[stop]

However, OCP[stop] cannot outrank the faithfulness constraints based on tableau (12).

(15) Tableau (12) requires:

MAX[Place] MAX[[stop]

OCP[stop]

Furthermore, OCP[Place] cannot outrank the faithfulness constraint based on tableau (13).

(16) Tableau (13) requires:

MAX[Place] MAX[[stop]

OCP[Place]

Thus, we must conclude that there is no valid ranking here to explain all the data above.

Yucatec spirantization is not accounted for by ranking the individual constraints above. This is because OCP[Place] can be violated, and OCP[stop] can be violated, but not both cannot be violated at the same time. With the ranking of the individual constraints separately, we cannot obtain the correct analysis. In the next section, I will propose a local conjunction, OCP[Place]&OCP[stop], and discuss the reason why the conjunction is necessary in the analysis.

4.4.2 An Analysis with Local Conjunction

4.4.2.1 Local Conjunction (Smolensky 1993, 1995, 1997)

Within the OT framework (Prince and Smolensky 1993), different constraint rankings account for the different grammars in the world's languages. There are, however, some phonological phenomena which cannot be explained by the ranking of single constraints: such as Southern Palestinian Arabic RTR phenomena (McCarthy 1996b), stress assignment in Diyari (Hewitt & Crowhurst 1995), vowel length phenomena in the Wellagga dialect of Oromo (Alderete 1997), vowel raising phenomena in Nzɛbi (Kirchner 1996), and front vowel raising in the Northern Mantuan Italian dialect (Miglio 1995). In such cases, each researcher has reported that the analyses of the data are made possible only by introducing local conjunction.

Local Conjunction is defined as a combination of two single lower-ranked constraints that produces a violation of a higher one (Smolensky 1993, 1995, 1997). If constraint A and constraint B are each ranked lower than constraint C, a candidate can violate either of them so as to satisfy C.

(17)

C >> A, B.

However, if a candidate violates both A and B, the conjunction of these two violations may force the violation of constraint C:

(18)

A&B >> C >> A, B

(18) indicates that A and B are each separately violable so as to satisfy the higher ranked constraint C; however, both of them are not violable at the same time, i.e. in the same domain.

On the basis of the idea of Local Conjunction in this section, I will propose a local conjunction, OCP[Place] & OCP[stop], and discuss its validity and necessity in the analysis of Yucatec Maya. I will further discuss Local Conjunction in section 4.7 regarding its motivation and the conjoinability of the constraints accompanied by the review of the previous literature on Local Conjunction.

4.4.2.2 OCP[Place] & OCP[stop]

I propose a local conjunction, OCP[Place] & OCP[stop]. This constraint will be violated only when both OCP[Place] and OCP[stop] are violated. If only one of the members is violated, then the conjunction is not violated.

Next, I will re-examine those data discussed above using the local conjunction. The revised ranking I propose is as follows:

(19)

OCP[Place]&OCP[stop]
|
MAX[Place]   MAX[stop]
|
OCP[Place]   OCP[stop]

With this ranking, let us re-examine the data in tableaux (11), (12), and (13):

(11)' a stop and a homorganic stop (revised version of tableau (11)):

/ **k** **k**ool/	OCP[Place] & OCP[stop]	MAX[Place]	MAX[stop]
☞ a. **h** **k**ool		*	*
b. **k** **k**ool	*!		

Candidate (b) violates the conjunction because it violates both of the two OCPs. This is a fatal violation. Thus, candidate (a) correctly wins. Candidate (b) also violates each single OCP constraint; however, this does not matter, since each single OCP[Place] or OCP[stop] is not ranked highly enough to be active as shown in the following tableau in (20).

(20)

/ **k** **k**ool/	OCP[Place] & OCP[stop]	MAX[Place]	MAX[stop]	OCP[Place]	OCP[stop]
☞a. **h** **k**ool		*	*		
b. **k** **k**ool	*!			*	*

Next, let us reexamine the sequence of a stop and a non-homorganic stop:

(12)' a stop and a non-homorganic stop (revised version of tableau *(12)):

/ **k** **p**ak'ik/	OCP[Place] & OCP[stop]	MAX[Place]	MAX[stop]	OCP[Place]	OCP[stop]
a. **h** **p**ak'ik		*!	*!		
☞ b. **k** **p**ak'ik					*

Candidate (b) does not violate the conjunction, since it violates only OCP[stop]. Thus, it correctly wins. The violation of the single OCP[stop] does not matter, since OCP[stop] is lower ranked than the MAX[F] constraints. We can obtain the correct output by introducing the conjunction in this tableau in contrast to tableau *(12).

A similar result is achieved with a sequence of a fricative and a homorganic stop.

(13)' a fricative and a homorganic stop (revised version of tableau *(13)):

/kàa**s** **t**eyàanoh/	OCP[Place] & OCP[stop]	MAX [Place]	MAX [stop]	OCP [Place]	OCP [stop]
a. kàa**ht**eyàanoh		*!			
☞ b. kàa**st**eyàanoh				*	

Candidate (b) in this tableau does not violate the conjunction, because it violates only OCP[Place]. Thus, candidate (b) is correctly optimal. Again, the violation of single OCP[Place] does not matter, since it is lower ranked than the two MAX[F] constraints.

We have observed that neither of the two single OCP constraints should be higher ranked than faithfulness constraints in the language. Nevertheless, some constraint for the OCP effect must account for the attested phonological alternation. I propose that OCP[Place]&OCP[stop] is necessary to explain the Yucatec data.

4.5 How to Satisfy the Conjunction: The Ranking in Yucatec Maya

4.5.1 OCP[Place]&OCP[stop] >> MAX[Place], OCP[stop] >> OCP[Place], MAX[stop]

As discussed in section 3.3, in Basque, the higher-ranked OCP[stop] constraint is satisfied at the expense of violating MAX[stop] and MAX-IO.

In contrast, in Yucatec, the higher-ranked constraint which has to be satisfied is not a single OCP constraint (e.g. OCP[Place] or OCP[stop]), but the conjunction OCP[Place]&OCP[stop]. Recall that the conjunction is violated only when both are violated. In other words, it is satisfied when either OCP[Place] or OCP[stop] is satisfied. To avoid changing both features, yet avoid a violation of the local conjunction, which single OCP should be satisfied?

In Yucatec Maya, I claim that only OCP[stop] is satisfied to satisfy the conjunction, and OCP[Place] is violated. This claim is supported by the affricate alternation. In the affricate alternation, what is changed is not the Place feature but the manner feature. Thus, we conclude that MAX[Place] must be satisfied.

This claim implies the following two points: One is that OCP[stop] outranks MAX[stop], which gives rise to deletion of the [stop] feature. Next is that MAX[Place] outranks OCP[Place] which prohibits deleting the Place feature.

Let us summarize the claim above with the ranking of these four constraints:

(21)

OCP[Place]&OCP[stop]

MAX[Place] OCP[stop]

OCP[Place] MAX[stop]

First, the ranking "MAX[Place] >> OCP[Place]" will be examined. In the case of the affricate alternation, only the manner feature is changed, and the place feature is kept, resulting in the violation of OCP[Place]. Therefore, we conclude that MAX[Place] outranks OCP[Place]:

(22) MAX[Place] >> OCP[Place]:

/ʔu**c** **t** /	OCP[Place] & OCP[stop]	MAX[Place]	OCP[Place]
a. ʔu**c** **t**	*!		
☞ b. ʔu**s** **t**			*
c. ʔu**h** **t**		*!	

Due to the higher-ranked constraint MAX[Place], candidate (b) wins.

Next, the ranking "OCP[stop] >> MAX[stop]" will be examined:

(23) OCP[stop] >> MAX[stop]:[1]

/ **k** **k**ool/	OCP[Place] & OCP[stop]	OCP[stop]	MAX[stop]
☞ a. **h** **k**ool			*
b. **ʔ** **k**ool		*!	
c. **k** **k**ool	*!		

As tableau (23) shows, a stop becomes [h] not [ʔ] to satisfy the conjunction. This indicates that OCP[stop] should be satisfied at the expense of violating MAX[stop]. The ranking in (23) states that two stop feature cannot be adjacent to satisfy OCP[stop]; therefore, MAX[stop] is violated, resulting in MAX[stop] alternation. The winning candidate (a) actually carries the Place feature change. However, as I already pointed out in tableau (22), the faithfulness constraint for the place feature, MAX[Place] cannot be demoted. Thus, in order to explain the manner feature change in tableau 23, there must be some other constraint interaction. I will deal with this issue by introducing Sympathy Theory in section 4.6.

Thus, tableaux (22) and (23) make it clear that the feature [stop] deletes due to the constraints OCP[Place]&OCP[stop], and OCP[stop] which are ranked high enough to be active, while OCP[Place] is not ranked high enough to be active as the ranking in (21) shows.

Before going on, I must discuss the ranking of MAX[Place] in this language. I claim that MAX[Place] is not only higher ranked than OCP[Place] but also than the markedness constraints for the place feature. Recall the discussion of Lombardi's proposal (1995b) of the markedness constraint for the place features. If the

1. Another candidate which changes only manner, [x kool], is not ruled out by this ranking; it will be discussed in section 4.6.

markedness constraints for the place feature outranked the faithfulness constraint, the candidate with the most unmarked Place feature should always be optimal regardless of the input. In other words, all consonants turn into pharyngeal:

*(24) *Lab, *Dor >> *Cor >> *Phar >> MAX[Place]:

/ʔu**c** **t** /	*Lab / *Dor	*Cor	*Phar	MAX[Place]
a. ʔu**s** **t**		*!		
*☞b. ʔu**h** **t**			*	*

With this ranking, candidate (b) incorrectly wins. To obtain the correct optimal candidate, the constraints should be re-ranked as follows:

(25) MAX[Place] >> *Lab, *Dor >> *Cor >> *Phar:

/ʔu**c** **t** /	MAX[Place]	*Lab / *Dor	*Cor	*Phar
☞a. ʔu**s** **t**			*	
b. ʔu**h** **t**	*!			*

Thus, MAX[Place] must outrank the markedness constraint to account for the correct output .

If MAX[Place] is highly ranked, a question immediately arises about changing the place feature of the stop segment in the sequence of a stop and a homorganic stop (or affricate). I will argue that changing the place feature of the stop is derived from the interaction of other constraints. This will be discussed in detail in section 4.6.

Before moving on to the next section, I will reanalyze the data examined in tableaux (11)', (12)' and (13)', since the ranking in (19) has been revised in (21) in this section. I will revise tableau (12)' first:

*(12 a)" wrong result: a stop and a non-homorganic stop

/ **k** **p**ak'ik/	OCP[Place] & OCP[stop]	OCP [stop]	MAX [Place]	OCP [Place]	MAX [stop]
*☞a. **hp**ak'ik			*		*
b. **kp**ak'ik		*!			

As tableau (12a)" shows, the ranking in (21) will not provide the optimal candidate. Violation of MAX[stop] does not penalize candidate (a) unless OCP[stop] and MAX[Place] are tied. However, there is no evidence which indicates that they are tied constraints. Thus, I conclude that another ranking "MAX[Place] >> OCP[stop]" is necessary to account for the correct output in this tableau.

Let us reanalyze this tableau with the new ranking:

(12 b)" a stop and a non-homorganic stop: 2

/ **k** **p**ak'ik/	OCP[Place] & OCP[stop]	MAX [Place]	OCP [stop]	OCP [Place]	MAX [stop]
a. **hp**ak'ik		*!			*
☞ b. **kp**ak'ik			*		

Since MAX[Place] outranks OCP[stop], candidate (b) correctly wins.

Thus, (26) is the revised version of (21) with the ranking MAX[Place] >> OCP[stop]:

2 With the ranking in this tableau, there is better candidate, [x pak'ik], which violates only the lower ranked constraint, MAX[stop]. I will account for this in section 4.6.

(26)

OCP[Place] & OCP[stop]

MAX[Place]

OCP[stop]

OCP[Place] MAX[stop]

The ranking in (26) makes clear that the conjunction should be satisfied, and that keeping the place feature is better than keeping the manner feature.

4.5.2 MAX-IO, HAVEMANNER >> DEP[cont]

In Basque, the entire stop deletes as already observed, because HAVEMANNER and DEP[cont] are higher-ranked than a segmental faithfulness constraint, MAX-IO.

In Yucatec Maya, the stop in the sequence does not delete even after deletion of the feature [stop]. Instead, it spirantizes into a fricative. Therefore, we assume that both HAVEMANNER, and MAX-IO should be satisfied at the expense of violating some lower-ranked constraint, i.e. DEP[cont].

(27)

(a) HAVEMANNER : Every segment must bear some manner feature.

(b) DEP[cont]: An output continuant feature must have an input correspondent.

To satisfy HAVEMANNER without violating MAX-IO, some manner feature, namely, [cont] should be inserted. I conclude, therefore, that DEP[cont] is lower-ranked than HAVEMANNER or MAX-IO in Yucatec Maya. Let us observe how the ranking accounts for the actual data.

(28) A stop and a homorganic stop (affricate):

/ o**t** **č**o /	HAVEMANNER	MAX-IO	DEP[cont]
a. o**t** **č**o ‡ [stop]	*!		
b. o **č**o		*!	
☞ c. o**h** **č**o			*

Tableau (28) indicates that spirantization is preferred to deletion of the entire segment.

(29) The ranking for spirantization:

```
HAVEMANNER,  MAX-IO
     |__________|
        |
   DEP[cont]
```

Before discussing the interaction of other constraints, let us revise the ranking provided in (26) by adding the new ranking in (29).

(30) Ranking of constraints in Yucatec Maya (revised version of (26)):

OCP[Place] & OCP[stop], HAVEMANNER, MAX-IO

MAX[Place]

OCP[stop]

OCP[Place] MAX[stop] DEP[cont][3]

In order to make it clear that HAVEMANNER and MAX-IO outrank MAX[Place], and DEP[cont] is lower ranked than OCP[stop], we should reanalyze spirantization with this new ranking.

(31) spirantization of a stop in a homorganic cluster:[4]

/o**t** **č**o /	OCP[pl.] & OCP[stop]	Have Manner	MAX-IO	MAX [Place]	OCP [stop]	OCP [Pl.]	MAX [stop]	DEP [cont]
a. o**t** **č**o	*!				*	*		
☞b. o**h** **č**o				*			*	*
c. o **č**o			*!					
d. o**t** **č**o ‡ [stop]		*!				*	*	
e. o**ʔ** **č**o				*	*!			

3 DEP[cont] is lower ranked than OCP[stop], because the continuant feature is not inserted in the sequence of a stop and a non-homorganic stop such as [k.p], where OCP[stop] is violated.

4 With the ranking in this tableau, there is a better candidate, [osčo], which violates only the lower ranked constraints, OCP[Place], MAX[stop], and DEP[cont]. I will discuss the issue later in section 4.6.

In (31), candidate (a) loses due to a violation of the conjunction. Violation of HaveManner penalizes candidate (d). Candidate (c) shows why deletion of the segment is impossible. Since violation of MAX-IO penalizes (c), MAX-IO should outrank MAX[Place]. Candidate (e) illustrates why the stop becomes not the glottal stop but the glottal fricative. OCP[stop] violation penalizes this candidate. This indicates that OCP[stop] outranks DEP[cont]. Consequently, candidate (b) in which the stop spirantizes into a pharyngeal fricative becomes optimal.

Let us examine spirantization of an affricate in a homorganic sequence next:

(32) spirantization of an affricate in a homorganic cluster:

/ʔu**c** **t** /	OCP[pl.] & OCP[stop]	Have Manner	MAX-IO	MAX [Place]	OCP [stop]	OCP [Place]	MAX [stop]	DEP [cont]
a.ʔu**c** **t**	*!				*	*		
☞ b.ʔu**s** **t**						*	*	
c.ʔu**h** **t**				*!			*	
d.ʔu **t**			*!					
e.ʔu**t** **t**	*!				*	*		

Candidate (e) in tableau (32) shows that hardening of the affricate will not help the situation, since it still violates the conjunction. Violation of MAX-IO penalizes candidate (d).

Thus, candidate (b), with the affricate spirantizing into the homorganic fricative, wins. Tableaux (31) and (32) are full explanations of the ranking of the constraints in (30). In Yucatec Maya, keeping the input manner feature is not important in contrast to keeping the place feature due to the ranking.

In the following section, I will discuss the rest of the constraints whose interaction is very similar to that of Basque. In other words, all the constraint interactions are the same between Yucatec Maya and Basque except what I have pointed out in this section, i.e. Local Conjunction, and the ranking of DEP[cont] >> MAX-IO.

4.5.3 UNIFORMITY[stop] and DEP-IO

Neither fusion of the two stop features nor epenthesis of a segment is observed in Basque and Yucatec Maya. In the analysis of Basque, I have concluded that UNIFORMITY[F] and DEP-IO are relatively higher ranked. The same argument carries over to Yucatec Maya.

(33)

(a) DEP-IO: Every segment of the output has a correspondent in the input (No phonological epenthesis) (McCarthy & Prince, 1995);

(b) UNIFORMITY[F]: No feature of the input has multiple correspondents in the output (McCarthy and Prince 1995, Causeley 1997).

Let us analyze a sequence of two homorganic stops with the fusion and epenthesis candidates:

(34) UNIFORMITY[stop], DEP-IO >> MAX[Place]:

/**k** **k**ool/	UNIFORMITY[stop]	DEP-IO	MAX[Place]
☞ a. **h** **k**ool			*
b. **k** **k**ool \ / [stop]	*		
c. **k V k**ool		*	

As tableau (34) indicates, UNIFORMITY[F] and DEP-IO should outrank MAX[Place] for candidate (a) to win.

(35)

UNIFORMITY[stop], DEP-IO

MAX[Place]

4.5.4 MAXONS[stop]

So far, I have discussed only the candidates in which the [stop] feature deletes in the first segment of the sequence. In this section, I will examine the candidates in which the [stop] feature deletes in the onset position.

The analysis should be very similar to the Basque case, because the [stop] feature deletes only in the first segment (i.e., in the coda) in both Basque and Yucatec Maya. For Basque, I concluded that the [stop] feature deletes not in the onset but in the coda due to the constraints MAXONS[stop], MAX-IO and MAXONS-IO. MAXONS[stop] is necessary, since the [stop] feature deletes in the coda position in the sequence of a stop and an affricate.

(36)

MAXONS[stop]: An input stop feature in the onset must have an output correspondent (Beckman 1995, Lombardi 1995a, Padgett 1995a);

The following ranking is expected in Yucatec Maya:

(37)

MAXONS[stop] >> MAX[stop]

By adding this ranking, let us reexamine the sequence of a stop and an affricate with an additional candidate analyzed in tableau (32).

(38) spirantization of a stop in a sequence of a stop and a homorganic affricate (revised version of (32)):

/o**t** **č**o /	OCP[pl.] & OCP [stop]	HAVE MANNER	MAX-IO	**MAX Ons [stop]**	MAX [Place]	OCP [stop]	MAX [stop]
a. o**t** **č**o	*!					*	
☞ b. o**h** **č**o					*		*
c. o **č**o			*!				
d. o**t** **č**o ‡ [stop]		*!					*
e. o**ʔ** **č**o					*	*!	
f. o**t** **s**o				*!			*

The fact that candidate (f) in this tableau loses demonstrates that MAXONS[stop] should outrank both MAX[Place] and MAX[stop].

(39)

MAXONS[stop]
|
MAX[Place]
|
MAX[stop]

This ranking in addition to the proposed ranking in (30) is crucial in the language.

Let us revise the entire ranking which we have obtained so far. The following is the ranking of all the constraints utilized in the analysis of Yucatec Maya:

(40) Ranking of the constraints in Yucatec Maya:

```
 OCP[Place]      HAVE      MAX-IO    MAXONS   UNIFORMITY   DEP-IO
&OCP[stop]       MANNER               [stop]     [stop]
     |_____________|__________|____________|___________|_________|
                              |
                         MAX[Place]
                              |
                         OCP[stop]
                  ____________|__________
                 |            |          |
            OCP[Place]   MAX[stop]   DEP[cont]
```

With this ranking, the following phenomena have been accounted for:

First, in the sequences of a stop and a non-homorganic stop, and a fricative and a homorganic stop, no phonologically alternation is observed. This is because the sequences themselves are well-formed given the ranking in (40). They do not violate the conjunction; therefore, the alternation is not triggered.

Second, a stop or an affricate in a homorganic cluster would result in the violation of the higher-ranked local conjunction by violating two of the OCPs for the place and the manner features. Hence, the alternation takes place so as to satisfy the conjunction.

Third, I have shown that fusion of two features and epenthesis of a segment to break the cluster, are impossible due to the higher-ranked constraints, UNIFORMITY[F], and DEP-IO.

Fourth, deletion of [stop] is observed in the coda, not in the onset. This is due to a positional featural faithfulness constraint MAXOns[stop].

Fifth, to satisfy the conjunction, one of the two members of the conjunction, OCP[stop], is satisfied. Hence, both a stop and an affricate spirantize by deleting the feature [stop]. This results in a violation of MAX[stop]. While only deleting the feature [stop] takes place in the affricate alternation, the [cont] feature is inserted in the stop alternation as well as the [stop] feature deletion. This is because the affricate originally bears the [cont] feature which the stop does not.

In Yucatec Maya, the manner feature change is preferred to the place feature change. In other words, there is no need to change the place feature in Yucatec Mayan grammar according to the ranking obtained so far. Nevertheless, the place feature as well as manner feature change in the stop alternation.

In the next section, I consider why the place feature changes in the case of stop alternation although the ranking indicates that the stop alternation is not necessary. I discuss the asymmetry between the alternation of the stop and that of the affricate in the homorganic sequence. The stop in the homorganic sequence turns not into a homorganic fricative but into a pharyngeal fricative, while the affricate becomes a homorganic fricative. I claim that this asymmetry is derived from a new type of faithfulness relationship among candidates–Sympathy Theory (McCarthy 1997b, 1998).

4.6 Sympathy Theoretic Account of the Yucatec Alternation: /t/ $\rightarrow$ [h]

4.6.1 Issue

In section 4.4 and 4.5, the necessity of the conjunction, and the way to satisfy the conjunction have been discussed. Now, we should go back to the problem which I pointed out in section 4.5: why does the place feature of the stop in the sequence change to [phar] in spite of the highly ranked constraint, MAX[Place]?

We have not found any problems in the analysis of the stop alternation in the previous sections. That is because we have not discussed a candidate in which only the manner feature changes, and the place feature does not.

In this section, I will add this candidate to make it clear that a problem remains, and that the ranking given in section 4.5 cannot account for the change in place.

First, let us observe why the ranking given in (40) fails to account for the phenomenon with the additional candidate.

*(41) a sequence of stop and a homorganic stop (or an affricate):

/ o**t** **č**o /	OCP[Place] & OCP[stop]	MAX [Place]	OCP [stop]	OCP [Place]	MAX [stop]
a. o**t** **č**o	*!		*	*	
*☞ b. o**s** **č**o				*	*
c. o**h** **č**o		*!			*
d. o**ʔ** **č**o		*!	*		

The actual optimal candidate is (c). However, the ranking which has been assumed so far incorrectly allows candidate (b) to win. If the ranking of MAX[Place] and OCP[Place] were reversed, candidate (c) would win. However, as already stated in section 4.5, this reversal is impossible, because in the case of the affricate alternation, the place feature is kept and the manner feature deletes.

Also, if this alternation were forced by the universal markedness hierarchy (*[lab], *[dor] >> *[cor] >> *[phar]) thus resulting in the emergence of unmarked structure, then candidate (c) would win, too. However, the analysis in section 4.5

has already demonstrated that this argument is not possible, because MAX[Place] outranks the markedness constraints for the place features. In this language, not all consonants turn to pharyngeal.

Let us focus on the problem in this tableau. Candidates (b), (c) and (d) all satisfy the conjoined OCP at the expense of a violation of faithfulness constraints. Candidate (b) violates MAX[stop] by changing the manner feature; candidate (d) violates MAX[Place] by changing the place feature; and candidate (c) violates both MAX[stop] and MAX[Place] by changing both the manner and the place features. Candidate (c) intuitively looks like the worst of the three due to the two violations. Nevertheless, (c) is the actual output.

In order to solve this problem, it is necessary to discuss further constraint interactions. I introduce Sympathy Theory in the next section, and indicate how the theory takes care of the Yucatec case in the following section.

4.6.2 Sympathy Theory (McCarthy 1997b, 1998)

McCarthy (1997b, 1998) proposes Sympathy Theory to solve the opacity problem in Optimality Theory (Prince & Smolensky 1993). Opacity means that a surface form is not what we expect it to be. Therefore, in order to explain the unexpected situation, we need some additional mechanism.

In rule-based theory, opacity is derived from the counterbleeding or counterfeeding rule order. In other words, the extra rule ordering gives rise to opacity. For example, in the analysis of Tiberian Hebrew in a rule-based theory, we observe a counterbleeding relation between the two rules: "epenthesis in final clusters" and "ʔ-deletion in coda":

(42)

UR	/dešʔ/
epenthesis	dešəʔ
ʔ-deletion	dešə
SR	[dešə]

The order of the application of the two rules is crucial here. If we applied the ʔ-deletion rule first, then, the epenthesis rule would not apply; hence, the surface form would be [deš]. Thus, the counterbleeding rule order is inevitable to account for why the surface representation is not [deš] but [dešə].

A case such as this leads to a problem when we analyze it in parallelist OT. Since a grammar consists of only the input and the output in OT, a simple constraint ranking cannot account for the phenomenon:

Two constraint rankings of "MAX-IO >> DEP-IO" and "CodaCond >> MAX-IO" describe the phenomena of "epenthesis in final clusters" and "ʔ-deletion in coda", respectively. Therefore, we establish one constraint ranking," CodaCond >> MAX-IO >> DEP-IO" here. However, the ranking cannot explicate the correct output as the following tableau shows.

(43) CodaCond >> MAX-IO >> DEP-IO

/dešʔ/	CodaCond	MAX-IO	DEP-IO
(☞) a. dešə		*	*!
*☞ b. deš		*	
c. dešəʔ	*!		

Regardless of ranking, the actual output (a) cannot be a better candidate than the wrong winner (b) in the tableau, since (b) has a subset of the marks of (a). We cannot explain the actual output on the basis of the given constraint ranking.

Sympathy Theory (McCarthy 1997b, 1998) proposes that there is a new type of constraint interaction based on a faithfulness relationship between the optimal candidate and one of the failed candidates. When a failed candidate is the most harmonic with respect to some constraint, but it cannot win due to a violation of a higher-ranked constraint, it can still allow another candidate, which is the most faithful to it in terms of some other constraint, to win through "*sympathy*". This non-optimal, yet influential candidate is called the sympathy candidate. Phonological opacity is derived from such constraint interactions within OT since we never observe the sympathy candidate in the input or in the output.

We need Sympathy Theory to obtain the correct analysis of Tiberian Hebrew above, because it is an instance of phonological opacity. A constraint, "Align-R IO (Root, σ)[5]" plays a crucial role to designate the sympathy candidate as the following tableau shows. The sympathy candidate is indicated by ❀:

(44) Designation of sympathy candidate (McCarthy 1997b: 5):

/dešʔ/	CodaCond	MAX-IO	DEP-IO	Align-R $_{IO}$❀ (Root, σ)
opaque ☞ a. dešə		*	*	*
transparent ← b. deš		*		*
sympathetic ❀ c. dešəʔ	*!		*	

5 Align-R IO: $]_{Root} =]_{\sigma}$ (all the right edge of the root coincides with the right edge of the syllable.)

Candidate (c) is the most harmonic candidate in terms of Align-R IO (Root, σ). However, it cannot be the optimal candidate due to its violation of the higher ranked CodaCond constraint. Hence, it is designated as the sympathy candidate to let an other candidate win. The opaque output is faithful to the sympathy candidate.

It is necessary to introduce an additional constraint, MAX-❀O, to clarify how the sympathy candidate exerts its influence. This new constraint is a kind of segmental faithfulness constraint which forces identity between the sympathy candidate and the output.

(45)

MAX-❀O: every segment in the sympathy candidate (❀) should have a correspondent in the output (O).

McCarthy (1997b, 1998) calls such a constraint a sympathy constraint. This sympathy constraint, MAX-❀O, outranks DEP-IO in the language:

(46) Constraint interaction with sympathy:

/dešʔ/	CodaCond	MAX-IO	MAX-❀O	DEP-IO	Align-R$_{IO}$❀ (Root, σ)
opaque ☞a. dešə		*	*	*	*
transparent ← b. deš		*	**!		*
sympathetic ❀c. dešəʔ	*!			*	

In tableau (46), candidate (a) correctly wins since it best-satisfies the entire constraint ranking, including the sympathy constraint.

Thus, McCarthy (1997b, 1998) succeeds in solving the opacity problem in OT with Sympathy Theory. All the examples McCarthy (1997b, 1998) provides are standard instances of the opacity problems in OT which are derived from serial derivation in rule-based theory.

Itô & Mester (1997) suggest that we should consider the conception of phonological opacity in parallelist OT. If Sympathy Theory is a fully generalized theory, then it must also explain other cases of opacity which are not just residual problems from a rule-based theory. They indicate in their analysis of German truncation that Sympathy Theory could account for all the grammars where some failed candidate, which is realized neither in the input nor in the output, plays an important role. The case of German which Itô and Mester analyze is not an opacity case derived from serial derivation but some type of prosodic morphological size restriction which has been studied by previous research (such as McCarthy and Prince's (1990) Prosodic Circumscription).

In German, there are two types of truncational forms. In one the clusters in the base are fully maximized, e.g. *Górbachow* → *Górbi*. In the other the clusters are not maximized, e.g. *Andrea* → *Andi* . In the former case, all the clusters in the base are fully maximized in the truncation form, i.e. (górb), while they are not in the latter case, i.e. *(andr), and (and).

This asymmetry cannot be explained with a single constraint ranking. A ranking predicts consistent truncational forms, i.e. either (1) (górb) and (andr) or (2) (gór) and (and). Let us look at the actual analysis of this problem by Itô and Mester.

In order to account for the truncational form, we need to consider three kinds of constraints: the faithfulness constraints for input and output (MAX-IO), the constraints for restricting size (All-Ft-L: Align (σ, Left, PrWd, Left), Parse-σ), and the faithfulness constraints for base and truncatum (MAX-BT: SEGMENTAL faithfulness constraint for the base and the truncatum). The proposed ranking of these constraints to account for the *Gorbi* type is MAX-IO >> All-Ft-L, Parse-σ >> MAX-BT.

(47) (Itô and Mester 1997:121)

	Base:[(.gór.ba).(čòf.)] Input:/TRUNC + i/	MAX-IO	All-Ft-Left	Parse-σ	MAX-BT
a.	(.gór.ba).(čòf-i.)		*!		
b.	(.gór.ba).č-i.			*!	óf
☞ c.	(.gór.b-i).				ačòf
d.	(.gó.r-i.)				bačòf!
e.	(.gór.ba.)	i!			čòf
f.	(.górb.)	i!			ačòf
g.	(.gór.)	i!			bačòf

As tableau (47) shows, the given ranking seems to correctly give rise to the optimal candidate. However, the same ranking cannot account for another type of truncation.

(48)

Base:[(.an.dre).(as.)] Input:/TRUNC + i/	MAX-IO	All-Ft-Left	Parse-σ	MAX-BT
a. (.an.dre).(a.s-i.)		***!		
*☞b. wrong winner (.an.dr-i.)		*		eas
c. desired winner (.an.d-i.)		*		reas!
d. (.a.n-i.)		*		dreas!
e. (.and.)	i!			reas
f. (.an.)	i!			dreas
g. (.a.)	i!			ndreas

Regardless of the ranking, the desired candidate (c) cannot win, because there is always better candidate (b) which has a subset of the marks of (c). Thus, we must conclude that such a constraint ranking cannot account for the correct analysis, and the conclusion leads to the suggestion that we need some extra explanation.

Itô and Mester assert that this German case is an instance of phonological opacity, because the faithfulness relation between the actual output and the failed candidate is crucial to account for the truncational forms. In other word, the failed candidates such as (.gorb.) in the former case or (.and.) in the latter case, which never surface, plays an important role in deciding which candidate will win.

Let us take a look at how the failed candidate makes the optimal candidate win through the sympathetic relation in the case of *Andreas*. In this case, (.and.) is the sympathy candidate because it is the most harmonic with respect to the designated constraint, All-Ft-Left.

(49) Designation of Sympathy candidate:

Base:[(.an.dre).(as.)] Input:/TRUNC + i/	MAX-IO	All-Ft-Left❁	MAX-BT
a. (.an.dre).(a.s-i.)		***!	
b. (.an.dr-i.)		*	eas
c. (.an.d-i.)		*	reas!
d. (.a.n-i.)		*	dreas!
❁ e. Sympathy Candidate (.and.)	i		reas
f. (.an.)	i		dreas
g. (.a.)	i		ndreas

Among the candidates which satisfy the designated constraint, All-Ft-Left, candidate (e) is the best candidate as shown in (49).

However, this candidate cannot become the actual output, because it violates the higher-ranked constraint, MAX-IO. The actual winner is candidate (c) since it satisfies not only the constraints already introduced but also satisfies another faithfulness constraint between the sympathy candidate and the output, namely DEP-❁O.

(50)

Base:[(.an.dre).(as.)] Input:/TRUNC + i/	MAX-IO	DEP-❁O.	All-Ft-Left❁	MAX-BT
a. (.an.dre).(a.s-i.)		reasi!	***!	
b. (.an.dr-i.)		ri!	*	eas
☞ c. (.an.d-i.)		i	*	reas
d. (.a.n-i.)		i	*	dreas!
❁ e. (.and.)	i!			reas
f. (.an.)	i!			dreas
g. (.a.)	i!			ndreas

Tableau (50) shows that the correct output is explained with an additional faithfulness relation between the sympathy candidate and the output.[6] Thus, Itô and Mester

6 The ranking with the faithfulness constraint between the sympathy candidate and the output also correctly accounts for the case of another type of truncation in

conclude that German truncation is an instance of opacity although it is not opaque from a serial derivation point of view.

Building on Itô & Mester's suggestion, I propose that Sympathy Theory can be extended to account for an opaque phenomenon in OT which is not derived from serial derivation in rule-based theory. The evidence for my claim comes from a new analysis which focuses on the Yucatec Maya stop alternation discussed in this chapter. Neither rule-based theory nor OT has succeeded in elucidating this alternation. I claim that the alternation is also derived from phonological opacity in OT; hence, only OT with Sympathy Theory can lead to the correct analysis of the language.

4.6.3 Rule-based and Bare OT (without Sympathy Theory) Account of the Stop Alternation

The Yucatec stop alternation is not a standard case of opacity like those discussed by McCarthy (1997b, 1998). The opacity cases he deals with are well-explained in rule-based analyses. The intermediate stages in a serial derivation play crucial roles in accounting for such cases. As noted above, problems for those cases appear when we try to explain the data in parallelist OT, because we have only the input and the output there. That is why McCarthy proposes Sympathy Theory.

On the other hand, the Yucatec stop alternation cannot be explained based on serial derivational analyses in rule-based theory, because no rule exists which can account for the change of the intermediate stage into the surface form.

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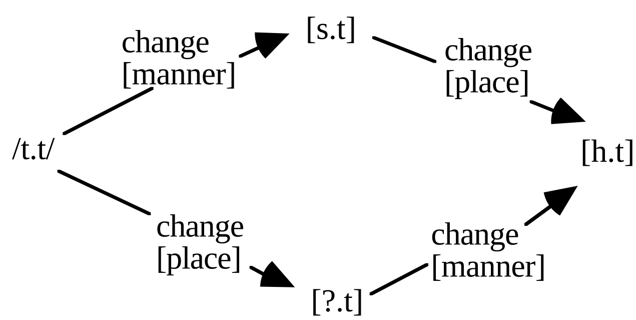
which the clusters in the base is fully maximized such as *górbi.*, and the case of the non-truncation form.

Previous autosegmental analyses such as McCarthy (1988) and Lombardi (1990a, b) argue that the Yucatec alternation is OCP-motivated debuccalization. However, one major problem with those approaches is that they fail to explain why /t.t/ turns into [h.t], not [ʔ.t] as is expected, if debuccalization were the result of changing the place feature.

As indicated in section 4.5, the alternation from /t.t/ into [h.t] involves two types of phonological changes: the place feature change and the manner feature change. [t] is both [stop] and [coronal], while [h] is [continuant] and [pharyngeal] (Lombardi 1990a, b). Therefore, there are two possible patterns in this stop alternation depending on the order of rule application.

(51) Changing place and manner features:



Now, a question arises. Since both [s.t] and [ʔ.t] in the intermediate stages of the alternations are permissible surface sequences in Yucatec Maya, we cannot justify the rules that turn /s.t/ into [h.t], or that turn [ʔ.t] into [h.t]. Thus, a rule-based theory cannot account for the data without stipulating a special rule to change both the place and manner features simultaneously.[7]

This section has made it clear that the Yucatec stop alternation is not a standard case of opacity as described by McCarthy (1997b, 1998). The intermediate stages in serial derivation play a crucial role in accounting for such cases. The problems for these cases appear when we try to explain the data in parallelist OT, because we have only the input and the output to refer to. On the other hand, the Yucatec stop alternation cannot be explained via a serial derivation within a rule-based theory because no rule exists which can account for the alternation from the intermediate stage to the surface form.

I have already proposed that a ranking: MAX[Place], OCP[stop] >> MAX[stop], OCP[Place] is found in the language. The affricate alternation is the evidence for the fact that MAX[Place] is highly ranked. In the sequence of an affricate and a stop, the affricate becomes not a pharyngeal fricative but a homorganic fricative. That is why the alternation is changing the manner feature rather than changing the stop feature. Therefore, I assume that MAX[Place] is higher ranked than MAX[stop].

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7 Smolensky (p.c.) suggests that there is a logically possible way to explain this alternation as a case of feeding in serial derivation. First, a rule for deletion of the place feature from the stop segment applies when it is followed by homorganic stop.

For example, /t.t/ becomes [t.t].
| | ‡ |
[cor][cor] [cor][cor]

Next, another rule which states the placeless segment turns into [h] applies. This second rule makes /t. t/ turn into [h.t].
‡
[cor]

However, as with the rules proposed above, it is unclear what the justification would be for this second rule instead of, for example, a rule turning the placeless segment into [ʔ].

(52) MAX[Place], OCP[stop] >>MAX[stop], OCP[Place]:

/ʔu**c** **t** /	OCP[Place] & OCP[stop]	MAX [Place]	OCP[stop]	MAX [stop]	OCP[Place]
a. ʔu**c** **t**	*!		*		*
☞ b. ʔu**s** **t**				*	*
c. ʔu**h** **t**		*!		*	

I have also determined the ranking MAX[Place] >> OCP[stop] in the analysis of the sequence of a stop and a non-homorganic stop sequence. MAX[Place] must be higher ranked than OCP[stop] to account for the correct winner.

(53) a stop and a non-homorganic stop:

/ k pak'ik/	OCP[Place] & OCP[stop]	MAX [Place]	OCP [stop]	OCP [Place]	MAX [stop]
a. **hp**ak'ik		*!			*
☞b. **kp**ak'ik			*		

Candidate (a) loses due to its fatal violation of MAX[Place].

Now, I summarize the relevant part of the ranking which I have established for the language so far.

(54) Constraint Ranking in Yucatec Maya:

OCP[stop]&OCP[Place]
|
MAX[Place]
|
OCP[stop]
|
MAX[stop]   OCP[Place]

Since the ranking in (54) is established, we must assume that the stop alternation is also the result of keeping the place feature and changing only the manner feature due to its satisfaction of MAX[Place], and to its violation of MAX[stop]. The ranking in (54) specifically predicts that the manner feature will change, but the place feature will not. However, we should recall the asymmetry between the affricate and the stop alternations illustrated in section 4.5. In the affricate case, we observe that only the manner feature changes, while the change of the place feature, as well as that of the manner feature, is observed in the stop alternation as chart (51) illustrates. The ranking in (54) cannot account for the asymmetry:

(55) Stop alternation in the sequence of a stop and a homorganic stop (affricate):

/o**t**. čo/	OCP[Place] & OCP[stop]	MAX [Place]	OCP [stop]	OCP [Place]	MAX [stop]
a. o**t**. čo	*!		*	*	
b. o**ʔ**.čo		*!	*		
← c. wrong winner o**s**. čo				*	*
d. desired winner o**h**. čo		*!			*

As tableau (55) shows, the actual output, candidate (d), loses to candidate (c). With this ranking, the stop alternation should result in changing the manner feature like the affricate case.

As a matter of fact, there is no chance for candidate (d) to win unless we stipulate some higher-ranked constraint which would penalize candidate (c). Promotion of OCP[Place] is impossible since OCP[Place] is violated in the optimal sequence of an affricate and a stop. Candidates (b) with only changing the place feature and (c) with only changing the manner feature violate faithfulness constraints for the place feature and for the manner feature, respectively. In contrast, candidate (d) changes both the place and the manner features and violates both faithfulness constraints, i.e. for the place and the manner features. Therefore, candidates (b) and (c) are less unfaithful to the input than candidate (d) in terms of these faithfulness constraints. Candidate (d) should always lose, because it has a superset of the marks of the less unfaithful candidates with respect to the faithfulness constraints.

Thus, the Yucatec data cannot be accounted for in OT without some extra mechanism. This section has demonstrated that neither a rule-based analysis nor an OT analysis with a simple constraint ranking can lead to a correct analysis for the Yucatec data. The next section discusses how Sympathy Theory successfully explains the phenomenon.

4.6.4 Sympathy Theory Account of the Alternation

The previous sections have shown that neither a rule-based theory nor OT with a simple constraint ranking can explain why the affricate alternation results in only changing the manner feature, while the stop alternation involves changing the place feature as well as changing the manner feature. This section discusses the application of Sympathy Theory in the analysis of this asymmetry.

As section 4.6.2 indicates, McCarthy (1997b, 1998) proposes that phonological opacity in OT is derived from a new type of constraint interaction on the basis of a faithfulness relation between co-candidates. I claim that the Yucatec Maya stop alternation is an instance of such a phonological opacity.[8] The actual output [h] (changing both the place and the manner features) is selected by virtue of its sympathetic relationship to the less unfaithful failed candidates [ʔ] (debuccalization). Since the failed candidate [ʔ] is realized neither in the input nor in the output, the selection of the optimal candidate is opaque. We observe the actual analysis based on Sympathy Theory in the following sections.

4.6.4.1 Selecting the Sympathy Candidate: DEP[cont]❀

First of all, we should select the sympathy candidate and the designated constraint (the "flower-picker" constraint) which is responsible for the selection of a sympathy candidate.[9]

In the following tableau, DEP[cont] is the designated constraint. Only candidate (a) and (b) satisfy the designated constraint. Between (a) and (b), (b) best-satisfies the ranking:

---

8 Smolensky (p.c.) points out that OT would explain the alternation without introducing any new theoretical device if we introduced a markedness hierarchy *[ʔ] >> *[h]. This ranking seems unlikely since fricatives are probably in general more marked than stops: for example, many languages have more stops than fricatives in their sound systems. However, I will leave the examination of this alternation to future research.

9 McCarthy (1997b, 1998) claims that only faithfulness constraints can be the designated constraint to choose the sympathy candidate, while Itô & Mester (1997) suggest that either faithfulness or markedness constraints can be the designated constraint. My analysis is consistent with McCarthy's proposal.

(56) Selecting the sympathy candidate:

/o**t**. čo/	OCP[pl.] & OCP [stop]	MAX [Place]	OCP [stop]	OCP [Place]	MAX [stop]	DEP❁ [cont]
a. o**t**.čo	*!		*	*		
❁b. sympathetic o**ʔ**.čo		*!	*			
← c. transparent o**s**.čo				*	*	*
d. opaque o**h**.čo		*!			*	*

Hence, I conclude that candidate (b) is the sympathy candidate, because it is the most harmonic candidate with respect to the designated constraint, DEP[cont].

Before going on to the next section which provides further discussion on the selection of the winning candidate, I would like to explain why other constraints cannot become the designated constraint.[10]

First, MAX[Place] cannot become the designated constraint when we consider the sequence of the stop and the homorganic stop or affricate as in tableau (56). If MAX[Place] were the designated constraint, then, candidate (c) becomes the sympathy candidate. Then, regardless of the ranking of all kinds of faithfulness constraints between the sympathy candidate and the output, candidate (c) would become always the optimal candidate. It is because candidate (c) never violates any faithfulness constraints between the sympathy candidate and the output since candidate (c) is both the sympathy and the optimal candidate by itself.

Let us look at the following tableau:

10 Following McCarthy (1997b, 1998), I consider only the faithfulness constraints as the candidates for the designated constraints.

*(57) Wrong selection of the designated constraint (1)

/o**t**. čo/	OCP[pl.] & OCP [stop]	MAX❁ [Place]	OCP [stop]	OCP [Place]	MAX [stop]	DEP [cont]
a. o**t**.čo	*!		*	*		
b. o**ʔ**.čo		*!	*			
❁ c. o**s**.čo				*	*	*
d. actual winner o**h**.čo		*!			*	*

Thus, if MAX[Place] were the designated constraint, then, the correct output, i.e. candidate (d) could not be optimal.

Next, as far as we analyze the stop alternation in the sequence, MAX[stop] as well as could be the designated constraint. However, I determine only DEP[cont] can be the designated constraint on the basis of the analyses of other sequences such as the affricate alternation.

Let us examine the affricate alternation with the hypothesis in which MAX[stop] were selected as the designated constraint.

*(58) Wrong selection of the designated constraint(2):

/ʔu**c t** /	OCP[Place] & OCP[stop]	MAX [Place]	OCP[stop]	❁ MAX [stop]	OCP[Place]
a. ʔu**c t**	*!		*		*
actual winner b. ʔu**s t**				*	*
c. ʔu**h t**		*!		*	
❁ d. ʔu**ʔ t**		*!	*		

As tableau (58) shows, if MAX[stop] were the designated constraint, candidate (c) became the designated constraint because it is the most harmonic candidate with respect to MAX[stop]. Then, there is no possible faithfulness constraint between the sympathy candidate and the output which can let the actual optimal candidate (b) win. Thus, I conclude DEP[cont] is the designated constraint in Yucatec Maya.

4.6.4.2 OCP[Place]&OCP[stop] >> MAX[Place]❀O >> MAX[Place]IO: Account for the Winning Candidate

This section discusses the rest of the analysis obtaining the correct output, namely, selection of the sympathy constraint and selection of the actual winner. According to McCarthy (1997b, 1998), a sympathy constraint is a kind of faithfulness constraint for a correspondence relation between the sympathy candidate and the output.

Here, in the analysis, I introduce a sympathy constraint: MAX[Place]❀O which is a faithfulness constraint for the place feature between the sympathy candidate and the output. Since the sympathy constraint outranks MAX[Place]IO in the language, the actual output is correctly selected:

(59) The entire ranking:

/o**t**. čo/	OCP[pl] & OCP [stop]	MAX [Place] ❀O	MAX [Place] IO	OCP [stop]	OCP [Place]	MAX [stop]	❀ DEP [cont]
a. o**t**.čo	*!	*		*	*		
sympathetic ❀b. o**ʔ**.čo			*	*!			
transparent ←c. o**s**.čo		*!			*	*	*
opaque ☞d. o**h**.čo			*			*	*

In tableau (59), candidate (d) correctly wins, because it best-satisfies the entire constraint ranking including the sympathy constraint.

We have seen in this section that selection of the actual output is opaque; therefore, we must apply a constraint ranking which includes the sympathy constraint to characterize the whole grammar.

4.6.5 Other Phenomena

We have observed that the grammar of Yucatec Maya consists of a constraint ranking with a sympathy constraint. Therefore, the ranking should explicate other phenomena as well as the stop alternation. In the following section, I will confirm the validity of the ranking by examining the sequences of an affricate and a homorganic stop (affricate), and a glottal stop and a non-homorganic stop.

4.6.5.1 The Affricate Alternation with Sympathy Theory

In the sequence of an affricate and a stop (or affricate), the candidate in which only the [stop] feature changes is the most harmonic candidate with respect to the designated constraint DEP[cont]; therefore, it is the sympathy candidate. This candidate is also optimal because it best-satisfies the entire constraint ranking, including the sympathy constraint. In other words, in this case, the sympathetic relation has no particular effect.

(60) An affricate and a stop:

/ʔu**c**. **t**/	OCP[pl] & OCP [stop]	MAX [Place] ❀O	MAX [Place] IO	OCP [stop]	OCP [Place]	MAX [stop]	❀ DEP [cont]
a. ʔu**c**. **t**	*!			*	*		
b. ʔu**ʔ**. **t**		*!	*	*			*
sympathetic and optimal ❀ ☞ c. ʔu**s**. **t**					*	*	
d. ʔu**h**.**t**		*!	*			*	

As tableau (60) shows, in this sequence, candidate (c) is both sympathetic and optimal. This is an instance of transparent phonology, which is observed when the sympathy and optimal candidates are the same.

4.6.5.2 A Sequence of a Glottal Stop and a Non-homorganic Stop

Another sequence we should examine is that of a glottal stop and a non-homorganic stop such as in /ʔ.t/. We do not observe any alternation in this sequence.

(61) Sequence of a glottal stop and a non-homorganic stop
(Straight 1976: 28 & 241):

tene**ʔ t́**in čam b'in h màan → tene**ʔ t́**in čam b'in h màan
'no gloss'

Since the non-homorganic sequence is already well-formed in Yucatec Maya, we do not observe any alternation. Therefore, the ranking established in section 4.6.4 must also account for this phenomenon. However, as the following tableau shows, the ranking does not account for this case.

(62) A wrong result:

/teneʔ t́in/	OCP[pl] & OCP [stop]	MAX [pl] ❀O	MAX [pl] IO	OCP [stop]	OCP [Place]	MAX [stop]	DEP❀ [cont]
a. tene**t** **t́**in	*!			*	*		
desired winner ❀ b. tene**ʔ** **t́**in				*!			
wrong winner *☞c. tene**h** **t́**in						*	*

In tableau (62), candidate (b) is the sympathy candidate, because it is the most harmonic candidate with respect to DEP[cont]. Then, candidate (c) is incorrectly optimal because it best-satisfies the entire constraint ranking. Since the correct output is candidate (b), we need to introduce an additional constraint to explain this case. I claim that the additional constraint is MAX[constricted glottis] which is a faithfulness constraint for the constricted glottis feature.

Let us first review the place, manner, and laryngeal features each obstruent bears. As noted in section 4.5.1, Lombardi (1995b) indicates that both [ʔ] and [h] have the pharyngeal place features. Also, [ʔ] and [h] bear the [stop] feature and the

[cont] feature, respectively. Kenstowicz (1994:39) explains that we observe the absence of [constricted glottis] in a plain stop, an aspirated stop, and a pharyngeal fricative [h], while the feature is present in an ejective stop and a glottal (pharyngeal) stop [ʔ]. On the other hand, [spread glottis] is absent in a plain stop, an ejective stop, and a glottal stop, while an aspirated stop and a pharyngeal fricative [h] bear the feature. The following table summarizes which obstruent has which feature:

Table V: The features in obstruents:

	[Place]	[stop]	[cont]	[spread glottis]	[constricted glottis]
[p] (plain)	lab	+	–	–	–
[p'] (ejective)	lab	+	–	–	+
[p^h] (aspirated)	lab	+	–	+	–
[ʔ]	phar	+	–	–	+
[h]	phar	–	+	+	–

On the basis of this observation, I analyze the glottal stop case with an additional faithfulness constraints, MAX[constricted glottis]

(63)

MAX[constricted glottis (constr. gl.)]: every input constricted glottis feature has an output correspondent.

Since the candidate with the glottal stop is optimal, I assume that MAX[constr.gl.] outranks OCP[stop].[11] Let us reexamine the sequence which was analyzed in tableau (62).

(64) A glottal stop and a non-homorganic stop:

/teneʔ t̂in/	OCP[pl] & OCP [stop]	MAX [pl.] ❀O	MAX [pl.] IO	MAX [constr. gl.] IO	OCP [stop]	OCP [pl.]	MAX [stop]	DEP❀ [cont]
a. tene**t** **t̂**in	*!	*	*	*	*			
☞ ❀ b. tene**ʔ** **t̂**in					*	*		
c. tene**h** **t̂**in				*!		*	*	*

The designated candidate in this tableau is (b) because it is the most harmonic candidate in terms of the designated constraint, DEP[cont]. Candidate (a) loses due to its violation of the conjunction. Candidate (c) loses to (b) due to the crucial ranking in which MAX[constr. gl.] outranks OCP[stop].

With this ranking, I re-examine the sequence of a non-glottal stop and a homorganic stop. Since the non-glottal stop does not bear [constricted glottis], no segments of the input contain the feature [constricted glottis].

11 MAX[constr. gl.] must also outrank *[constr. gl.]. This ranking is needed in any case in Yucatec Maya, since its sound system contains glottalized stops.

(65) A stop and a homorganic stop:

/o**t**. čo/	OCP[pl.] & OCP [stop]	MAX [pl.]❁O	MAX [pl] IO	MAX [constr. gl.] IO	OCP [stop]	MAX [stop]	DEP❁ [cont]
a. o**t**.čo	*!	*				*	
❁b. o**ʔ**.čo			*		*!		
c. o**s**.čo		*!					*
☞d. o**h**.čo			*				*

All the candidates in this tableau vacuously satisfy MAX[constr.gl.] so that the previous analysis without this constraint is still valid. Similarly, the proposed analysis of the sequence of an affricate and a stop is correct with the constraint, MAX[constr.gl.].

4.6.5.3 Impossibility of [x] or [f]

So far, we have discussed spirantization of the coronal stop and affricate. Next, we have to discuss spirantization of the dorsal stop and labial stop. According to Straight (1976), both the dorsal and labial stop in the sequences under investigation spirantize to a pharyngeal fricative [h].

The obtained ranking brings forth the correct analysis in the dorsal (or labial) stop and a homorganic stop.

(66) A dorsal stop and a homorganic stop

/**k k**ool/	OCP[pl] & OCP [stop]	MAX [pl.] ❀O	MAX [pl.] IO	MAX [constr. gl.] IO	OCP [stop]	MAX [stop]	DEP❀ [cont]
☞ a. **h k**ool			*			*	*
b. **x k**ool		*!				*	*
c. **k k**ool	*!	*			*		
d. **s k**ool		*!	*			*	*
❀ e. **ʔ k**ool			*		*!		

The designated candidate (e) is selected as the sympathy candidate because it is the most harmonic with respect to DEP[cont]. The optimal candidate is (a) since it best-satisfies the entire ranking.

We can correctly analyze spirantization of the dorsal or labial stop in the homorganic sequence. However, the same ranking does not properly work for the non-homorganic sequence of the dorsal or labial. In the non-homorganic sequence, no alternation is observed. However, the candidate in which the dorsal (or the labial) spirantizes into the homorganic fricative will win with the proposed ranking.

*(67) A wrong result: A dorsal stop and a non-homorganic stop

/**k** **p**ak'/	OCP[pl] & OCP [stop]	MAX [pl.] ❀O	MAX [pl.] IO	MAX [constr. gl.] IO	OCP [stop]	MAX [stop]	DEP❀ [cont]
a. **h** **p**ak'		*!	*			*	*
*☞ b. **x** **p**ak'						*	*
❀ c. **k** **p**ak'					*!		
d. **s** **p**ak'		*!	*			*	*
e. **ʔ** **p**ak'		*!	*		*		

In tableau (67), candidate (b) wrongly wins because it best-satisfies the entire ranking. However, candidate (c) is the actual winner. How can we account for this? Note that neither a dorsal nor a labial fricative exists in Yucatec phonemic inventory. Thus, I assume that markedness constraints for those sounds (*[x] or *[f]) are highly ranked in the language.

In order for the actual output to win, those markedness constraints are at least higher ranked than OCP[stop].

(68) A dorsal stop and a non-homorganic stop

/**k** **p**ak'/	OCP[pl] & OCP [stop]	MAX [pl.] ❀O	MAX [pl.] IO	***[x]**	OCP [stop]	MAX [stop]	DEP❀ [cont]
a. **h** **p**ak'		*!	*			*	*
b. **x** **p**ak'				*!		*	*
❀ ☞ c. **k** **p**ak'					*		
d. **s** **p**ak'		*!	*			*	*
e. **ʔ** **p**ak'		*!	*		*		

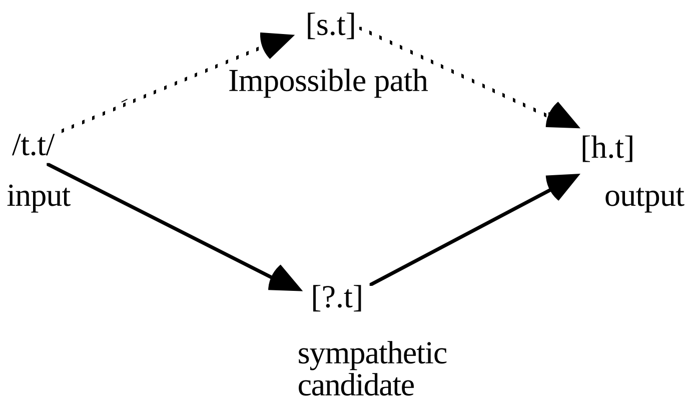
Since *[x] outranks OCP[stop] in this tableau, candidate (c) becomes both the designated and the optimal candidate.

4.6.6 Summary of the Section

In this section, I have argued that the stop alternation in Yucatec Maya is an instance of phonological opacity in OT; therefore, neither rule-based theory nor OT without Sympathy Theory can provide the correct analysis of the data. I have concluded that the constraint ranking with the sympathy constraint can correctly account for all the phenomena of the OCP effects both on the [stop] and on the [Place] features in Yucatec Maya.

The actual output [h] in the alternation /t.t/ → [h.t] becomes optimal through the influence of the sympathetic candidate as follows:

(69) The path for the output:



As shown in (69), a candidate-to-candidate correspondence relation between [ʔ.t] and [h.t] accounts for the path for the alternation /t.t/ → [h.t].

Sympathy Theory accounts for the following points in the language:

First, DEP[cont] is the designated constraint which is responsible for the selection of the sympathy candidate. Secondly, the debuccalized candidate which fails by itself is the sympathy candidate in the stop alternation, because it is the most harmonic candidate with respect to the designated constraint, DEP[cont]. Thirdly, the sympathy constraint which demands mapping between the sympathy candidate and the output is the MAX[Place] ❀O. This is a faithfulness constraint for the place feature between the sympathy candidate and the output. Lastly, the debuccalized and spirantized candidate correctly wins in the entire constraint ranking, including the sympathy constraint.

The Yucatec case is not a standard case of the problem of phonological opacity which arises from serial derivation in rule-based theory. However, the discussion in the section has made it clear that this is a new type of opacity in OT. I claim that Sympathy Theory can deal with such a case of opacity as well.

My proposal that Sympathy Theory can be extended to more general opacity in OT makes the theory more universal, and is supported by the actual data which we could explain neither in rule-based theory nor in OT without Sympathy Theory.

4.7 Local Conjunction (Smolensky 1993, 1995, 1997)

4.7.1 Introduction

Local Conjunction has been introduced, and the necessity of the device in the analysis of Yucatec Maya has been examined in section 4.4.2.2. In this section, I will further probe Local Conjunction by reviewing the previous research on the topic.

Within the OT framework (Prince and Smolensky 1993), different constraint rankings account for the different grammars in the world's languages. As mentioned in section 4.4.2.1, there are, however, some phonological phenomena which cannot be explained by ranking single constraints (e.g. Southern Palestinian Arabic RTR case (McCarthy 1996b), and so on). In such cases, analyses of the data are made possible only by introducing Local Conjunction.

Local Conjunction is defined as a combination of two single lower-ranked constraints that together form a higher ranked constraint (Smolensky 1993, 1995, 1997) as already shown in section 4.4.2.1.

The Local Conjunction which Alderete (1997) and Itô and Mester (1996) use is a kind of self-conjunction as already introduced in section 2.1.2.1: violating the same single constraint twice in the same domain is worse than a single violation of it. Alderete's conjunction is illustrated as follows:

(70)

A&A >> B >> A

In this sense, the idea of Alderete's self-conjunction (70) is the same as that of local conjunction. The only difference between them is that one is conjunction of the same constraint, and the other is the conjunction of the two different constraints.

Although several studies have focused on local conjunction, its scope and definition are still under debate. If local conjunction is a type of constraint, it must be in UG. However, if it is in UG, it must be cross-linguistically valid. A question now arises: Are all possible local conjunctions truly in UG? If so, UG grows extremely large.

Fukazawa and Miglio (1996, to appear) and Miglio and Fukazawa (1997) propose that the possibility of local conjunction is in UG, in other words, the "&" operator for conjunction is in UG. However, the choice of which two constraints to be conjoined is language specific.

This proposal reduces the size of UG, and seems to be corroborated by the cross-linguistic rarity of each particular type of local conjunction. Because of the nature of local conjunction, as the union of two lower-ranked constraints overriding hierarchically higher-ranked ones, it should be considered a last resort option. In other words, Local Conjunction should come into play only when every ranking of single constraints fails to explain the data in a language.

However, it seems necessary to restrict local conjunction even further. If any constraint can be conjoined with any other, then, even the language-specific grammar becomes extremely unrestricted. Smolensky (1993, 1995, 1997) has pointed out one restriction of local conjunction: locality must be respected in Local Conjunction. The two constraints to be conjoined must be violated in the same specified domain at the same time. This is based upon the idea that constraint interaction is stronger locally than non-locally.

However, this is not a restriction on the conjoinability of the two constraints itself. There must also be some strict control on the nature of the constraints to be conjoined.

McCarthy (1996b) suggests that the two constraints to be conjoined must be phonetically conjoinable. The local conjunction he uses in his analysis of Southern Palestinian Arabic is *RTR [HI] & *RTR [FRONT]. According to him, RTR (retracted tongue-root) is phonologically one of the distinctive features for "emphasis" and phonetically a kind of uvularization. Hence, *RTR [HI] indicates that the distinctive feature RTR does not coexist with the feature HIGH in the same segment. *RTR [FRONT] means that the two features RTR and FRONT are mutually exclusive within a segment. McCarthy states that the two constraints, *RTR [HI] and *RTR [FRONT], are phonetically conjoinable since both of them are a formalization of the fact that it is not possible "to constrict the pharynx when the tongue body is being pulled in the wrong direction." Thus, McCarthy's conjunction is restricted to constraints which are phonetically conjoinable.

It might be true that the restriction of phonetic conjoinability is valid for some local conjunctions, because we can consider that all the conjunctions are originally phonetically motivated.[12]

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12 When we consider the phonetically motivated constraints from the perspective of only the articulatory view, there might be several examples which are categorized into the phonetically non-motivated constraints. However, when we take the perceptional view into consideration, we might be able to consider all the constraints phonetically motivated. I will leave this issue in future investigation.

Thus, Fukazawa and Miglio (1996) make it clear that it is necessary to introduce more specific restrictions on conjunction, and propose that only two constraints which belong to the same constraint family[13] are conjoinable. This proposal is supported by the examination of several previous analyses of local conjunction.

From what has been discussed above, it must be pointed out that whenever data may be analyzed with local conjunction, the following points should be taken into consideration:

1. Motivation: the ranking of single constraints fail to produce the correct analysis;
2. Restrictions: (a) locality must be respected;
   (b) phonetic conjoinability may be taken into consideration
   (c) two constraints to be conjoined must belong to the SAME CONSTRAINT FAMILY.

In order to clarify these points, this section will discuss data from several previous studies of various languages.

My analysis of Yucatec Maya consonant clusters discussed in section 4.1 through 4.6 is a relevant example. From section 4.4.2.2, I conclude that a local conjunction introduced to analyze Yucatec Maya is a valid constraint for the following reasons. First, the motivation is very strong. Without the conjunction OCP[Place] & OCP[stop], the data can not be explained. Secondly, the two conjoined constraints belong to the same constraint family, OCP. Thirdly, the locality of the constraint is also respected because the domain is the sequence of two adjacent segments.

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13 See Fukazawa and Miglio (to appear) for discussion of the definition of constraint family.

With the above conditions on motivation and conjoinability in mind, I will review McCarthy's analyses of Southern Palestinian Arabic (1996b) in the following sections 4.7.2. In section 4.7.3, Miglio's (1995) analysis of front vowel raising in the Northern Mantuan Italian dialect will be described. Section 4.7.4 will discuss vowel raising phenomena in Nzɛbi analyzed by Kirchner (1996). In section 4.7.5, an example of the local conjunction of the two different constraint families will be introduced (Itô and Mester 1996), and it will be argued that the data should be analyzed with only single constraints when possible. Section 4.7.6 concludes this section by summarizing how the previous research supports the present proposal.

4.7.2 RTR Rightward Harmony in the Southern Palestinian Dialect of Arabic (McCarthy 1996b)

In the Southern Palestinian dialect of Arabic, there is bidirectional harmony of the RTR (retracted tongue-root) distinctive feature. Leftward harmony of RTR does not have any relationship with the discussion of local conjunction; therefore, it will not be discussed in this section. What will be focused on is Rightward harmony of RTR as illustrated in the following data:

(71) Southern Palestinian Harmony Data (McCarthy 1996b:2)

Right Harmony

sabaah	**?aTfaal**
Tuubak	**Twaal**
Sootak	**Seefak**

Blocking of Right Harmony

Tiinak	**Sayyaad**
ʕaTšaan	**Dajjaat**

RTR is spread to the right unless it is blocked by high front segments (/i, y, š, j/). Note that rightward harmony is not blocked by either high back segments (as in [**Tuubak**]) or non-high front segments (as in [**Seefak**]).

In order to account for the blocking of rightward RTR harmony by only high front segments, McCarthy claims that local conjunction is necessary.

4.7.2.1 An Analysis of the Data with Ranking of Each Single Constraint

McCarthy uses the following constraints to analyze the phenomena of rightward harmony:

(72) Single Constraints

(a) RTR-right: Any instance of [RTR] is aligned finally in a word.

(b) *RTR [HI]: *[high, RTR]

(c) *RTR [FR]: *[front, RTR]

To account for the blocking of rightward RTR harmony by high front segments, as in [**Tiinak**], we must assume that either *RTR[HI] or *RTR[FR] must be higher ranked than RTR-right. If RTR-right outranks both *RTR[HI] and *RTR[FR], then the output should be as follows:

*(73) wrong result: RTR-right >> *RTR[HI], *RTR[FR]

/**<u>T</u>iinak**/	RTR-right	*RTR[HI]	*RTR[FR]
*☞ a. **<u>Tiinak</u>**		**	**
b. **<u>T</u>iinak**	*!****		

When RTR-right outranks both *RTR[HI] and *RTR[FR], candidate (b) loses. Candidate (a) wins even though it violates both of *RTR[HI] and *RTR[FR]. This is the wrong result. Thus, we must assume that at least either *RTR[HI] or *RTR[FR] is higher ranked than RTR-right to have the correct optimal candidate.

Let us see the tableau in which *RTR[HI] is higher ranked than RTR-right:

(74) *RTR[HI] >> RTR-right

/**<u>T</u>iinak**/	*RTR[HI]	RTR-right
a. **<u>Tiinak</u>**	*! *	
☞ b. **<u>T</u>iinak**		*****

When *RTR[HI] outranks RTR-right, candidate (b) in which RTR is blocked wins. This ranking correctly predicts the optimal candidate. The same result is obtained, if *RTR[FR] is higher ranked than RTR-right, or both *RTR[HI] and *RTR[FR] are higher ranked than RTR-right. Therefore, it is assumed that there should exist at least one of the following rankings in this language:

(75)

A. *RTR[HI] >> RTR-right

B. *RTR[FR] >> RTR-right

C. *RTR[HI] , *RTR[FR] >> RTR-right

However, those rankings each give rise to other problems. If we adopt ranking (75 A) or (75 C), we cannot account for the fact that high-back segments do not block the harmony. Let us look at the following tableau:

*(76) wrong result *RTR[HI] >> RTR-right

/**<u>T</u>uubak**/	*RTR[HI]	RTR-right
a. **<u>Tuubak</u>**	*! *	
*☞ b. **<u>T</u>uubak**		*****

Ranking (A) in (75) incorrectly yields the optimal candidate as (b). When both *RTR[HI] and *RTR[FR] outrank RTR-right (as in ranking (C) in (75)), the result is the same, since *RTR[FR] is irrelevant in this tableau.

Thus, we must conclude that it is not possible for the ranking (A) or (C) in (75) to exist in this language. When ranking (B) in (75), *RTR[FR] >> RTR-right, is adopted, it is not possible to account for the inability of non-high front segments to block harmony. Let us look at tableau (77):

*(77) wrong result *RTR[FR] >> RTR-right

/**Seefak**/	*RTR[FR]	RTR-right
a. **Seefak**	*!*	
*☞ b. **Seefak**		*****

Ranking (B) in (75): *RTR[FR] >> RTR-right also wrongly predicts that candidate (b) in which the RTR harmony is blocked wins. Thus, we cannot adopt this ranking, either. What has been seen so far demonstrates that we cannot obtain the correct optimal candidate by ranking the single constraints.

4.7.2.2 Introduction of Local Conjunction

Since ranking each single constraint does not give rise to the correct output, McCarthy introduces the following local conjunction to account for the Southern Palestinian Arabic data:

(78) Local Conjunction

*RTR[HI] &*RTR[FR]: *[high, front, RTR]

The full ranking proposed by McCarthy is:

(79) Ranking

*RTR[HI] &*RTR[FR] >> RTR-right >> *RTR[HI], *RTR[FR]

With this new ranking, let us review all the phenomena mentioned above. First, RTR harmony to the right is blocked by high front segments:

(80) **Tiinak**

/**Tiinak**/	*RTR[HI] & *RTR[FR]	RTR-right	*RTR[HI]	*RTR[FR]
a. **Tiinak**	*!*		**	**
☞ b. **Tiinak**		*****		

The ranking in (79) correctly produces the optimal candidate (b) in which RTR harmony is blocked. Since candidate (a) violates both *RTR[HI] and *RTR[FR], it violates the conjunction, which is highest-ranked. Violation of each single constraint *RTR[HI] or *RTR[FR] does not matter since both of them are lower ranked.

Next, Let us look at the fact that RTR harmony is not blocked by high back segments:

(81) **Tuubak**

/**Tuubak**/	*RTR[HI] & *RTR[FR]	RTR-right	*RTR[HI]	*RTR[FR]
☞ a. **Tuubak**			**	
b. **Tuubak**		*!****		

Candidate (a) violates only *RTR[HI]; therefore, it does not violate the conjunction. Since neither candidate (a) nor (b) violates the conjunction, violation of RTR-right becomes fatal. Therefore, candidate (a) wins. This is the correct output. Thus, the ranking in (79) correctly yields these phenomena.

Finally, the fact that non-high front segments do not block the harmony is seen in the following:

(82) **<u>Seefak</u>**

/<u>S</u>**eefak**/	*RTR[HI] & *RTR[FR]	RTR-right	*RTR[FR]	*RTR[HI]
☞ a. **<u>Seefak</u>**			**	
b. **<u>S</u>eefak**		*!****		

Candidate (a), in which RTR harmony to the right is not blocked, wins. This is the optimal output. Since candidate (a) violates only *RTR[FR], it does not violate the conjunction. In fact, neither (a) nor (b) violates the conjunction. Candidate (b) loses due to the fatal violation of RTR-right. The conclusion is that only the ranking in (79), including local conjunction, accounts for all the relevant phenomena in this language.

4.7.2.3 Discussion

Let us examine the local conjunction, *RTR[HI] &*RTR[FR], with the criteria provided in section 4.7.1.

Motivation of this local conjunction has proved to be strong. Without local conjunction, it is not possible to account for all the phenomena of rightward RTR harmony in this language.

Next, let us see about restrictions on this local conjunction. First, locality is respected because both *RTR[HI] and *RTR[FR] are violated in the same segments. Secondly, the conjoined constraints belong to the same constraint family, *RTR.

Thus, McCarthy's local conjunction is valid from the viewpoint of motivation and restrictions.

4.7.3 Front Vowel Raising in the Northern Mantuan Italian Dialect (Miglio 1995)

Miglio (1995) shows that stressed mid front vowels raise when stress shifts to another syllable in the Northern Mantuan Italian dialect:

(83) Mid Front Vowel Raising

p**ɛ**l	"skin"	p**e**l + 'zina	"cuticle"
p**e**l	"hair"	p**i** 'l + In	"little hair"
k**a**n	"dog"	k**a** 'ñIn	"small dog"
p**i**la	"battery"	p**i** 'lina	"small battery"

As (83) shows, only mid front vowels raise, when stress shifts. Neither low nor high vowels are affected.[14] The data is summarized as follows:

Stressed	Unstressed	
ɛ	→	**e** : -ATR → +ATR, -high → - high
e	→	**i** : +ATR → +ATR, -high → + high

As the summary indicates, the Mantuan vowel raising has a slightly unexpected character. [-ATR] becomes [+ATR] as in "**ɛ**→ **e**", but [-high] becomes [+high] as in "**e** → **i** ".

14 I assume that high vowels do not raise anyway.

4.7.3.1 An Analysis with Ranking of Each Single Constraint

In order to account for this irregular vowel raising, Miglio first presents the analyses with ranking of each single constraint . She uses the following four single constraints in two constraint families:

(84) Single Constraints:

***MID** : mid vowels are penalized;

a. *MID [-ATR] : *[mid, -ATR]

b. *MID [+ATR] : *[mid, +ATR]

DEP : output candidates must be faithful to featural values of the input (specified in the subscripts);

c. DEP [HI]

d. DEP [+ATR]

First, she analyzes the phenomena of vowel raising with the following ranking:

(85) The First Ranking:

*MID[-ATR] >> DEP[+ATR], DEP [HI] >> *MID [+ATR]

With this ranking, raising "**ɛ**$\rightarrow$ **e**" is explained as follows:

(86) "**ɛ**→ **e**"

/p**ɛ** l 'zina/	*MID[-ATR]	DEP[+ATR]	DEP[HI]	*MID [+ATR]
a. p**ɛ**l'zina	*!			
☞b. p**e**l'zina		*		*
c. p**i**l'zina		*	*!	

Tableau (86) correctly indicates that the optimal candidate is (b). Candidate (a) loses due to violation of the highest-constraint. Violation of DEP[+ATR] is canceled, since both (b) and (c) violate the constraint. Violation of DEP[HI] is fatal, since DEP[HI] outranks *MID [+ATR].

Next, let us examine raising "**e** → **i** " with the ranking in (85):

*(87) wrong result "**e** → **i** "

/pr**e** 'tin/	*MID[-ATR]	DEP[+ATR]	DEP[HI]	*MID [+ATR]
a. pr**ɛ** 'tin	*!			
*☞b. pr**e** 'tin				*
c. pr**i** 'tin			*!	

In tableau (87), DEP[+ATR] is irrelevant, since the input already bears the [+ATR] feature. Candidate (a) loses due to a violation of the highest ranked constraint. Violation of DEP[HI] is fatal, because DEP[HI] is higher ranked than *MID [+ATR]; therefore, candidate (c) incorrectly loses. This tableau incorrectly predicts that the optimal candidate is (b). The actual output should be (c).

Then, Miglio re-ranks those constraints as follows:

(88) The Second Ranking:

*MID [-ATR] >> *MID [+ATR] >> DEP [+ATR], DEP [HI]

In the second ranking, *MID [+ATR] outranks each single constraint DEP[+ATR] or DEP[HI]. With this ranking, she re-examines raising "**e** → **i** " as follows:

(89) "**e** → **i** "

/pr**e** 'tin/	*MID[-ATR]	*MID [+ATR]	DEP[+ATR]	DEP[HI]
a. pr**ɛ** 'tin	*!			
b. pr**e** 'tin		*!		
☞ c. pr**i** 'tin				*

As in tableau (87), DEP[+ATR] is also irrelevant in tableau (89), since the input already bears the feature [+ATR]. In this tableau, the correct optimal candidate (c) is attested, because both candidates (a) and (b) lose due to a violation of the two higher ranking constraints *MID[-ATR] and *MID[+ATR], respectively. Thus, the new ranking seems to be plausible.

Miglio points out, however, that raising "**ɛ**→ **e**" which had been correctly accounted for in tableau (86) will not be adequately analyzed with the new ranking as the following incorrect tableau shows:

(90) "**ɛ**→ **e**"

/p**ɛ** l 'zina/	*MID[-ATR]	*MID [+ATR]	DEP[+ATR]	DEP[HI]
a. p**ɛ**l'zina	*!			
b. p**e**l'zina		*!	*	
*☞c. p**i**l'zina			*	*

With the new ranking, both *MID [-ATR] and *MID [+ATR] outrank each single constraint DEP[+ATR] or DEP[HI]. Therefore, candidate (c) wins, because violation of neither DEP[+ATR] nor DEP[HI] is fatal in this tableau. This is the wrong result, since candidate (b) should actually win.

Thus, Miglio concludes that it is not possible to account for the phenomena of front vowel raising in this language by ranking only single constraints.

4.7.3.2 Introduction of Local Conjunction

Since ranking each single constraint fails to give rise to the correct analysis, Miglio introduces the local conjunction "DEP[+ATR] & DEP[HI]", and describes how the phenomena of front vowel raising in Northern Mantuan are correctly analyzed with this constraint. She presents the following new ranking:

(91) The Third Ranking:

*MID [-ATR] >> DEP[+ATR] & DEP[HI] >>*MID [+ATR] >>

DEP[+ATR], DEP[HI]

In this ranking, each single constraint DEP[+ATR] or DEP[HI] is lowest ranked. Let us see the two phenomena of raising, "**ɛ**→ **e**" and "**e** → **i** " with this new ranking.

(92) "**ɛ**→ **e**"

/p**ɛ** l 'zina/	*MID [-ATR]	DEP[+ATR] & DEP[HI]	*MID [+ATR]	DEP[+ATR]	DEP[HI]
a. p**ɛ**l'zina	*!				
☞b. p**e**l'zina			*	*	
c. p**i**l'zina		*!		*	*

Each violation of DEP[+ATR] and DEP[HI] does not matter, since both of the single constraints are low ranked. Candidate (a) loses due to a violation of the highest-ranked constraint *MID [-ATR] as in tableau (86) What is important in this tableau is that candidate (c) loses due to violation of the local conjunction, since it violates both DEP[+ATR] and DEP[HI]. Thus, candidate (b) wins despite its violation of *MID [+ATR]. Thus, the new ranking, including local conjunction, gives rise to the correct analysis for raising "**ɛ**→ **e**" .

Let us consider "**e** → **i** " raising next:

(93) "**e** → **i** "

/pr**e** 'tin/	*MID [-ATR]	DEP [+ATR] & DEP[HI]	*MID [+ATR]	DEP [+ATR]	DEP[HI]
a. pr**ɛ** 'tin	*!				
b. pr**e** 'tin			*!		
☞c. pr**i** 'tin					*

Candidate (a) loses due to violation of the highest ranking constraint *MID [-ATR] as in the former tableau. What is to be noted is that candidate (c) does not violate local conjunction in this tableau, since it violates only DEP[HI]. Then, violation of *MID[+ATR] becomes fatal; therefore, candidate (b) loses. This is the desired result.

4.7.3.3 Discussion

Miglio's analysis of front vowel raising in the Northern Mantuan Italian dialect confirms that local conjunction plays an important role. Without it, the data lead to ranking paradoxes. Thus, it is concluded that there is strong motivation for the introduction of local conjunction in her analysis.

Next, what about the restrictions on local conjunction? First, locality is respected since the two constraints in the local conjunction are violated within the same segments. Secondly, both DEP[+ATR] and DEP[HI] belong to the same constraint family,DEP. Therefore, it is concluded that the most important conjoinability restrictions are satisfied.

4.7.4 Vowel Raising in Nzɛbi (Kirchner 1996)

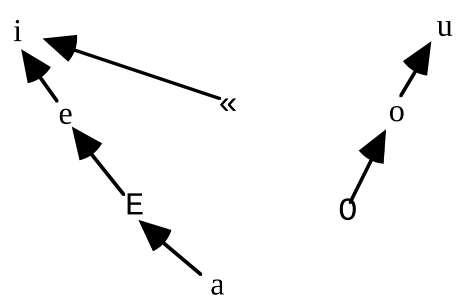
Kirchner (1996) presents the data of vowel raising observed in Nzɛbi, a Bantu language spoken in Gabon. In Nzɛbi, vowels raise when they appear in verb forms selected by certain tense and aspect affixes as follows:

(94) Vowel Raising in Nzɛbi:

	Unraised	Raised	
i → i	b**i**s	b**i**s[-i]	"to refuse"
u → u	s**u**ɛm	s**u**em[-i]	"to hide self"
o → u	k**o**rən	k**u**rin[-i]	"to go down"
ə → i	kor**ə**n	kur**i**n[-i]	"to go down"
e → i	b**e**t	b**i**t[-i]	"to carry"
ɛ → e	β**ɛɛ**d	β**ee**d[-i]	"to give"
ɔ → o	t**ɔɔ**d	t**oo**d[-i]	"to arrive"
a → ɛ	s**a**l	s**ɛ**l[-i]	"to work"

The above data shows that each non-high vowel raises only one vowel height. This is summarized as follows:

(95) Vowel Raising:



Kirchner shows that there is no way to account for the relativity of vowel raising observed above, if we rely on only the ranking of single constraints. He states the necessity for local conjunction to account for the phenomena appropriately, as we will see in the next two sections.

4.7.4.1 An Analysis with Ranking of Each Single Constraint

Kirchner uses two kinds of constraints to analyze vowel raising in Nzεbi: One is Raising, and the other is ParseF:

(96) Constraints:

(a) Raising: Maximize vowel height (in verbs when occurring with certain tense and aspect affixes);

(b) ParseF: For all $\alpha \in \{+, -, 0\}$, if feature F is specified α in the input, it is specified α in the output.

His use of the definition of the constraints above has to be discussed before examining his analyses. He uses ParseF for featural faithfulness constraint; however, he does not actually use the constraint as he himself defines it.

The definition of ParseF in (96 b) is the same as the featural faithfulness constraint (MAX[F]) proposed by Lombardi (1995a):

(97)

MAX[F]: Every input feature has an output correspondent.

MAX[F] in (97) and ParseF (96 b) state faithfulness of features of the input in the output; therefore, it is a sort of one way definition. Lombardi (1995a) also proposes another featural faithfulness constraint, DEP[F] as already introduced in section 2.3.2.2 as follows:

(98)

DEP[F]: Every output feature has an input correspondent.

What to be noticed is that Kirchner's use of ParseF includes the definition of DEP[F] as well as that of MAX[F]. In other words, he uses ParseF as a combination of MAX[F] and DEP[F]; hence, it is different from what is defined in (96b).

In order to avoid any confusion, his definition of ParseF should be revised as follows:

(99) (Revised Version of 96 b):

ParseF: For all $\alpha \in \{+, -, 0\}$, if feature F is specified α in the input, it is specified α in the output, **and vice versa (if feature F is specified α in the output, it is specified α in the input.)**

Now that definition of Parse F used in his analysis has been made clear, let us begin the discussion of his analysis of vowel raising of Nzεbi.

Kirchner indicates that the following constraint ranking should be obtained to account for the vowel raising:

(100) Ranking

a. Raising >> Parse[low]

b. Raising >> Parse [ATR]

c. Raising >> Parse [hi]

He explains that ranking (100 a) is necessary to account for raising /a/ → [ɛ]. Also, without (100 b), there is no raising /ɛ/→ [e], and we need to have ranking (100 c), otherwise raising /e/ → [i] is not obtained. Let us look at the following tableau in which he examines one of the raising cases in which unconjoined constraints are not sufficient.

*(101) wrong result: a → ɛ

/a/	Raising	Parse [low]	Parse [ATR]	Parse [hi]
a. [a]	*!**			
b. [ɛ]	*!*	*		
c. [e]	*!	*	*	
*☞ d. [i]		*	*	*

The highest constraint, Raising requires /a/ to raise all the way to [i]. When it raises all the way to [i], there are three steps: a → ɛ → e → i. Since the constraint requires all the steps, it becomes a fatal violation if even one step is missing. Candidate (a) violates Raising three times, because it misses all three steps. Candidate (b) incurs two violation of the constraint, since it misses the last two steps. Candidate (c) violates Raising once due to missing the very last step. Regardless of the number of violations, all three candidate, (a), (b) and (c) lose. Thus, candidate (d) incorrectly wins. The actual output is (b).

4.7.4.2 Introduction of Local Conjunction

Kirchner introduces two kinds of local conjunction to be used in his analysis:

(102) Local conjunctions:

(a) Parse[low] & Parse [ATR] : violated iff Parse [low] and Parse [ATR] are violated with respect to a given vowel

(b) Parse [hi] & Parse [ATR] : violated iff Parse [hi] and Parse [ATR] are violated with respect to a given vowel

With these local conjunctions, he proposes the following new ranking:

(103) New Ranking

Parse[low] & Parse [ATR], Parse[hi] & Parse [ATR] >> Raising >> Parse[low], Parse[ATR], Parse[hi]

He analyzes all the vowel raising phenomena in Nzεbi such as a → ε , ε → e, e → i and so on. For the sake of simplicity, however, I will show only one of his analyses in order to demonstrate how the local conjunction works.

(104) a → ε

/a/	Parse[low] & Parse [ATR]	Raising
a. [a]		***!
☞ b. [ε]	(only Parse[low] violation)	**
c. [e]	*!	*
d. [i]	*!	

Both candidate (c) and (d) violate the conjunction because the [low] feature is not parsed from the input to the output, and an [ATR] feature is inserted in the output. They lose due to this fatal violation of the conjunction.

Neither candidate (a) nor (b) violates the conjunction. Candidate (b) violates only Parse [low]. Candidate (a) violates Raising three times, while (b) does twice. Thus, Candidate (b) wins. Candidate (b) is the correct output in the language. Thus, it is concluded that the introduction of local conjunction leads to the correct analysis of the vowel raising phenomena in Nzɛbi.

4.7.4.3 Discussion

Validity of the use of local conjunction has been confirmed in the analysis of vowel raising in Nzɛbi just as in the other three analyses in the previous sections. In this section, let us examine the local conjunctions used in Kirchner's analysis with the criteria mentioned in section 4.7.1.

In the first place, there is a strong motivation to introduce local conjunction in Kirchner's analyses of Nzɛbi, since ranking of each single constraint fails to lead the correct result as discussed in section 4.7.4.2.

Next, let us examine the restrictions on local conjunction in Kirchner's analysis. First, locality is respected, since the two constraints to be conjoined are violated in the same segment. Secondly, the two constraints to be conjoined belong to the same constraint family, Parse.[15]

Thus, the validity of the criteria proposed in section 4.7.1 has also been confirmed in Kirchner's analyses.

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15 Although his use of featural faithfulness constraints is different from that of most current literature, the similar analysis of Miglio (1995) given above suggests that this may not be crucial.

4.7.5 Local Conjunction from the Two Different Families

In this section, I will introduce an analysis with a local conjunction which consists of two different constraint families. Itô and Mester (1996:3: (12)) use a Local Conjunction of NoCoda &*Voice to explain German final devoicing.

(105) an analysis of final devoicing with local conjunction:

/bund/ sg. 'union'	MAXSeg	NOCODA& *[+voi, -son]	NOCODA	IDENT [+voi]	*[+voi, -son]
a. .bUnd.		*!	*		**
b .bUn.	*!		*		*
☞ c .bUnt.			*	*	*
d .pUnt.			*	**!	

In this case candidate (a) violates both the constraint against having a coda and the *Voice constraint placed on obstruents, and loses to (c). However, observe the following tableau (from Lombardi 1995a). Final devoicing can be explained without introducing local conjunction.

(106) an analysis of final devoicing without local conjunction:

/big/	IDOnsLar	*Lar	MAXLAR	DEP-IO	MAX-IO
a. big		**!			
☞ b. bik		*	*		
c. bigi		**!		*	
d. bi		*	*		*!
e. pik	*!		**		

In this hypothetical case, modified to cover all the German candidates above, the interaction between the markedness of voiced obstruents (*Lar) rules out candidate (a) and (c). As argued in Lombardi (1995a), candidate (c) shows that there can be no repair strategy involving epenthesis to avoid word-final voiced obstruents, a repair strategy that is quite common in the case of languages trying to avoid certain place features in word-final positions (CodaCondition). Candidate (d) shows that deletion of the offending consonant is also not an option, and candidate (e) violates a higher-ranked positional faithfulness constraint that requires segments in onsets to surface more faithfully than in other positions. There seems to be no need to invoke conjunction in this case, and the motivation for the local conjunction is not strong.

In fact, the unnecessary use of Local Conjunction can sometimes produce wrong predictions (Lombardi 1997). If the CodaCond could be broken down into a Local Conjunction of “NoCoda&*Place” which Smolensky (1993) suggests, one would expect “NoCoda & *F” in general to be possible. This is contradicted by Lombardi’s work demonstrating that there can be no CodaCond[voice] (Lombardi 1995a). As a consequence there can be no “NoCoda & *voice” conjunction substituting CodaCond[voice]. Therefore positing a Local Conjunction “NoCoda & *F” makes the wrong prediction as to what kinds of Local Conjunctions to expect.

4.7.6 Summary and Conclusion of the Section

I have reviewed the research on Local Conjunction: the analysis of Yucatec Maya in sections 4.1 through 4.6, McCarthy's analysis of Southern Palestinian Arabic, Miglio's account of the Mantuan dialect of Italian, and Kirchner's analysis of Nzεbi, and reached the conclusion that local conjunction is sometimes necessary. However, it is not randomly introduced. On the contrary, its introduction should be strictly restricted. First, a strong motivation is necessary. It is introduced only after ranking of each single constraint fails to give rise to the correct analyses. Second, there should be locality. Finally, it is crucial that the two constraints to be conjoined belong to the same constraint family.

In addition to the previous studies I have observed so far, there is other recent research which supports the Fukazawa and Miglio's (1996) proposal that the two constraints to be conjoined into a local conjunction belong to the same constraint family.

In Yip's (1997) study of Min dialects Chaoyang (Chung), she proposes a local conjunction, Align [Nasality, R] & Align [Nasality, L]. Both members of the conjunction belong to the same Align[F] family.

Let us summarize the previous study on local conjunction which supports Fukazawa and Miglio's claim:

Table VI: General Chart of Research Proposing Local Conjunctions:

Researcher Criteria	**McCarthy (1996b)**	**Kirchner (1996)**	**Miglio (1995)**	**Yip (1997)**	**Fukazawa (in section 4.4, 4.5 and 4.6)**
language	Southern Palestinian Arabic	Nzɛbi	Northern Mantuan dialect of Italian	Min dialects Chaoyang (Chung)	Yucatec Maya
local conjunc-tion	*RTR [HI] & *RTR [FR]	Parse [low] & Parse[ATR] Parse[ATR] & Parse [hi]	DEP [+ATR] & DEP [HI]	Align [Nasality, R] & Align [Nasality, L]	OCP[Place] & OCP [stop]
constraint family	same *RTR family	same Parse family	same DEP family	same Align family	same OCP family
motiva-tion	necessary	necessary	necessary	necessary	necessary
locality	respected	respected	respected	respected	respected

Table VII: Research Proposing Self Conjunctions

Researcher Criteria	**Alderete (1997)**	**Itô and Mester (1996)**
language	Wellagga (Oromo)	Japanese
local conjunction	No Long Vowel & No Long Vowel	*[F][F]
constraint family	No Long Vowel	*[F]
motivation	necessary	necessary
locality	respected	respected

As Tables VI and VII show, in all the previous research, motivation, locality and restriction to the same constraint family have been confirmed.[16]

The most important point which I have confirmed from those studies is that the two constraints to be conjoined always belong to the same constraint family. In addition to the previous research which I have already mentioned, a very recent study also supports the proposal. Suzuki (1998) suggests in his analysis of the generalized

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16 Hewitt and Crowhurst (1995) propose another kind of constraint combination. Although they call it conjunction, compared to the authors discussed up to this point, theirs seems to be a kind of constraint disjunction.

Hewitt and Crowhurst's definition, local conjunction is violated whenever at least one of the two conjoined constraints is violated. On the other hand, in Smolensky's definition mentioned above, in order to violate the conjunction "A&B", both A and B must be violated. In other words, the conjunction is satisfied when either A or B is satisfied in Smolensky's, while both A and B must be satisfied in order to satisfy the conjunction in Hewitt and Crowhurst's.

Although the definition is different, Hewitt and Crowhurst's example also meets the constraint family restriction proposed by Fukazawa and Miglio (1996, to appear) and Miglio and Fukazawa (1997).

Constraint Disjunction:

Researcher Criteria	**Hewitt & Crowhurst (1995)**
Language	Diyari
local conjunction	Align [Morpheme, L, Foot, L] & Align [Morpheme, R, Foot, R]
constraint family	Align
motivation	necessary
locality	N/A

OCP effect: the similarity effect in Arabic etc. that a Generalized OCP constraint (GOCP) can be conjoined only with another GOCP constraint.

The weakness of the motivation of the example of local conjunction from the two different family given by Itô and Mester (1996) has also been pointed out. I claim that local conjunction should not be introduced into a grammar if the ranking of single constraints could account for the language.

Thus, local conjunction is a constraint which will be introduced on the basis of certain strong motivation and strict restrictions. The "& operator" for local conjunction is in UG. However, the choice of the two constraints to be conjoined is language specific.

4.8 Summary and Conclusion of the Chapter

This section summarizes what we have discussed in this chapter. The following is the ranking of all the constraints utilized in the analysis of Yucatec Maya:

(107) The overall ranking of the constraints in Yucatec Maya:

```
  OCP[Place]      HAVE      MAX-IO     MAXONS   UNIFORMITY   DEP-IO
 &OCP[stop]       MANNER                [stop]     [stop]
      |_____________|_________|_____________|___________|__________|
                              |
                       MAX[Place]-❁O
                              |
            MAX[Place]-IO  MAX[constr.gl]  *[x]  *[f]
                 |____________|_____________|_____|
                              |
                          OCP[stop]
                 _____________|_____________
                 |            |            |
            OCP[Place]   MAX[stop]    DEP[cont]
```

With this ranking, the following phenomena have been accounted for:

First, in sequences of a stop and a non-homorganic stop and of a fricative and a homorganic stop, no phonological alternation is observed. The ranking accounts for the well-formedness of these sequences.

Second, the alternation of a stop or an affricate in a homorganic cluster is observed so as to satisfy the higher-ranked local conjunction. To satisfy the conjunction, one member of the conjunction, OCP[stop] is satisfied. Hence, the fact that both a stop and an affricate lose the [stop] feature results in a violation of MAX[stop].

Third, deletion of [stop] is observed only in the coda (first segment in the sequence). This is due to a positional featural faithfulness constraint MAXOns[stop].

Fourth, changing the place feature in addition to spirantization is observed in the case of a stop in the sequence, while only spirantization is observed in the case of an affricate. I have explained this asymmetry using Sympathy Theory.

Fifth, I have shown that the fusion of two features, and epenthesis of a segment to break up the cluster, are impossible alternations due to the highly-ranked constraints, UNIFORMITY[F] and DEP-IO.

I conclude that Yucatec Maya belongs to Type 3 in the typology due to the ranking proposed to analyze the language. The Yucatec Mayan ranking in (107) is comparable to the constraint ranking for Type 3 proposed in section 2.3.3.3, which is repeated below.

(108) Constraint Ranking for Type 3:

```
OCP[F], HAVEPLACE, UNIFORMITY[F], MAX-IO
 |_________|____________|____________|
       _________|________
       |                |
    MAX[F]           DEP[F]
```

The Yucatec ranking is similar to that in Type 3 for the following three reasons. First, both featural deletion and featural insertion are observed. Secondly, no segmental deletion is observed. Thirdly, no featural fusion takes place.

However, the OCP effects on features in this language is very complex so that a simple constraint ranking cannot correctly provide the analysis. I have thus introduced the notions of Local Conjunction and utilized Sympathy Theory to characterize the language within the OT framework.

Local Conjunction and Sympathy Theory have also been discussed from new perspectives in this dissertation. Local Conjunction has been examined with respect to its motivation and the conjoinability by reviewing previous research.

Through the analysis of the OCP effects in Yucatec Maya, I have reconsidered the concept of "opacity" within the OT framework, and generalized the scope of Sympathy Theory to cases not covered by derivational theories.