OT-CC and English Opacity in Flapping

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I. Introduction

This paper analyzes opacity effects found in English that involves flapping: vowel lengthening and flapping in General American English and vowel raising and flapping in Canadian English. These particular data are very interesting in that Canadian Raising shows overapplication of vowel raising, while General American English shows underapplication of vowel lengthening. Underapplication and overapplication are cited as two major sources of opaque interactions in phonology in McCarthy (1999). These two sets of data will serve as translucent cases to illustrate the capacity of Optimality Theory with Candidate Chains (=OT-CC) proposed in McCarthy (2006).

OT-CC (McCarthy 2006, Lee 2006) is an implementation of derivational process in the course of evaluation. The gist of the proposal is that it alters the Generator component (=Gen) and introduces a new family of constraints. Gen in OT-CC is different from that in classical OT in that it does not randomly alternate the shape of inputs. Instead, Gen works with Evaluation component (=Eval) to produce candidate chains (not candidates). Each chain string shows progressive improvement in markedness and gradual divergence in faithfulness at the same time.

It is those chains (not candidates) that are sent to Eval for the selection of the most harmonic of all chains. The chain shows successive divergence from the input and the course of divergence is chronologically recorded in the form of faithfulness violations. The faithfulness divergence is justified only by the improvement of markedness. Therefore, any change which does not help to improve markedness (or harmony) is ruled out in Gen operation.

What Eval does on top of the classic evaluation is to evaluate the order of the violations with precedence constraints. Precedence constraints are not concerned with output wellformedness or input-output correspondence. They just evaluate the order of faithfulness violations and filter out some illformed chains.

This line of thought presents a simple and straightforward explanation on opacity. Precedence constraints specify the order of violation, which simulate the extrinsic ordering found in traditional generative phonology. Some transparent outputs may be filtered out by precedence constraints. As a result, the opaque form may appear on the surface. The relative ordering of precedence with respect to the related markedness constraints results in overapplication or underapplication opacity.1)

The interaction of vowel lengthening and flapping in General American English (=GAE) shows that some vowels are not lengthened before a voiced sound, if the voiced sound (a flap sound in this paper) is derived from voiceless one. The surface short vowel before a flap seems to show that vowel lengthening is not applied in the perfectly applicable environments. Judging from the surface forms, we may expect the lengthened vowel before a flap. This type of opacity is called “underapplication opacity” in McCarthy (1999). OT-CC with precedence constraints can specify desirable order of violation to screen out some of the chains that may lead to transparent outputs.

In Canadian English (=CE), flapping interacts with vowel raising to produce what is called “overapplication opacity.” A diphthong [ay] in Canadian is raised to be [ʌy] before a voiceless consonant. But [ʌy] is sometimes found before a flap. There does not seem to be any motivation for the raising, if only the surface is considered, hence the term overapplication opacity. Here again, we will show that precedence constraint

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1) Please refer to Lee (2006) for more detailed introduction to OT-CC and to the notion of underapplication and overapplication.
placed between markedness and faithfulness constraints can explain opacity effect and produce the correct optimal output.

In section 2, we will take a closer look at the interaction between flapping and vowel lengthening to see underapplication opacity and OT-CC proposal will be compared to the Local Constraint Conjunction proposal to see how they diverge. In section 3, we move onto Canadian vowel raising and flapping, which highlight the overapplication opacity. Sympathy theory, another proposal for overapplication opacity, will be compared to OT-CC. Finally, section 4 sums up the discussion and concludes the paper.

II. Flapping and Vowel Lengthening in GAE: Underapplication Opacity

Wilk (1965) and Shen (1966) observe that vowels are longer before a voiced consonant than before a voiceless consonant. Comparing *bag* and *back*, we find that the vowel [æ] is longer in *bag* than in *back*. And there is a well-documented phonological change, called flapping in English. /t, d/ is realized as a flap sound, [D], if it is placed between two vowels where the second one is stressless. (cf. Kahn 1976: 55, Selkirk 1982: 373). The interaction between the two changes results in an interesting vowel length contrast in GAE. Though there appears to be neutralization of /t/ and /d/ in an intervocalic position, the vowels are still longer before an underlying /d/ than before an underlying /t/. Examples of this kind are given in (1):

2) As a matter of fact, Wilk (1965) distinguishes 5 different vowel lengths. The difference depends on the nature of the following consonants: before a voiced fricative > before a voiceless fricative > before a voiceless stop > before a voiced stop > before a sonorant. But we are going to make dichotomy of vowel length saying that it is longer before a voiced sound than before a voiceless sound.

3) There is no consensus on the phonetic nature of a flap sound. Selkirk (1984) classifies it as a sonorant while de Jong et al. (1993) regard it as a form of released voiced stop. The detailed phonetic argument does not concern us here. And we will assume that a flap has [+voice, +flap] features.

Kenstowicz (1994: 6) documents that the interaction of the two phenomena, Vowel Lengthening and Flapping, produces dialectal differences. In GAE, the difference between *writer* and *rider* is clearly audible due to the vowel length contrast. Kenstowicz schematizes the change as in (2):

(2) Representation of *writer* and *rider*:

<table>
<thead>
<tr>
<th>write</th>
<th>ride</th>
<th>writer</th>
<th>rider</th>
</tr>
</thead>
<tbody>
<tr>
<td>phonological representation /rayt/</td>
<td>/rayd/</td>
<td>/rayt-ər/</td>
<td>/rayd-ər/</td>
</tr>
<tr>
<td>phonetic representation [rayt]</td>
<td>[rayd]</td>
<td>[rayDər]</td>
<td>[rayDər]</td>
</tr>
</tbody>
</table>

In the framework of traditional generative phonology model, the difference can be easily dealt with by referring to rule ordering. The following two rules and rule ordering may be posited to explain the surface vowel length difference.

(3) Counterfeeding ordering

a. Two rules
   i) Vowel Lengthening: V → [+long] __ [+voiced]
   ii) Flapping: {t, d} → [D]/V __ V[-stress]

b. Rule ordering
   Vowel Lengthening must apply before Flapping.

If Flapping applied first, it would feed to Vowel Lengthening. But the actual interaction shows the other way around. This reversed order is called counterfeeding. The rule ordering is very important in deriving the surface

4) The phonetic transcription is slightly different from Kenstowicz, but the difference is only for the consistency throughout the paper.
vowel length difference. It may not be problematic for underlying /d/. For underlying /t/, however, the ordering between the two rules results in different surface form as shown in (4):

\[(4) \text{ Different ordering results in different surface form}
\]

a. /rayt-ər-(VL)→raytər-(Flap)→[rayDər]

b. */rayt-ər-(Flap)→rayDər-(VL)→[ra:yDər]

If /t/ became a flap, a voiced sonorant, it could feed to the vowel lengthening rule as in (4b) to lead to a wrong surface form */[ra:yDər]* for writer. The reversed order, counterfeeding order, should be extrinsically set to explain the surface difference.

2.1. OT-CC analysis of underapplication

The difference noted above is not readily explainable in OT, which does not refer to any intermediate derivational stage. Consider the following constraints and tableau to identify the locus of the problem in classic OT.

\[(5) \text{ OT analysis}
\]

a. Constraints:

\[(M1) \text{ Length: No short vowel before a voiced sound.}
(M2) \text{ Flap: a flap sound is preferred in intervocalic position.}
(F1) \text{ ID(length): No length difference between input and output.}
(F2) \text{ ID(voice): No voice difference between input and output.}
\]

b. Ranking

\[\text{Length} \gg \text{ID(length)}: \text{Vowels are lengthened before a voiced sound.}
\text{Flap} \gg \text{ID(voice), ID(flap): \{t,d\} are flapped intervocically.}
\]

5) Here, M means a markedness constraints and F means a faithfulness constraints. Identical subscript numeric indices show that they are interacting. Thus $M_1$ interacts with $F_1$ but not with $F_2$. We see that $M_1$ outranks $F_1$ to trigger a change in phonological forms.

6) We have excluded ID(flap) from the faithfulness for the sake of simplicity of tableaux. Suffice it to say that we simply presume that ID(flap) is anywhere below Flap and Length.

Given the constraints in (5a) and their ranking in (5b), we see that the classical OT makes a wrong prediction on the actual output form. The cause of the problem here lies in the ordering of change as evidenced in the traditional generative phonology. The derivation, however, can be captured by the history of faithfulness violation in OT-CC. Consider the candidate chains given in (6) to derive the output given in (5c):

\[(6) \text{ Candidate chains}
\]

a. <rayt> : No faithfulness violation
b. */<rayt, rayt> : *ID(length), not motivated

c. <rayt, rayD> : *ID(voice), to satisfy Flap

d. */<rayt, rayDer, rayD> : *ID(voice)→*ID(length), to satisfy Flap and Length

Immediately we detect that (6b) chain is not allowed in OT-CC. There is a faithfulness violation, but it does not help to satisfy any of the markedness constraints. This, therefore, is not a well-formed candidate chain as in McCarthy (2006).\(^7\) Now, the unwanted form given in (6d) has a violation history of ID(voice) and ID(length) in that order, which contradicts with the derivational account given in (4a), where we find that lengthening comes before flapping. The simplest way to incorporate the derivation into OT-CC is to posit the following precedence constraint:

7) Since (6b) is illformed, any operation thereafter on the chain is illformed. Therefore a hypothetical chain */rayt, rayt, rayDer> is also ruled out. I appreciate one of the reviewers who directed me to this point.
(7) Precedence constraint

a. Precedence in Vowel Lengthening and Flapping
Prec(ededence) (ID(length), ID(voice))

b. Assessment (McCarthy 2006: 25)
Prec (A, B)
Let A’ and B’ stand for forms that add violations of the
faithfulness constraint A and B, respectively.
1. To any chain of the form <X, B’, Y>, if X does not contain
A’, assign a violation mark, and
2. To any chain of the form <X, B’, Y>, if Y contains A’,
assign a violation mark.

Following the assessment regulation given in (7b), we see that the
different chains given in (6) have different violation of the Prec constraint.
Consider the Prec(ID(length), ID(voice)) violation given in (8):

(8) Prec violation table

<table>
<thead>
<tr>
<th>rayt-ər (write-er)</th>
<th>Prec (ID(length), ID(voice))</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. &lt;raytər&gt;</td>
<td>✓</td>
</tr>
<tr>
<td>b. &lt;raytər, rayDər&gt;</td>
<td>*</td>
</tr>
<tr>
<td>c. &lt;raytər, rayDər, rayDər&gt;</td>
<td>**</td>
</tr>
</tbody>
</table>

(8a), having no faithfulness violation, vacuously satisfies Prec (ID(length), ID(voice)) (henceforth Prec in this section). (8b), however, violates Prec according to (7bi), because there is ID(voice) violation without preceding ID(length) violation. (8c) shows the worst violation. Since ID(voice) violation is not preceded by ID(length) violation, it is given a penalty by (7bi). And, at the same time, since ID(length) violation follows ID(voice) violation, another penalty is given by the clause in (7bii). Now consider the evaluation tableau in OT-CC:

(9) OT-CC evaluation of underapplication opacity

<table>
<thead>
<tr>
<th>rayt-ər (write-er)</th>
<th>Flap</th>
<th>Prec</th>
<th>Length</th>
<th>ID (length)</th>
<th>ID (voice)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. &lt;raytər&gt;</td>
<td>✓</td>
<td>√</td>
<td>☐</td>
<td>✓</td>
<td>○</td>
</tr>
<tr>
<td>b. &lt;raytər, rayDər&gt;</td>
<td>☐</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>c. &lt;raytər, rayDər, rayDər&gt;</td>
<td>*<em>!</em></td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

(✓: assessed as optimal. +: actual output form)

Given the opacity ranking argument in Lee (2006: 13), we see that the underapplication opacity is concerned with vowel length, and Prec, therefore, dominates the related markedness constraint, Length, but should be dominated by other unrelated markedness constraint, Flap, in this case. And by transitivity of ranking as in Prince & Smolensky (1993: 51), Flap dominates Length.

Now in (9), we see that the actual output form is selected as optimal with the introduction of Prec in the evaluation tableau. Just to make sure that our analysis is on the right track, we will have to see whether Prec interacts with any transparent output. Take rider for example and consider the following evaluation tableau:

(10) OT-CC evaluation of transparent output

<table>
<thead>
<tr>
<th>rayd-ər (ride-er)</th>
<th>Flap</th>
<th>Prec</th>
<th>Length</th>
<th>ID (length)</th>
<th>ID (voice)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. &lt;raydər&gt;</td>
<td>☐</td>
<td>☐</td>
<td>*</td>
<td>*</td>
<td>☐</td>
</tr>
<tr>
<td>b. &lt;raydər, rayDər&gt;</td>
<td>☐</td>
<td>☐</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>c. &lt;raydər, rayDər, rayDər&gt;</td>
<td>☐</td>
<td>☐</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>✓ d. &lt;raydər, rayDər, rayDər&gt;</td>
<td>☐</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

As for transparent interactions, we immediately see that there is no ID(voice) violation involved here. Having no violation of ID(voice), all the
candidate chains given in (10) vacuously satisfy Prec, and therefore Prec does not interfere with transparent processes. As such, we see that OT-CC with Prec can deal with underapplication opacity in a simple manner.

2.2. Local constraint conjunction

An alternative proposal, antecedent OT-CC, was made in Smolensky (1995) and Kager (1999), which might be applicable in explaining underapplication opacity. It is called Local Constraint Conjunction (=LCC). Let's go back to examine (5c). From the viewpoint of LCC, the problem with the wrongly chosen optimal form is that it has two violations of faithfulness constraints. If we conjoin these two faithfulness constraints to make a conjunctive constraint and to put it approximately where Prec stands in (10), we can get the correct result. Consider the conjunction and evaluation given in (11):

(11) Constraint conjunction
a. Conjoined constraint

\[
\text{ID(length)} \& \text{ID(voice)} \text{Adj-}\sigma
\]

Assign a violation mark to a structure which has the violation of \text{ID(length)} in one syllable and the violation of \text{ID(voice)} in the adjacent syllable.

b. Evaluation with local conjunction

<table>
<thead>
<tr>
<th>Flap</th>
<th>Length</th>
<th>ID (length)</th>
<th>ID (voice)</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. rayt_ar</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ii. rayD_ar</td>
<td>?</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>iii. ray_ar</td>
<td>*!</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>iv. rayD_ar</td>
<td>*!</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

LCC proposal says that the problem with (11biv) is that it violates two low level faithfulness constraints and the combined violation of these two is fatal and ruled out by the locally conjoined constraint given in (11a). Here locality means certain specified domain and we posited adjacent syllables as a specified domain. LCC with its promising first approximation, however, has a fatal theoretical flaw. OT-CC says that what is problematic with wrongly chosen optimal form is the order of violation. Prec(A, B) imposes the correct ordering of violation. Even though there are two violations, Prec just screens out one particular chain that shows \(B \rightarrow A\) change, while allowing chains with \(A \rightarrow B\) history. But LCC is blind to the derivational stage and any combined violation of \(A\) and \(B\) will be filtered out. The crucial difference, therefore, is that Prec penalizes the wrong order of faithfulness constraints that interact with each other.

Let's take petaline for example for a clearer exposition. We see observe /pet\_layn/\text{-}\text{[pe.D\_la:y\_yn]} changes. Consider the following tableau that points to a problem in LCC:

(12) Wrong evaluation of petaline in LCC.

<table>
<thead>
<tr>
<th>Flap</th>
<th>Length</th>
<th>ID (length)</th>
<th>ID (voice)</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. petalyn</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ii. peD_aly n</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>iii. petalyn</td>
<td>*!</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>iv. peD_al_yn</td>
<td>*!</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

Here, what we see in the actual form (12iv) is the flapping in the second syllable, and lengthening in the third syllable. We see \text{ID(voice)} violation in the second syllable and \text{ID(length)} violation in the next syllable. The domain, adjacent syllables is blind about the loci of violation. The actual form (12iv) is ruled out because of the combined violation of \text{ID(length)} and \text{ID(flap)}. This is the crucial violation of LCC proposed in (11a) and will be wrongfully eliminated in the evaluation process. And the tableau wrongly choose (12ii) as optimal.

But Prec is concerned only with interactive constraints. Since \text{ID(length)} and \text{ID(voice)} do not show any interaction (neutral ordering in the traditional term), Prec does not blindly penalize them. Consider the following chains.
OT–CC and English Opacity in Flapping

(13) Comparison of non-interactive violations

<table>
<thead>
<tr>
<th>/petal-ain/ (petal-ine)</th>
<th>Flap</th>
<th>Prec</th>
<th>Length</th>
<th>ID (length)</th>
<th>ID (voice)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. &lt;petalayn&gt;</td>
<td></td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. &lt;petalayn, pedDolayn&gt;</td>
<td></td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. &lt;petalayn, petalayn&gt;</td>
<td></td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. &lt;petalayn, pedDolayn, pedDolayn&gt;</td>
<td></td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. &lt;petalayn, petalayn, pedDolayn&gt;</td>
<td></td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

We are concerned particularly with (13d) and (13e). We see that both (13d) and (13e) render the same output. What we see is that since both of the chains are valid, (13e) will show up as optimal, even though (13d) may be filtered out by Prec. McCarthy (2006) says, when two or more chains share the same output, they can be merged together, which means that (13d) and (13e) are merged to (13e) to stay away from Prec violation. Note that (13d) and (13e) are both filtered out by LCC.

Another problem that LCC has is that it cannot deal with overapplication opacity at all. As will be seen in the next section, overapplication opacity chooses the form which is harmonically bounded by other candidates as explained in McCarthy (2002: 23). In other words, overapplication opacity allows more violation of faithfulness constraints. These cases cannot be explained by LCC, which penalizes multiple violations of faithfulness constraints.

III. Flapping and vowel raising in CE: overapplication opacity

Joos (1942) documented diphthong raising in Canadian English. Diphthongs, /ay/ and /aw/, are realized as /aɪ/ and /aʊ/ respectively, when they are placed before a voiceless consonant, so that ice is pronounced as /aɪs/, while eyes is realized as /aʊz/. Moreover, McCarthy and Thomas (2004) report that

“Canadian” raising is not limited to Canada. It is also found in Michigan, North Dakota, Minnesota, and many north American regions close to Canada.

What is interesting here is that vowel raising interacts with flapping in CE and produces overapplication opacity. Consider the following examples:

(14) Interaction of Flapping and Vowel Raising

a. ride [rayd] ~ rider [rayDər]
b. write [rayt] ~ writer [rayDər]

Interestingly, both GAE and CE preserve the underlying contrast between /t/ and /d/, though in different manners. In CE, raised diphthong signals the underlying /t/, while GAE uses vowel length to signal the underlying /d/.

Take a look at the opacity effect shown in (15) for detailed exposition of their interaction:

(15) Counterbleeding opacity in CE

a. Two rules
   i) Diphthong Raising /ay, aw/ \rightarrow [aɪ, aʊ]/[\_ voice]
   ii) Flapping: (td) \rightarrow [D]/V[\_ stress]

b. Ordering argument
   i) /rayt-ər/ (Raise) \rightarrow [raytar] (Flap) \rightarrow [rayDər] (counterbleeding order)
   ii) */rayt-ar/ (Flap) \rightarrow [rayDər] (Raise) \rightarrow [rayDər] (bleeding order)

c. Rule ordering
   Raising must apply before Flapping.

If Flapping applied first, it would block Raising in CE as shown in (15bii) to produce a wrong form. This is a bleeding order. To get the right result, we apply Raising before Flapping. Here, we find surface opacity, where vowel seems to have been raised in the wrong environment in that the raised vowel is followed by a voiced consonant.

8) Here, we will not be concerned with the exact phonetic description of raised diphthongs. Moreton & Thomas (2004) used /aɪ/ for one thing. But, to keep the consistency of vowel description in this paper, we will represent diphthongs as vowel-glide sequences.
3.1. OT–CC analysis of overapplication

The traditional generative explanation is not available for OT since there should not be any reference to the intermediate level in the course of derivation. Consider the following constraints and undesirable evaluation to see the source of problem.

(16) Classic OT analysis

a. Constraints

(M1) Raise: No low diphthong before a voiceless consonant.
(M2) Flap: A flap sound is preferred in intervocalic position.
(F1) ID(low): No height difference between input and output.
(F2) ID(voice): No voice difference between input and output.

b. Ranking

Raise ≫ ID(low): /ay/ becomes [ʌy] before a voiceless sound.
Flap ≫ ID(voice), ID(flap): {t,d} are flapped intervocally.

(17) Chains and precedence constraint

a. Valid chains from /raytər/ (writer)9)
   i) <raytər>: No faithfulness violation
   ii) <raytər, rayDər>: *ID(low) to satisfy Raise
   iii) <raytər, ray, rayDər>: *ID(voice) to satisfy Flap
   iv) <raytər, ray, rayDər>: *ID(low)→*ID(voice) to satisfy Raise and Flap10)

b. Precedence constraint

Prec (ID(low), ID(voice))

OT–CC, as explained before, produces well-formed candidate chains as partly shown in (17a). Compare (17aiii), the wrongly chosen optimal form, and (17ai), the actual output form. Given Prec(ID(low), ID(voice)) (henceforth Prec in this section) in (17b), we see that (17aiii) <raytər, rayDər> chain violates Prec, since ID(voice) violation is not preceded by ID(low) violation. With this much observation, we see that (17aiii) has ID(voice) and Prec violations, while (17ai) has ID(low) and ID(voice) violations. Now all we have to do is to place Prec higher than ID(low).

Consider the following evaluation tableau:

(18) OT–CC evaluation of overapplication opacity

<table>
<thead>
<tr>
<th>rayt-ər (write-ər)</th>
<th>Flap</th>
<th>Raise</th>
<th>ID(voice)</th>
<th>ID(low)</th>
</tr>
</thead>
<tbody>
<tr>
<td>? i) rayDər</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>= ii) rayDər</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iii) raytər</td>
<td>*!</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>iv) raytər</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The wrong optimal form has fewer violations than the attested form. In McCarthy’s (2002: 23) term, the unwanted form in (16ci) harmonically bounds (16cii). Since the violated constraints of (16cii) are a subset of the violated constraints of (16ci), no ranking manipulation can make the attested form optimal. This might be viewed as a crucial evidence for the necessity of an intermediate stage. Here again, we see that the precedence constraint may step in to explain the overapplication opacity. Consider the following valid chains and precedence constraints.

(17a) Chains and precedence constraint

9) Please note that another possible chain, *<raytər, rayDər, rayDər>, is ruled out since the change rayDər→rayDər fails to improve markedness.

10) Here again, another hypothetical chain, *<raytər, rayDər, rayDər>, that may lead to the identical surface form to (17ai) is ruled out since the rayDər→rayDər change is not motivated by a markedness constraint.
Now the shackle of harmonic bounding is broken. In (18), we see that (18c) does not harmonically bound (18d), since their violations are not in subset relations. With proper ranking, Flap $\gg$ Prec $\gg$ Raise $\gg$ ID(voice), ID(low), we can explain the overapplication opacity within OT-CC.\(^{11}\)

Again, we have to make sure that the postulation of Prec does not interfere with transparent outputs. Consider the tableau given in (19), which shows the output selection for rider.

(19) OT-CC evaluation of transparent output\(^{12}\)

<table>
<thead>
<tr>
<th>rayd-$\ddag$r (ride-$\ddag$r)</th>
<th>Flap</th>
<th>Raise</th>
<th>Prec</th>
<th>ID (voice)</th>
<th>ID (low)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. &lt;rayd-$\ddag$ar&gt; &lt;    &gt;</td>
<td>$\ast$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\sqrt{\ast}$ b. &lt;rayd-$\ddag$ar, rayd-$\ddag$ar&gt; &lt;ID(\text{flap})&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

We immediately see that /rayd-$\ddag$ar/→[rayD-$\ddag$ar], truly violate ID(voice). But, since /d/ is voiced just like [D], the change does not involve ID(voice) violation, which is the crucial constraint in assessing Prec violation. This shows that all the transparent interaction has nothing to do with Prec. Therefore, we see that there is no interference of Prec for transparent interactions.

3.2. Sympathy Theory

The immediate predecessor to OT-CC is Sympathy Theory proposed in McCarthy (1999). Sympathy Theory argues that not only the input and output forms but also the third form, dubbed as a sympathetic candidate, can interact in the evaluation via sympathy constraints. The sympathetic candidate is chosen among those which obey the designated faithfulness constraint, known as a selector. For further elaboration, consider the following surface variation and their violation of faithfulness constraints:

(20) The surface variants of /ray-$\ddag$ar/ and their faithfulness violation

<table>
<thead>
<tr>
<th>rayt-$\ddag$r (Faithful)</th>
<th>Flap</th>
<th>Raise</th>
<th>ID (voice)</th>
<th>ID (low)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. rayt-$\ddag$r</td>
<td>$\ast$</td>
<td></td>
<td>$\ast$</td>
<td>$\checkmark$</td>
</tr>
<tr>
<td>$\sqrt{\ast}$ b. r-$\ddag$yt-$\ddag$r</td>
<td></td>
<td>$\checkmark$</td>
<td>$\ast$</td>
<td>$\ast$</td>
</tr>
</tbody>
</table>

Having made ID(voice) a selector constraint marked by $\ast$ in the tableau, we see that there are two possible sympathetic candidates, (21a) and (21b). Compare these two. (21a) fairs worse than (21b) since it has worse violation of markedness constraints. Therefore (21b) is selected as a sympathetic...
candidate indicated by ◦. Now, the sympathetic constraint, ◦ ID(low), specifies that the output and the sympathetic candidate must correspond in [low] value. Since the sympathetic candidate has /ay/, the surface should not be /ay/, and if the sympathy constraint is placed anywhere above ID(low), it can successfully explain the opacity.

Sympathy Theory, like OT-CC, simulates derivational approach in the evaluation. This means that Sympathy proposal can also explain the underapplication opacity laid out in section 2. Remember that in (9) and (11b), we observe that underapplication opacity comes from the ranking of Prec above related faithfulness constraints and one of the markedness constraints. The similar effect can be made in Sympathy theory, too. Consider the following evaluation tableau:

<table>
<thead>
<tr>
<th>rayt-or</th>
<th>Flap</th>
<th>ID(length)</th>
<th>Length</th>
<th>ID (length)</th>
<th>*ID (voice)</th>
</tr>
</thead>
<tbody>
<tr>
<td>○ a. raytor</td>
<td>*!</td>
<td>*</td>
<td>*</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>✓ b. rayDar</td>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c. raytar</td>
<td>*!</td>
<td>*</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. rayDar</td>
<td>*!</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In (22), we see that Sympathy can also deal with underapplication opacity found in GAE. Comparing (22) with OT-CC evaluation given in (10), we see that, if we posit *ID(voice) as the selector, we can make (22a) a sympathetic candidate, and the sympathy constraint, ◦ ID(length) crucially eliminates (22d) to select (22b) as an optimal output.

As a matter of fact, Sympathy theory is too strong and too unconstrained to be a proper phonological theory. There is almost nothing that it cannot explain, though Idsardi (1997) reports some cases where Sympathy theory fails. Further, Kiparsky (2001) argues that Sympathy can even explain unattested changes in human languages. McCarthy (2006: 11-12) shows this with exemplification: even the impossible change, /pam/ → [paə], is explained with multiple sympathetic candidates. Idsardi (1997) surveys Sympathy Theory and concluded that “Sympathy creates chaos.”

In short, though both Sympathy theory and OT-CC can handle two types of opacity in a consistent manner, Sympathy is too powerful in the sense that it can generate impossible forms in human languages.

IV. Discussion and Conclusion

We have analyzed two different types of opacity that are observed in English phonology within the framework of OT-CC. The summary of ranking argument is given in (23):

(23) Opacity effect in OT-CC

a. Underapplication opacity: $M_b \gg \text{Prec}(F_a, F_b) \gg M_a \gg F_a, F_b$

b. Overapplication opacity: $M_b \gg M_a \gg \text{Prec}(F_a, F_b) \gg F_a, F_b$

The ranking, $M_i \gg F_i$, causes some phonological changes (where the same subscript means that they are interacting). This ranking is assumed for both underapplication and overapplication opacities. This basic ranking interacts with precedence constraints. If Prec($F_a, F_b$) is placed over $M_a$, then Prec($F_a, F_b$) has the effect of prohibiting the changes caused by $M_a$. As a result, we see the effect of underapplication. On the other hand, if Prec($F_a, F_b$) is dominated by both of the markedness constraints, $M_a$ and $M_b$, but still ranked above $F_a$ and $F_b$, it means that phonological changes should be involved, but, in some cases, due to the ranking, Prec($F_a, F_b$) $\gg F_a, F_b$, more violation of faithfulness constraints (more changes in the input) is allowed in some special cases, hence the overapplication effect.

Two previous approaches, LCC and Sympathy theory, are compared to OT-CC. LCC can explain some of the underapplication, but it fails to account for overapplication opacity. Further, there are problems of blind filtering of legitimate candidates, which are chosen as optimal under OT-CC precedence constraint. Sympathy Theory can deal with both types of opacity.
But we have shown that it is too strong and powerful in that there is almost no alternation it cannot explain. In other words, Sympathy theory suffers from serious overgeneration.

The discussion in this paper, as such, clearly demonstrates that OT–CC can offer a comprehensive, consistent and concise explanation for both types of phonological opacity, while staying away from the theoretical drawbacks other approaches have.

Works Cited


Kiparsky, P. 2001. Stratal OT or Sympathy? Handout of talks presented at University of Massachusetts, Amherst, MA.


abstract

OT-CC and English Opacity in Flapping

Lee, Yong-Sung

McCarthy’s (2006) OT-CC incorporates derivational effects in Optimality Theory in the form of faithfulness violation recorded in candidate chains. These chains are subject to the evaluation by precedence constraints, which checks upon the order of violation. This paper applies the proposed OT-CC in analyzing both overapplication and underapplication opacities involving flapping. In General American English, Flapping interacts with Vowel Lengthening. Vowels are long before a flap that comes from /d/. But they remain short before a flap derived from underlying /t/: a case of underapplication. In Canadian English, Flapping interacts with Raising. Diphthongs are raised only before a voiceless consonant. But we find raised diphthongs before a flap showing the effect of typical overapplication. It is shown that both types of opacity can be consistently analyzed within the OT-CC framework. The proposal can obviate controversial proposals such as Local Constraint Conjunction or Sympathy Theory.

Key words: OT-CC, candidate chains, precedence constraints, Local constraint conjunction, sympathy, opacity, overapplication, underapplication, flapping, vowel lengthening, vowel raising.