ABSTRACT: In this paper I have argued that the Contrast Preservation approach with Neighbours can account for chain shifts with semi-iterative raising only if the attribute of ‘feature distance’ is built into the proposal. This attribute can factor out irrelevant Neighbours in chain shifts, and at the same time it can also predict the right Neighbours. The tool of feature distance evaluates distances in such a way that the minimum difference must be at least the number of unshared features. The data that are currently investigated are from Standard Colloquial Bengali and Cachar Bengali. Extant proposals within the Preserve Contrast approach fail to account for chain shifts adequately and adoption of feature distance leads to a more comprehensive analysis.

KEYWORDS: chain shift, Standard Colloquial Bengali, Cachar Bengali, Contrast Preservation, feature distance

0. INTRODUCTION

In this paper I deal with two examples of chain shifts in two varieties of Bengali and show how their analysis is possible in a Contrast Preservation model. The concerned varieties are SCB (Standard Colloquial Bengali) and Cachar Bengali (CB). Vowel harmony in SCB is non-iterative, but it is also not driven by suffixes alone. See examples in (1a) and (1b) where the vowel /a/ immediately preceding the trigger agrees with the [A TR] feature of the following /i/, by raising to /o/ even though it is root internal¹.

¹ The overwhelming number of such instances is a pointer in the direction of root-internal harmony.

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(1) Non-iterative harmony in SCB

<table>
<thead>
<tr>
<th>Word</th>
<th>Gloss</th>
<th>Word</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>kوث'a</td>
<td>‘spoken’</td>
<td>Kot'to</td>
<td>‘uttered’</td>
</tr>
<tr>
<td>k侥幸</td>
<td>‘resembling’</td>
<td>Kolphito</td>
<td>‘invented’</td>
</tr>
<tr>
<td>kထা</td>
<td>‘game’</td>
<td>kဗု</td>
<td>‘to play’</td>
</tr>
<tr>
<td>hဗု</td>
<td>‘Lord’</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In the examples above, only the vowel preceding the trigger undergoes harmony. In SCB, in words of two or more than two syllables, high vowels on the right-hand side trigger harmony in the preceding syllable. As shown in the examples in (1) above, /i/ and /u/ in SCB trigger harmony in the preceding [–ATR] vowels /el/ and /ə/. This shows that in SCB there is a process of vowel harmony where [–ATR] and [–High] vowels are raised in the presence of following high vowels. In the regular vowel harmony system of the language, a following high vowel raises a /ə/ to its surface alternant [o] and a /e/ raises to /el/. Of course, this pattern can be analyzed in a standard OT model of Faithfulness and Markedness constraints. There is another process in SCB (restricted only to verbs) where [–ATR] vowels /o/ and /e/ are raised to [+ATR] [o] and [e] respectively, before high vowels, and /o/ and /e/ are raised to /u/ and /i/ respectively, in the same environment. For instance, in the /e/ → [e] and /el/ → [i] mappings, the change from /el/ → [e] is only a [–ATR] to [+ATR] change, but /el/ → [i] involves change in height. Therefore, the same context leads to two Faithfulness violations, the /el/ → [e] mapping is an IDENT[ATR] violation and /el/ → [i] mapping leads to IDENT[High] violation. Hence, this type of ‘chain shift’ in SCB is caused by vowels alternating to another vowel just one notch above the other in the vowel space so that the process leads to the alteration of more than one feature. This chain shift process cannot be dealt with in a standard OT model of Faithfulness and Markedness constraints and has been subject to analysis in Optimality Theory with the aid of constraint conjunction (Mahanta 2007).

While chain shifts are encountered in SCB and CB, CB introduces another complexity which is not seen in SCB, i.e. whereas harmony is only local in SCB, CB brings in iterativity in the harmonic domain. In CB, underlying [+ATR] mid vowels /o/ become high [u] before a high vowel and this process may become iterative if there are three syllables...
with varying height specifications and where the rightmost vowel is the
highest preceded by two mid vowels, the leftmost of which is the
[–ATR] vowel /ɔ/ followed by /o/. This paper argues that existing
proposals within the Preserve Contrast approach fail to account for this
pattern satisfactorily and hence the property of ‘phonological distance’
needs to be integrated for a satisfactory analysis.

The organization of the paper is as follows: Section 1 starts with a
discussion on chain shift in SCB verbs and iterativity and opacity in CB.
Section 2 presents the background literature on the analysis of chain
shifts in Optimality Theory. Section 3 presents the extant theories of
Preserve Contrast and the need for revision of the theoretical tools offered
by Preserve Contrast. The subsections in 4 present the revised proposal
of Preserve Contrast with Neighbours and the need for distance checking
as an additional property of Preserve Contrast. The paper ends with a
conclusion in 4.3.

1. SCB VERBS

In order to analyse the alternation pattern in verbs, we need to take note
that alternations in verbs demonstrate a chain shift. In a chain shift process,
a segment changes from /A/ to [B] but if /B/ is underlying, it alters to
[C] in the same environment. ‘Chain shifts’ in SCB are caused by vowels
alternating to another vowel just one notch above the other in the vowel
space so that the process leads to the alteration of more than one feature.
For instance in the /e/ → [e] and /e/ → [i] mappings, the change from /e/
to [e] is only a [–ATR] to [+ATR] change, but /e/ to [i] is a change of the
feature [High]. Therefore, the same context leads to two Faithfulness
violations, the /e/ → [e] mapping is an IDENT[ATR] violation and /e/ → [i]
mapping leads to an IDENT[High] violation.

2 Preliminary investigations suggest that like SCB, /e/ → /e/ → /i/ process involving the
front vowels may also be there in CB, but we did not get enough data to show it here.
We will assume that the relevant features for this process are [ATR] and [High] and the
process affects both front and back vowels. No alternations have been attested for the
features [Round] or [Back].
(2) **Examples from the verbal paradigm**

<table>
<thead>
<tr>
<th>Nominal</th>
<th>/-i/ 1st person present</th>
<th>/-un/ 2nd person honorific</th>
</tr>
</thead>
<tbody>
<tr>
<td>ŋekʰa</td>
<td>ŋikʰi</td>
<td>ŋikʰun</td>
</tr>
<tr>
<td>kʰola</td>
<td>kʰuli</td>
<td>kʰulun</td>
</tr>
<tr>
<td>dækʰa</td>
<td>dækʰi</td>
<td>dækʰun</td>
</tr>
<tr>
<td>kʰra</td>
<td>kori</td>
<td>korun</td>
</tr>
</tbody>
</table>

As the examples show, SCB verbs appear in agreement with the inflectional augments following the root. Whenever the inflectional extension is /a/, the root appears with a lowered vowel, but when the inflectional augments are the high vowels /i/ and /u/, the raised counterpart surfaces. Following Ghosh (1996), I assume that the underlying verb roots contain /e/, /i/, /o/ and /u/, and that these vowels undergo raising which result in the following alternations: /e/ → [e], /e/ → [i], /o/ → [o], /o/ → [u], and /a/ → [e]. As a result of this, the underlying form of the surface verbal form of ‘buy’ will be /ken/ (and not /kin/), and its appearance as [kin] will be the result of raising under the influence of a following high vowel. The systematic raising in SCB verbs does not mean that agreement involves the feature [A TR] only. In this process both the features [High] and [A TR] play a role.

The chain shift in SCB, where mid vowels raise to higher vowels may result in an output of harmony with a new violation of the constraint demanding non-iterative agreement. In that case, a second change will be required to undo this violation. This hypothetical condition will result in a series of repairs, till the point the representation meets a [–A TR] mid vowel that will stop this semi-iterative process. In SCB itself, this kind of semi-iterativity does not occur because verbal roots exhibiting chain shifts are always monosyllabic. There is also no prefixation that can occur to the verbal base, so that the vowel in the prefix is subject to the process of raising and subsequent repairing. Therefore, there can be only one instance of chain shift in the verbal base and not more. There are instances of such iterative raising in another language and that brings to the fore an opacity issue to the chain shift data addressed here. The language is Cachar Bengali (CB) and the CB data are presented in the section below.

---

3 This assumption of the Bengali vowel inventory lends itself to an abstract analysis as root forms such as /ken/ do not occur in isolation.
1.1 Enter Cachar Bengali (CB)

In CB, the underlying /o/ of SCB is subject to reconstruction, such that /o/ → [u] changes are observed when there is a following /i/ or a /u/. Otherwise, CB shows the same non-iterative system as SCB, which means that harmony occurs when a [-ATR] vowel follows a [+ATR +High] vowel. The reconstruction of /o/ to [u] in Cachar Bengali (as shown in the examples below) means that IDENT[±High] must have been demoted at some stage in the formation of the language. /o/ changes to [u] if there is a following /i/ or /u/, otherwise sometimes to [ə] (Tunga 1995).

(3) CB /o/ → /u/ and /ɔ/ reconstruction

<table>
<thead>
<tr>
<th>SCB</th>
<th>CB</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. goru</td>
<td>guru</td>
<td>‘cow’</td>
</tr>
<tr>
<td>b. bɔrloki</td>
<td>borluki</td>
<td>‘lavishness’</td>
</tr>
<tr>
<td>c. korisil</td>
<td>korecʰilo</td>
<td>‘had done’</td>
</tr>
<tr>
<td>d. borichi</td>
<td>baritecʰe</td>
<td>‘is growing’</td>
</tr>
<tr>
<td>e. muteu</td>
<td>motei</td>
<td>‘any way’</td>
</tr>
</tbody>
</table>

The data above show that both the [ATR] and [High] values can be altered depending on whether the mid vowel is underlying or derived. The harmony system of CB is also a [ATR] harmony system, but IDENT[High] is not ranked higher than the constraint demanding agreement. In this ranking schema, as rightly predicted by OT, the output will be a vowel harmony system where both [ATR] and [High] can alternate. The example /borluki/ means that /o/ → [u] changes in CB result in harmonically iterative outputs, as a result of lower-ranking IDENT[High]. Another important aspect of CB is the kind of chain shift this pattern of reconstruction creates. In CB, /o/ occurs only as a result of harmony, i.e. when underlying /ɔ/ changes to [o] in the presence of /i/.

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4 This is like the chain shift in SCB (where a segment changes from /A/ to /B/ but if /B/ is underlying it alters to /C/+), but all underlying instances of /o/ which are still present in SCB have changed to either /u/ or /ɔ/. It is not very clear as to why there is no systematic way in which /u/ and /ɔ/ are favoured. We will not proceed to elaborate on the non-harmonic contexts due to space restrictions. However, in harmonic contexts, note that the alteration is uniformly to /u/ instead of /ɔ/.
The interesting difference from SCB which CB presents is that A changes to B (/o/ → [o]), but B changes to C (/o/ → [u]), if B is underlying and these changes persist even in an iterative harmonic domain, i.e. where successive syllables with mid vowels occur and are therefore possible candidates for undergoing raising, raising will be determined by the underlying property of the vowel as [-ATR] or [+ATR]. In such cases, all instances of [o] which are derived from /o/ → [o] mapping are not subject to any more repairing. This twist in CB leads to [high] value changes and also results in opacity as a result of the iterative chain-shift.

2. CHAIN SHIFTS IN PHONOLOGY

2.1 Chain shifts in phonological theory and Optimality Theory

If phonological rules are only applicable to derived structures but are systematically blocked in nonderived environments, then they are known to be instances of Non Derived Environment Blocking (NDEB), Kiparsky (1993). A derived structure is one where (a) the segments participating in the phonological process traverse a morpheme boundary, or (b) the relevant segment, i.e. the segment undergoing a phonological process arises as a result of another phonological process (applying in the same cycle, as per Kiparsky 1982 and Mohanan 1986). In much of the literature which has dealt with Non Derived Environment Blocking, these two processes have been identified as Morphological NDEB and phonological NDEB respectively. Phonological derived environments are well known in the literature. In Kiparsky (1973), a rule A creates a derived environment for rule B, if B will apply only as a result of prior application of A. Some of the most recent OT analysis of phonologically derived environments in Lubowicz (2002) and McCarthy (2003) discuss similar problems in Polish, Basque and Makassarese. In Polish spirantisation, in heteromorphemic sequences, velars turn into postalveolars before front vowels, but in the very same environment /g/ → ž, but avoids */g/ → /j/, and Lubowicz (2002) shows this to be the result of a local conjunction of a Markedness and Faithfulness constraints.

In a chain shift process, a segment changes from A to B but if B is underlying it alters to C in the same environment. This is known as
counter-feeding opacity (Kiparsky 1973) where derived forms are recalcitrant to a phonological process of the language. In the SCB and CB cases discussed here, a rule specifically avoids a phonologically derived environment, that is prior application of A prevents B from applying. The SCB case does not let us test this in successive syllables but the chain shift as such can be seen in SCB as well. In the CB case, we can see the operation of chain shift in successive syllables and this iterativity in the harmonic domain tests the assumptions about chain-shifts and also brings in additional opacity. This is problematic to Standard OT (Prince & Smolensky 1993), as Standard OT does not distinguish between underlying and derived forms, thereby predicting that if a Markedness constraint is above Faithfulness then both underlying and derived [o]s should become the [+High] vowel /u/ or none of them should do so if Faithfulness outranks Markedness, i.e. \( /o/ \rightarrow [u] \) when Markedness outranks Faithfulness \( */o/ \gg \text{IDENT} \text{(High)} \). However, this problem is also not amenable to analysis in the available approaches within Preserve Contrast Theory, the theoretical model within OT which will be used to analyze counterfeeding opacity in this paper. The approach to be adopted here is that of Preserve Contrast proposed in Lubowicz (2003) and Tessier (2004). Lubowicz’s proposal is specifically for those chain shift mappings where the underlying status of the alternant is important for the chain shift to take place. I propose that incorporating the aspect of phonological distance in the vowel space is crucial to account for the chain shift pattern seen in CB. The underlying property of the alternating vowels in the CB example like /bɔrlɔki/ \( \rightarrow [bɔrlnki] \) plays a crucial role in CB and the property of ‘distance’ is absolutely essential for CB. Therefore, CB offers us the real test of counter-feeding opacity.

In the Preserve Contrast approach, chain shifts can be accounted for in terms of pairs of contrasts in surface forms by appealing to their underlying distinctiveness. Chain shifts maintain underlying contrasts in surface forms but not in exactly the same form as that of the underlying structure. Contrast preservation is only possible by executing yet another alternation which makes it distinct from the underlying form. We will argue that a semi-iterative chain-shift can only be analyzed in a CP approach where a minimum distance between features is maintained.
2.2 Preserve Contrast Theory: the basics

In standard OT, constraint interaction does not allow counter-feeding opacity. The main claim of PCT is that a family of rankable and violable constraints such as the Preserve Contrast constraints, allow contrasts to be preserved in the surface forms. According to the view of Contrast Preservation Theory, preservation of contrasts is an independent principle present in the grammar and the results that can be obtained from this approach to OT is not possible to be generated by the interaction of Faithfulness and Markedness constraints as in standard Optimality Theory (Prince & Smolensky 1993/2009). Unlike standard OT, in Contrast Preservation Theory, Lubowicz (2003) proposed ‘scenarios’ which compete in the evaluation and not candidate outputs (Flemming 1995, 1996; Padgett 1997, 2003; Lubowicz 2003, 2009). These scenarios constitute input/output mappings which are unlike outputs in standard OT, where different settings of input-output mappings are not taken into consideration. Hence what is important in such scenarios is not just the bare surface output stripped of its association to the input, but also the mapping which leads to the output. So the same output may be the result of a different scenario, unlike standard OT. Within Contrast Preservation theory there are two proposals which determine input-output mappings. Among these two, Lubowicz (2003) presented a proposal where scenarios are evaluated in the context of their input-output mappings. Following this proposal, Tessier (2007) proposed an alternative which does not map one input to one output in competing scenarios but considers all the possible neighbours of a base form in a candidate. Tessier also proposes an algorithm which determines the correct neighbours for the base form, which may be eventually the selected output. The selection of neighbours follows an algorithm which leads to the choice of the neighbours. The reason for the proposal of an algorithm for the selection of neighbours, is because in a Contrast Preservation approach with scenarios, as long as the principle of infinite number of inputs apply as in standard Generative Theory, there will be no principled way of determining the number of inputs or the number of input-output mappings that are theoretically possible in such an approach.
2.3 The constraints

I assume, following Archangeli & Pulleyblank (1994), that there are articulatory constraints which govern the combination of the two vowel features [ATR] and [High]. Furthermore, [+High] and [+ATR] interact more closely in some languages. For instance in Kimatuumbi, (Odden 1991, 1994) in a word, [+ATR] vowels have to agree in their [+High] specifications, otherwise all vowels are [-ATR]. I will not go into the details of these languages, but it is not far-fetched to assume that [ATR] and [High] have close interactions, especially in languages displaying vowel harmony.

AGREE[F]: (Lombardi 1996a,b, 1999, Bakovicò 2000)

(4) AGREE[+High +ATR]: Adjacent segments must have the same [+High] and [+ATR] features

(5) PRESERVE(FEATURE): For a pair of input forms /X/ and /Y/ contrasting for the feature F, assign a violation mark to any output candidate in which /X/ and /Y/ merge the contrasting feature F

The specific instantiations of PRESERVE (FEATURE) which can be found in this paper are as follows:

(6) PC[ATR]: For a pair of input forms /X/ and /Y/ contrasting for the feature [ATR], assign a violation mark to any output candidate in which /X/ and /Y/ merge the contrasting feature [ATR]

To illustrate how these constraints will function given a contrast between [High] and [ATR], we can take the following example:

(7) (a) /kɔɾ+/i/ → [kori]
(b) */kori/ → [kuri]

/kɔɾi/ contrasts with /kori/ with regard to [ATR], and /kori/ contrasts with /kuri/ with regard to [high]. In this ‘scenario’ PC[ATR] will be effective in maintaining the underlying contrastiveness of ATR by not admitting a shift where /s/ → [u]. Thus, contrast is preserved between underlying /ɔ/ vs. /o/ despite the process of raising resulting in a surface contrast in height.
In the languages under discussion, height and [ATR] features are subject to alternations. One of the relevant constraints is IDENT [High] which preserves the height features of the input.

(8) **IDENT[High]:** Assign a violation mark to a segment in the output which differs from identical specifications with regard to the feature [High] in the input.

(9) **IDENT[ATR]:** Assign a violation mark to a segment in the output which differs from identical specifications with regard to the feature [ATR] in the input.

3. A DISCUSSION OF THE PRESERVE CONTRAST APPROACHES IN THE LITERATURE

3.1 Preserve Contrast with Scenarios

This Preserve Contrast approach generates scenarios which explain the relationships between a set of possible inputs and the outputs. The transparent and chain shift scenarios have different input-output relations, even though they have the same outputs. Therefore, Preserve Contrast constraints on contrast are expressed as sets of input-output mappings, called scenarios (Flemming 1995; Padgett 1997).

(10) **Possible scenarios**

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>A. Identity</th>
<th>B. Transparency</th>
<th>C. Chain shift</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>/ɔ/ /o/ /u/</td>
<td>/ɔ/ /o/ /u/</td>
<td>/ɔ/ /o/ /u/</td>
</tr>
<tr>
<td>Output</td>
<td>[ɔ] [o] [u]</td>
<td>[ɔ] [o] [u]</td>
<td>[ɔ] [o] [u]</td>
</tr>
</tbody>
</table>

Assuming the constraints etched in section 2.3, the ‘Scenario’ model of Contrast Preservation would predict that the contrast preserving approach successfully maintains the surface contrast between /ɔ/ and /o/. Scenarios are built with the purpose of checking all possible contrast neutralizations. The process involves generating scenarios for input strings which are not necessarily language dependent and as a result the inputs and scenarios...
may be largely removed from the specific phonological problem which
is the subject of analysis. The underlying contrast between /kɔɾi/ and
/kori/ is with regard to the feature [ATR] which is preserved.

(11) Some scenarios

<table>
<thead>
<tr>
<th>Contrast Preserving</th>
<th>I:/kɔɾi/+i/</th>
<th>PC[ATR] _A G R E E(+High+ATR)</th>
<th>IDENT[+High]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>/kɔɾi/+i/→[kori]</td>
<td></td>
<td>*!</td>
</tr>
<tr>
<td></td>
<td>/kɔɾi/+i/→[kuri]</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>/kur/+i/→[kuri]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Contrast Neutralizing</th>
<th>kɔɾi/+i/→[kuri]</th>
<th>*!</th>
<th>*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>/kur/+i/→[kuri]</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>/kur/+i/→[kuri]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There could be many input forms in the Contrast Preservation approach,
with the result that input scenarios may not be restricted to the ones
discussed above, resulting in inputs which are irrelevant for the contrast
preservation in question. This is shown below and it will be taken up
again in section 4.1.

(12) Preserve Contrast with PC[ATR]

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>a. kɔɾi</td>
<td></td>
<td>**!</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>b. ꞌkɔɾi</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c. kuri</td>
<td></td>
<td>**!</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

(13) Preserve Contrast with PC[ATR]

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a. kɔɾi</td>
<td></td>
<td>**!</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>b. ꞌkɔɾi</td>
<td></td>
<td>**!</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c. ꞌkɔɾi</td>
<td></td>
<td>*</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>
With regard to analyzing the problem of scenarios where the contrast in question may be present but with a different vowel with an additional specification (here PC [Round]), we would insist that this aspect of the Preserve Contrast approach with Scenarios will have to account for multiple contrasts in the grammar which have hardly any relation to the alternation in question. Trying to deal with problems like these, Tessier (2004) proposes the Preserve Contrast model which compares neighbours for Contrast Preservation. The following section is a detailed discussion of Tessier (2004).

3.2 Preserve Contrast with Neighbours

In the Contrast Preservation (CP) approach of Tessier, she analyzes a DEE pattern where, if three inputs are ABC (as linear points according to their features), A maps to C because of high ranked *A and *B, whereas B remains intact without any change to its contrastive features with A and C. It is proposed that to preserve the contrast between /B/ and /C/, marked /B/ emerges faithful. In the specific Campidinian Sardinian example discussed in Tessier the data is as below. The data shows DEE patterns where [p/] → /β/, [b] → /b/, but *[b] → /β/.

(14) [A] → [C], i.e. p → β
    [p]i:ji ‘fish’ belu[β]i:ji ‘nice fish’

(15) /B/ → [B] i.e. b → b
    [b]ia ‘road’ sa[b]ia ‘the road’

In the CP account proposed by Tessier, the following argument seems to account for Contrast Preservation between two distinct segments: it is to preserve the contrast between /B/ and /C/ that marked /B/ is unexpectedly faithful. /A/ is unfaithful for pure Markedness reasons, and /C/ is faithful because there are no Markedness pressures against it. Hence in a Preserve Contrast approach, it is imperative that the analysis captures that /B/ does not map to [C], and hence a proper algorithm should build [C] as one of the potential neighbours of /B/.

With a rich set of input forms, input scenarios not only contain a lot of unnecessary patterns, they might also project the wrong input-output
scenarios as shown in (13). Tessier’s input clusters seek to redress these problems by employing general Markedness and Faithfulness constraints within OT. The candidate set in a Preserve Contrast approach needs to be relevant to the input in question, primarily because the input-output relationship is crucial in preservation or neutralization of underlying contrasts which appear in the surface forms. In accounting for this relationship, while Lubowicz proposes for scenarios, Tessier proposes ‘neighbours’ of the input. In order to do so, Tessier (2007) proposes a new algorithm to predict the relevant ‘neighbours’ in a contrast preservation model. These neighbours restrict the number of inputs that the GEN component has to deal with. Tessier’s model proposes a mechanism for deciding ‘neighbours’, which will eventually put a restriction on the number of possible inputs relevant for contrast preservation. The algorithm also takes into account losing candidates and their violations. The losing candidate qualifies as a neighbour only if there is a single *X violation.

(16) **Tessier’s algorithm**

Step 1: Run base through *X (excluding all others) and other Faithfulness constraints and count the violation marks.

Step 2: If the base did not map to a fully-faithful candidate in step 1), include step 1’s winning output as a neighbour in the base’s cluster.

Step 3: Include as neighbours all the forms which (a) violate *X exactly once and (b) are otherwise most harmonic (i.e. most faithful)

(17)

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Step 2</th>
<th>Step 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run Grammar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Find *X violations</td>
<td>Selected Neighbours:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• The fully faithful candidate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• A winning candidate with exactly one *X violation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Selected Neighbours:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Losers with only one *X violation</td>
<td></td>
</tr>
</tbody>
</table>

Tessier’s algorithm can be checked for its performance on non-iterative examples of SCB and CB.
(18) **Step 1:**

<table>
<thead>
<tr>
<th>I: korí</th>
<th>AGREE (+High + ATR)</th>
<th>IDENT [±High]</th>
<th>IDENT [±ATR]</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. korí</td>
<td>*!</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>b. kɔri</td>
<td>**</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>c. Ḟkuri</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

- Result of Step 1: /korí/ has one violation mark for AGREE(+High + ATR) /kuri/ has none. The fully faithful candidate incurs two violation marks for AGREE.
- Result of Step 2: /kuri/ is the chosen neighbour, winning output of this tableau.
- Result of Step 3: /korí/ is chosen as the other neighbour because it has exactly one AGREE violation even though it is a loser.

Thus this algorithm provides us with the correct set of neighbours for the non-iterative pattern. If we now show this in a tableau we will be able to get the correct output.

(19) **CP and Neighbours in non-iterative bases**

<table>
<thead>
<tr>
<th>/korí/ᵣ₁, /kɔri/ᵣ₂, /kuri/ᵣ₂</th>
<th>PC [ATR]</th>
<th>AGREE (+ATR)</th>
<th>AGREE (+High)</th>
<th>IDENT [±High]</th>
<th>IDENT [±ATR]</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Ḟ/kori/ᵣ₁, /kɔri/ᵣ₂, /kuri/ᵣ₂</td>
<td>*</td>
<td>*</td>
<td>**</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>(ii) /kɔri/ᵣ₁, /kɔri/ᵣ₂, /kuri/ᵣ₂</td>
<td>*!</td>
<td>***</td>
<td>**</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>(iii) /kori/ᵣ₁, /kɔri/ᵣ₂, /kuri/ᵣ₂</td>
<td>*</td>
<td>***!</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

The tableau above shows the performance of the three candidates with regard to the input base and neighbours. While the first candidate falls foul of the demands of AGREE[ATR] and AGREE[High], the second candidate violates the highest ranked PC[ATR], by altering the [ATR] contrasts. Candidate (19iii) incurs multiple violations AGREE[high], higher than the violations in (19i) and therefore the evaluation chooses the right base and neighbours in (19i).
Even though Tessier’s algorithm does not face any hurdle in analyzing the non-iterative patterns, iterativity introduces a new complexity and is a stumbling block in allowing the steps in the algorithm to proceed. Therefore successive changes of Height and ATR lend themselves to incorrect predictions without ‘feature distance’ within Preserve Contrast. The reason Tessier’s algorithm fails to account for all the legitimate neighbours in the cases of chain shift is because Tessier (2007) considers only single violations of the Markedness constraint. Note that in a chain shift, violation of Markedness can exceed the minimality requirement determined by Tessier in the algorithm. Tessier does not analyse any counterfeeding opacity in her approach and makes her analysis test only the DEE pattern in Campidanian. The analysis in the next section shows how Tessier’s algorithm will have to be modified to also account for chain shifts like those in CB. This is shown in the section below:

3.3 Iterativity and Preserve Contrast with Neighbours

In counter-feeding opacity, a phonological process applies only to the underlying forms and not to all the extant forms. In CB it applies to underlying Mid [+ATR] vowels and turns them into the high vowel [u], but it fails to apply to [o] derived from [+ATR] harmony. Thus, contrast is preserved between underlying [ɔ] vs /o/ and is manifested as surface contrast in height. I propose, therefore, that this type of chain shift is a requirement on preserving contrast in [ATR]. However, in the model proposed by Lubowicz (2005), the proposed scenarios encounter the problem that there is little restriction on the number of contrasts and can therefore predict irrelevant scenarios. Hence, even [bɔrloki] could be one of the possible inputs and none of the scenarios predict how that could be controlled. As discussed in (13) PC[Round] could be employed here to show how to maintain the contrast between round and non-round vowels. However, this might bring complications of having to address each and feature contrast bearing no relevance to the problem/alternation which needs to be accounted for. Therefore Preserve Contrast approach with Scenarios is a unwieldy procedure where the mapping of

5 Lubowicz model can restrict upto 2n+1 places for any base consisting of n segments. See Tessier for a discussion on the restriction of contrasts’ (or absence thereof) in the Scenarios model.
the input with the potential output may not have any relevance to the contrast in question. On the other hand, Preserve Contrast approach with Neighbours as per Tessier (2004) has an algorithm which allows only one violation mark of a Markedness constraint. Therefore, if we take the example of /bɔrloki/ → [borluki] in CB, then the violations that are incurred in /bɔrloki/ → [borluki] mapping will be evaluated by Tessier (2004) in such a way that the actually occurring output candidate [borluki] will become inadmissible as a neighbour. This is shown in detail below:

(20) *CP with Neighbours: Step 1

<table>
<thead>
<tr>
<th>bɔrloki</th>
<th>AGREE (+High+ATR)</th>
<th>IDENT [±High]</th>
<th>IDENT [±ATR]</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>bɔrloki</td>
<td>**</td>
<td>*</td>
<td>*</td>
<td>Violates AGREE twice</td>
</tr>
<tr>
<td>borloki</td>
<td>**</td>
<td></td>
<td></td>
<td>Violates AGREE twice</td>
</tr>
<tr>
<td>bɔrluki</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>Violates AGREE twice and IDENT [±High]</td>
</tr>
<tr>
<td>borluki</td>
<td>*</td>
<td>*</td>
<td></td>
<td>Violates AGREE twice and IDENT [±High]</td>
</tr>
<tr>
<td>burluki</td>
<td></td>
<td>**</td>
<td>**</td>
<td>Neighbour</td>
</tr>
</tbody>
</table>

- Step 1 & Step 2: Since the result of these two steps leads to [burluki], it has to go through another step in the algorithm.
- Step 3: This step will result in the selection of [bɔrloki] as the second neighbour.

As seen in the tableau above, [bɔrloki] violates AGREE only once, but is otherwise more faithful than /burluki/, the winning candidate with no Faithfulness violation in its profile.
- Resulting neighbours of this evaluation: [bɔrloki] and [burluki].

The candidate with these two neighbours will then fail in the final constraint evaluation as the expected output is [borluki]. The evaluation will crash if the neighbours are [burluki] and [bɔrloki]. In other words, adopting the complete algorithm proposed by Tessier would lead to a flawed analysis where the appropriate neighbour [borluki] will be ignored by the evaluation.
4. PRESERVE CONTRAST WITH FEATURE DISTANCE: 
THE NEW PROPOSAL

4.1 The new proposal

In this approach we integrate the aspect of ‘feature distance’ among the inputs in a chain shift. The schematic representation of these could be seen as /A/, /B/ and /C/, whose ‘feature distance’ can be interpreted from their linear relation to each other, where /A/ and /B/ have a distance of 1 (difference of one feature) /B/ and /C/ have a distance of two (difference of two features) and /A/ and /C/ also have a distance of two. Hence, in the current proposal, we show that neighbours could be restricted in chain shifts by integrating a basic aspect of chain shifts, i.e. in a chain where the points are /A/, /B/ and /C/, the elements on both sides of the chain become relevant. Hence it is proposed that the neighbours be evaluated with the tool of ‘feature distance’. This tool of feature distance evaluates distances in such a way that the minimum segment distance will always be the difference in the shared features. Henceforth, we propose that:

(21) Include as neighbour only those candidates which are within the distance $d$.

In the present proposal, neighbours need to be evaluated from the feature composition of the candidates, not by a blind reference to the number of violations of the Markedness constraint. As is well known, a chain shift reaction takes place in a chain where /A/ → /B/ → /C/ in a chain. In a chain shift, the fell-swoop mapping from /A/ → /C/ is avoided unlike in other DEE patterns (like Campidinian Sardinian). If this property is prioritized then we may have successful analyses of contrast preservation.

Neighbours cannot be selected by incurring one violation of a Markedness constraint *X. It has to be ensured that the neighbours for B belong to the chain. The locus of violation cannot be determined by the Markedness constraint *X. This seems to be the primary problem faced by the neighbours model in analyzing a chain shift. The solution offered here deems it necessary to refer to the elements which link the segmental inventory. The feature chain in discussion can also receive interpretation
as a chain of constraint violations whose motivations are derived from cross-linguistic factors but whose ranking may be language-dependent.

Constraining neighbours is inherently restricted as a result of the properties of this chain and cannot be determined by arbitrary references to the number of violations of Faithfulness and Markedness constraints. This tool of feature distance evaluates distances in such a way that the minimum difference must be at least the number of unshared features, such as Advanced Tongue Root for vowels or [±continuant] in consonants. In other words, the minimum segment distance will always be the difference in the shared features. For example, for vowel height and ATR, the distance between /ɔ/ and /u/ will be 2 with regard to High and ATR. In the charts below, feature distances are being considered and it is shown that the maximum distance is \( \leq 2 \).

(22) Feature distance in a vowel (\( ɔ \rightarrow o \rightarrow u \)) chain shift

<table>
<thead>
<tr>
<th></th>
<th>ɔ</th>
<th>o</th>
<th>u</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>ATR</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Distance</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

(23) Feature distance in a consonant (\( p \rightarrow b \rightarrow \beta \)) chain shift

<table>
<thead>
<tr>
<th></th>
<th>p</th>
<th>b</th>
<th>( \beta )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuant</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Voice</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Distance</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

As a result, the range of distances possible will be restricted to a minimum of 0 if all the shared features match and a maximum of 2 if none do. Applying this concept of ‘feature distance’ to the evaluation will ensure that /b̥r̥l̥uki/ is the neighbour for /b̥rl̥uki/ as the distance here can be restricted to 1. Recall that without this option we could not determine the appropriate neighbours in (20).
4.2 Step 3 – distance checking
To implement the tool of feature distance, the evaluation needs to perform the final step of distance checking. Therefore, the proposed modification involves the function of a distance checking code which determines neighbours which are within the distance $d$. The distance checking code will check if the distance $d$ is less than or equal to one. In order to take up the algorithm from Step 2 in (20) where /burluki/ was selected as one of the neighbours, we proceed with Step 3 in this new version of the algorithm:

Step 3: If the base did map to a fully-faithful candidate in step 1), inspect the violations of step 1’s losing candidates, and include as neighbours all the forms which: a) Select as neighbour the candidate with the MD (Minimum Distance) 1 from the base word’s feature values. Or (b) are otherwise most harmonic (i.e. most faithful).

Recall that /burluki/ was selected as a result of the evaluation till step 2. The final step in 3 (distance checking) will inspect the violations and determine the number of violations incurred in relation to the feature values of the base. After this check, /borloki/ is returned as the neighbour because its distance is less than 1.

The distance checking code will ensure that candidates like /burluki/ are not the neighbours produced as a result of the evaluation. The final checking will eliminate the results of step 2. Furthermore, distance checking has to reevaluate all the steps again, so that /borluki/ is selected as a neighbour. Given this parameter, only /borluki/ can be selected as a neighbour by this algorithm. Thus, as a result of the final distance checking step we arrive at a properly functioning algorithm which selects the relevant neighbours. This is shown below:

$$(24) \quad \text{Base} \quad \text{Neighbour1} \quad \text{Neighbour2}$$

$$/borloki/_{N_1} \quad /borloki/_{B} \quad /borluki/_{N_2}$$
(25) Full chain shift effect in SCB

<table>
<thead>
<tr>
<th>/borloki/<em>{N1} /bɔrlɔki/</em>{B} /borluki/_{N2}</th>
<th>PC [ATR]</th>
<th>AGREE [+High +ATR]</th>
<th>IDENT [±High]</th>
<th>IDENT [±ATR]</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) /borloki/<em>{N1} /bɔrlɔki/</em>{B} /borluki/_{N2}</td>
<td></td>
<td>*<em>!</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii) /bɔrlɔki/<em>{N1} /bɔrlɔki/</em>{B} /bɔrluki/_{N2}</td>
<td>*!</td>
<td>*****</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| (iii) /ɔɾlɔki/_{N1} /bɔrlɔki/_{B} /borluki/_{N2} | ** | * | * | *

Some of the plausible candidates are shown above in (25). High-ranking PC[ATR] rules out fully faithful candidates; Preserve [ATR] rules out the merger of the base’s /ɔ/ with /o/ (candidate ii). The candidate in (25iii) incurs less violations of AGREE but those violations are not that costly as they are lower ranked than IDENT and hence (25iii) emerges as the optimal candidate.

Considering the whole cluster and neighbours *ala* Tessier as shown above displays how the high ranking PC[ATR] and AGREE constraints can predict the correct cluster in (25iii). Thus the CB instance shows how distance checking can be the only way of accounting for contrast preservation in counterfeeding opacity.

Distance checking will also result in the right neighbours in the analysis of DEEs like Campidinian Sardinian. In Campidinian Sardinian /sabia/ → [saβia], but the base does not map to [sapia]. The b→β mapping and selection of the neighbor [saβia] for the base [sabia] is the correct analysis as shown in Tessier (2007). Distance checking also predicts the same result. This is borne out by the table in (23) where it is shown that the b→β alternation has a MD < 1.

4.3 Conclusion

In this paper I have argued that Contrast Preservation with Neighbours needs the attribute of ‘feature distance’ to be built into the proposal so as to account for iterativity in chain shifts. This attribute can factor out irrelevant Neighbours in chain shifts, but at the same time it can also predict the right neighbours. The CP model where Scenarios are crucial
for the evaluation leads to a procedure with irrelevant input-output pairs. On the other hand, a Neighbours model without a distance checking procedure can yield neighbours which incur multiple violations of a Markedness constraint prohibiting such Neighbours from participating in the algorithm. Hence this paper successfully establishes that the distance between segments in an inventory is important in the CP approach towards the analysis chain shifts.

REFERENCES


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